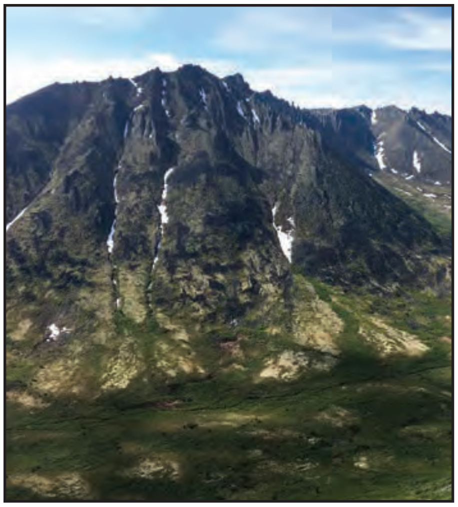
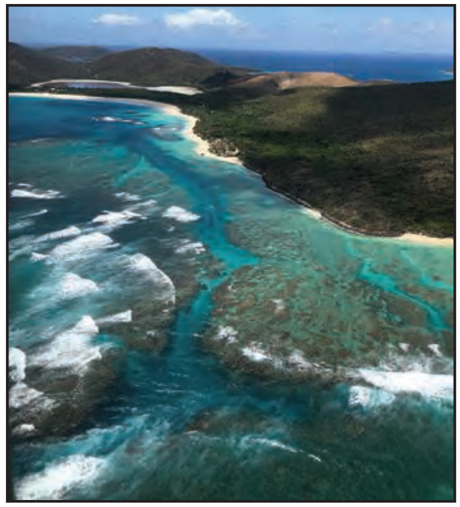
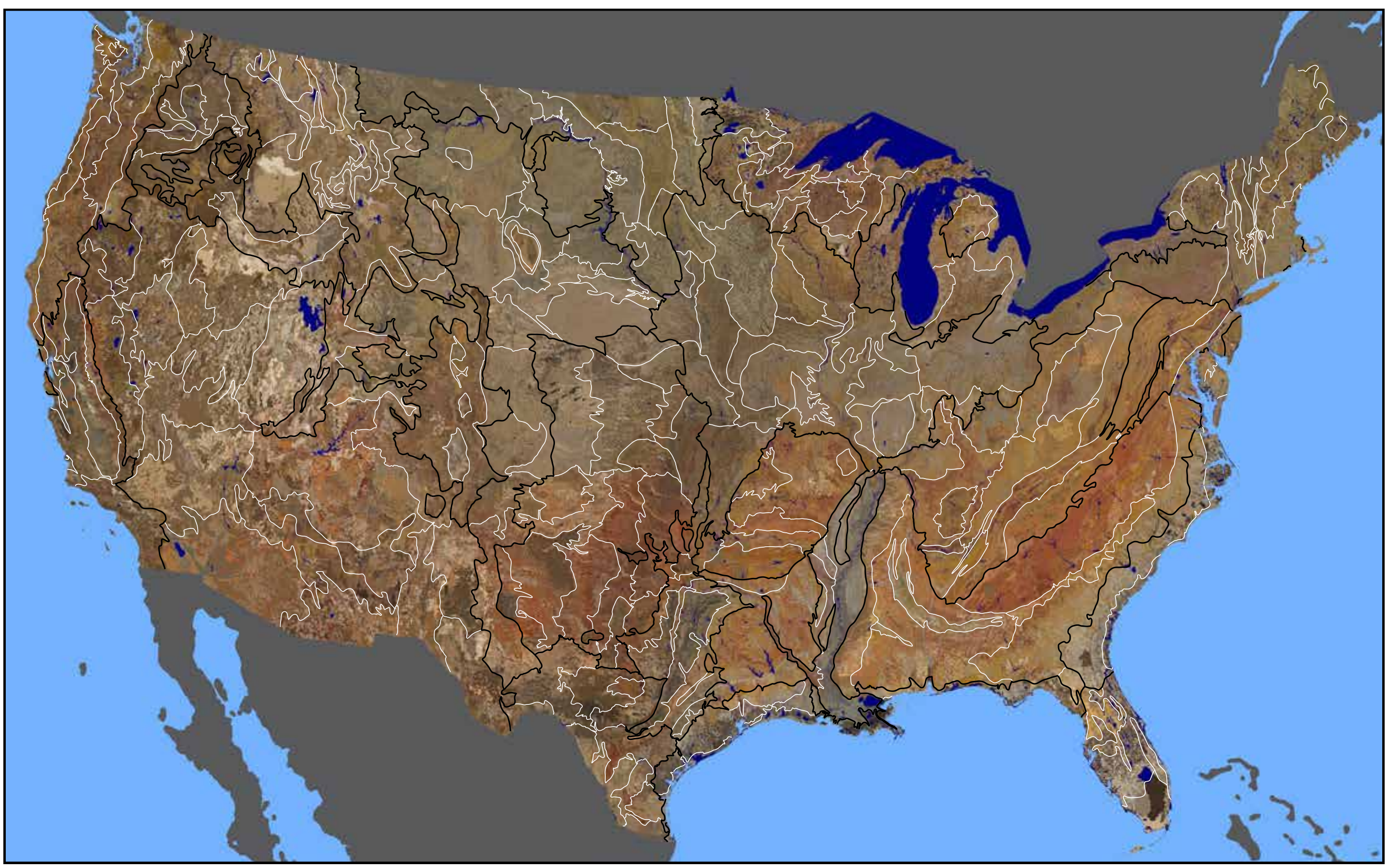
USDA Natural Resources Conservation Service
U.S. DEPARTMENT OF AGRICULTURE

Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin

United States Department of Agriculture, Agriculture Handbook 296



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United States Department of Agriculture,
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Issued May 2022

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Inside cover: Upper left—A landscape in Interior Alaska (Land Resource Region X1). Upper middle— A landscape in the Caribbean Region (Land Resource Region Z). Upper right—A landscape in Hawaii Region (Land Resource Region V). Bottom—Map of actual soil colors at a depth of 75 centimeters overlain by the boundaries of land resource regions (black lines) and major land resource areas (white lines) for the conterminous United States.

Additional imagery: Photographs and block diagrams for many of the areas described in this document are available at the website of the National Soil Survey Center (https://www.nrcs.usda.gov/wps/portal/nrcs/site/soils/home/). Search for "Major Land Resource Area" on the site.

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Preface

Natural vegetation is a result of the combination of geography, soils, and climate. Ancient peoples learned that soils that produced grass and trees could also produce grain, fruits, and vegetables. Soil scientists recognized these relationships. Some of their earliest publications included a description of the climate and vegetation (or crop types) typical for particular soils, for example, “Chestnut soils of the temperate to cool semiarid regions of grain and cattle grazing.” Different social, economic, and political cultures can be considered outgrowths of the various types of soils, crops, and climate that occur in different regions. For example, the lives of cattle ranchers in western South Dakota are in sharp contrast to the lives of potato farmers in northern Maine.

Early farmers and ranchers realized that different soils and climates determined the types of crops they could economically produce. Terms such as “Corn Belt” and “Cotton Belt” were coined because of the crops typically grown by pioneering settlers in certain areas. These areas were essentially the original versions of land resource areas. As soil mapping progressed across the country, soil scientists worked with other natural resource managers to subdivide land into resource units with similar soils, climate, and vegetation or crop types. As a result, a few soil scientists and natural resource planners were able to provide useful soil interpretations and soil conservation recommendations to many landowners in a region instead of just a few individuals.

The first edition of Agriculture Handbook 296 was published in 1965. It presented subdivisions of the United States as several land resource regions made up of many major land resource areas. Because each land resource region had similar climate, soils, and land use activities, natural resource planners could target efforts in education and financial and technical assistance on a regional basis. Agriculture Handbook 296 was used in making decisions about regional and national agriculture and helped to identify the need for research and resource inventories. It became the vehicle for applying research results across political boundaries. It also became the basis for organizing and operating natural resource conservation programs.

Acknowledgements

More than 200 soil scientists, ecologists, GIS specialists, data quality specialists, and editors contributed directly to the data presented in this volume. Staff at the National Soil Survey Center, the regional update leaders (points of contact), and the regional directors involved in the production of this volume are listed below. Others that provided detailed knowledge about physiography, geology, climate, water resources, soils, or biological resources; land use data; imagery; and the central concepts and nature of boundaries are listed alphabetically under Contributors.

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Introduction

United States Department of Agriculture Handbook 296 is a broadscale synthesis of current knowledge about land areas based on patterns of physiography, geology, climate, water resources, soils, biological resources, and land use (Austin, 1965). These patterns were used to establish the unique central concept and boundaries for each land resource region (LRR) and major land resource area (MLRA). This handbook is designed primarily for use in developing soil and water conservation programs at the continental scale (using the LRR concept) and the inter-State scale (using the MLRA concept).

The LRR is the highest level of a hierarchal segmentation of land areas of the United States and its territories (National Soil Survey Handbook, Part 649). Because of their large size, LRRs are delineated at a scale of 1:7,500,000 for the conterminous United States and Alaska and at a scale of 1:1,000,000 for the islands (see accompanying LRR-MLRA map). There are 28 LRRs: 20 in the conterminous United States, 5 in Alaska, and 1 each for Hawaii, the Caribbean, and the Pacific Basin Islands. The largest LRR is “D,” which consists of 1,420,100 square kilometers (548,305 square miles) (fig. 1). The smallest is “Q” (the Pacific Basin Islands), which consists of 2,295 square kilometers (885 square miles).

The MLRA is the second-level hierarchal segmentation of land areas of the United States. MLRAs are delineated at scales of 1:7,500,000 to 1:1,000,000 (see accompanying LRR-MLRA map) and are useful for State-wide, inter-State, and regional planning. There are 267 MLRAs, ranging in size from MLRA 35 (Colorado Plateau), which consists of 181,855 square kilometers (70,215 square miles), to MLRA 196 (Coral Atolls of Micronesia), which consists of 11 square kilometers (3 square miles).

This edition of the handbook is designed for publication in traditional book form, for the purposes of longevity and conciseness, as well as in an electronic form available online. Future iterations should become more frequent and easier as the hierarchy system becomes digitized in a database format. For the current edition, the linework is digitally available on the Geospatial Data Gateway with tabular data linked to other databases, such as the National Soil Information System (NASIS) and the Ecosystem Dynamics Interpretive Tool (EDIT).

The three previous editions of Agriculture Handbook 296 were published in 1965, 1981, and 2006. The 1965 edition evolved from the 1950 map entitled “Problem Areas in Soil Conservation” (Austin, 1965). It was designed primarily for use by the Soil Conservation Service. This edition presented 20 LRRs that were labeled from northwest to southeast using letters, beginning with “A” for the Pacific Northwest and ending with “U” for Florida. It presented 156 MLRAs that were numbered consecutively, beginning with “1” in the Northern Pacific Coast Range and ending with “156” in the Florida Everglades. Concepts for LRRs and MLRAs were based on the combination of five factors: (1) land use, (2) elevation and topography, (3) climate, (4) water, and (5) soil.

The 1981 edition expanded LRR descriptions to include Hawaii (LRR V) and Alaska (LRRs W, X, Y). New MLRAs were created from subdivisions of the original 156 MLRAs and identified by symbols that included a letter. For example, MLRA 58 was subdivided into four new MLRAs: 58A, 58B, 58C, and 58D. In the second edition, MLRA concepts were based on the original five factors as well as a sixth factor: potential natural vegetation.

The 2006 edition added LRR Q (the Pacific Basin Islands) and included additional LRRs for Alaska (W1, W2, X1, X2), designated by both a letter and a number because all the letters in the alphabet were already used. New MLRAs were again created by subdivision of previous MLRAs and labeled with a letter added to the number. This edition contained 278 MLRAs. Two notable developments in this edition were the addition of geology as a factor in the MLRA concept and the reordering of the factors. Land use, for example, which was listed first in both the 1965 and 1981 editions, was now listed seventh.

LRR and MLRA concepts are similar but not identical to the Environmental Protection Agency (EPA) ecoregions and the Forest Service (USFS) ecological units (Omernik, 1987; US EPA, 2003; Cleland et al., 2005; McNab et al., 2005). The purpose of the LRR and MLRA concepts is to provide the knowledge needed to make decisions about national and regional agricultural concerns, provide a basis for resource inventories and extrapolating research results, and serve as a framework for organizing and operating soil surveys and resource conservation programs. The purpose of the EPA’s ecoregion concept is to provide a spatial framework for assessing and regulating surface water quality, facilitating ecosystem management, and increasing environmental understanding. The concept of the Forest Service’s ecological unit is a scale-based, nested hierarchy in which progressively more specific ecological units are developed as a vegetation classification system (Salley et al., 2016a). Significant overlap, however, occurs between NRCS mapping, which focuses on soil properties, and Forest Service mapping, which focuses on the Terrestrial Ecological Unit Inventory (TEUI) that distinguishes units based on geology, climate, soils, hydrology, and vegetation (USFS, 2005). Both systems involve mapping at multiple spatial scales for inventory and land use planning.

In this edition of the handbook, a location map is provided for each LRR and MLRA. Descriptions of the central concept, boundaries, climate, soils, and land use are provided for each LRR. In addition to the central concept and the boundaries, the MLRA descriptions provide a summary of physiography, geology, climate, water, soils, biological resources, and land use. Information for the central concepts and the physiography section is based mainly on Fenneman and Johnson (1946), Wahrhaftig (1965), Thornbury (1965), and Hunt (1967). Information on bedrock and surficial geology for each MLRA was derived from a wide variety of State and Federal maps and reports. Information on climate, water, soils, biological resources, and land use are based on sources listed in the reference section.

This update of Agriculture Handbook 296 was driven by the need to improve the usability of the land resource hierarchy system so that a more consistent application of soil-ecological-landscape concepts could provide more accurate and efficient application of conservation on the ground. It involved innovations to the current system through incorporation of updated climate, elevation, soil, and land use data and improvement in linework accuracy based on advances in remote sensing and geographic information systems (GIS). The update has also been driven by the need to fit ecological sites into the hierarchy of LRRs, MLRAs, and LRUs (land resource units) (Salley et al., 2016b). This edition retains the labeling convention of the three previous versions because: (1) the current names are familiar to practitioners working with MLRAs, (2) retaining the labels does not necessitate extensive changes in the databases, and (3) the labeling convention provides a straightforward method for creating new MLRAs by subdividing existing ones or recombining smaller ones that are more appropriate as land resource units back into a larger MLRA (National Soil Survey Handbook, Part 649).

Land resource units generally are several thousand acres in size and are the basic units from which MLRAs are determined. LRUs are typically, but not necessarily, coextensive with State general soil map units. Being too numerous and too small to be designated at a scale of 1:7.5 million, LRUs are not listed and described in this publication. They are mentioned here, however, because of their importance in providing a structured framework for soil survey projects, developing ecological site descriptions (ESDs), and facilitating correlation, especially in the West. Beginning in 2005, LRUs were temporarily designated as common resource areas (CRAs) within NRCS.

Climate is one of the seven factors that determine the LRR and MLRA boundaries. As climate is changing (IPCC, 2018), many boundaries will shift, particularly those separating the shrublands and grasslands, the grasslands and woodlands, and the woodlands and forests. In humid regions, the thermic boundary and its associated species will continue expanding at the expense of the mesic temperature regime, the mesic at the expense of the frigid, and the frigid at the expense of the cryic. This edition of Agriculture Handbook 296, along with its predecessors, can serve as baseline data for future generations to assess the degree of environmental change and need for adaptive strategies.

Changes in This Edition

Line Adjustments

Modifications to cartographic boundaries were made to accommodate new ideas or changes to the LRR or MLRA concepts that arose from issues in the usability, consistency, or ambiguity of older concepts. Changes to the boundaries of LRRs and MLRAs involved modifications by NRCS staff serving as points of contact (POCs), as assigned by the directors of the 13 soil survey regions. The POCs worked on the line adjustments with field soil scientists, ecological site specialists, State soil scientists, conservationists, and other cooperators within the National Cooperative Soil Survey. Line changes were submitted to the GIS specialist at the National Soil Survey Center, who then created a national map. The national map was then sent back to the POCs for assessment. Several iterations of this process took place. The POCs and their associates also updated the narratives.

The accompanying fold-out map was made by overlaying the LRR and MLRA linework on a hillshade base map. Colors used to identify the LRR polygons and MLRA symbols were based on standard NRCS base colors. The legend was made with GIS software (i.e., ArcMap) and exported as a SVG (scalable vector graphics) file. The SVG file was imported into open-source vector graphics software (i.e., Inkscape), which was used to create LRR and MLRA titles, symbols, patches, and names.

Line Smoothing

The goal of generalizing the lines was to make them cartographically appropriate at the 1:7,500,000 scale. A smoothing process was applied to the MLRA delineations (which were commonly coincidental with general soil map units) after the revisions were applied to the 2006 edition of the spatial data. The smoothing process eliminated jagged lines and small delineations of outliers, such as isolated mountain peaks, valleys, and coastal islands surrounded by water. For this reason, the reader is cautioned about using these maps for detailed information. The details of these small polygons are available in SSURGO (Soil Survey Geographic Database).

Addition of New MLRAs and Recombination of Small MLRAs

The formation of new MLRAs and the combination of others were a major part of the updating process. The 19 new MLRAs are 42A, 42B, 42C, 44A, 44B, 55D, 56A, 56B, 85A, 85B, 91, 95, 102D, 107, 108, 111, 114, 115, and 133C. In addition, MLRA 95 was moved from LRR K to LRR L. Recombined small MLRAs, which will be labeled "obsolete" in the NASIS database, include 20, 31, 42, 44, 56, 70C, 70D, 85, 91A, 91B, 95A, 95B, 102B, 107A, 107B, 108A, 108B, 108C, 108D, 111A, 111B, 111C, 111D, 111E, 114A, 114B, 115A, 115B, 115C, 221, and 235.

Central Concepts and Boundaries

The core idea and nature of boundaries are described for each LRR and MLRA. Other changes to the narrative include the addition of tables showing the extent of the MLRAs. Information on cities, highways, parks, and national forests was removed except where it added to the understanding of the central concept and boundaries. Also removed were data on withdrawals of freshwater and the parts per million of total dissolved solids. For this data, the reader can refer to U.S. Geological Survey (USGS) reports. The section on soils now presents information on the main series and their classification as lists rather than in narrative form.

Thematic Maps of Soil Properties

Maps of soil properties, such as argillic horizons and restrictive layers, have been added to elucidate LRR and MLRA boundaries and provide visual information for continental-scale interpretations. These soil property maps, as well as climate and land use maps, make up figures 1 to 15. They are based on SSURGO data, and, where SSURGO data are unavailable, the STATSGO2 (State Soil Geographic) database. The maps were made by querying component diagnostic features, diagnostic horizons, and taxonomic class in Soil Data Access. By using different queries, it was possible to extract features that were otherwise missed by using one query alone due to inconsistent data population. For example, plinthite might not be populated as a component diagnostic feature, but a search for "plin*" in the taxonomic subgroup would reveal its presence.

Tables

MLRA data on size, elevation, temperature, freeze-free periods, and precipitation were added to each LRR section. The elevation tables provide information in both meters and feet on the low, the 10th, 50th, and 90th percentiles, and the high. Elevation is overgeneralized by the tables for mountainous regions with narrow canyons and mountain peaks and for low-relief areas with quarries and landfills. In this case, the narrative information provides a more accurate account of the local topographic diversity. Similarly, where climatic data provided by the tables was too coarse to capture the local diversity in mountainous regions, local data provide a more accurate description of rainfall, temperature, and freeze-free days. The tabular data, however, provide more statistical information about range and central tendency. In addition, they provide a database with continental-scale uniformity that is useful for modeling.

Sources of the elevation data for the conterminous United States, Hawaii, Puerto Rico, and the U.S. Virgin Islands are USGS 3D Elevation Program 1/3-arc-second resolution tiles, which represent the best available coast-to-coast raster elevation data for the Nation. For Alaska, small portions of the State only had 1-arc-second resolution data available, which were resampled to 1/3-arc-second. The elevation data were obtained in September and October of 2019, mosaiced for each region into a seamless data set, and projected to a local reference system at 10-meter horizontal resolution. Elevation values are reported from the source in meters. Each MLRA was subset from its source layer, so all pixel values were evaluated for the minimum, the 10th, 50th, 90th, and maximum quantiles, and the mean. These values were converted to feet using meters * 3.28084. The 10th quantile was rounded down to a multiple of 10, and the 90th quantile was rounded up to a multiple of 10. Median and mean were rounded to a multiple of 5. The elevation information for the remaining Pacific Basin territories is the same as that in the 2006 edition of the handbook.

Sources of climatic data are from the Parameter-elevation Regressions on Independent Slopes Model (PRISM) developed by the Spatial Climate Analysis Service at Oregon State University, in cooperation with the NRCS National Water and Climate Center (NWCC). The period of record for the climate normals covered varying dates depending on region. For the conterminous United States and Alaska, the period was 1981-2000; Puerto Rico, 1963-1995; the U.S. Virgin Islands, 1971-2000; and the Pacific Basin Islands, 1971-2000. These data were used to generate mean annual precipitation (MAP) and mean annual air temperature (MAAT) maps for the lower 48 States (figs. 6 and 7) as well as the climate summaries presented in the tables.

Precipitation values are reported from the source as millimeters. Each MLRA was subset from its source layer, so all pixel values were evaluated for the minimum (rounded down to a multiple of 10), the 10th, 50th, 90th, and maximum (rounded up to a multiple of 10) quantiles, and the mean. The untransformed quantiles were converted to inches using mm / 2.54 and were rounded to the nearest integer.

Temperature values are reported from the source as degrees Celsius. Each MLRA was subset from its source layer, so all pixel values were evaluated for the minimum, the 10th, 50th, 90th, and maximum quantiles, and the mean and all were rounded to 0.1 degree Celsius. The quantiles were converted to degrees Fahrenheit using degree Celsius * 1.8 + 32 and were rounded to the nearest integer.

Frost-free day (FFD) estimates were created for the conterminous United States using daily minimum air temperature values (PRISM Group). For each year, and at each pixel, the day of last freezing temperature (0 degrees Celsius) in spring (January to July) and day of first freezing temperature (0 degrees Celsius) in fall (August to December) were calculated. The FFD estimates are based on the number of days between pixel-wise evaluation of the median date of the last frost day in spring and the median date of the first frost day in fall. Each MLRA was subset from its source layer, so all pixel values were evaluated for the minimum, the 10th, 50th, 90th, and maximum quantiles, and the mean for the length of growing season in days.

Land Use Charts

Bar charts are included in the LRR and MLRA descriptions to augment the land use map (fig. 8) and narratives. Most of the categories are self-explanatory (e.g., corn, soybeans, and rice). However, some categories, are not. For example,"Shrubs" contain some woodlands with trees that are taller than 6 feet (e.g., pinyon, juniper, and barberry). Other categories that are not self-explanatory include the following:

Developed, Open Space.—Areas that have a mixture of some constructed materials but are mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of total cover. These areas commonly include large-lot, single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.

Developed, Low Intensity.—Areas that have a mixture of constructed materials and vegetation. Impervious surfaces account for 20 to 49 percent of total cover. These areas commonly include single-family housing units.

Developed, Medium Intensity.—Areas that have a mixture of constructed materials and vegetation. Impervious surfaces account for 50 to 79 percent of the total cover. These areas commonly include single-family housing units.

Developed High Intensity.—Highly developed areas where large populations reside or work. Examples include apartment complexes, row houses, and commercial or industrial areas. Impervious surfaces account for 80 to 100 percent of the total cover.

The sources for land use data are as follows:

Conterminous United States—National Agricultural Statistics Service, 2019
Hawaii—NOAA Coastal Change Analysis Program, 2010-2011
Alaska—USGS LANDFIRE, 2014
Puerto Rico and the U.S. Virgin Islands—NOAA Coastal Change Analysis Program, 2010-2012
Guam, the Northern Mariana Islands, and American Samoa—NOAA Coastal Change Analysis Program, 2004-2016
The Republic of Palau—USFS Land Cover Monitoring, 2005
The Marshall Islands—USFS Land Cover Monitoring, 2008

For each MLRA, the top 10 classes were identified. The classes were sampled using a regular (systematic) method at a density of 0.0005 to 0.005 points per acre. Many MLRAs did not have 10 classes represented. Any class with less than 1 percent of the area was lumped into "Other." Where "Other" classes make up significant proportion, there are numerous classes with less than 1 percent coverage in the MLRA. Efforts were made to keep the colors of the histogram charts the same as the source spatial layer. The colors of the histogram are from the color map of the spatial layer from which they were developed, with the exception of the USFS sourced layers whose colors were matched to the colors in NASS (National Agricultural Statistics Service) and other land use sources.

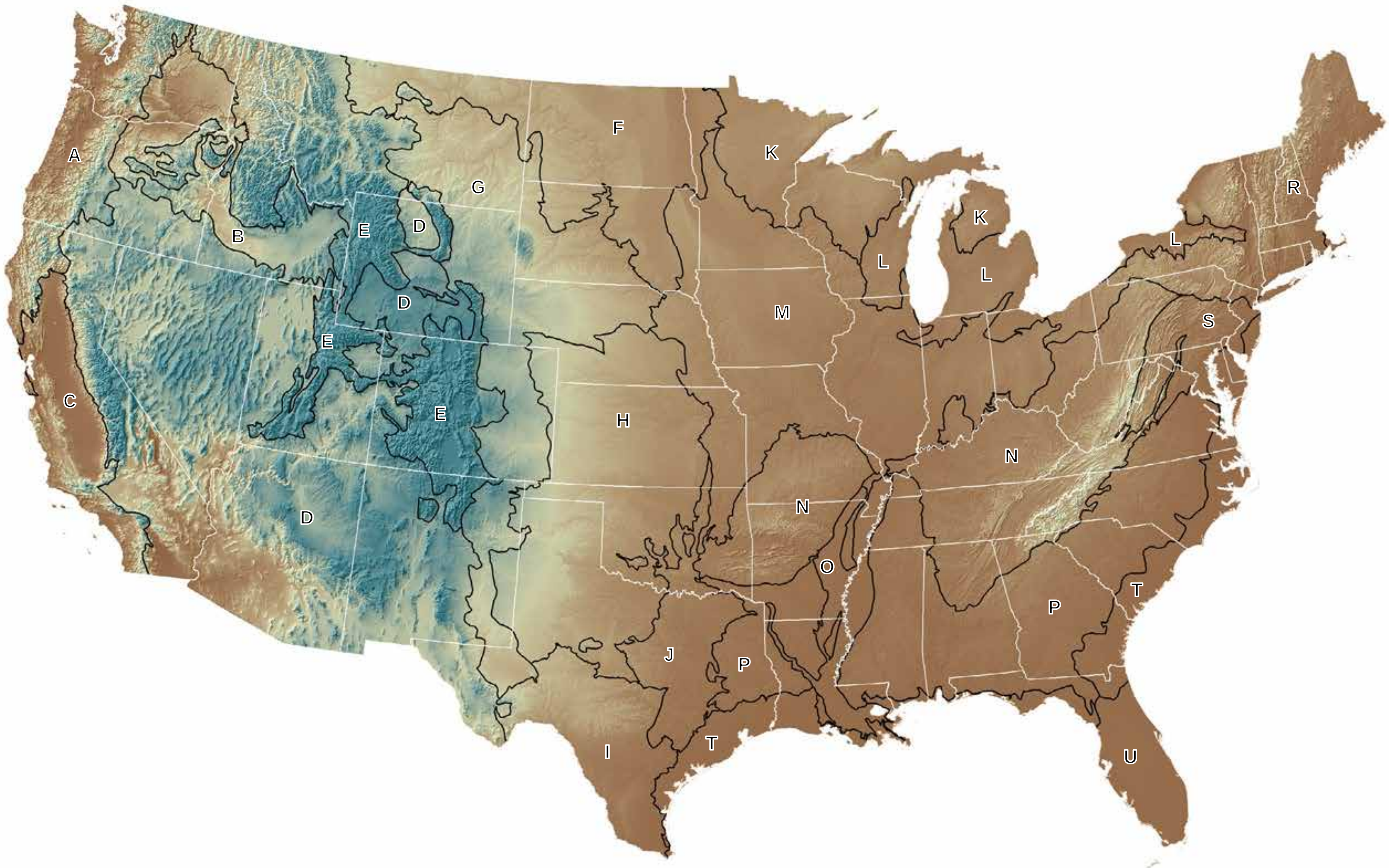

Figure 1: Boundaries of the land resource regions (LRRs) of the conterminous United States (CONUS).

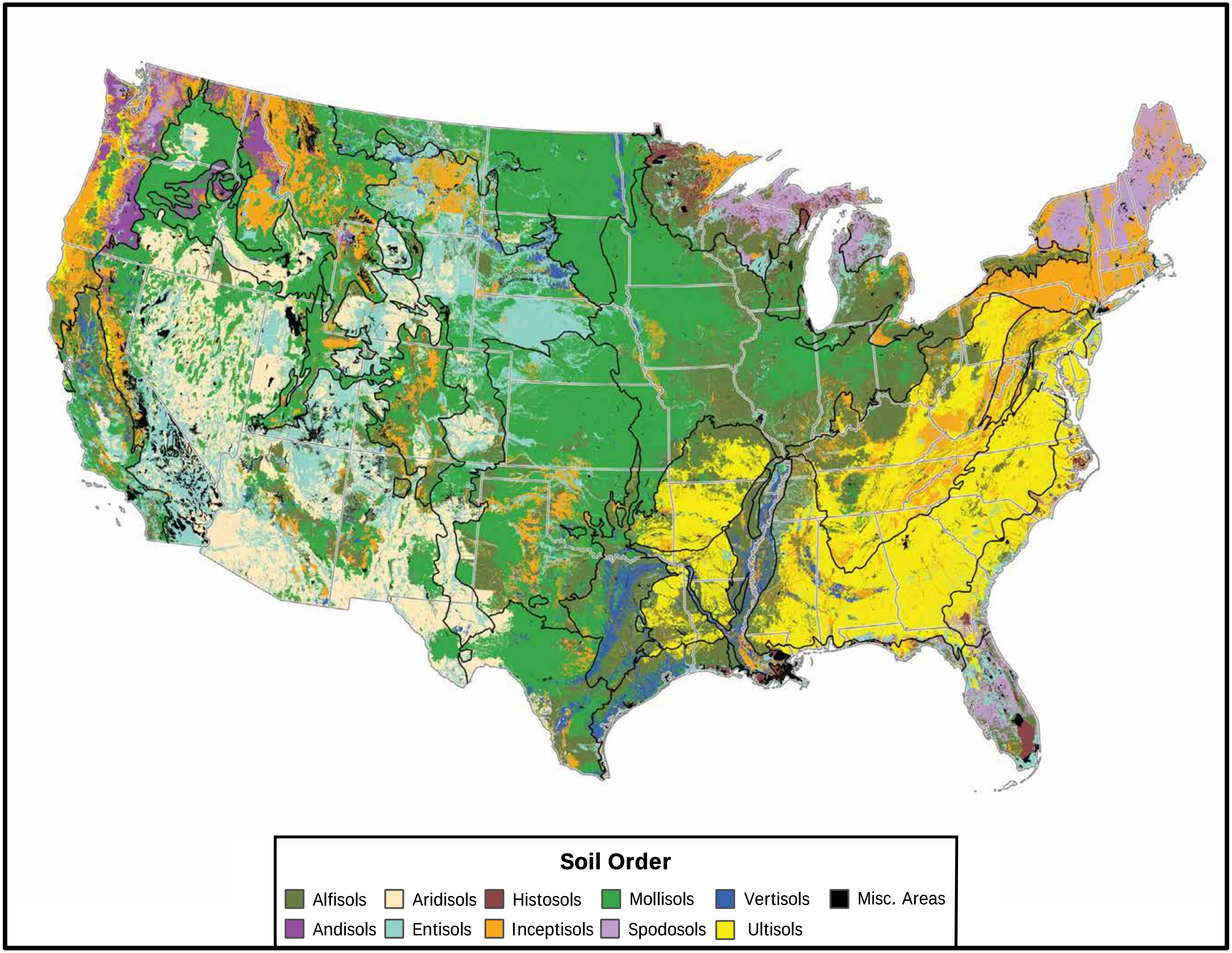

Figure 2: Dominant soil orders of the conterminous United States based on SSURGO and STATSGO2 mapping. LRR boundaries are in black.

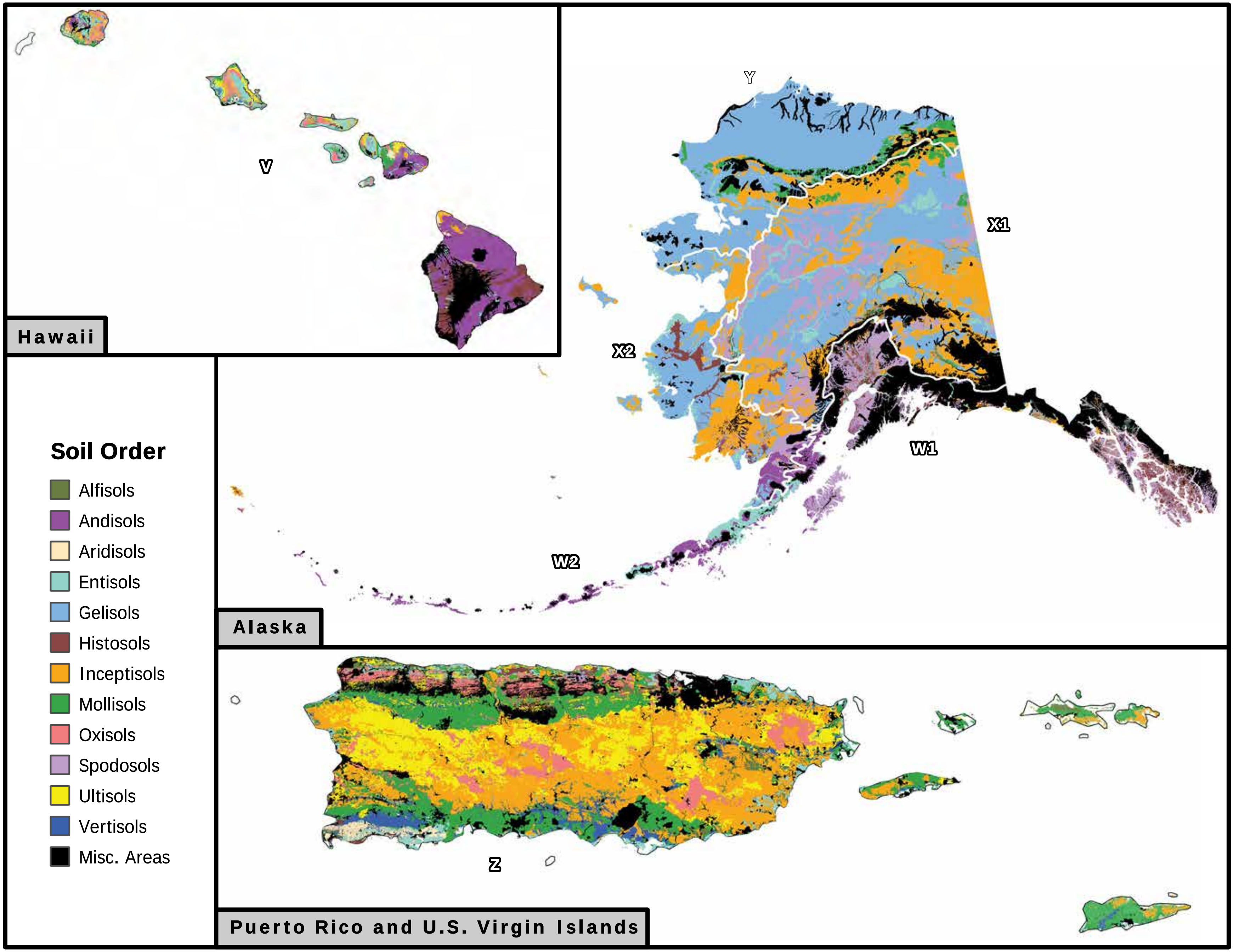

Figure 3: Dominant soil orders of Hawaii, the Caribbean, and Alaska. LRR boundaries are in white.

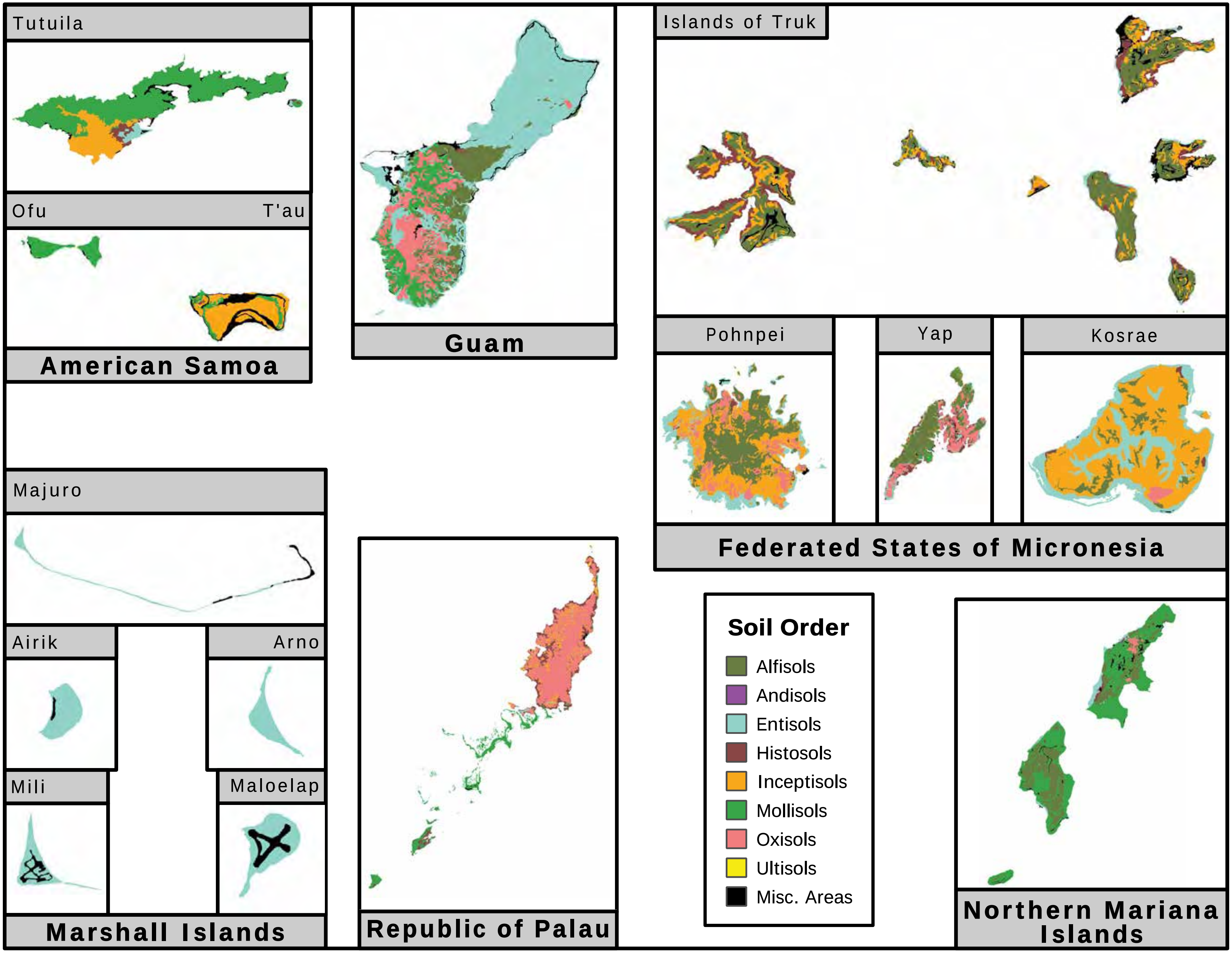

Figure 4: Dominant soil orders of the Pacific Basin Islands (LRR Q).

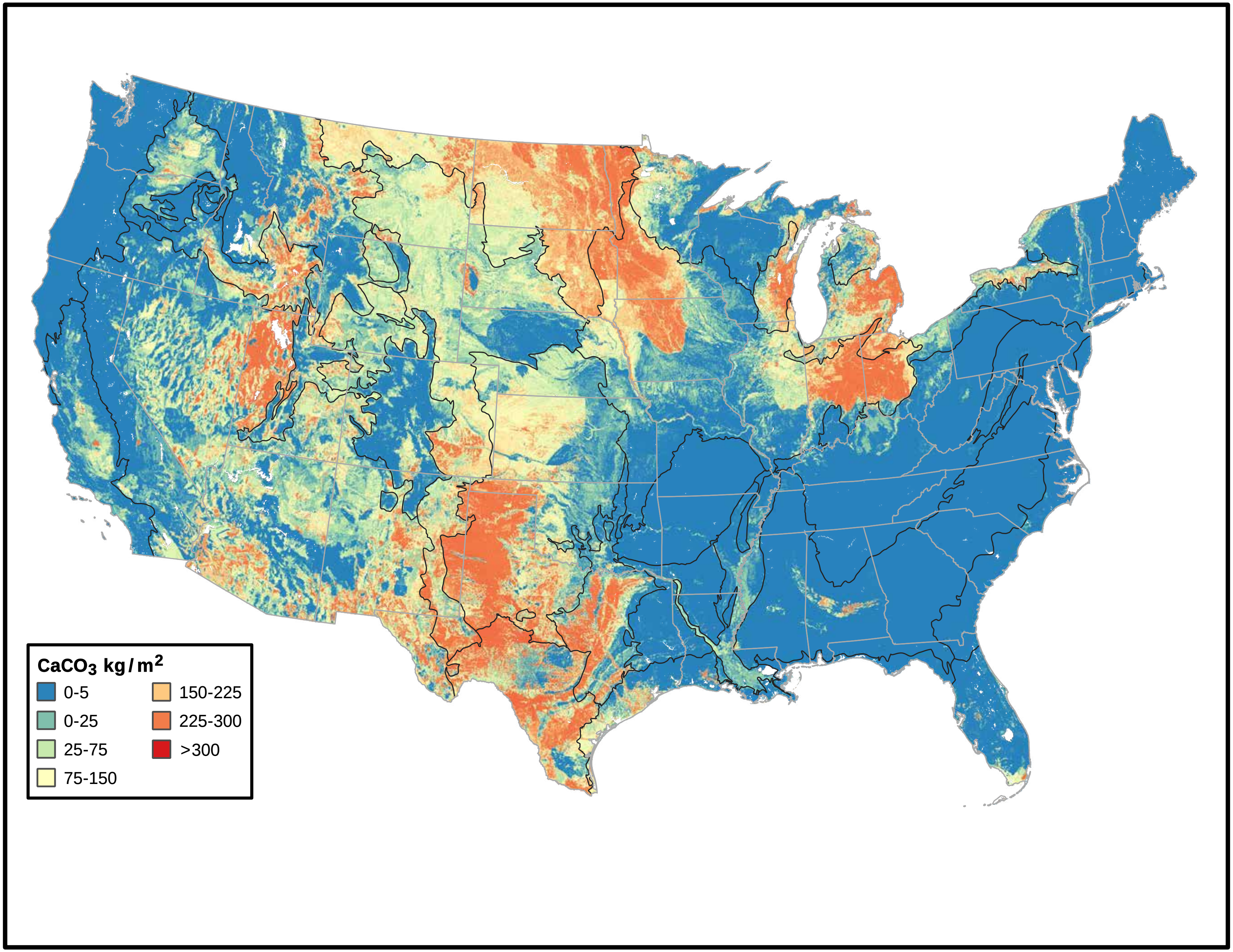

Figure 5: Distribution of soil calcium carbonate in the continental United States.

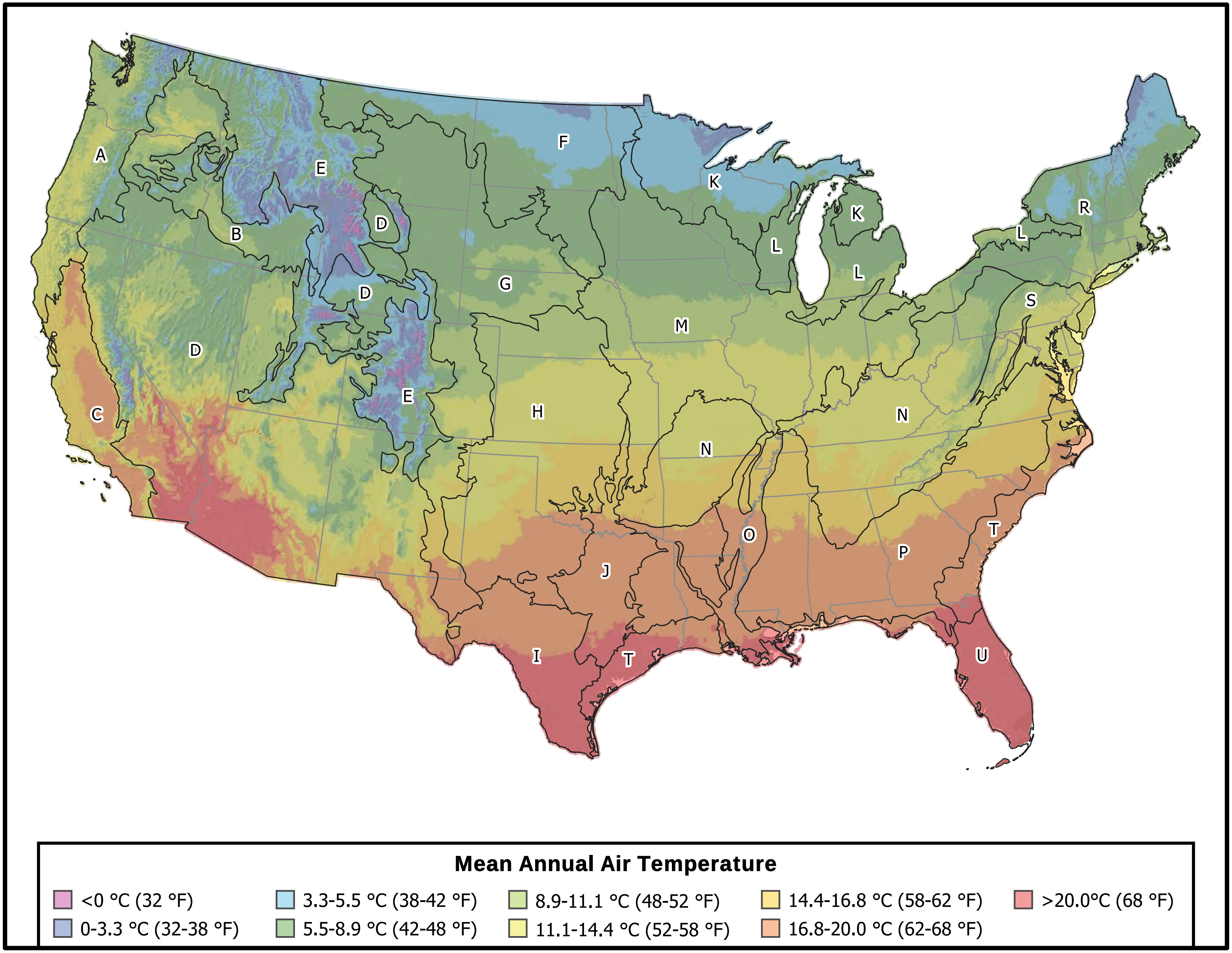

Figure 6: Mean annual air temperature and LRR boundaries of the conterminous United States based on PRISM 1981–2010 data.

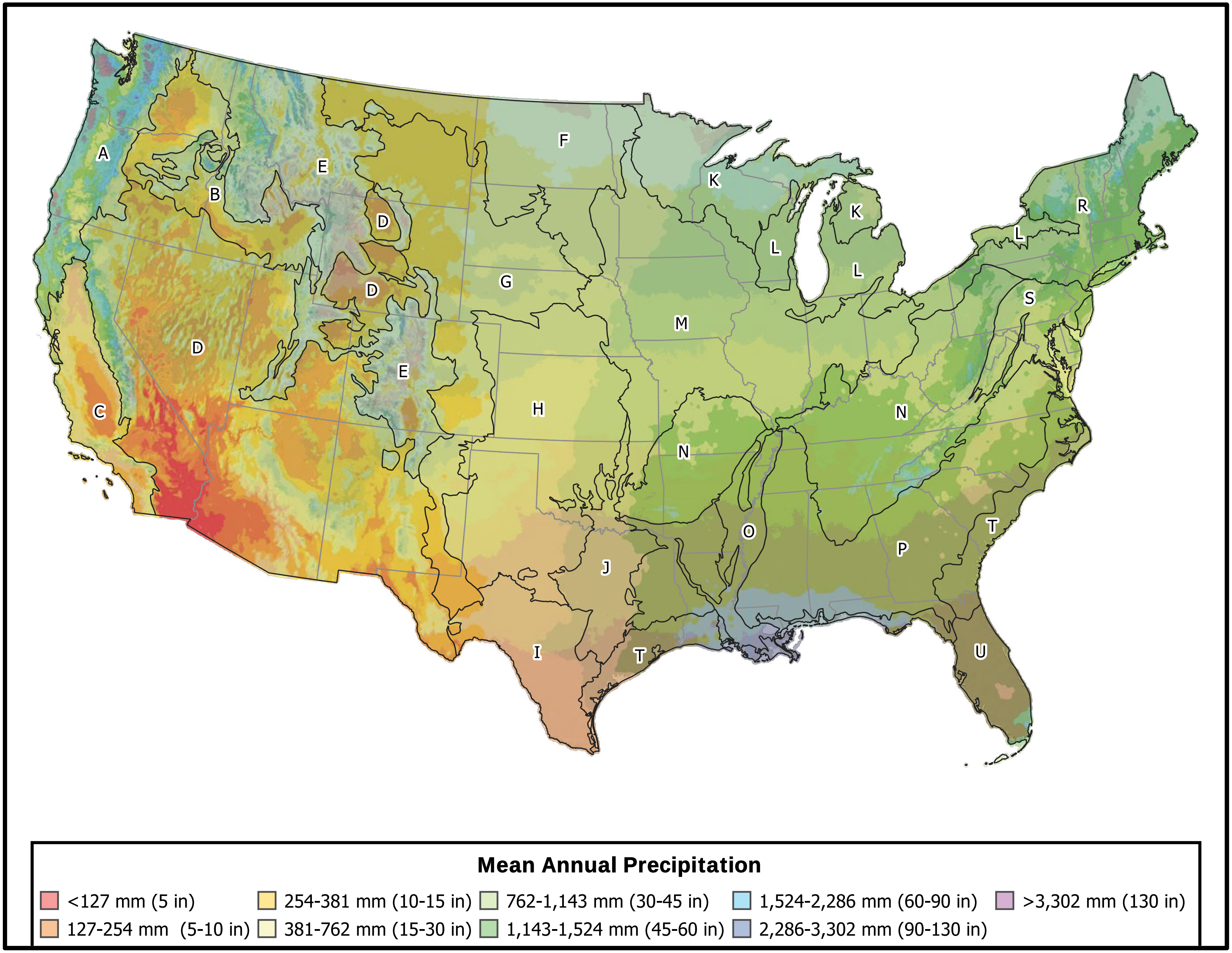

Figure 7: Mean annual precipitation and LRR boundaries of the conterminous United States based on PRISM 1981–2010 data.

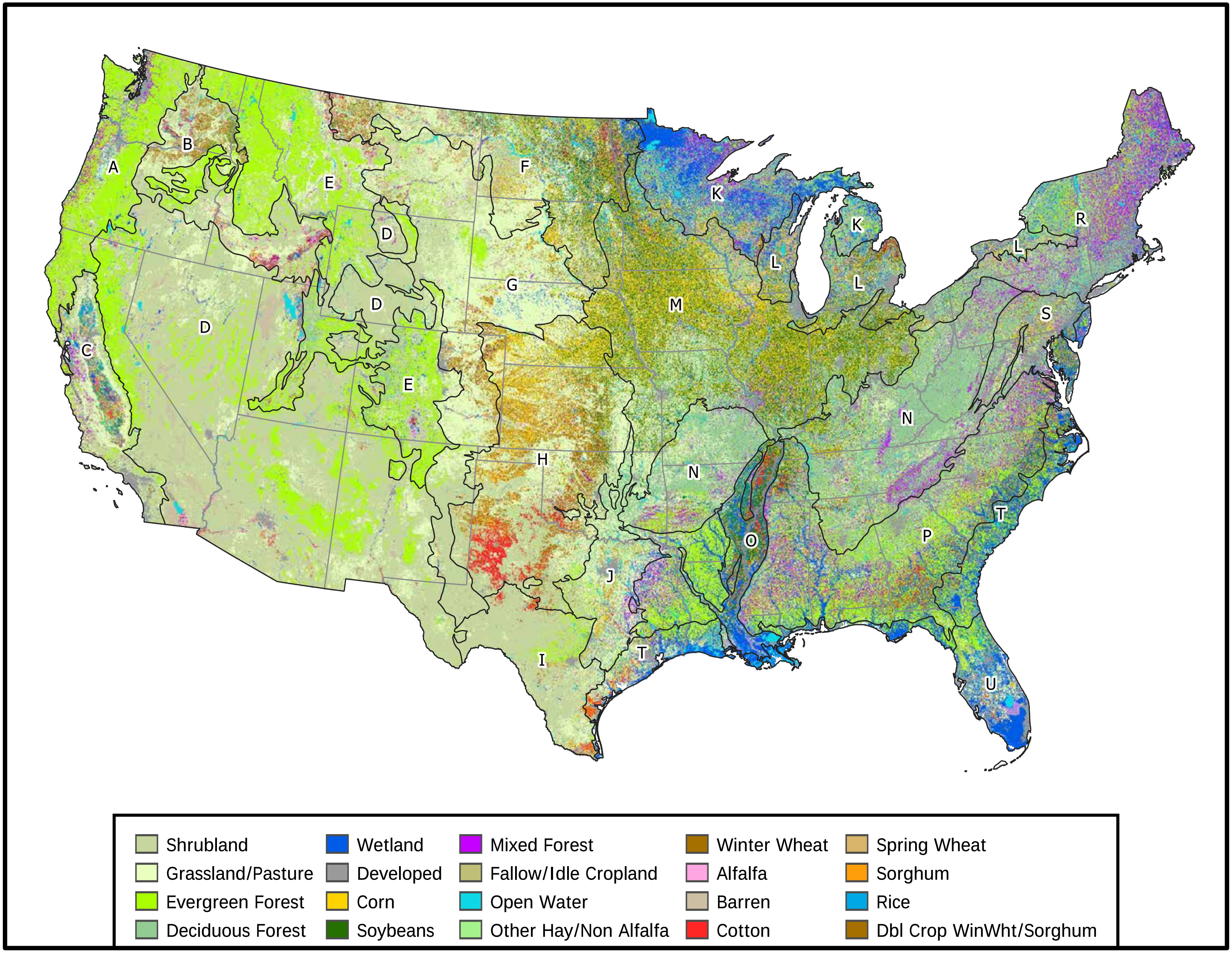

Figure 8: Land use categories and LRR boundaries of the conterminous United States based on 2018 data from the USDA National Agricultural Statistics Service.

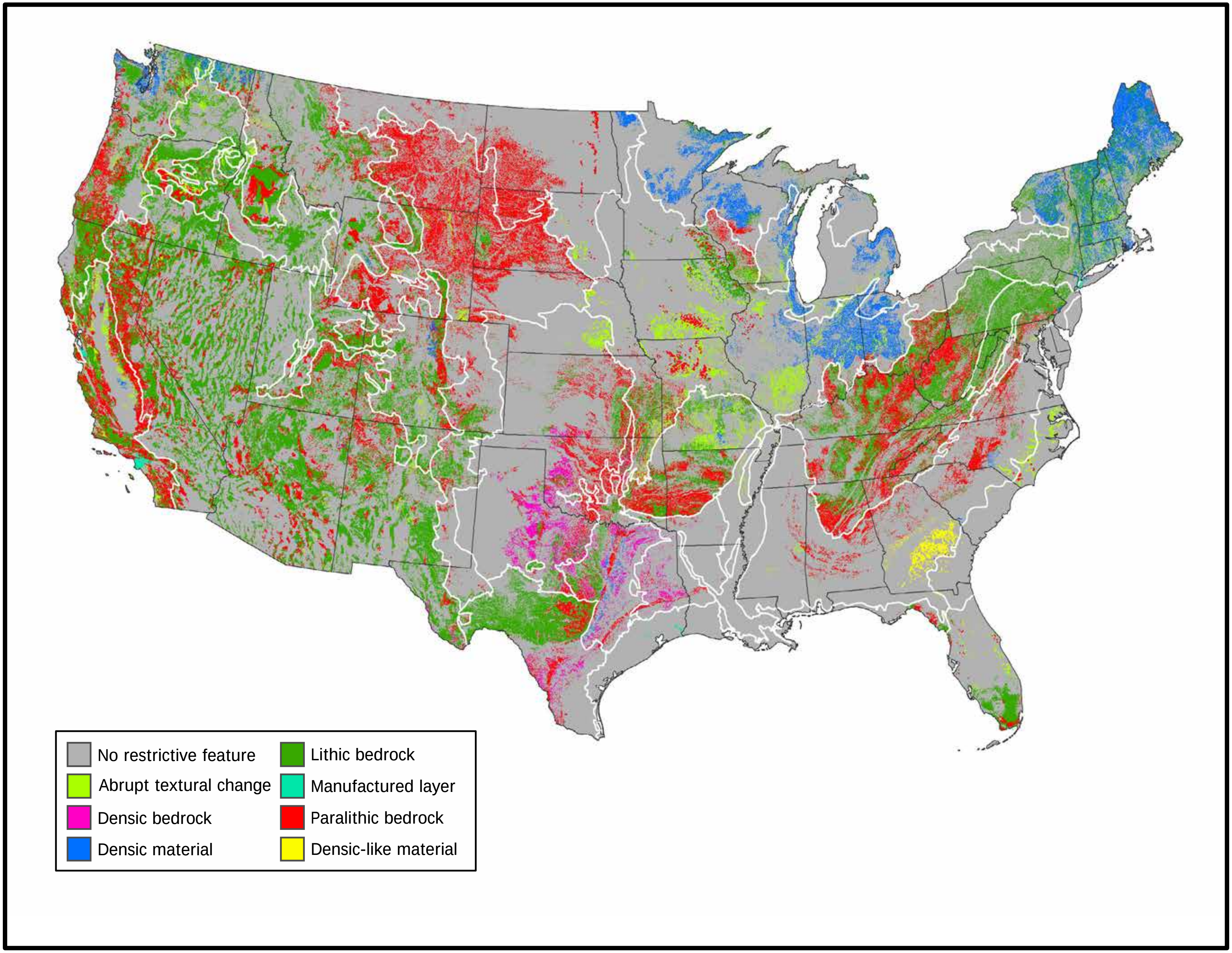

Figure 9: **Geogenic root-restrictive material within 2 meters based on the dominant component's first restrictive feature (if there is more than one). Exceptions include "abrupt textural change," especially in southern Illinois, and "densic-like material" in Georgia that are probably pedogenic. "Densic bedrock" refers to restrictive material from weathered siltstone. Data from NASIS.**

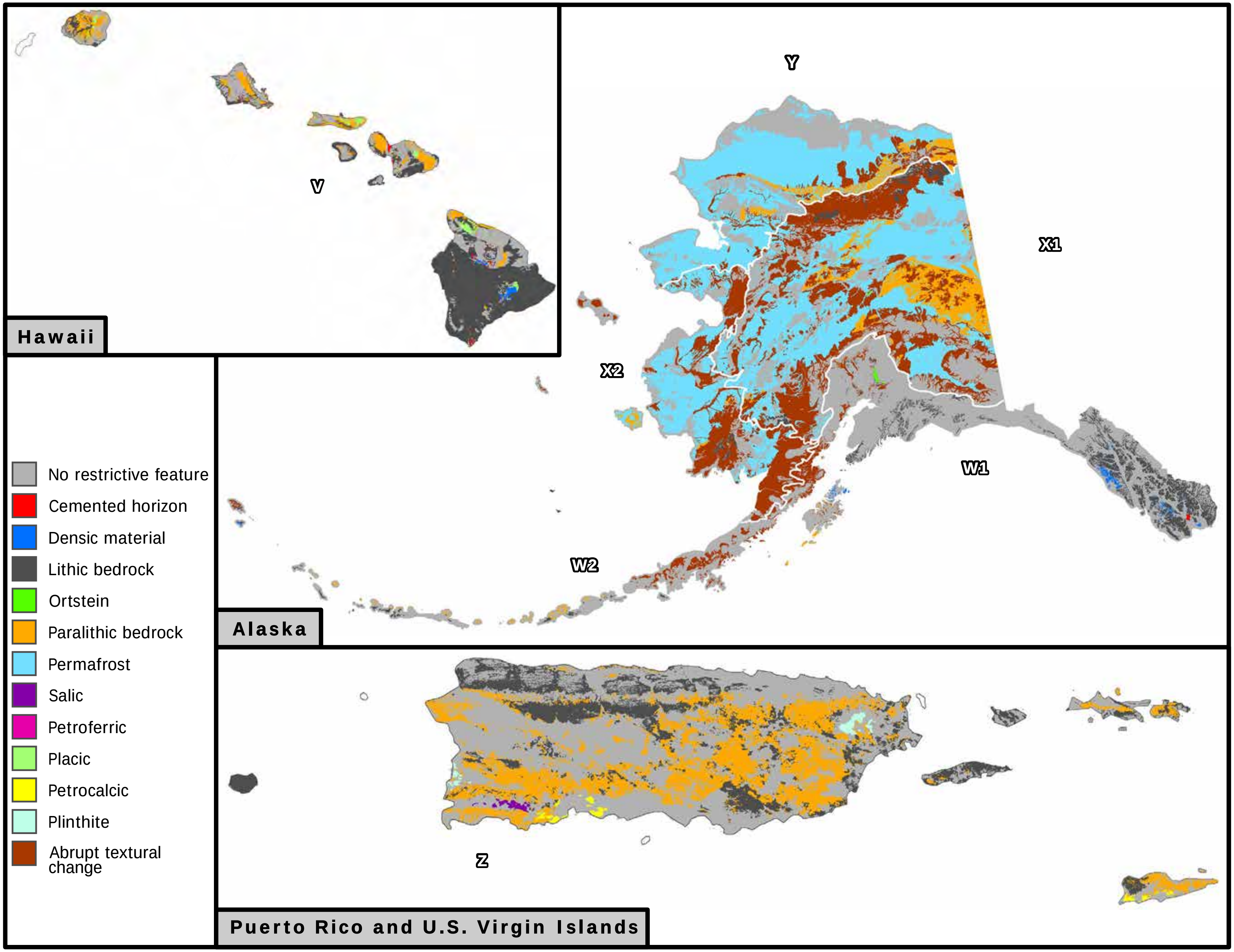

Figure 10: Geogenic and pedogenic root-restrictive material within 2 meters based on the dominant component's first restrictive feature (if there is more than one). "Cemented horizon" refers to cemented earthy material that does not slake in water or meet the criteria for other restrictive types. Other categories are defined in the "Keys to Soil Taxonomy" (2014). Data from NASIS.

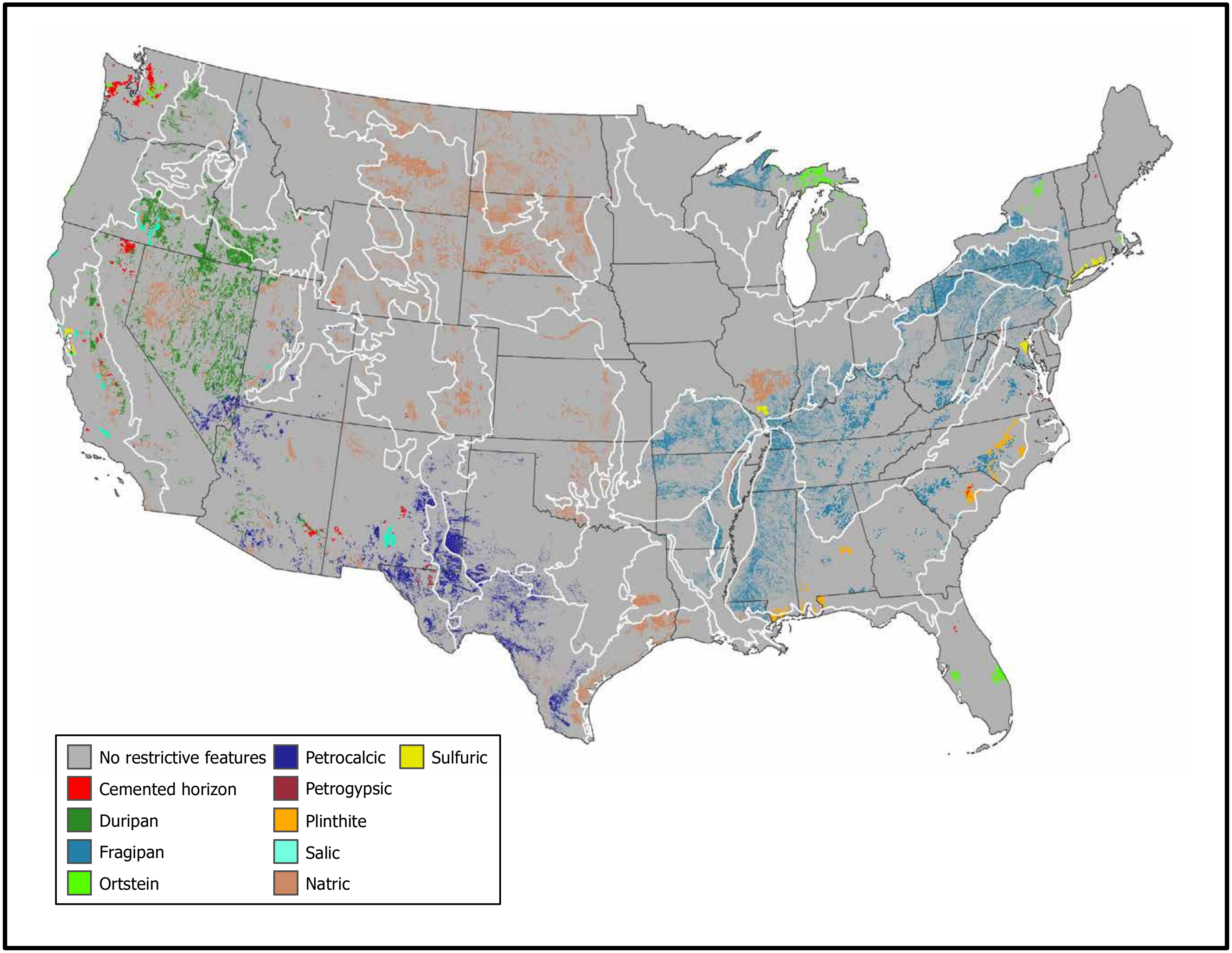

Figure 11: Pedogenic root-restrictive material within 2 meters based on the dominant component's first restrictive feature (if there is more than one). "Cemented horizon" refers to cemented earthy material that does not slake in water or meet the criteria for other restrictive types. Other categories are defined in the "Keys to Soil Taxonomy" (2014). Data from NASIS.

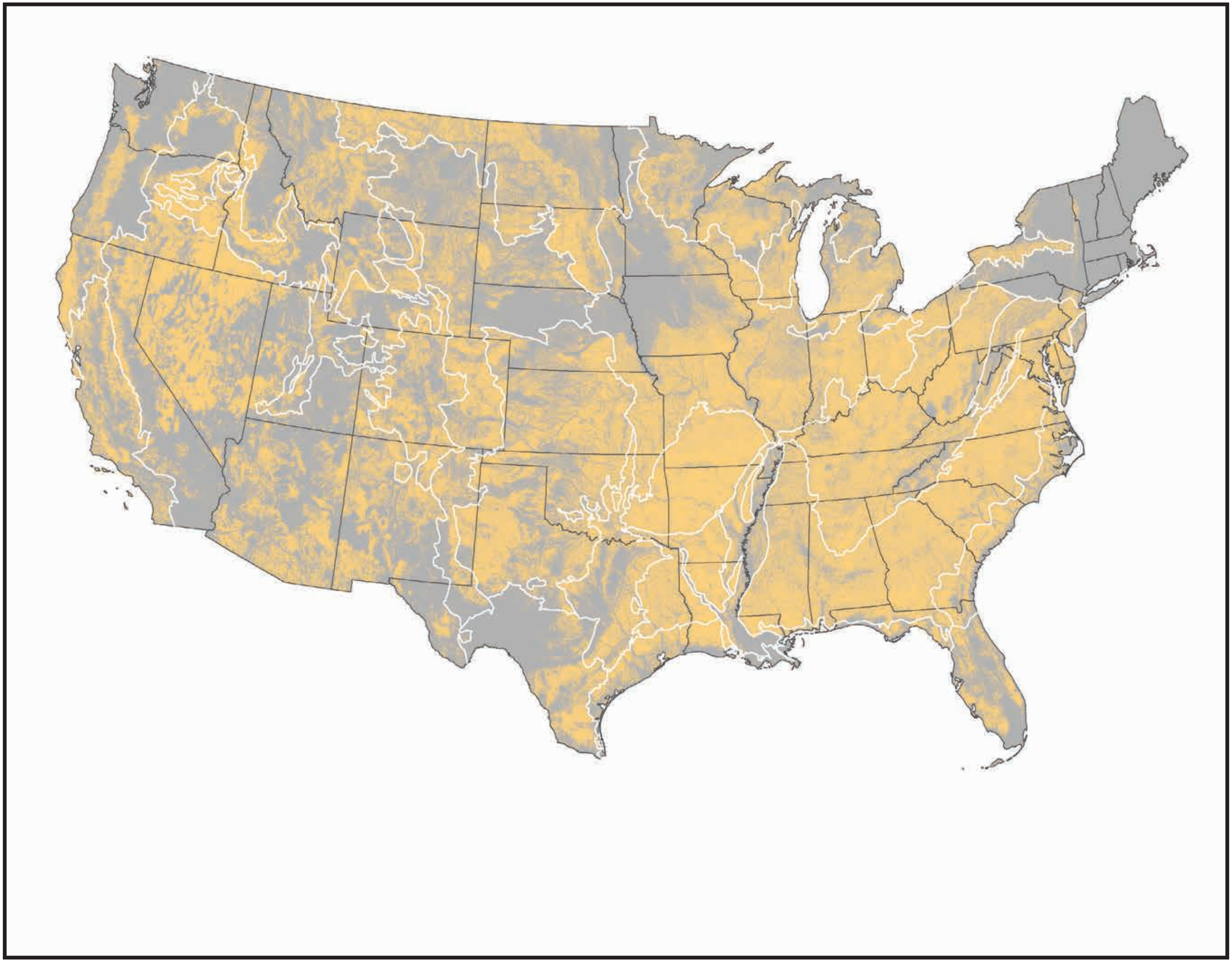

Figure 12: Distribution of argillic horizons (orange areas). Data from NASIS based on a search for "argillic" as a diagnostic feature and as a diagnostic horizon in Soil Taxonomy via classification at the suborder, great group, and subgroup levels.

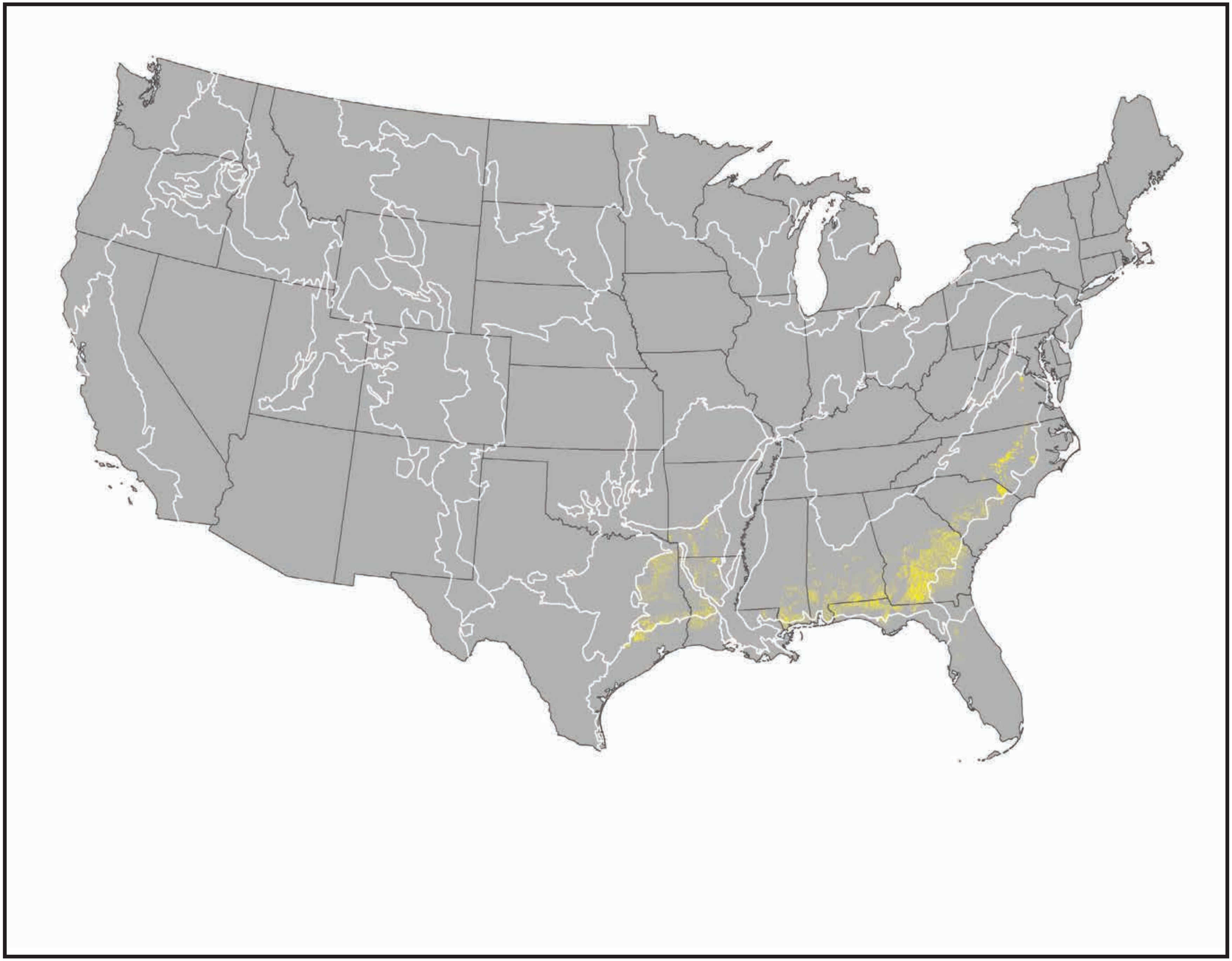

Figure 13: Distribution of plinthite (yellow areas). Data from NASIS based on a search of "plinthite" as a diagnostic feature and property in Soil Taxonomy via classification at the suborder, great group, and subgroup levels.

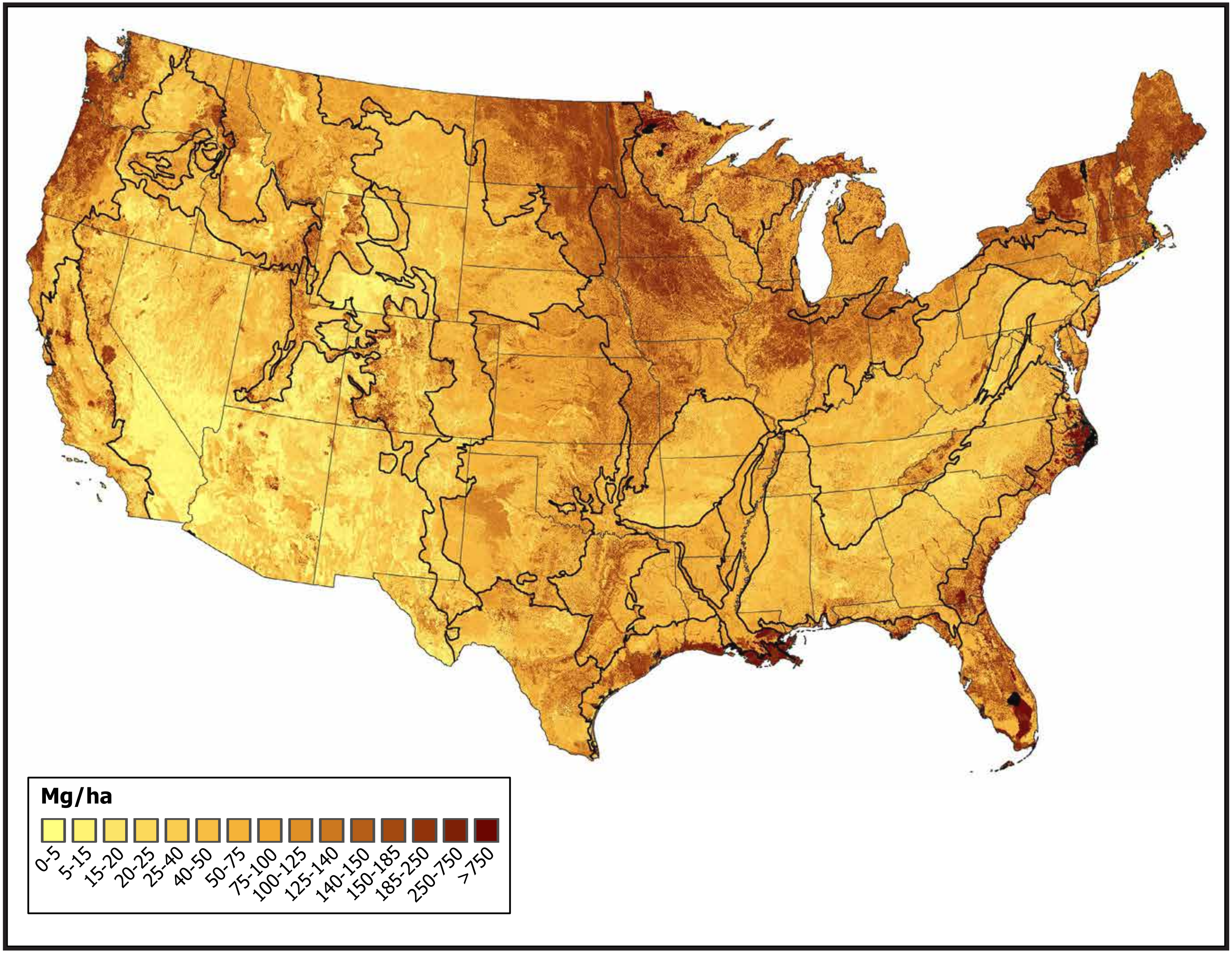

Figure 14: Weighted average of soil organic carbon in the upper 1.5 meters of soil in the conterminous United States based on the NASIS database. LRR boundaries are in black.

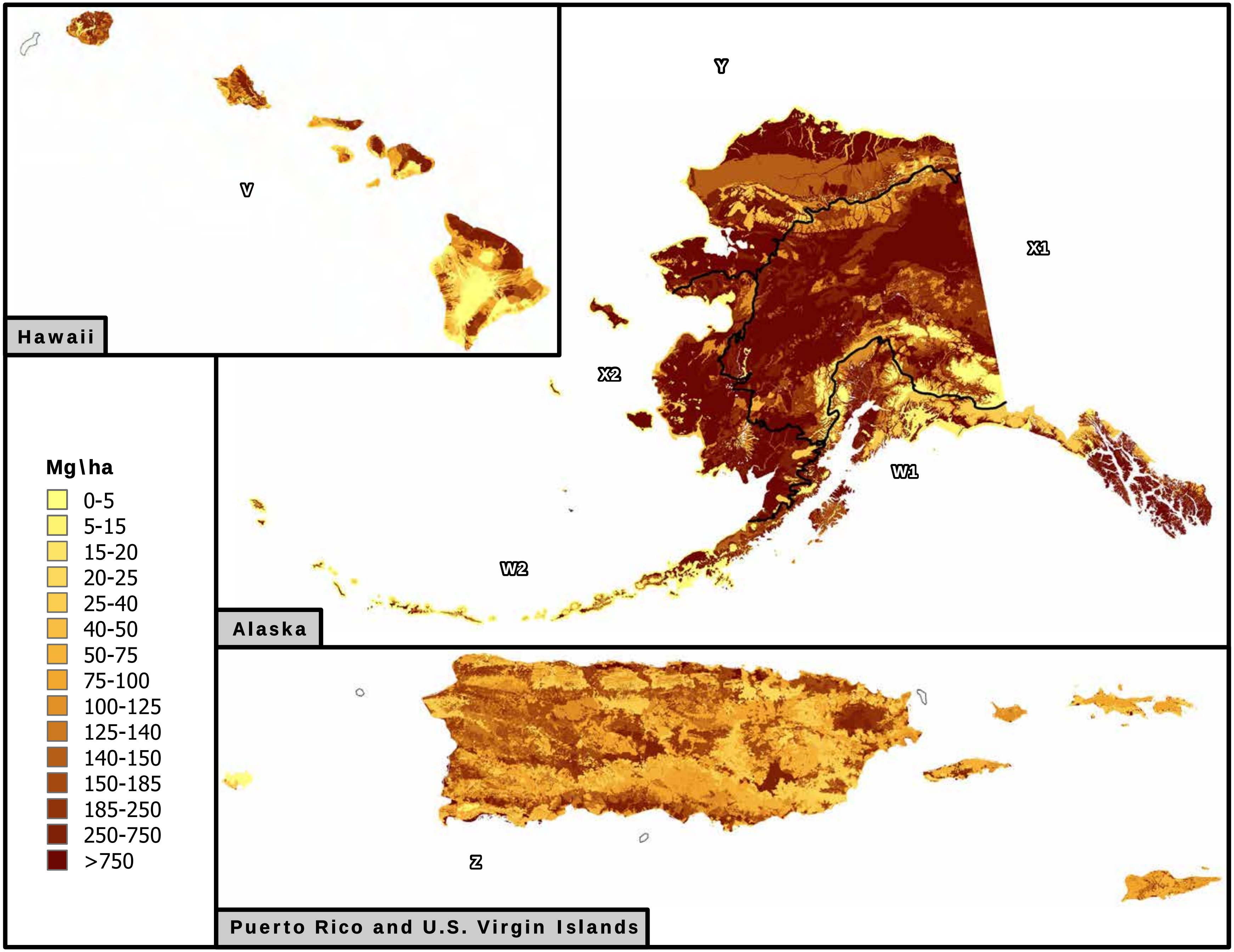

Figure 15: Weighted average of soil organic carbon in the upper 1.5 meters of soil in Alaska, Hawaii, and the Caribbean based on the NASIS database.

Land Resource Regions and Major Land Resource Areas

A—Northwestern Forest, Forage, and Specialty Crop Region

Land Resource Region A (fig. A-1) is the wet, mild region of abundant forests that consists of two major mountain ranges separated by a large structural valley and stretches from Canada to the Klamath Mountains. The two mountain ranges are the Coast Range and the Cascade Range. The Coast Range consists of the Olympic Mountains to the north and the Klamath Mountains to the south. It is composed primarily of tilted, folded, and faulted sedimentary and metamorphic rocks. The mountains in the Coast Range grade to gently sloping marine terraces and a narrow coastal plain along the Pacific Ocean, which are cut by the many rivers draining this area. The Cascade Range consists primarily of volcanic rocks and has many peaks reaching heights greater than 10,000 feet. This range contains the only active volcanoes in the conterminous United States. Its volcanic activity is driven by subduction of the oceanic plate under the continental plate. The Willamette Valley separates the Coast Range and the Cascades. It is a rich agricultural area because of the mild coastal climate, high amounts of rainfall, and deep soils that formed in alluvium and glacial drift. The Klamath Mountains are tectonically complex and composed of a variety of rock types, including Mesozoic marine sandstones and shales, granodiorite, gabbro, ultramafic rocks, and Paleozoic marine sediments, all of which have been metamorphosed to some extent. This region contains seven major land resource areas. The extent of these MLRAs and their range in elevations are shown in table A-1.

The boundaries between Region A and Regions C, D, and B (fig. 1, page 5) are all physio-climatic. The boundary between Regions A and C marks the topographic transition to lower elevation mountains and the Sacramento Valley. It is associated with a change from wetter, cooler forests to warmer, drier grasslands, shrublands, and agricultural areas and an increased extent of Alfisols and Vertisols (see Introduction, figs. 2, 6, 7, and 8). The boundary between Regions A and B marks the change from the wetter, cooler forested Cascades to the drier, warmer lowlands of Region B, which includes shrublands, grasslands, and agricultural areas. There is an abrupt change from Andisols, in Region A, to Mollisols, in Region B (fig. 2). The boundary between Regions A and D also marks a change from Andisols to Mollisols as well as from Inceptisols to Mollisols (fig. 2).

Figure A-1: Location and size of Land Resource Region A, which covers 236,535 square kilometers (91,325 square miles) along the Pacific Coast from Canada to northern California.

Table A-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
1	27,545	10,635	0	0	100	320	300	1,010	730	2,390	2,080	6,820
2	32,550	12,570	0	0	10	60	100	330	260	880	1,820	5,990
3	62,725	24,220	0	0	390	1,300	1,060	3,470	1,780	5,840	4,380	14,380
4A	13,520	5,220	0	0	0	20	90	300	290	970	990	3,250
4B	12,545	4,845	0	0	40	140	260	850	560	1,840	1,270	4,170
5	53,980	20,840	10	40	370	1,220	860	2,830	1,520	4,990	2,880	9,440
6	33,665	13,000	20	70	650	2,150	1,320	4,330	1,750	5,760	2,630	8,630

Table A-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
1	2	36	8.8	48	10.4	51	11.5	53	12.9	55	85	182	205/210	249	310
2	3.7	39	10.1	50	10.9	52	11.7	53	12.3	54	95	196	223/225	255	290
3	-11.9	11	3.3	38	6.9	44	10	50	12.1	54	35	83	150/145	202	280
4A	8.4	47	9.7	49	10.4	51	11.5	53	13.1	56	155	192	218/230	288	365
4B	9.6	49	11.7	53	12.9	55	14.5	58	15.7	60	165	244	286/295	365	365
5	3.4	38	9.1	48	11.5	53	13.5	56	16.6	62	65	142	183/190	237	365
6	-0.5	31	4.7	40	6.5	44	8.6	48	12.6	55	45	64	110/115	168	245

Table A-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
1	760	30	1,425	56	2,069/2,310	81/91	3,655	144	6,090	240
2	400	16	924	36	1,165/1,210	46/48	1,565	62	3,620	142
3	300	12	1,295	51	1,991/2,085	78/82	3,016	119	6,600	260
4A	1,350	53	1,790	70	2,386/2,470	94/97	3,244	128	5,650	222
4B	590	24	983	39	1,400/1,530	55/60	2,275	90	4,320	170
5	390	16	801	32	1,361/1,475	54/58	2,251	89	4,240	167
6	230	9	408	16	668/715	26/28	1,066	42	2,380	93

Due to the climate, most soils in Region A have a mesic soil temperature regime. The soils on mountain slopes typically have a frigid temperature regime, and those at the highest elevations have a cryic temperature regime. The dominant soil moisture regimes in the region are udic and xeric; xeric is commonly in the rain shadow areas at lower elevations. The average annual precipitation ranges from 45 to 60 inches (1,145 to 1,525 millimeters) in much of the region, but it is 30 to 45 inches (760 to 1,145 millimeters) in the Puget Sound and Willamette Valley and 9 to 25 inches (230 to 635 millimeters) on the east side of the Cascades. The annual precipitation in the mountains is typically more than 100 inches (2,540 millimeters), but it can exceed 250 inches (6,350 millimeters) on the highest peaks. This region is dry in summer. The average annual temperature is 45 to 55 degrees F (7 to 13 degrees C) in most of the region, but it is 37 to 42 degrees F (3 to 5.5 degrees C) in the Cascades and can be as low as 32 degrees F (0 degrees C) on the highest peaks. The freeze-free period is more than 200 days in most of the valleys, as long as 365 days along the coast in the southern part of the region, and only 40 to 70 days on mountain slopes. Temperatures and precipitation for this region are shown in figures 6 and 7. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables A-2 and A-3.

Soils in Region A are dominated by Andisols and Inceptisols, but the region also contains substantial areas of Spodosols, Mollisols, and Ultisols and lesser amounts of Alfisols and Entisols (fig. 2). Andisols and Inceptisols formed on the hilly and steep uplands. Spodosols are common in the high-elevation forested areas. Mollisols are mainly in the Willamette Valley. Ultisols are on the lower slopes surrounding the Willamette Valley. Other Ultisols, as well as Alfisols, formed in northwestern California on the lower elevation, forested mountain slopes; the Alfisols occur on Cretaceous deposits. Entisols and Inceptisols are on flood plains and along estuaries. Soils with restrictive lithic, paralithic, densic, and ortstein zones occur in various locations in Region A (see Introduction, figs. 9 and 11). Carbonates are nonexistent in this area due to the high amounts of rainfall (fig. 5, page 9). Argillic horizons occur in the Willamette Valley and on stable geomorphic surfaces in the southern mountains (fig. 12, page 16). Region A has some of the highest amounts of soil organic carbon accumulation in the conterminous United States (fig. 14, page 18).

Forest, recreation, and timber production are the major industries (fig. A-2 and fig. 8, page 12). Dairy farming is an important enterprise in the valleys that receive abundant rainfall. Grain crops, grass and legume seeds, fruits, and horticultural specialty crops are grown extensively in the drier valleys. Water erosion on the steeper slopes and in unprotected orchards, vineyards, and other areas of specialty crops is a common management concern. Sediment from logging roads and landings on steep forested slopes also is a concern. Landslides can occur during wet periods in the mountains.

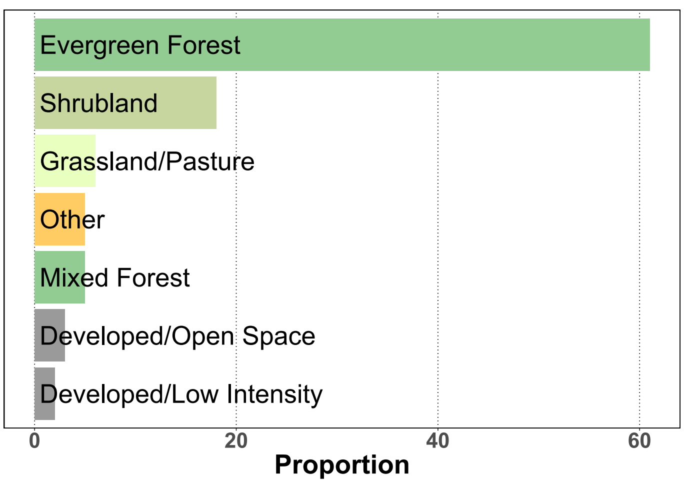

Figure A-2: Relative proportions (percentages) of land uses in Land Resource Region A (National Agricultural Statistics Service, 2019).

1—Northern Pacific Coast Range, Foothills, and Valleys

This area (fig. 1-1) makes up about 10,635 square miles (27,545 square kilometers). It is in Oregon (60 percent) and Washington (40 percent). MLRA 1 consists of a long, narrow, north-south-trending range of mountains with associated foothills and narrow valleys that parallels the Pacific Ocean. Most of the area is accreted terrane from tectonic processes. It is characterized by forests dominated by western hemlock and Douglas-fir with a dense understory of salal, vine maple, and western swordfern.

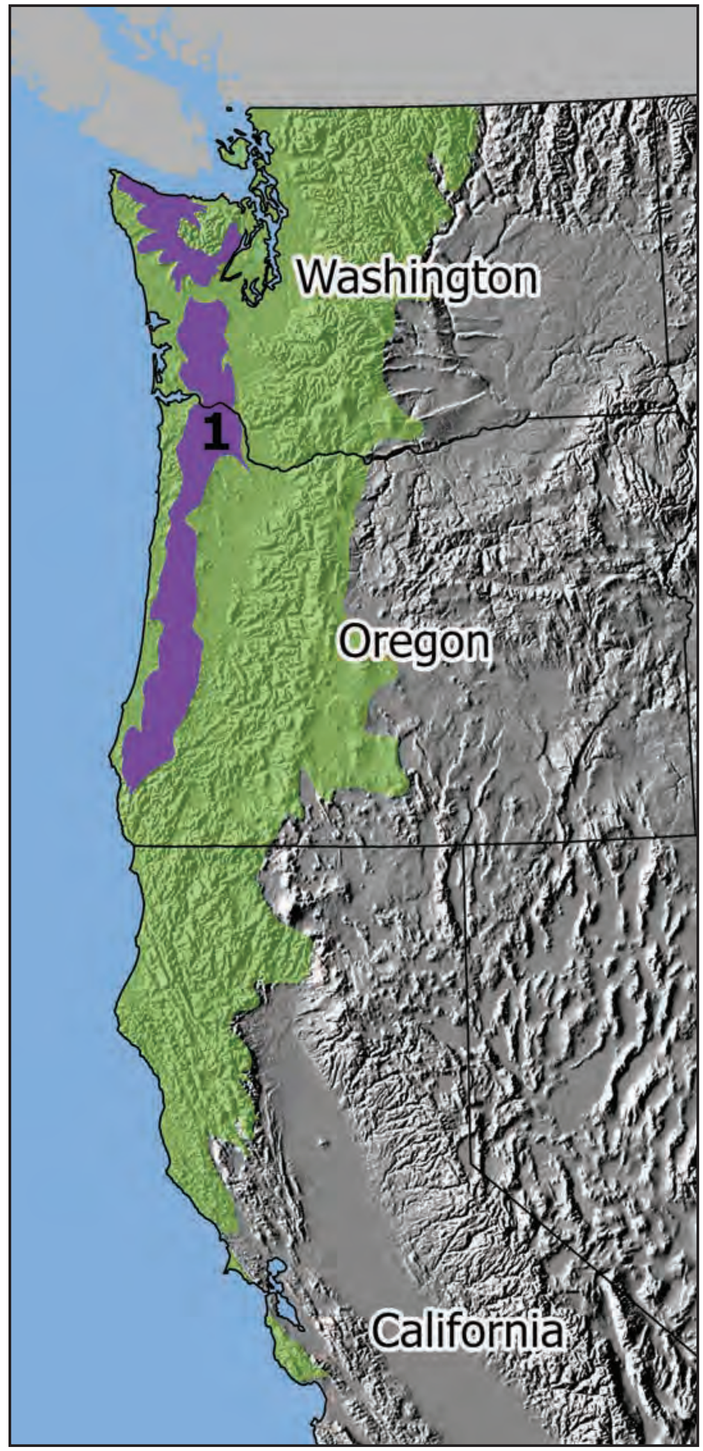

Figure 1-1: Location of MLRA 1, which covers 2,754,500 hectares (6,806,500 acres), within Region A.

The east and west boundaries of the MLRA coincide with physiographic changes—mountains transition to foothills and broad valleys. The Siskiyou Trinity area to the south is generally warmer and drier, with a gradual transition from udic to xeric soil moisture regimes. The MLRA is bounded to the south by the Klamath Mountains and to the north by the highest elevations of the Olympic Mountains and the Strait of Juan de Fuca.

Physiography

All of this area is within the Pacific Border province of the Pacific Mountain System. The northern third of the area, in Washington, is in the Olympic Mountains section, and the rest of the area is in the Oregon Coast Range section.

In Washington, elevation ranges from 0 to 2,500 feet (0 to 760 meters); it is mostly 200 feet (60 meters). Elevations are typically higher in Oregon. Some peaks in the southern end of the area range to 4,000 feet (1,220 meters). The Columbia River bisects this MLRA, and the headwaters for several rivers are in this area.

Geology

The portion of this MLRA in Washington consists primarily of young Tertiary sedimentary rocks (siltstone and sandstone) mixed with volcanic rocks of the same age. In addition, glacial till and outwash deposits are in the northern half of the portion of the area in Washington. The portion of this MLRA in Oregon consists primarily of sedimentary rocks with some minor volcanic rocks. In the far southern portion of the area, near the Klamath Mountains, the sedimentary rocks are older and some have been metamorphosed.

Climate

The average annual precipitation is 60 to 220 inches (1,525 to 5,580 millimeters), increasing with elevation. Most of the rainfall occurs during low-intensity, Pacific frontal storms. Precipitation is evenly distributed throughout fall, winter, and spring; summers are cool and dry. Snowfall occurs throughout the area. The average annual temperature is 43 to 53 degrees F (4 to 13 degrees C), decreasing with elevation. The freeze-free period averages 170 days and ranges from 140 to 200 days, decreasing as elevation increases.

Water

Precipitation and perennial streams fed by springs provide abundant surface water for all needs. This area supplies water to the adjoining MLRAs at lower elevations that receive less precipitation. Surface water quality is generally good for all uses. The ground water is mainly of good quality; it generally meets the water-quality standards for most designated uses.

Soils

The dominant soil orders in this MLRA are Andisols, Inceptisols, and Ultisols. The soils in the area dominantly have a mesic or frigid temperature regime and a udic moisture regime. They are generally shallow to very deep, well drained, medial, and loamy or clayey and occur on foothills and mountain slopes and ridges.

The main soils and their series:

- Dystrudepts that formed in colluvium and residuum derived from sedimentary lithologies (Remote series)
- Eutrudepts that formed in colluvium and residuum derived from sedimentary lithologies (Digger series)
- Fulvudands that formed in colluvium and residuum derived from sedimentary lithologies (Elochoman, Lytell, and Zenker series)
- Hapludands that formed in colluvium and residuum derived from igneous lithologies (Hemcross and Klistan series)
- Humudepts that formed in colluvium and residuum derived from sedimentary lithologies (Bohannon and Preacher series)
- Palehumults that formed in colluvium and residuum derived from igneous or sedimentary lithologies (Honeygrove series)

Biological Resources

This area supports dense forest stands. Douglas-fir, western hemlock, and red alder are the most common species. There are lesser amounts of western redcedar, bigleaf maple, and grand fir. At the higher elevations, noble fir is an important part of the plant community. Huckleberry, salal, trailing blackberry, twinflower, vine maple, Pacific yew, thimbleberry, rhododendron, Oregon grape, salmonberry, violet, Pacific trillium, western swordfern, threeleaf foamflower, Oregon oxalis, beargrass, and rusty menziesia dominate the understory.

Major wildlife species include black bear, cougar, Roosevelt elk, black-tailed deer, coyote, bobcat, river otter, beaver, raccoon, skunk, muskrat, rabbit, squirrel, weasel, chipmunk, bald eagle, northern spotted owl, marbled murrelet, and Steller’s jay. Fish species include salmon, steelhead, and cutthroat trout.

Land Use

Most of the area is densely forested (fig. 1-2). Recreation and timber production are the major industries. The major soil resource concerns are water erosion, surface compaction, and sedimentation of streams. The quality of surface water resources also is a major concern.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams.

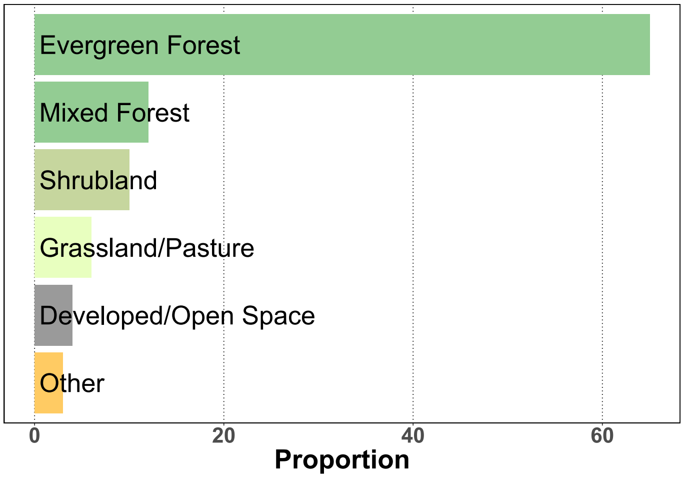

Figure 1-2: Relative proportions (percentages) of land use in MLRA 1.

2—Willamette and Puget Sound Valleys

This area (fig. 2-1) is in Washington (57 percent) and Oregon (43 percent). It makes up about 12,568 square miles (32,550 square kilometers). The Cascade Mountains border this MLRA to the east, and the Coast Range and Olympic Mountains border it to the west. The valleys are part of a structural basin. The Puget Sound area was extensively glaciated, while the Willamette Valley was dominated by alluvial processes.

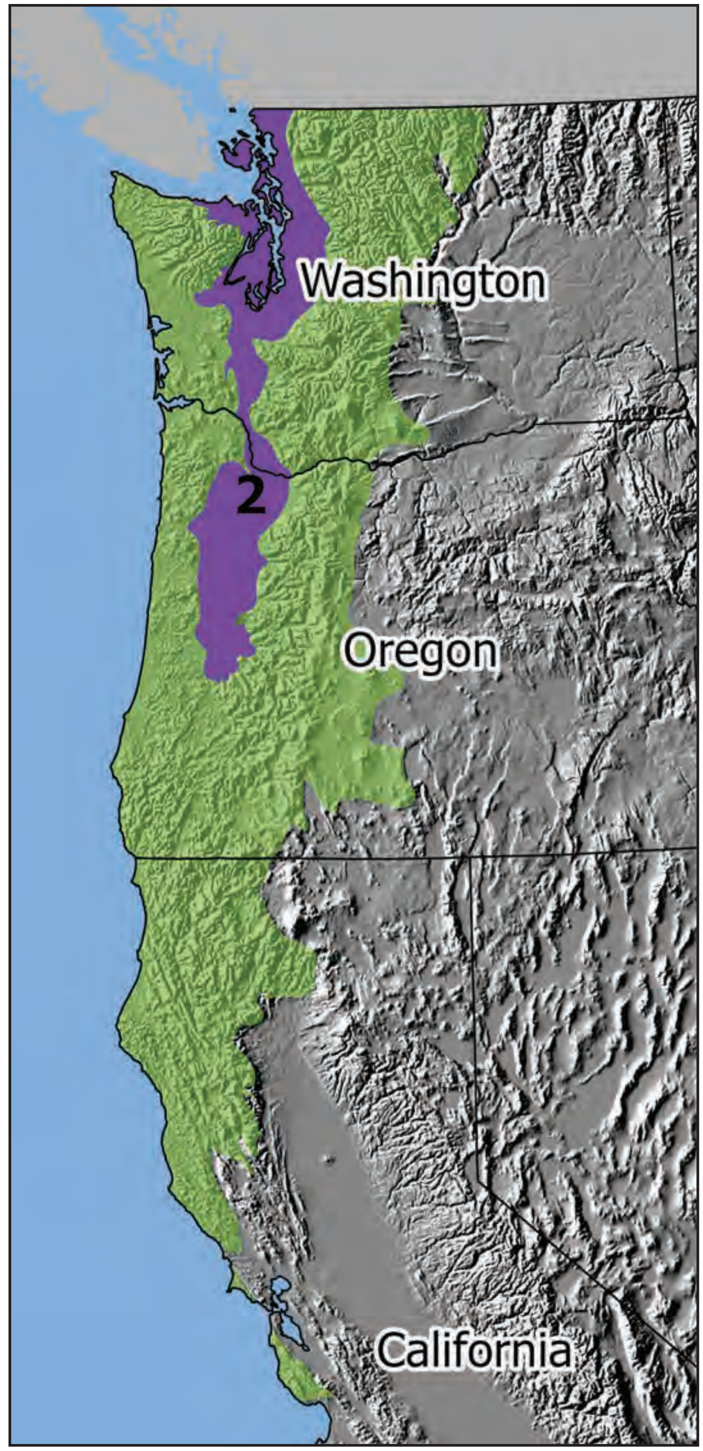

Figure 2-1: Location of MLRA 2, which covers 3,255,000 hectares (8,043,200 acres), within Region A.

Physiography

This MLRA is in the Pacific Border province of the Pacific Mountain System. Almost all of it lies within the Puget Trough section. The lowlands of the Puget Sound are partly submerged, and major terrace systems flank the Willamette Valley. The western edge of this area is in the Oregon Coast Range section.

Elevation ranges from sea level to 1,640 feet (500 meters). The Willamette Valley consists of nearly level to gently sloping flood plains bordered by higher terraces that are cut by tributaries of the Willamette River. The Puget Sound Valley consists of glacial drift plains and glacial outwash plains, some of which are dissected by contemporary rivers. The Columbia River, flowing east to west, bisects the area. The Willamette River runs through the middle of the southern half of the area.

Geology

Glacial drift and glacial outwash deposits are the primary surficial material of the Puget Sound Valley. The Willamette Valley surficial material is alluvium, dominantly from cataclysmic glacial outburst floods of the Columbia River during the Pleistocene Epoch.

Climate

The average annual precipitation is 30 to 60 inches (760 to 1,525 millimeters) in much of the area. Lower annual rainfall, as little as 17 inches (430 millimeters), occurs on the lee side of the Coast Range mountains along the western border of this area. The highest average annual rainfall, 60 to 109 inches (1,525 to 2,770 millimeters), is in the higher areas along the eastern border of the MLRA. Most of the rainfall occurs during low-intensity, Pacific frontal storms. Rain turns to snow at the higher elevations. Precipitation is evenly distributed throughout fall, winter, and spring; summers are dry.

The average annual temperature is 42 to 54 degrees F (6 to 12 degrees C). The lower temperatures occur at the higher elevations on the eastern edge of this area. The average annual temperature is 50 degrees F (8 degrees C) or more in much of the area. The freeze-free period averages 190 days and ranges from 165 to 220 days in most of the area. It can be as short as 70 days at the highest elevations and as long as 305 days near the Puget Sound.

Water

Seattle and Portland consume most of the public water supply in Washington and Oregon, respectively. High-value crops are grown under irrigation in parts of the Willamette Valley, but rainfall is the source of water for most crops.

Moderate precipitation and abundant streamflow provide enough water for present needs. Surface water supplies, however, are often short in summer, and farms located far from streams may require ground water supplements for irrigation. The adjoining mountain ranges can provide additional surface water if reservoirs are constructed. Surface water quality is good for all uses, but irrigation return flows may be high in salts from fertilizers.

Ground water quality in this area generally meets drinking water standards. Ground water is plentiful in glacial and alluvial deposits around Seattle. It is soft and of good quality. High concentrations of naturally occurring iron and manganese, however, may exceed the drinking water standards for some ground water in the Puget Sound area. Portland obtains some of its drinking water from wells in the basalt along the Columbia River. The water from the basalt aquifer is moderately hard and of good quality.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, Mollisols, and Ultisols. The soils in the area dominantly have a mesic temperature regime, a xeric moisture regime, and mixed or isotic mineralogy. They generally are moderately deep to very deep, very poorly drained to well drained, and sandy to clayey.

The main soils and their series:

- Albaqualfs that formed in silty alluvium (Dayton series)
- Argixerolls that formed in silty alluvium (Woodburn series)
- Dytsroxerepts that formed in glacial drift or outwash (Alderwood and Everett series)
- Endoaquolls that formed in silty alluvium (Wapato series)
- Fragixerepts that formed in loess (Cascade series)
- Haplohumults that formed in colluvium and residuum from sedimentary lithologies (Bellpine series)
- Haploxerolls that formed in silty alluvium (Chehalis series)
- Palehumults that formed in colluvium and residuum derived from sedimentary and basic igneous lithologies (Jory series)
- Vitrixerands that formed in loess, volcanic ash, and glacial till (Tokul series)

Biological Resources

This area supports forest vegetation in many places and prairie or savanna vegetation in other places. Douglas-fir is the dominant tree species. Bigleaf maple, western redcedar, western hemlock, and grand fir also are common. Red alder is aggressive on disturbed sites in Washington. Pacific madrone is common on balds and near rock outcrops. Stands of cottonwoods and willows grow on overflow channels, streambanks, and islands. Oregon white oak is common in savannas. Red fescue, western fescue, bromes, and sedges are common in the prairies and savannas. Forest and savanna understory species include Oregon grape, Indian plum, salmonberry, snowberry, hazelnut, oceanspray, serviceberry, rose, poison oak, western swordfern, and thimbleberry. Major wildlife species include black-tailed deer, coyote, bobcat, beaver, rabbit, bald eagle, osprey, heron, swan, geese, owls, and woodpeckers.

Land Use

In the Puget Sound Valley, nearly one-third of the land is forested and recreation and timber production are the major industries. In the Willamette Valley, less than one-tenth of the land is forested and timber production is less important. Urbanization is increasing in much of the area (fig. 2-2). Agriculture is highly diversified. Deciduous fruits, berries, vegetables, seed crops, and grains grown under intensive management are the major crops. The acreage used for wine grapes is increasing rapidly, especially in the Willamette Valley. A large acreage is used for nursery plants and hay or grain for

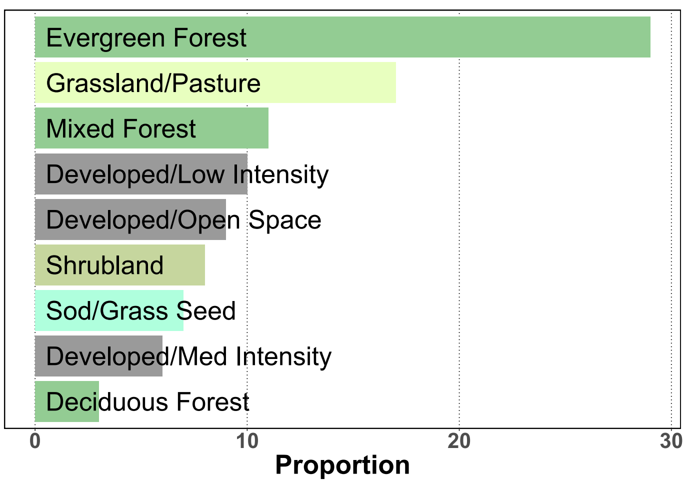

Figure 2-2: Relative proportions (percentages) of land use in MLRA 2.

dairy cow and poultry feed. High-value crops are grown under irrigation in some areas, but rainfall is the source of water for most crops.

The major soil resource concerns are water erosion, maintenance of the content of soil organic matter and tilth, soil productivity, and sedimentation of streams and road ditches. The quality of surface and ground water resources also is a major concern.

Conservation practices on cropland generally include crop residue management, conservation crop rotations, waste utilization, nutrient management, pest management, filter strips, grassed waterways, and irrigation water management. Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices help to protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water. Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams.

3—Olympic and Cascade Mountains

This area (fig. 3-1) is in Oregon (61 percent) and Washington (39 percent). It makes up about 24,217 square miles (62,724 square kilometers). Most of the area is densely forested, and timber production is the major industry.

Physiography

This MLRA is in the Pacific Mountain System. The northern one-fourth of this area is in the Northern Cascade Mountains section of the Cascade-Sierra Mountains province. Almost all of the rest of this MLRA is in the Middle Cascade Mountains section of the same province. The Olympic Mountains are included within this MLRA, in the Olympic Mountains section of the Pacific Border province.

Elevation generally ranges from 660 to 5,600 feet (200 to 1,710 meters) but is as high as 14,410 feet (4,390 meters). The Cascade Mountains are commonly very steep due to active tectonic uplifting and erosional processes. Volcanic peaks make up the highest elevations. These peaks rise thousands of feet above the surrounding mountains. Examples are Mount Baker, Mount Rainier, Mount Hood, and Mount Jefferson. The Olympic Mountains are very similar to the Cascades but do not have the volcanic cones. Steep mountains, narrow valleys, some U-shaped glaciated valleys, and narrow divides are dominant in the Olympic Mountains. Plateaus and narrow bands of flood plains and terraces border some of the streams.

The Columbia River bisects this MLRA. This mountainous area contains the headwaters of numerous rivers in Washington and Oregon, including the Willamette River.

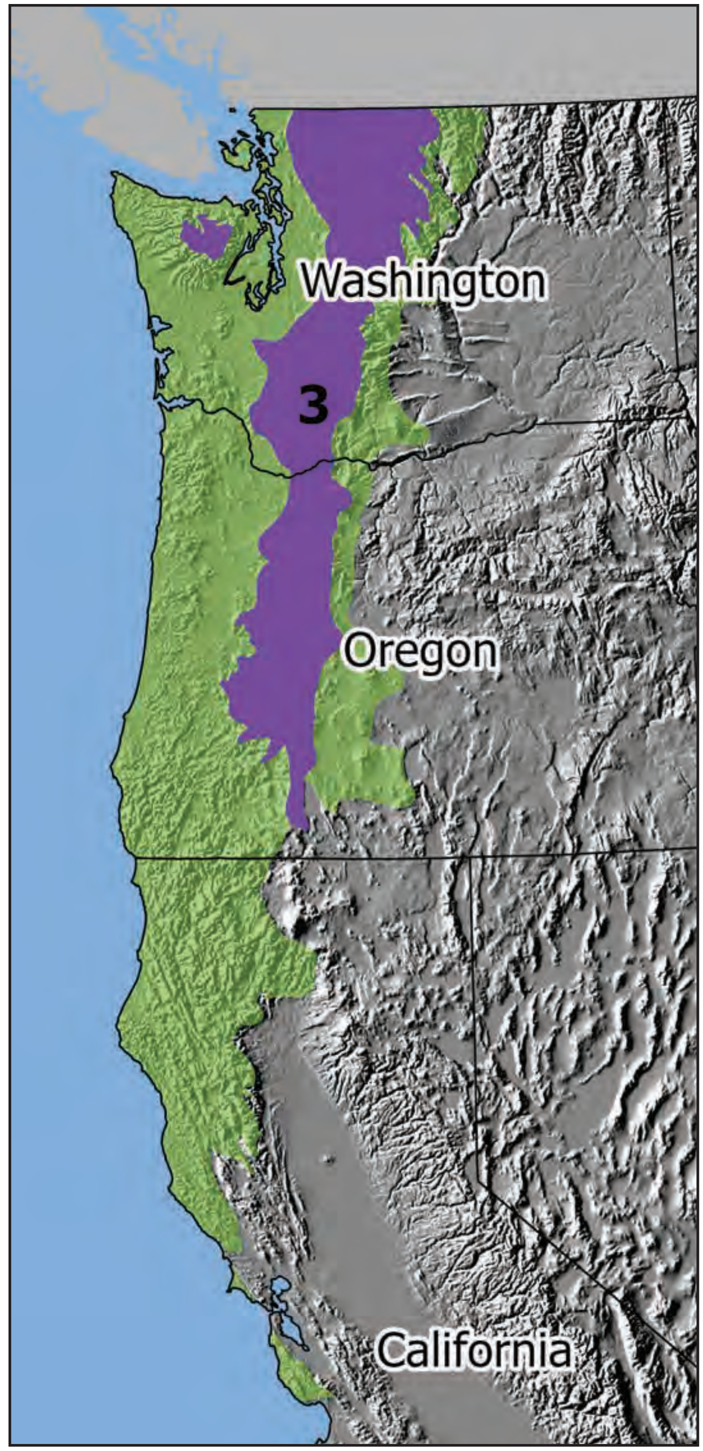

Figure 3-1: Location of MLRA 3, which covers 6,272,400 hectares (15,499,300 acres), within Region A.

Geology

The Northern Cascades are comprised of varying and complex lithologies and terranes. The rest of the Cascades south of this consist primarily of andesite and basalt flows and some tuffs. The Olympic Mountains consist of uplifted igneous and sedimentary rocks. Thin deposits of alluvium are at the lower elevations along the major streams draining the Cascades. All of the Cascades were glaciated, and isolated remnants of till, drift, and outwash deposits are at the lower elevations on the flanks of the mountains.

Climate

The average annual precipitation is 60 to 180 inches (1,525 to 4,570 millimeters) in most of this area and as much as 280 inches (7,110 millimeters) on Mount Olympus. Most of the precipitation occurs during low-intensity, Pacific frontal storms in fall, winter, and spring. Rain turns to snow at the higher elevations, and all of the area receives snow in winter. The average annual temperature is 27 to 50 degrees F (-3 to 10 degrees C), decreasing with increasing elevation. The freeze-free period averages 90 days and ranges from 10 to 180 days. The longest growing season is in the southernmost part of this area, and there may be no growing season at the highest elevations. Frost may occur during every month of the year at the higher elevations.

Water

Precipitation and perennial streams fed by glaciers and springs provide abundant surface water for all of the needs in the area. This MLRA supplies water to the lower lying adjoining MLRAs that receive less precipitation. It has very few aquifers. Columbia River Basalt and basin fill and alluvial aquifers along the Columbia River in Oregon are the only two extensive aquifers. Ground water is mainly of good quality and generally meets the standards for most designated uses.

Soils

The dominant soil orders in this MLRA are Andisols, Inceptisols, Spodosols, and Ultisols. The soils in the area dominantly have a mesic, frigid, or cryic temperature regime and a udic moisture regime. They generally are moderately deep to very deep, well drained, ashy, medial, and loamy or clayey and occur on mountain slopes and ridges.

The main soils and their series:

- Haplocryods that formed in colluvium or glacial sediments with some influence of volcanic ash (Lastance, Nimue, Playco, and Winopee series)
- Haplohumults that formed in colluvium from mixed lithologies (Peavine series)
- Humudepts that formed in colluvium or residuum with some influence of volcanic ash (Aschoff, Illahee, Kinney, and Klickitat series)
- Vitricryands that formed in volcanic ash or volcanic ash over glacial till (Castlecrest and Doubtful series)

Biological Resources

This area supports dense forest stands. Douglas-fir, Pacific silver fir, and western hemlock are the most common species. There are lesser amounts of western redcedar, noble fir, grand fir, and white fir. At the higher elevations, mountain hemlock is an important part of the plant community and subalpine fir, lodgepole pine, and whitebark pine grow near timberlines. Subalpine meadows occur above tree lines and are comprised of a variety of low-growing shrubs, forbs, grasses, and sedges. Huckleberry, salal, trailing blackberry, twinflower, vine maple, Pacific yew, thimbleberry, Cascade azalea, rhododendron, Oregon grape, salmonberry, violet, trillium, western swordfern, Oregon oxalis, common beargrass, devilsclub, and rusty menziesia may occur in the understory.

Major wildlife species include black bear, cougar, Roosevelt elk, black-tailed deer, coyote, bobcat, river otter, mountain beaver, raccoon, skunk, opossum, muskrat, rabbit, squirrel, weasel, pika, chipmunk, bald eagle, osprey, turkey vulture, ruffed grouse, blue grouse, Steller’s jay, northern spotted owl, and meadowlark. Fish species include salmon, steelhead, smelt, shad, sturgeon, whitefish, and trout.

Land Use

Most of the area is densely forested, and recreation and timber production are the major industries (fig. 3-2). At high elevations, alpine meadows provide summer range. Mining is important in some areas.

The major soil resource concerns are water erosion, surface compaction, and sedimentation of streams. The quality of surface water resources also is a major concern. Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams.

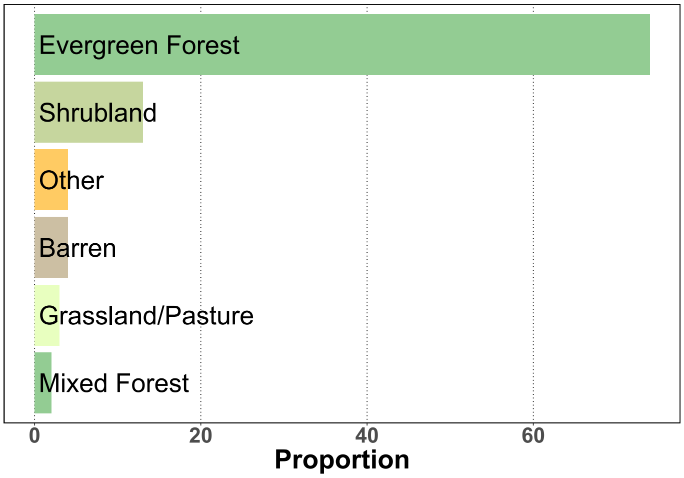

Figure 3-2: Relative proportions (percentages) of land use in MLRA 3.

4A—Sitka Spruce Belt

MLRA 4A (fig. 4A-1) is in Oregon (53 percent) and Washington (47 percent) along the Pacific Ocean. This long, narrow area makes up about 5,220 square miles (13,521 square kilometers). It is comprised of marine terraces, coastal estuaries, sand dunes, and low-relief hills and mountain slopes. The climate is cool and moist with minimal change between seasons. Summer temperatures are moderated by the proximity of cool ocean water and fog. The Sitka spruce forests are characteristic of the area.

Figure 4A-1: Location of MLRA 4A, which covers 1,352,100 hectares (3,341,000 acres), within Region A.

The MLRA is bordered to the south by MLRA 4B, which has characteristic coastal redwood forests. To the east, it transitions upward in elevation toward the more variable climate in the Coast Range mountains. The Sitka spruce forests of MLRA 4A transition to the western hemlock and Douglas-fir forests of MLRA 1.

Physiography

All of this area is within the Pacific Border province of the Pacific Mountain System. The three different physiographic sections in this area are, from north to south, the Olympic Mountains, the Oregon Coast Range, and the Klamath Mountains. Although the sections are named for mountains, MLRA 4A contains few mountain slopes.

In Washington, this area ranges in elevation from sea level to a maximum of 1,800 feet (550 meters) inland. Most of this part of the MLRA has an elevation of 50 to 300 feet (15 to 90 meters). From the ocean beaches, the land slopes up onto glacial drift deposits, marine terraces, or young, continental sedimentary rocks in the northern portion. In the southwest corner of Washington, the land slopes from the ocean beach to alluvial or marine terraces or flood plains and beach dunes. Hillslopes are the dominant landform adjacent to the coastal landforms.

The Oregon portion of this MLRA is similar to the portion in Washington. The coastal area around the mouth of the Columbia River and the flood plains along the major rivers near the coast are flat, but inland areas are very hilly. Common features include marine terraces, bays, coves, headlands, and estuaries. Isolated rocks and small islands are common directly offshore.

The area is highly dissected by numerous perennial rivers and creeks. The Columbia River discharges into the Pacific Ocean in the middle of this MLRA.

Geology

The portion of this MLRA in Washington consists primarily of glacial and alluvial sediments and some scattered areas of young Tertiary sedimentary rocks (siltstone). Glacial deposits are dominant in the northern half of the area, and alluvium and beach dune deposits are more prominent in the southern half of the part of the MLRA in Washington. A significant portion of the part of the MLRA in Oregon consists of marine and estuarine sediments and some minor sedimentary and volcanic rocks. At the far southern part of this MLRA, near the Klamath Mountains, the sedimentary rocks are older and some have been metamorphosed.

Climate

The average annual precipitation is 52 to 60 inches (1,320 to 1,525 millimeters) near the beach and can be as much as about 150 inches (3,800 millimeters) at the higher elevations along the inland edge of the MLRA. Most of the rainfall occurs during low-intensity, Pacific frontal storms. Precipitation is evenly distributed throughout fall, winter, and spring; summers are cool and dry. Snowfall accumulation is rare on the ocean side of this area, but some snowfall occurs along the eastern boundary. This area lies within the coastal fog belt zone, and heavy fogs are common in summer. Supplemental moisture is provided by fog condensation. The average annual temperature is 45 to 55 degrees F (7 to 13 degrees C). The freeze-free period averages 200 days and ranges from 160 to 240 days in most of this area. The ocean influence along the western edge of this area increases the length of the freeze-free period. The period is much shorter at the higher elevations along the eastern edge of the area.

Water

Abundant precipitation and many perennial streams provide enough water for most needs. Rainfall is the source of water for most crops, but some high-value crops are grown under irrigation on the coastal flats and on the flood plains a short distance inland from the mouths of the major rivers. The drier valleys depend on streamflow from the mountains. The surface water supply is often short in summer, and farms located far from streams may require ground water supplements for irrigation. Surface water quality is generally good for all uses.

Ground water is plentiful in alluvial, glacial outwash, terrace, and beach dune deposits. The water is soft, and it generally meets drinking water standards, except for naturally occurring levels of iron and manganese in the northern part of the area.

Soils

The dominant soil orders in this MLRA are Andisols, Inceptisols, Spodosols, and Entisols. The soils in the area have either an isomesic or isofrigid temperature regime. They have a udic or perudic moisture regime. They are acid throughout; most are very strongly acid or strongly acid. The hilly to extremely steep uplands are dominated by Andisols and Inceptisols that are shallow to very deep and are well drained. These soils have ferrihydritic or isotic mineralogy. The marine and glacial outwash terraces are dominated by Andisols and Spodosols that are shallow or moderately deep to cemented materials or are deep or very deep. These soils are poorly drained to well drained. They have ferrihydritic or isotic mineralogy. The soils on the nearly level flood plains and along the estuaries are primarily Entisols and Inceptisols with minor areas of Histosols. These soils are very deep and typically very poorly drained or poorly drained. They have mixed mineralogy.

The main soils and their series:

- Duraquods that formed in stratified marine sediments (Depoe series)
- Durudands that formed in alpine glacial till (Hoko series)
- Endoaquepts that formed in alluvium from mixed lithologies (Coquille series)
- Fulvudands that formed in residuum and colluvium from a variety of sources, including glaciofluvial sediments, loess, siltstone, sandstone, conglomerate, and volcanic rocks (Klootchie, Mopang, Palix, and Snahopish series)
- Haplorthods that formed in sandy alluvial and eolian deposits (Bullards series)
- Humudepts that formed in colluvium and residuum from sedimentary lithologies (Templeton series)
- Udipsamments that formed in eolian sand (Waldport series)

Biological Resources

This area is highly diverse in flora and fauna. Its eastward extent is coincident with the extent of plant communities dominated by Sitka spruce. The uplands are dominated by a dense overstory of Sitka spruce, western hemlock, western redcedar, red alder, and Douglas-fir. The understory is dominated by salal, western swordfern, evergreen huckleberry, Pacific rhododendron, salmonberry, false lily of the valley, and Oregon oxalis. Stabilized dunes on the terraces have shore pine as a dominant overstory species in addition to the species occurring on uplands. The flood plains and estuaries are dominated by saltgrass, skunk cabbage, tussock and other sedges, and reeds. In addition, balds, bluffs, and prairies support an extensive array of shrubs, wildflowers, and grass species. During periods of low tide, large unvegetated flats are exposed in the coastal bays.

Major wildlife species include black bear, Roosevelt elk, black-tailed deer, coyote, fox, bobcat, beaver, otter, raccoon, skunk, muskrat, opossum, rabbit, squirrel, mink, woodrat, bald eagle, osprey, crow, ruffed grouse, blue grouse, raven, merganser, kingfisher, band-tailed pigeon, spotted owl, and marbled murrelet. Salamanders, newts, and slugs are common in the decomposing forest litter. The tidal estuaries are habitat for clams, crabs, and salmonids. The rivers and bays in this area are important spawning grounds and habitat for steelhead, salmon, and cutthroat trout. Other fish species are white sturgeon and Columbia River smelt.

Land Use

Most of this area consists of privately owned farms, ranches, and forests (fig. 4A-2). Forestry is the major industry. A small acreage is grassland used for grazing. Less than 1 percent of the area is cultivated land, which is used mainly for forage and grain for dairy cattle. Although the freeze-free period is long, the area lacks the consistent warm summer temperatures necessary for the maturation of most crops. Vegetables and

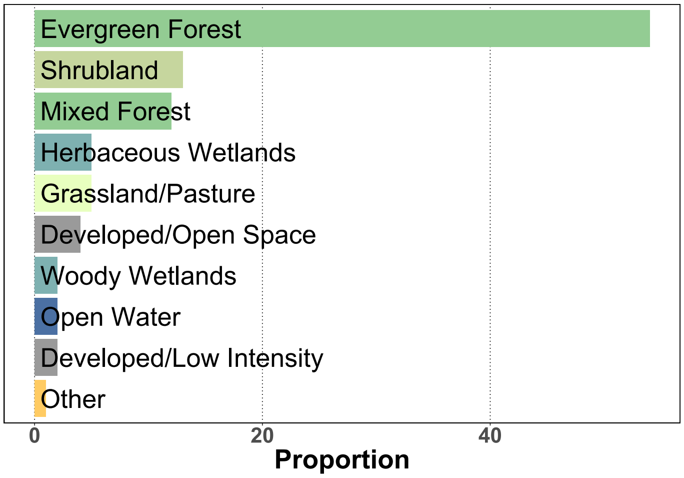

Figure 4A-2: Relative proportions (percentages) of land use in MLRA 4A.

fruits (apples) are grown where the soils and climate are favorable. Specialty crops, such as cranberries and lily bulbs, also are grown in the area.

The major soil resource concerns are water erosion and the subsequent deposition of sediment into rivers and creeks. Soils in basins and on flood plains are susceptible to flooding, deposition of sediments, and local streambank cutting. The hazard of erosion is moderate on terraces and coastal benches. Erosion can be severe if the vegetative cover on upland soils is removed by logging, fire, overgrazing, or cultivation. Landslides from hills and mountains are a source of sediment.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. Maintaining a vegetative cover or forest litter over the mineral soil surface helps to control runoff and erosion. Conservation practices on cropland are nutrient management and measures that reduce the hazard of erosion.

4B—Coastal Redwood Belt

MLRA 4B (fig. 4B-1) is primarily in California (98 percent). A small part of the area is in Oregon (2 percent). The MLRA makes up about 4,844 square miles (12,545 square kilometers). It is characterized by low-elevation beaches, elevated coastal plains and plateaus, marine terraces, and isomesic mountains; by a primarily udic soil moisture regime; and by exposure to heavy fog from the California Current, which favors the dominance of coast redwoods. The cool temperatures, higher precipitation, and winds created from the California Current interact with the low-elevation land surfaces to provide a significant portion of the yearly moisture by creating a daily heavy fog throughout the warmer summer months.

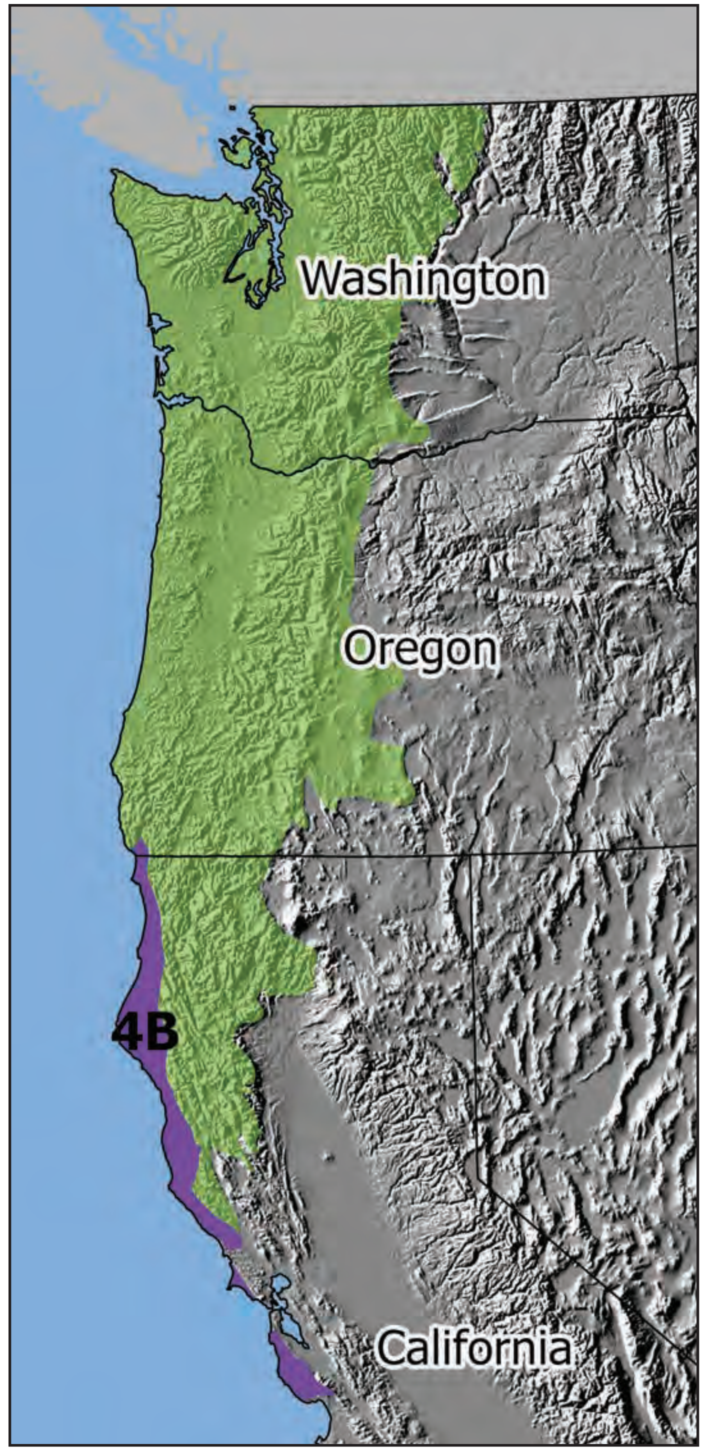

Figure 4B-1: Location of MLRA 4B, which covers 1,254,500 hectares (3,100,000 acres), within Region A.

A key distinguishing characteristic between MLRA 4B and MLRA 4A (to the north) is the colder winter temperatures and the decreased frequency and intensity of summer fog in MLRA 4A. The colder temperatures and occasional snow favor Sitka spruce, which dominates most of the landscape within MLRA

4A, and the soils have a udic or perudic moisture regime. To the east of MLRA 4B, as the maritime influence decreases, precipitation increases, the freeze-free period decreases, and the area gradually transitions into MLRA 5 (Siskiyou-Trinity Area). To the south and southeast, as the maritime influence decreases, temperatures increase and precipitation decreases and the area gradually transitions into MLRA 15 (Central California Coast Range). The soils in MLRA 15 dominantly have a thermic temperature regime and a xeric moisture regime and support oak woodlands, oak savannas, chaparral, and grasslands.

Physiography

This MLRA lies within the Pacific Border province of the Pacific Mountain System. The northern one-third of this area lies within the Klamath Mountains section, and the rest of the area is in the California Coast Ranges section. The Klamath Mountains are an uplifted peneplain consisting of resistant rocks that have been eroded by numerous streams. These low mountains have numerous peaks of erosion-resistant rock. The California Coast Ranges consist of parallel ranges and valleys underlain by folded and faulted metamorphic rocks. Their peaks are rounded, and landslides are a dominant geomorphic process.

Elevation generally ranges from sea level to 2,600 feet (795 meters), but some peaks in the Coast Ranges are as high as 3,940 feet (1,200 meters). The Pacific Ocean borders this area on the west, and the Coast Ranges form the eastern edge. The MLRA is an area of steep mountainous terrain where low but steeply sloping mountains are dominant. Gently sloping marine terraces border the coast, and a few broad valleys extend inland through the mountains. This area is very hilly inland. Most of the coast is a rugged, steep mountain face 200 to 900 feet (60 to 275 meters) high.

Beaches occur at the mouth of rivers. The coast is eroding. Some isolated rocks and small islands are directly offshore. The Smith, Klamath, Mad, Eel, Mattole, Noyo, Navarro, Chetco, Winchuck, and Garcia Rivers and Redwood Creek discharge into the Pacific Ocean from this area.

Geology

The mountains in this MLRA consist primarily of contorted metamorphic rocks. Some igneous intrusives are in the Klamath Mountains. Serpentine is evident in many of the metamorphic units, and failure planes in landslides are common within the serpentine layers. Changes in sea level created marine terraces along the coast. The terraces consist of sand and gravel that originated as beach or alluvial fan deposits at the mouth of the major rivers.

Climate

The average annual precipitation typically ranges from 30 to 90 inches (762 to 2,286 millimeters), increasing with elevation inland. Most of the rainfall occurs during low-intensity, Pacific frontal storms. Precipitation is evenly distributed throughout fall, winter, and spring; summers are dry. Snowfall is rare along the coast, but snow accumulates at the higher elevations directly inland. Heavy fogs are common along the coast in summer. The average annual temperature is 51 to 60 degrees F (11 to 16 degrees C). The freeze-free period averages 300 days and ranges from 230 to 365 days, decreasing inland as elevation increases.

Water

Abundant precipitation and many perennial streams provide enough water for most needs. Rainfall is the source of water for most crops, but some high-value crops, such as lily bulbs, are grown under irrigation on the coastal terraces and on the flood plains a short distance inland from the mouths of major rivers. The drier valleys depend on streamflow from the mountains. The surface water supply is often short in summer, and farms located far from streams may require ground water supplements for irrigation. Surface water quality is generally good for all uses.

Ground water is plentiful in alluvial deposits along the major rivers and in coastal valleys. It is moderately hard or hard, generally of good quality, and suitable for most uses.

Soils

The dominant soil orders in the MLRA are Alfisols, Entisols, Inceptisols, and Ultisols. The soils in the area dominantly have an isomesic or mesic temperature regime; a udic, xeric, or ustic moisture regime; and mixed mineralogy. They generally are deep or very deep, well drained, and loamy or clayey and occur on mountain slopes and hills in addition to coastal plains and marine terraces. The dominant parent material is residuum weathered from sandstone.

The main soil series:

- Caperidge series—Humustepts that formed in colluvium and residuum from sandstone, mudstone, and metasedimentary rock on mountains
- Coppercreek series—Palehumults that formed in colluvium and residuum from schist, sandstone, and mudstone on mountains
- Dehaven series—Hapludalfs that formed in colluvium and residuum from sandstone on hills
- Dolason series—Humixerepts that formed in colluvium and residuum from sandstone and mudstone on mountains
- Hugo series—Dystrudepts that formed in colluvium and residuum from sandstone, shale, schist, and conglomerate rock on hills and mountains
- Ornbaun series—Haplustalfs that formed in colluvium and residuum from sandstone and mudstone on hills and mountains
- Slidecreek series—Palehumults that formed in colluvium and residuum from sandstone and mudstone on mountains

Sproulish series—Dystrudepts that formed in colluvium and residuum from sandstone, mudstone, and metasedimentary rock on mountains
Vandamme series—Haplohumults that formed in colluvium and residuum from sandstone and mudstone on marine terraces
Yellowhound series—Haplustalfs that formed in colluvium and residuum from sandstone and conglomerate rock on hills and mountains

Biological Resources

This area supports forest, coastal shrublands, and grassland vegetation. Redwood, Douglas-fir, grand fir, shore pine, Bishop pine, cypress, western redcedar, Port Orford cedar, red alder, Pacific rhododendron, tanoak, and Sitka spruce are the dominant tree species. Coyotebrush, bush lupines, seaside woolly sunflower, poison oak, and thimbleberry are the dominant shrub species. Dominant herbs include California oatgrass, tufted hairgrass, Pacific reedgrass, western fescue, Idaho fescue, California brome, blue wildrye, meadow barley, cowparsnip, blackberry, swordfern, redwood sorrel, and numerous other native perennial forbs. Soft chess, wild oats, bromes, filaree, burclover, gorse, Scotch broom, and pampas grass are typical annual and non-native species dominating altered areas throughout the MLRA.

Major wildlife species include Roosevelt elk, tule elk, marbled murrelets, bald eagles, spotted owls, black bears, and marine wildlife such as California sea lions, sea otters, sea birds, and many fish species.

Land Use

Most of this area consists of privately owned farms, ranches, and forests (fig. 4B-2). Lumbering is the major industry. About 14 percent of the area is grassland used for grazing. Cultivated land is in the valleys and along the coast. It is used mainly for forage and grain for dairy cattle. Vegetables, fruits (apples), and lily bulbs are grown where the soils and climate are favorable.

Because of steep slopes, erodible soils, and high rainfall, the major soil resource concern on uplands is erosion. The erosion hazard is severe if plant cover is removed. Mass movement in the form of landslides and slips is a serious concern and a major source of sediment in the rivers. Older or improperly designed roads also contribute sediment. Other management concerns include compaction resulting from farming activities, impacts on forest health (such as catastrophic wildfire), and maintenance of the content of soil organic matter.

Conservation practices on forestland generally include tree and shrub establishment, forest stand improvement, forest harvest trails and landings, critical area planting, and control of understory fuels. These practices improve forest health and water quality and reduce the impacts on wildlife. They also control erosion on access roads and protect riparian areas and fish habitat.

Conservation practices on rangeland and other grazing land generally include prescribed grazing, fencing, and water management. Conservation practices on cropland generally include activities that keep erosion within acceptable limits in the fields while protecting riparian areas and reducing the hazard of streambank erosion. Conservation practices on dairy farms generally include the proper containment and disposal of animal waste.

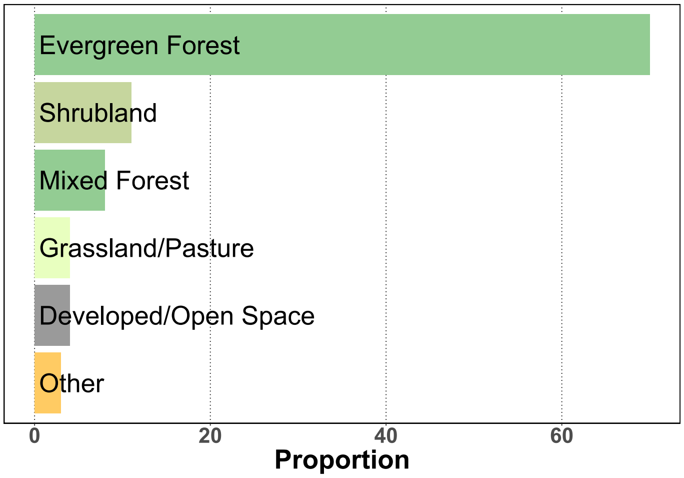

Figure 4B-2: Relative proportions (percentages) of land use in MLRA 4B.

5—Siskiyou-Trinity Area

MLRA 5 (fig. 5-1) is in California (63 percent) and Oregon (37 percent). It makes up about 20,842 square miles (53,981 square kilometers). The area is characterized by rugged, deeply dissected terrain with steep slopes and by abundant precipitation and hot, dry summers that result in lush, fire-prone forests. The soils dominantly have a mesic temperature regime, a xeric moisture regime, and mixed mineralogy. The principal land uses are recreation and commercial forestry. The mountains are underlain mainly by sandstone and shale.

To the west, MLRA 5 has a gradual boundary with MLRA 4B. The maritime influence increases and temperatures become moderate and cooler (isomesic), especially in summer when fog blankets much of the low-elevation terraces and mountains and allows species such as coast redwood to dominate. To the northwest, MLRA 5 has a gradual boundary with MLRA 1. The greater production of vegetation in MLRA 1, due to the more moderate summer temperatures, is noticeable. MLRA 1 commonly has low-intensity, Pacific frontal storms that evenly distribute precipitation throughout fall, winter, and spring and has summers that are cool and dry, whereas MLRA 5 receives most of the precipitation in winter and has hot, dry summers. Its soils are dominantly in a mesic or frigid temperature regime and a udic moisture regime. To the north and east, MLRA 5 has a distinct boundary with MLRA 3 along the Cascade Range, consisting primarily of andesite and basalt flows and some tuffs.

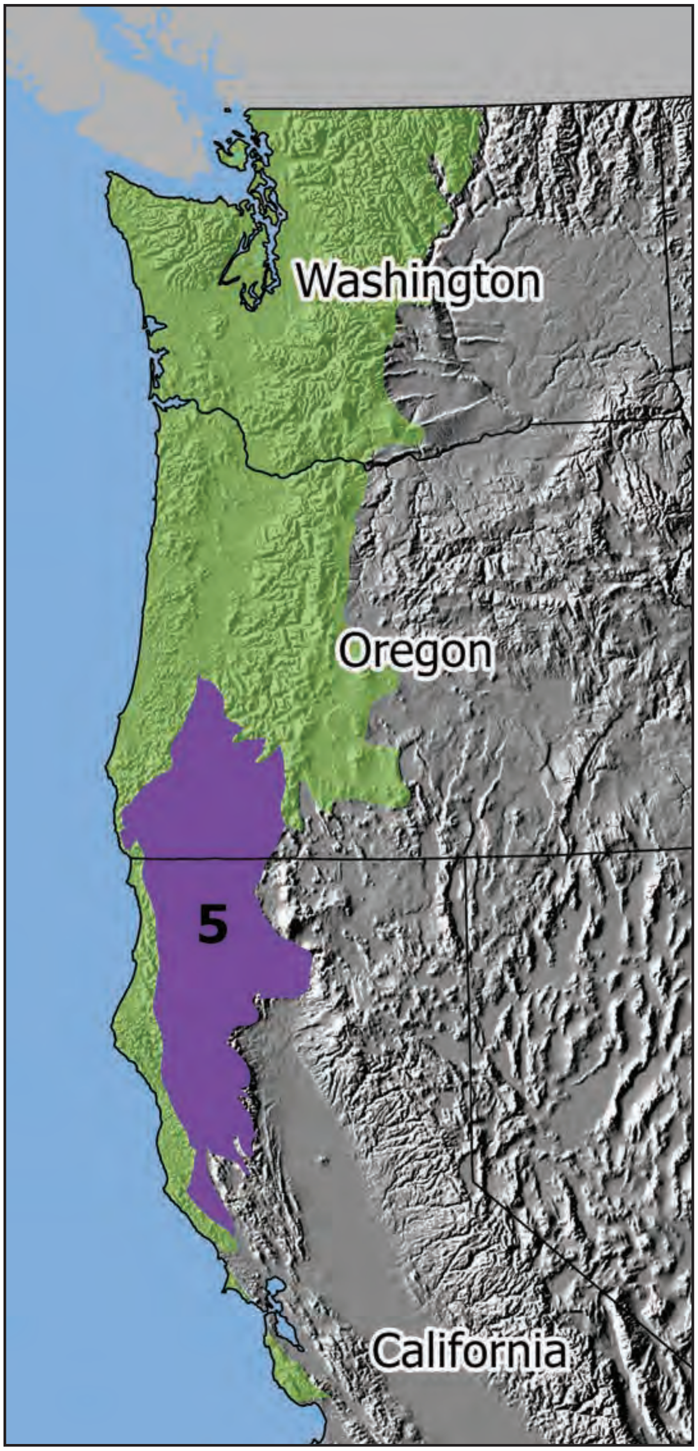

Figure 5-1: Location of MLRA 5, which covers 5,398,100 hectares (13,339,000 acres), within Region A.

MLRA 5 also has a distinct boundary with MLRAs 21 (Klamath and Shasta Valleys and Basins) and 22B (Southern Cascade Mountains), which have volcanic mountains and intermontane basins. To the south and east, MLRA 5 gradually transitions to MLRA 15, which has a warmer and drier climate and soils with a thermic temperature regime and supports oak woodlands, chaparral, and grasslands. Most of the land in MLRA 15 is used by the U.S. Forest Service; a small percentage consists of private land, mainly in farms and ranches.

Physiography

This MLRA lies within the Pacific Mountain System. The eastern half of the northern third of this area is in the Middle Cascade Mountains section of the Cascade-Sierra Mountains province. This section is an area of steep mountainous terrain with generally accordant summits interspersed with higher volcanic cones. The Klamath Mountains section of the Pacific Border province forms the western half of the northern third of this MLRA and also makes up most of the remaining area to the south. This section consists of an uplifted and eroded peneplain on very hard rocks. Numerous higher peaks are scattered throughout this mountainous region. The Trinity Alps and Marble Mountains are in the Pacific Border province. The southeast portion of this MLRA is in the California Coast Ranges section of this province. This section consists of parallel ranges and valleys underlain by folded and faulted metamorphic rocks. In this section, peaks are rounded and landslides are a dominant geomorphic process.

Elevation generally ranges from 330 to 6,000 feet (100 to 1,830 meters), but mountain peaks range to 9,037 feet (2,754 meters). Mountains are dominantly rounded but steeply sloping. They are underlain mainly by sandstone and shale. In some areas, they are underlain by granodiorite, gabbro, and other intrusive rocks. The narrow valleys have gently sloping flood plains and alluvial fans and are bordered by strongly sloping foothills. The Rogue River in Oregon and the Eel, Trinity, and Klamath Rivers in California are the largest rivers in this MLRA.

Geology

Most of this area consists of Mesozoic marine sandstones and shales. In some areas granodiorite, gabbro, and other intrusive rocks of the same age are dominant. Mesozoic ultramafic rocks also occur in this area. All of these rocks have been metamorphosed to some extent. An extensive area of older Paleozoic marine sediments occurs in the southern half of this MLRA. These marine sediments are cut by the Mesozoic volcanics common in the north. The rocks in the south have also been strongly metamorphosed.

Climate

The average annual precipitation in this MLRA is typically 32 to 89 inches (407 to 4,228 millimeters) but can be as low as 16 inches in some small areas and can range to 166 inches on average in high-elevation areas. Most of the rainfall occurs during low-intensity, Pacific frontal storms. Rain turns to snow at the higher elevations. Very little precipitation occurs in summer, when temperatures can be very high. Most of the precipitation occurs between November and April. The average annual temperature is 39 to 62 degrees F (4 to 17 degrees C), decreasing with elevation. The freeze-free period averages 240 days and ranges from 110 to 365 days. The shorter freeze-free periods occur at the higher elevations.

Water

The moderate to high precipitation provides enough water in the mountains and higher valleys for most needs. The mountains also supply irrigation water for the lower, drier valleys. The surface water is suitable for almost all uses.

There are no major aquifers in the Klamath Mountains or the Coast Ranges. Ground water is abundant, however, in alluvial deposits in most valleys. The surface water and ground water generally meet the recommended standards for all uses.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Ultisols. Xerolls are of minor extent on the grasslands. The soils in the area dominantly have a mesic temperature regime, a xeric moisture regime, and mixed mineralogy. They generally are moderately deep or deep, well drained, and loamy and occur on mountain slopes and hills.

The main soil series:

Beekman series—Dystroxerepts that formed in colluvium and residuum from altered sedimentary and extrusive igneous rocks on mountains

Burgsblock series—Palexeralfs that formed in colluvium and residuum from sandstone and mudstone on mountains

Casabonne series—Haploxeralfs that formed in colluvium and residuum weathered from sandstone or shale on mountains

Josephine series—Haploxerults that formed in colluvium and residuum from altered sedimentary and extrusive igneous rocks on mountains

Sanhedrin series—Haploxeralfs that formed in colluvium and residuum weathered from sandstone, shale, and siltstone on mountains

Sheetiron series—Dystroxerepts that formed in colluvium and residuum from mica-quartz schist on mountains

Siskiyou series—Dystroxerepts that formed in residuum and colluvium weathered from granitic bedrock on mountains

Vannoy series—Haploxeralfs that formed in colluvium weathered from metamorphic and sedimentary rocks on mountains

Vermisa series—Dystroxerepts that formed in colluvium and residuum from metasedimentary or metavolcanic rocks on mountains

Yorkville series—Argixerolls that formed in residuum and colluvium derived from chloritic schist, mudstone, and sandstone on mountains

Biological Resources

This area supports forest, open forest, shrubland, and grassland. Douglas-fir, ponderosa pine, sugar pine, incense cedar, white fir, red fir, tanoak, Oregon white oak, California black oak, canyon live oak, and Pacific madrone are all dominant tree species. Poison oak, snowberry, ceanothus, manzanita, and rose typically characterize the forest understory. Blue wildrye, fescues, bluegrass, mountain brome, and some browse species are in the understory in open stands of timber. Altered areas are dominated primarily by annual, non-native species, such as soft chess, wild oats, burclover, fescues, and bromes.

Major wildlife species include amphibians and reptiles along with black bear, mountain lion, mule deer, black-tailed deer, coyote, fox, raccoon, ring-tailed cat, porcupine, skunk, mink, squirrel, grouse, northern spotted owl, band-tailed pigeon, mountain quail, and California valley quail. Fish species include coho and king salmon, steelhead trout, and other trout.

Land Use

Most of this area is in coniferous forests (fig. 5-2), which are important for wood products, wildlife habitat, and recreation. About one-tenth of the area is grazed, and a smaller acreage is cropped. Production of livestock is the principal farm enterprise. Irrigated pasture, hay crops, and some truck crops are grown in the valleys where water is available. On the more sloping parts of the valleys, hay and pasture are grown as feed for livestock.

Because of steep slopes, erodible soils, and high rainfall, the major soil resource concern on uplands is erosion. The erosion hazard is severe if the plant cover is removed. Mass movement in the form of landslides and slips is a serious concern and a major source of sediment in the rivers. Older or improperly designed roads also contribute sediment. Other concerns include compaction from farming activities, impacts on forest health

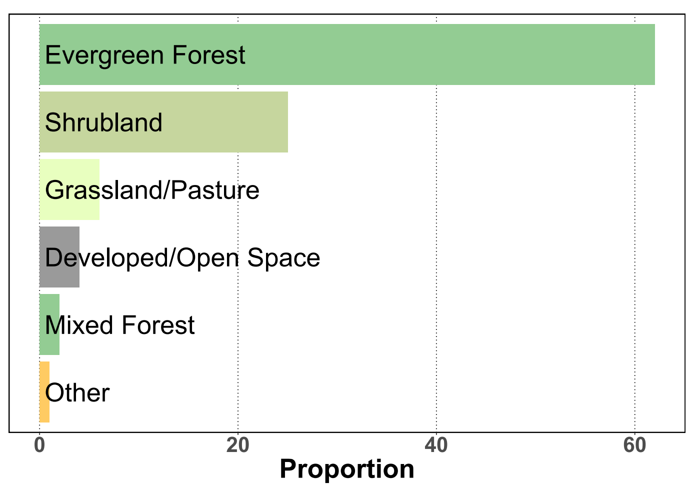

Figure 5-2: Relative proportions (percentages) of land use in MLRA 5.

(such as catastrophic wildfire), water quality, fish habitat, and maintenance of the content of soil organic matter.

Conservation practices on forestland generally include tree and shrub establishment, forest stand improvement, forest harvest trails and landings, critical area planting, and control of understory fuels. These practices improve forest health and reduce the impacts on wildlife. They also control erosion on access roads, protect riparian areas, and improve the habitat for fish.

Conservation practices on rangeland and other grazing land generally include prescribed grazing, fencing, and water management. Conservation practices on cropland generally include irrigation water management and nutrient management. The cropland and grazing land practices help to keep erosion within acceptable limits in the fields, protect riparian areas, and reduce the hazard of streambank erosion.

6—Cascade Mountains, Eastern Slope

This area (fig. 6-1) is in Oregon (52 percent) and Washington (48 percent). It makes up about 13,000 square miles (33,667 square kilometers). The forested eastern Cascade Mountains range from steep mountain slopes in the west to a dissected basalt plateau in the east. Plant communities are very diverse. They range from Oregon white oak near the Columbia River, to lodgepole pine on the pumice- and ash-mantled plateau, to Douglas-fir, grand fir, and ponderosa pine in the mountains. The northern portion of the area was impacted by glaciation, and the southern portion was impacted by the eruption of Mount Mazama (now Crater Lake) and subsequent deposition of ash and pumice. MLRAs 8 and 10, to the east, receive less precipitation and are predominantly rangeland with small, isolated areas of forest.

Physiography

About half of this MLRA, mostly south of the Columbia River in Oregon, is in the Walla Walla Plateau section of the Columbia Plateaus province of the Intermontane Plateaus. The southernmost tip of the MLRA is in the Great Basin section of the Basin and Range province of the Intermontane Plateaus. The Harney section of the Columbia Plateaus province lies between the Walla Walla Plateau and Great Basin sections in the southern end of this area. In Washington, almost all of this MLRA is in the Northern Cascade Mountains and Middle Cascade Mountains sections of the Cascade-Sierra Mountains province of the Pacific Mountain System. This mountainous area consists of sharp alpine accordant summits. MLRA 6 is a transitional area between the Cascade Mountains to the west and the lower lying Columbia Basalt Plateau to the east. It has some of the landforms typical of both the mountains and the plateau.

Elevations in this MLRA generally range from 900 to 8,000 feet (275 to 2,440 meters). Some mountain peaks approach 10,000 feet (3,050 meters). Strongly sloping mountains and U-shaped glaciated valleys are dominant in the north, and basalt plateaus are more typical in the south. A few isolated volcanic peaks occur in the Harney and Great Basin sections in the south. Many streams dissect the gently sloping crests

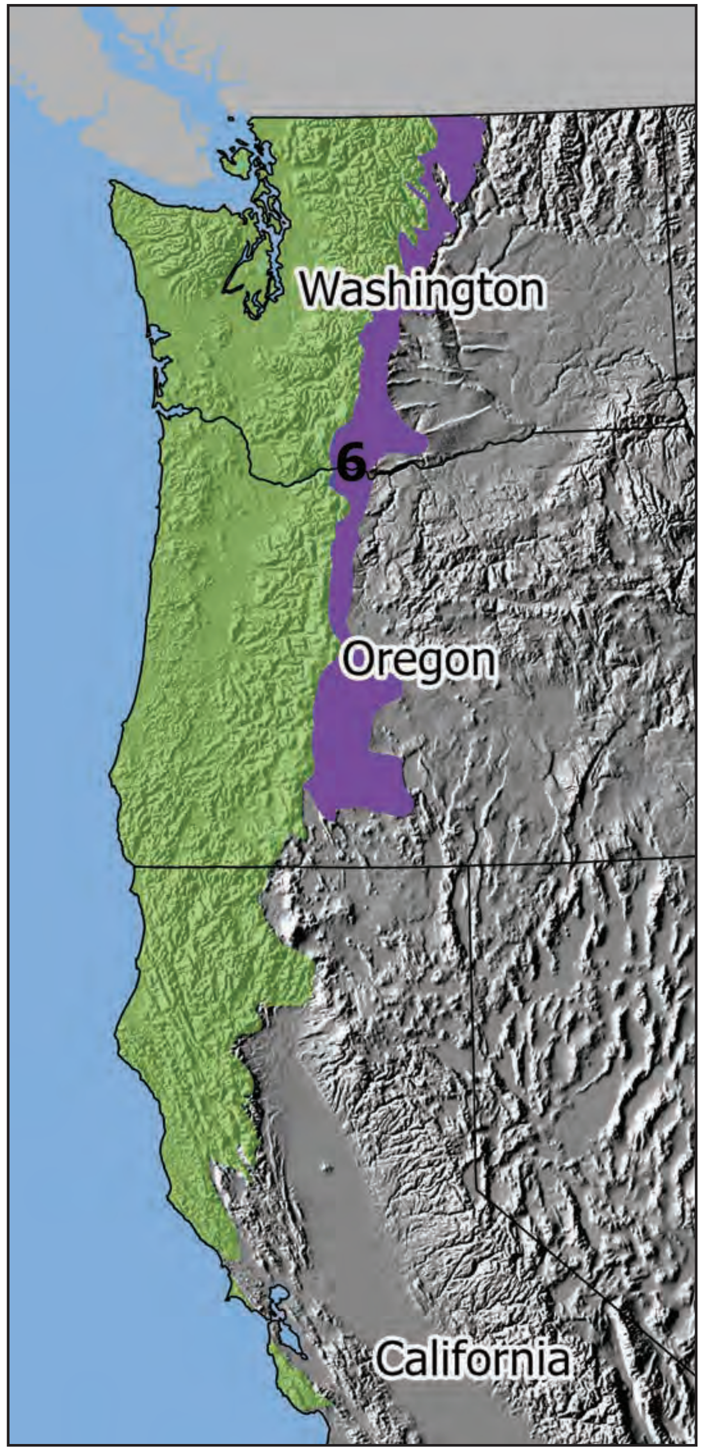

Figure 6-1: Location of MLRA 6, which covers 3,366,700 hectares (8,319,300 acres), within Region A.

and structural benches in the plateau sections. The Columbia River separates the north and south parts of this MLRA. The area includes the headwaters of a few streams in central Washington and Oregon.

Geology

The northern half of this MLRA consists of Pre-Cretaceous metamorphic rocks cut by younger igneous intrusive lithologies. Tilted blocks of marine shale, carbonate, and other sediments occur in the far north. Columbia River Basalt is the dominant lithology in the rest of the MLRA in both Washington and Oregon. The southern part of the area, south of Bend, Oregon, is blanketed by a very thick deposit of ash and pumice from the eruption of Mount Mazama (present-day Crater Lake). Isolated remnants of continental sediments occur within the expanse of basalt and andesite flows that make up the southern extent of the Cascade Range. Alpine glaciation has left remnants of glacial till, drift, and outwash in the northern part of this MLRA.

Climate

The average annual precipitation in most of this area is 15 to 50 inches (400 to 1,270 millimeters), generally increasing with elevation to the west. The lowest rainfall occurs along the eastern edge of the area, away from the mountains, where 12 to 15 inches (305 to 380 millimeters) per year is typical. The central part receives 15 to 45 inches (380 to 1,145 millimeters) per year. Most of the precipitation occurs during low-intensity, Pacific frontal storms in winter, spring, and fall. Summers are relatively dry. The average annual temperature is 37 to 45 degrees F (3 to 7 degrees C), decreasing with increasing elevation. The freeze-free period averages 100 days and ranges from 10 to 150 days. The shortest freeze-free periods occur along the western edge and at the northern and southern ends of this MLRA, which are mountainous. The longest freeze-free periods occur in the central part of the area, along the Columbia River Gorge.

Water

Precipitation and perennial streams provide ample surface water. Perennial streams and reservoirs supply water to the drier and lower lying MLRAs to the east. Surface water runoff is dominated by snowmelt, and water quality is good to excellent.

Almost all of the northern half of this MLRA and the western part of the southern half consist of rock units that are not aquifers. Most of the supplies of ground water are untapped. Irrigation water for cropland on valley floors can be pumped from river alluvium in Washington and from alluvium and basin fill deposits in Oregon. The Grand Ronde and Wanapum aquifers are in the Columbia River Basalt Group in Washington, directly north of the Columbia River. The basalt aquifer consists of five different units in Oregon, directly south of the Columbia River. Most of the southern half of this MLRA is underlain by the volcanic and sedimentary aquifer group in Oregon. Ground water is of good quality and has low levels of dissolved solids. The basalt aquifers provide hard or moderately hard water.

Soils

The dominant soil orders in this MLRA are Alfisols, Andisols, Inceptisols, and Mollisols. The Andisols and Inceptisols in this area are similar to the soils to the west, and the Mollisols in the area are more typical of the soils to the east. The soils in the MLRA dominantly have a mesic, frigid, or cryic temperature regime, a xeric moisture regime, and mixed or glassy mineralogy. They generally are moderately deep to very deep, well drained, and loamy or ashy. This MLRA has extensive areas where andesite and basalt crop out.

The main soils and their series:

- Argixerolls that formed in colluvium and residuum with an influence of loess and tephra (Sapkin series)
- Haplocryepts that formed in tephra over glacial sediments (Myerscreek series)
- Haploxeralfs that formed in tephra and loess over colluvium and residuum (Nard series)
- Haploxerepts that formed in tephra, loess, and colluvium (Jumpe and Wamic series)
- Vitricryands that formed in tephra or tephra over buried soils (Lapine and Shanahan series)
- Vitrixerands that formed in tephra over colluvium or glacial sediment (Nevine, Singh, Smiling, and Wanoga series)

Biological Resources

This area is dominated by conifer forest and, to a lesser extent, rangeland. The kind of vegetation gradually changes with increases in elevation and precipitation. Important species on rangelands at the lowest elevations are bluebunch wheatgrass, Sandberg bluegrass, big sagebrush, antelope bitterbrush, Idaho fescue, and Cusick's bluegrass. The dominant tree species in forested areas are ponderosa pine, Douglas-fir, grand fir, white fir, and western larch. Subalpine fir, lodgepole pine, and whitebark pine are at the highest elevations. Oregon white oak occurs in the south and central portions of the MLRA near the Columbia River Gorge. Understory species include vine maple, hazelnut, snowberry, oceanspray, Oregon grape, lupine, antelope bitterbrush, pinegrass, and green manzanita.

Major wildlife species include black bear, Rocky Mountain elk, mule deer, coyote, cougar, bobcat, rabbit, turkey, blue grouse, California quail, dove, and songbirds. The area has several species of trout and salmon.

Land Use

About one-half of this area is in privately owned farms, ranches, and woodland. Most of the area is coniferous forest (fig. 6-2). Timber production and recreation are important industries. About one-tenth of the area supports grasses and is used for grazing. Some of the forested areas are grazed by

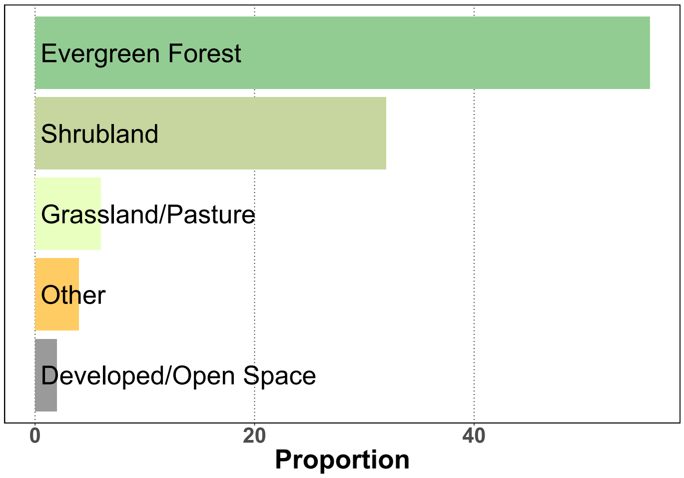

Figure 6-2: Relative proportions (percentages) of land use in MLRA 6.

cattle. A very small area in the valleys is cropland, most of which is irrigated. Crops include tree fruits, small grains, and forage crops.

The major soil resource concerns are wind erosion and water erosion, surface compaction, sedimentation of streams and road ditches, and maintenance of the content of soil organic matter. Surface water quality also is a concern.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams.

Conservation practices on cropland are used to help control erosion and protect water quality. They generally include cover crops, conservation crop rotations, crop residue management, waste utilization, nutrient management, pest management, filter strips, grassed waterways, and irrigation water management.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water.

Figure B-1: Location and size of Land Resource Region B, which covers 217,890 square kilometers (84,130 square miles) and extends from the Snake River Plain of Idaho northwest across Oregon into the Palouse loess region of eastern Washington.

B—Northwestern Wheat and Range Region

Land Resource Region B (fig. B-1) corresponds approximately to the Columbia Plateaus physiographic province, whose most distinctive feature is the extensive lava fields, with the exceptions of MLRA 12 north of the Snake River Plain and a similar protruding area of MLRA 17 to the south. It is a semiarid region with annual rainfall typically less than 20 inches (500 millimeters). With the exception of some areas of Basin and Range topography in Idaho (fig. 1, page 5), Region B generally consists of smooth to deeply dissected basaltic plains and plateaus and well developed terraces along the Snake River. The basalt is covered with a veneer of loess and volcanic ash in most areas. Loess deposits are substantial in the Palouse region of eastern Washington. Region B contains seven major land resource areas. The extent of these MLRAs and their range in elevations are shown in table B-1.

The boundaries between Region B and Regions E and A (fig. 1) are physio-climatic, marking the change from the drier lowlands of shrubs and grasslands in Region B to the steep-sided forested mountains in Regions E and A (see Introduction, figs. 6, 7, and 8). These bioclimatic conditions also result in abrupt changes in soils, especially along the contact between Regions B and A (fig. 2, page 6). The boundary between Regions B and D, to the south, is primarily geological. It reflects the change from Basin and Range north-south-trending mountain ranges of various lithologies to the prevalence of flood basalts of the Columbia Plateaus as well as an increase in cropland on the Snake River Plain (fig. 8).

The climate in Region B produces a mesic and frigid soil temperature regime in most areas, with a cryic temperature regime in the mountains. Almost all of the soils have a xeric or aridic moisture regime. The average annual precipitation is 6 to 20 inches (150 to 510 millimeters) in most of the region. It is lowest in the Columbia Basin area in central Washington and in valleys in Oregon, in southeastern Idaho, and south of the Snake River in Idaho. However, precipitation can be as high as 45 to 85 inches (1,145 to 2,160 millimeters) in the mountains. Summers are dry. The average temperature is 40 to 49 degrees F (5 to 10 degrees C) in most of the region, but it ranges from 27 to 55 degrees F (-3 to 13 degrees C). In most areas the freeze-free period averages 160 days and ranges from 125 to 220 days. It is typically 40 to 70 days in the mountains. Temperatures

Table B-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10^{th} percentile		50^{th} percentile		90^{th} percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
7	16,535	6,385	20	70	130	450	250	830	380	1,240	900	2,970
8	50,100	19,345	40	160	350	1,160	560	1,840	830	2,730	1,510	4,970
9	24,765	9,560	160	530	550	1,810	800	2,620	1,270	4,180	2,390	7,840
10	44,675	17,250	330	1,090	840	2,780	1,200	3,930	1,600	5,240	2,820	9,260
11	45,775	17,675	620	2,050	780	2,550	1,290	4,260	1,550	5,080	2,470	8,130
12	15,725	6,070	1,100	3,610	1,600	5,260	2,050	6,740	2,690	8,830	3,850	12,630
13	20,310	7,840	1,270	4,190	1,520	5,010	1,800	5,920	2,040	6,720	2,850	9,370

Table B-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10^{th} percentile		50^{th} percentile		90^{th} percentile		High		Shortest	10^{th} percentile	50^{th} percentile/ mean	90^{th} percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
7	8.2	47	10.3	51	11.4	53	12	54	12.6	55	145	175	188/190	206	230
8	4.7	40	8.2	47	9.5	49	11.1	52	12.6	55	115	151	170/170	195	240
9	3	37	7.1	45	8.5	47	10.4	51	12.8	55	75	130	151/155	182	220
10	2.1	36	6.2	43	8.1	47	9.7	49	11.8	53	55	93	128/125	159	210
11	4.4	40	6	43	8.7	48	10.7	51	11.8	53	90	111	143/140	163	210
12	-3	27	1.5	35	3.9	39	5.9	43	7.7	46	35	66	88/90	117	150
13	2.4	36	4.3	40	5.8	42	7.7	46	9.1	48	70	86	113/115	138	150

Table B-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10^{th} percentile		50^{th} percentile/mean		90^{th} percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
7	150	6	189	7	216/225	9/9	275	11	480	19
8	180	7	236	9	308/320	12/13	418	16	1,110	44
9	280	11	392	15	486/505	19/20	635	25	1,330	52
10	190	8	276	11	358/395	14/15	569	22	1,030	40
11	160	6	224	9	264/270	10/11	310	12	810	32
12	160	6	229	9	386/425	15/17	700	28	1,210	47
13	250	10	324	13	455/465	18/18	626	25	1,010	39

and precipitation for this region are shown in figures 6 and 7. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables B-2 and B-3.

Soils in this semiarid shrubland-grassland region are dominantly Mollisols. Aridisols are in the drier areas (figs. 2 and 6). The Mollisols and Aridisols formed in a deep mixture of loess and ash deposits overlying the basalt flows. Other soil orders include Entisols on young eolian and fluvial deposits, and relatively minor areas of Alfisols, Andisols, and Inceptisols. Calcium carbonate is common in these soils (fig. 5, page 9). Many areas have soils with restrictive paralithic and lithic zones and duripans (see Introduction, figs. 9 and 11). Argillic horizons reflect the locations of stable geomorphic surfaces (fig. 12, page 16). The highest amounts of organic carbon occur in the soils of the higher elevation forests (fig. 14, page 18).

Land use in this region is primarily a mixture of grazing land and cropland (figs. B-2 and 8). A few very small areas are forested. Wheat grown by dryfarming methods is the major crop in the region, but alfalfa, corn, oats, barley, lentils, and peas also are important. Fruits, mainly apples, are a major crop in the western part of the region. Potatoes, sugar beets, beans, and forage crops are grown under irrigation in the central

Columbia Basin in Washington and along the Snake River in Idaho. Ground water is obtained from basalt aquifers and from alluvium in river valleys. A variety of specialty crops are grown in local areas, including vegetables, vegetable seeds, mint, and hops. Grazing is the major land use in the drier parts of the region. Water erosion, wind erosion, surface compaction, maintenance of the content of soil organic matter and tilth, and conservation of soil moisture are major resource management concerns on cropland. Overgrazing and invasion of undesirable plant species are resource management concerns on grazing lands.

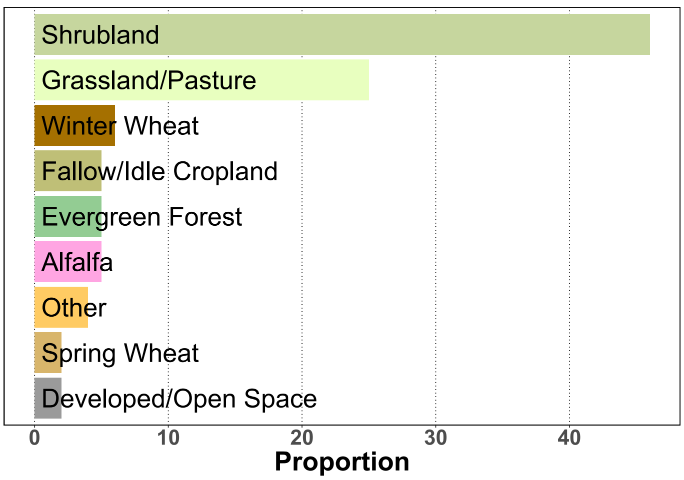

Figure B-2: Relative proportions (percentages) of land uses in Land Resource Region B (National Agricultural Statistics Service, 2018).

7—Columbia Basin

This area (fig. 7-1) is in Washington (81 percent) and Oregon (19 percent). It makes up about 6,385 square miles (16,537 square kilometers). It is characterized by very thick, coarse textured alluvium deposited by glacial outburst flooding during the Pleistocene Epoch. The age of the most recent deposits is between about 13,000 to 15,000 years before present.

Physiography

This MLRA is in the Walla Walla Plateau section of the Columbia Plateaus province of the Intermontane Plateaus. Elevation ranges from 300 to 2,000 feet (90 to 610 meters) above sea level, but most of the area ranges from 300 to 1,200 feet (90 to 365 meters). In general, the area is comprised of scoured valleys within the basalt plateau that were subsequently filled with flood sediments.

The Columbia River flows through this MLRA, and the Snake and Yakima Rivers join the Columbia River within it. The Deschutes, John Day, and Umatilla Rivers enter the Columbia River on the Oregon side in this area.

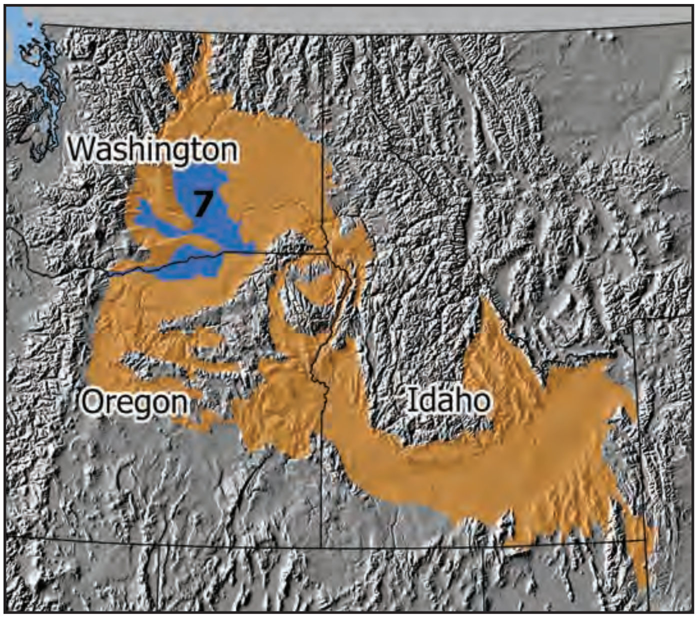

Figure 7-1: Location of MLRA 7, which covers 1,653,700 hectares (4,086,300 acres), within Region B.

Geology

This MLRA is almost entirely underlain by Miocene basalt flows. Columbia River Basalt is covered in most areas with as much as 200 feet of eolian, lacustrine, and alluvial deposits. The basin generally corresponds to the vast temporary lakes created by floodwaters from glacial Lakes Missoula and Columbia during the Pleistocene Epoch. These glacial lakes were created by the damming of Columbia River tributaries by advancing glaciers. When the glacial dams failed, cataclysmic floods were released. This was a repeating cycle during the Pleistocene.

Climate

The average annual precipitation is 6 to 10 inches (150 to 255 millimeters) in most of this area, but it can be as high as 20 inches (150 to 255 millimeters) in the southwest and southeast portions near the Cascade or Blue Mountains. This MLRA is the warmest and driest within the Columbia Plateau geographic area. Two-thirds of the precipitation occurs in winter during low-intensity, Pacific frontal storms. The winter precipitation typically occurs as a mixture of rain and snow. Summers are dry. The average annual temperature is 47 to 53 degrees F (8 to 12 degrees C). In most of this area, the freeze-free period averages 170 days and ranges from 150 to 200 days.

Water

This area is in the rain shadow of the Cascade Mountains. Irrigation is necessary for production of agricultural crops. The Columbia, Yakima, and Snake Rivers supply large quantities of surface water for irrigation. Surface water runoff is dominated by snowmelt, and water quality is good to excellent. Most of the irrigation water is diverted from the natural river channels or is pumped to a higher elevation and delivered to individual farms by gravity flow. Some high salt loads occur in irrigation return flows. Surface water is scarce in all nonirrigated areas.

Although ground water supplies have increased since irrigation became established in the area, they are largely untapped. The principal aquifer within this MLRA is Columbia River Basalt, which consists of three units in Washington called the Grand Ronde, Wanapum, and Saddle Mountain. The Grand Ronde aquifer occurs primarily in the west, along the Yakima River, and in the southeast, along the Snake River. The Wanapum and Saddle Mountain aquifers occur in most of the rest of the MLRA. The basalt aquifer in Oregon consists of five different groups. The basalt aquifers provide almost all of the domestic water supply on the Columbia Plateau. The Columbia Plateau unconsolidated aquifer is under a large area around Moses Lake. This aquifer consists of glacial drift and terrace and valley fill sediments. The aquifers in Oregon occur in areas of river valley alluvium and basin fill. Ground water is of good quality and has low levels of dissolved solids. It is hard or moderately hard. Applications of fertilizer in agricultural areas are creating high nitrate levels in some wells. Ground water beneath the Hanford Atomic Energy Reservation has been degraded by industrial spills and seepage.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The soils in the area dominantly have a mesic temperature regime, an aridic moisture regime, and mixed mineralogy. They generally are moderately deep to very deep and well drained to excessively drained.

The main soils and their series:

- Haplocalcids that formed in eolian sediments (Adkins and Sagehill series)
- Haplocambids that formed in alluvium or loess (Malaga, Shano, and Warden series)
- Haplodurids that formed in loess and alluvium (Burke and Tuanton series)
- Torriorthents that formed in alluvium (Burbank series); that formed in lacustrine sediments (Kennewick series)
- Torripsamments that formed in alluvium or eolian sands (Quincy series)

Biological Resources

This area supports shrub-grass associations. Basin big sagebrush, Wyoming big sagebrush, and bluebunch wheatgrass are the dominant species on the medium textured soils. Bitterbrush and needle and thread are abundant on the sandy soils. Very shallow soils support stiff sagebrush and Sandberg bluegrass. Inland saltgrass, basin wildrye, and greasewood grow on saline-alkali soils. Major wildlife species include coyote, hawks, eagles, prairie falcon, sharp-tailed grouse, sage grouse, gray partridge, California quail, and burrowing owl.

Land Use

About two-fifths of this area supports native grasses and shrubs grazed by cattle (fig. 7-2). Another two-fifths is irrigated cropland used for fruits, vegetables, sugar beets, hops, grain, hay, and pasture. Less than one-tenth of the area is urban.

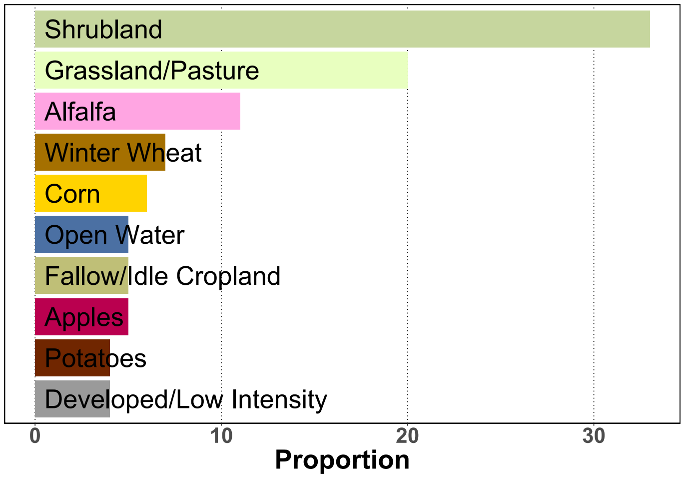

Figure 7-2: Relative proportions (percentages) of land use in MLRA 7.

The major soil resource concerns on cropland are wind erosion, water erosion, and maintenance of the content of soil organic matter. The major concerns on rangeland are overgrazing and invasion of undesirable plant species.

Conservation practices on cropland generally include conservation crop rotations, crop residue management, waste utilization, nutrient management, pest management, filter strips, and irrigation water management. These practices help to control erosion and protect water quality.

Conservation practices on rangeland generally include brush management, prescribed grazing, prescribed burning, exclusion from use as needed, and range planting. Rangeland conservation systems help to control erosion, improve forage production, and protect water quality.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water.

8—Columbia Plateau

MLRA 8 (fig. 8-1) is primarily in Washington (75 percent) and Oregon (25 percent), but it includes a small area in Idaho. It makes up about 19,344 square miles (50,100 square kilometers). This MLRA is characterized by loess hills, surrounding scablands, and alluvial deposits.

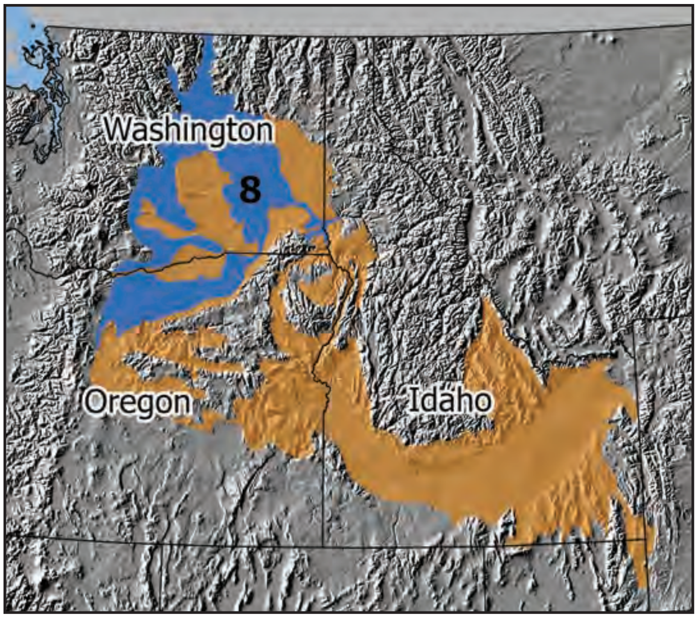

Figure 8-1: Location of MLRA 8, which covers 5,010,000 hectares (12,379,900 acres), within Region B.

Physiography

Almost all of this area lies within the Walla Walla Plateau section of the Columbia Plateaus province of the Intermontane Plateaus. The plateau is nearly level to steeply sloping, and its surface is a series of hills with incised valleys. Some of the western and far northwestern parts of this MLRA lie within the Northern Cascade Mountains and Middle Cascade Mountains sections of the Cascade-Sierra Mountains province of the Pacific Mountain System. Some of the far northern and northeastern parts of the MLRA are within the Northern Rocky Mountains province of the Rocky Mountain System. The valley of the south-flowing Okanogan River separates the Pacific Mountain System from the Rocky Mountain System near the Canadian border.

Elevation is 1,300 to 3,600 feet (395 to 1,100 meters). The area is characterized by a nearly level basalt plateau. The higher elevations occur along its western and northernmost edges. Steep slopes are common along the edges of the major valleys and in scablands.

The south- and west-flowing Columbia River bisects this area. Two major tributaries of the Columbia, the Yakima and Snake Rivers, cross the middle portion of this MLRA. The Deschutes and John Day Rivers enter the Columbia River from the Oregon side.

Geology

This MLRA is almost entirely underlain by Miocene basalt flows. Columbia River Basalt is covered in many areas with as much as 200 feet of loess and volcanic ash. Small areas of sandstones, siltstones, and conglomerates of the Upper Tertiary Ellensburg Formation are along the western edge of this area. Some Quaternary glacial drift covers the northern edge of the basalt flows, and some Miocene-Pliocene continental sedimentary deposits occur south of the Columbia River, in Oregon. The sediments in Oregon were deposited during episodes of natural damming of the Columbia River. These river-laid deposits have layers of ash-flow tuffs and some interbedded rhyolite flows. A wide expanse of scablands in the eastern portion of this MLRA, in Washington, was deeply dissected by cataclysmic glacial outburst floods during the Pleistocene Epoch.

The geology of the northernmost part of this MLRA is distinctly different from that of the rest of the area. Alluvium, glacial outwash, and glacial drift fill the valley floor of the Okanogan River and the side valleys of tributary streams. The fault parallel with the valley separates Pre-Tertiary metamorphic lithologies to the west, in the Cascades, from older, Pre-Cretaceous metamorphic lithologies to the east, in the Northern Rocky Mountains.

Climate

The average annual precipitation is 9 to 15 inches (230 to 380 millimeters) in most of this area. It can be as low as 6 inches (150 millimeters) along the boundary with the drier MLRA 7 and as high as 20 inches (510 millimeters) in the foothills in the valley of the Okanogan River. More than 80 percent of the precipitation occurs in fall, winter, and spring during low-intensity, Pacific frontal storms. The precipitation typically occurs as rain in fall and spring but may occur as either rain or snow in winter. The average annual temperature is 45 to 52 degrees F (7 to 11 degrees C) in most of the area. It can be as low as 41 degrees F (5 degrees C) in the valley of the Okanogan River. In most areas the freeze-free period averages 140 days and ranges from 100 to 170 days.

Water

This area is in the rain shadow of the Cascade Mountains. The low or moderate precipitation limits the choice of agricultural enterprises. The major rivers provide water for irrigation along their courses, but small streams provide little water. Surface water runoff is dominated by snowmelt, and water quality is good to excellent. Some high salt loads occur in irrigation return flows.

The principal aquifer in the northernmost part of this MLRA is the Northeast glacial drift aquifer underlying the valley of the Okanogan River. Some ground water is derived from small areas of glacial drift and terrace-and-valley or basin fill aquifers along the western edges of the MLRA and south of the Columbia River, in Oregon. In the rest of the MLRA, the supplies of ground water in the underlying basalt are small and mostly untapped. The Columbia River Basalt aquifer consists of three units in Washington called the Grand Ronde, Wanapum, and Saddle Mountain. The Grand Ronde occurs in the west, the Wanapum dominates the east, and the Saddle Mountain lies between the other two. The basalt is not differentiated in Oregon. Ground water is of good quality and has low levels of dissolved solids. The basalt aquifers provide almost all of the domestic water supply on the Columbia Plateau. The water is hard or moderately hard. Applications of fertilizer in agricultural areas are creating high nitrate levels in some wells.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic temperature regime, a xeric moisture regime, and mixed mineralogy. They generally are moderately deep to very deep, well drained, and loamy.

The main soils and their series:

- Argixerolls that formed in loess (Renslow series)
- Durixerolls that formed in glacial till mixed with volcanic ash and loess (Touhey series)
- Haploxerolls that formed in alluvium, loess, colluvium, and residuum from basalt or rhyolite (Bakeoven, Condon, Esquatzel, Lickskillet, Mikkalo, Ritzville, Roloff, and Walla Walla series)

Biological Resources

This area supports shrub-grass associations. Basin big sagebrush, Wyoming big sagebrush, and bluebunch wheatgrass are dominant on the moderately deep to very deep, gently sloping and moderately sloping soils and on soils that have steep and very steep southern exposures. Basin big sagebrush and Idaho fescue are dominant on most moist sites and on moderately steep to very steep northern exposures. Stiff sagebrush, low sagebrush, and Sandberg bluegrass are dominant on shallow and very shallow, stony soils. Small stands of ponderosa pine, along with oak on the warmer sites along the Columbia River, are on north-facing slopes, in canyons and draws, and along stream channels. Dwarf hardwoods of hackberry and maple also grow in canyons and draws. Snowberry is the most common shrub in the pine stands. Poison oak is the most common shrub in the oak stands.

Major wildlife species include mule deer, coyote, bobcat, goshawk, Cooper’s hawk, sharp-tailed grouse, pheasant, Canada goose, cackling goose, English sparrow, and dusky horned lark. Fish species include steelhead trout, rainbow trout, brown trout, Chinook salmon, bullhead, channel catfish, and sturgeon.

Land Use

More than two-fifths of this area is cropland (fig. 8-2), which is mostly dry-farmed. Where the annual precipitation is less than about 14 inches (355 millimeters), a 2-year rotation of small grains and summer fallow is commonly used. Some producers use a 3-year rotation, such as winter wheat-spring barley-fallow, or plant a crop every year. Small areas along the major streams are used for irrigated vegetables, apples, or hay. Less than one-half of the area is used as rangeland. A few small areas are used as woodland.

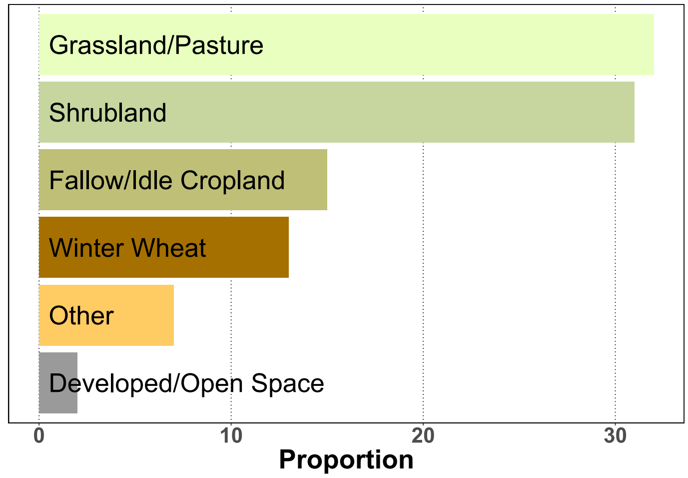

Figure 8-2: Relative proportions (percentages) of land use in MLRA 8.

The major soil resource concerns on cropland are wind erosion, water erosion, sedimentation of streams and road ditches, and maintenance of the content of soil organic matter and tilth. The major concerns on rangeland are overgrazing and invasion of undesirable plant species.

Conservation practices on cropland generally include conservation crop rotations, crop residue management, terraces, waste utilization, nutrient management, pest management, filter strips, grassed waterways, and irrigation water management. These practices help to control erosion and protect water quality. Conservation practices on rangeland generally include brush management, prescribed grazing, prescribed burning, exclusion from use as needed, and range planting.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, erosion caused by concentrated flow, and sediment delivery to streams.

9—Palouse and Nez Perce Prairies

This area (fig. 9-1) is in Washington (46 percent), Oregon (30 percent), and Idaho (24 percent). It makes up about 9,561 square miles (24,763 square kilometers). The area is characterized by loess hills over a basalt plateau. A large source of the loess is glacial outburst flood deposits, which are upwind (to the southwest) in MLRA 7.

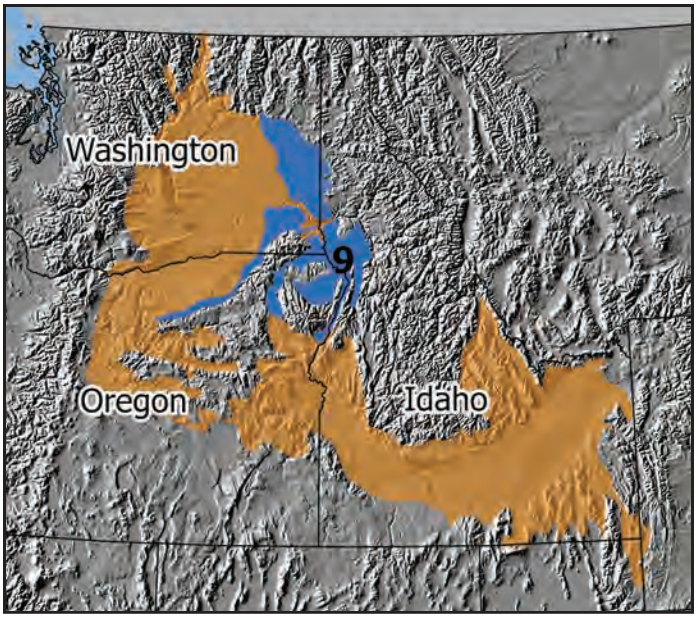

Figure 9-1: Location of MLRA 9, which covers 2,476,300 hectares (6,119,000 acres), within Region B.

Physiography

Almost all of this MLRA lies within the Walla Walla Plateau section of the Columbia Plateaus province of the Intermontane Plateaus. The area consists of an undulating basalt plateau that has been highly dissected. The major streams have cut deep, steep-walled canyons. The plateau is nearly level to steeply sloping, and its surface is moderately dissected or strongly dissected. Slopes are mostly hilly and steep. Some areas in the southeastern portion of this MLRA are in the Blue Mountain section of the Columbia Plateaus province. Small areas on the eastern edge of the MLRA are in the Northern Rocky Mountains province of the Rocky Mountain System. Elevation along the major streams is about 650 feet (200 meters). On most of the plain, however, it ranges from 2,000 to 4,000 feet (610 to 1,220 meters).

The Snake River flows through the center of this MLRA, where it forms the border between Washington and Idaho and between Oregon and Idaho. The Spokane River forms part of the northern boundary of the MLRA.

Geology

This MLRA is almost entirely underlain by Miocene basalt flows. Columbia River Basalt is covered in many areas by thick layers of loess and volcanic ash. Some Mesozoic sedimentary rocks occur along the eastern edge of the southeast limb of this MLRA, and some Precambrian sediments are exposed in a portion of the MLRA in the southeast corner of Washington.

Climate

The average annual precipitation is 13 to 28 inches (330 to 710 millimeters) in most of this area. It can be as low as 9 inches (230 millimeters) along parts of the western border and as high as 43 inches (1,090 millimeters) along the southern border, where the area abuts MLRAs that are much higher in elevation. Winter precipitation, primarily snow, occurs during low-intensity, Pacific frontal storms. In winter, these storms produce occasional rains that fall on frozen or thawing ground. High-intensity, convective thunderstorms produce some rain during the growing season. Precipitation is evenly distributed throughout fall, winter, and spring. Summers are relatively dry.

The average annual temperature is 47 to 54 degrees F (8 to 12 degrees C) in most of this area, but it can be as low as 40 degrees F (5 degrees C) at the higher elevations in the south. Including the extremes at the edges of this MLRA, the freeze-free period averages 165 days and ranges from 100 to 230 days.

Water

Precipitation is adequate for dryland farming. The Snake River and many of the smaller rivers and streams provide water for irrigation and hydroelectric power generation. Surface water runoff is dominated by snowmelt, and water quality is good to excellent. Some high sediment and salt loads occur during high runoff periods and in irrigation return flows. Runoff from mine tailings and from municipal and industrial waste impacts surface water quality in some areas.

The principal aquifer in this MLRA is Columbia River Basalt. The basalt has layers of tuffaceous sediments that also yield ground water. Some ground water is derived from small areas of glacial drift and terrace-and-valley or basin fill deposits. The Columbia River Basalt aquifer consists of three units in Washington called the Grand Ronde, Wanapum, and Saddle Mountain, all of which occur in this MLRA. The basalt is not differentiated in Idaho or Oregon. The ground water is of good quality, has low levels of dissolved solids, and is hard or moderately hard.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic or frigid temperature regime, a xeric moisture regime, and mixed mineralogy. They are generally deep or very deep, well drained or moderately well drained, and loamy.

The main soils and their series:

Argialbolls that formed in loess (Nez Perce series)

Argixerolls that formed in loess on hills and plateaus (Larkin and Southwick series); that formed in ash-mantled loess on plains and plateaus (Taney series); that formed in loess-mantled outwash (Hesseltine series); that formed in colluvium and residuum from basalt and loess (Gwin, Naff, Thatuna, and Waha series)

Haploxerolls that formed in loess in glaciofluvial deposits with an ash and loess mantle, on uplands (Cheney series); that formed in loess and ash mixed with residuum and colluvium from basalt, andesite, or welded tuff (Anatone, Athena, Bocker, Palouse, and Rockly series)

Biological Resources

This area supports grass, shrubs, and trees. The rangeland supports a shrub-grassland plant community in which the dominant shrub is snowberry in the eastern part of the MLRA and big sagebrush in the western part. Bluebunch wheatgrass and Idaho fescue are the dominant grasses. Rose, common cowparsnip, black hawthorn, and arrowleaf balsamroot also are common. On forestland, ponderosa pine and Douglas-fir are the major tree species and the understory is mainly snowberry, ninebark, Idaho fescue, bluebunch wheatgrass, and pinegrass. Major wildlife species include deer, California quail, mourning dove, thrushes, vireos, and woodpeckers.

Land Use

Some small areas of forestland are on north-facing slopes. The rangeland is on breaks, scablands, and buttes. Dry-farmed wheat is the major crop. Both annual cropping and fallow systems are common. Other important crops are barley, peas, lentils, alfalfa, and grasses. A small part of the cropland is irrigated and used for vegetables and other specialty crops. A few small areas are developed for urban uses (fig. 9-2).

The major soil resource concerns are water erosion and maintenance of the content of soil organic matter. Water erosion caused by snowmelt or rainfall when soils are frozen or thawing is of particular concern. The major concerns on rangeland are overgrazing and invasion of undesirable plant species.

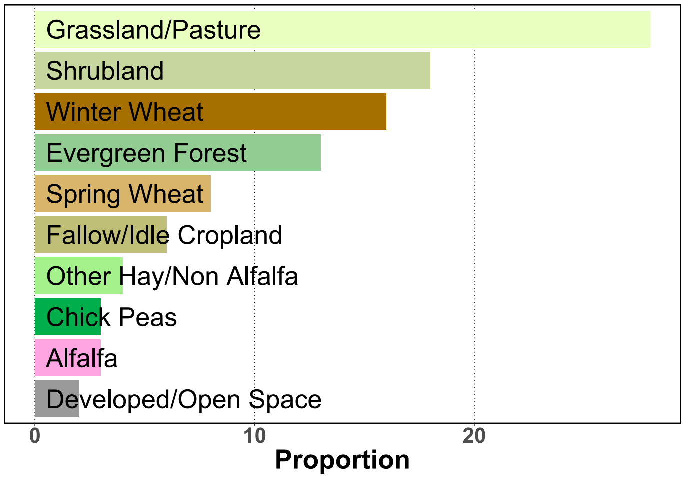

Figure 9-2: Relative proportions (percentages) of land use in MLRA 9.

Conservation practices on cropland generally include conservation crop rotations; crop residue management systems, such as mulch-till and no-till; terraces; contour stripcropping; cross-slope farming; divided slopes; buffer strips; water- and sediment-control basins; grassed waterways; nutrient management; pest management; and irrigation water management. These practices help to control erosion and protect water quality. Conservation practices on rangeland generally include brush management, prescribed grazing, prescribed burning, exclusion from use as needed, and range planting.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams.

10—Central Rocky and Blue Mountain Foothills

MLRA 10 (fig. 10-1) is in Oregon (75 percent) and Idaho (25 percent). It makes up about 17,250 square miles (44,677 square kilometers). This MLRA is typified by diverse landforms and soil parent materials on hills, plateaus, and low mountains with steppe vegetation.

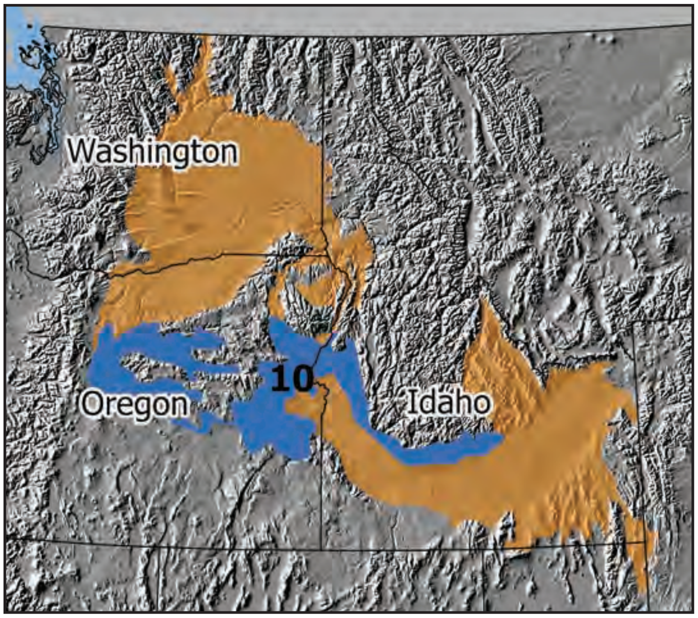

Figure 10-1: Location of MLRA 10, which covers 4,467,700 hectares (11,039,900 acres), within Region B.

Physiography

Almost all of this MLRA is in the Columbia Plateaus province of the Intermontane Plateaus. The western half of this area is in the Walla Walla Plateau section, which is an area of rolling plateaus with young, incised valleys. A portion on the west edge of Idaho is in the Payette section, which also is a young area of dissected plateaus. The eastern one-quarter of the MLRA is in two different physiographic provinces. The northern half is in the Northern Rocky Mountains province of the Rocky Mountain System, and the southern half is in the Snake River Plain section of the Columbia Plateaus province of the Intermontane Plateaus. A small area connecting the Oregon and Idaho parts of the MLRA is in the Harney section of the Columbia Plateaus province. It is a young lava plateau with some evidence of recent volcanism. Small areas in the central portion of the MLRA are in the Blue Mountain section, which is a dissected volcanic plateau in a complex of mountains. This MLRA is typified by gently rolling to steep hills, plateaus, and low mountains. Elevation ranges from 1,300 to 6,600 feet (395 to 2,010 meters), increasing from west to east.

The Deschutes and John Day Rivers, below the Blue Mountains in Oregon, are in this MLRA. The Snake River cuts across the area at the border between Oregon and Idaho.

Geology

The geology of this MLRA varies widely in age and lithology. It ranges from young lava flows at Craters of the Moon National Monument, in Idaho, to very old Cretaceous rocks at John Day Fossil Beds National Monument, in Oregon. The part of the area in southwest and south-central Idaho consists of basalt flows from the Columbia and Idaho batholiths. The flows in the eastern half are cut by Yellowstone volcanics. Some Paleozoic sediments occur in the east. Deep alluvial deposits are in valleys along the major streams and on fans adjacent to the mountains. Lithologies include basalt, rhyolite, schist, granite, graywacke, limestone, sandstone, and tuff.

Climate

The average annual precipitation is 8 to 16 inches (205 to 405 millimeters) in most of this area. It increases from west to east and with elevation. It is as much as 41 inches (1,040 millimeters) at the higher elevations along the northern border of the area. Precipitation is evenly distributed throughout fall, winter, and spring but is low in summer. Some high-intensity, convective thunderstorms occur during the growing season. Winter precipitation is primarily snow. The average annual temperature is 36 to 53 degrees F (2 to 12 degrees C). The freeze-free period averages 140 days and ranges from 60 to 220 days, decreasing from west to east and with elevation.

Water

Streams provide enough water to meet the present irrigation needs along the major valleys. Runoff from snowmelt is the principal source of surface water, and water quality is good to excellent. The surface water is typically soft.

The principal aquifers in this MLRA, in Oregon, are Columbia River Basalt and basin fill and alluvial aquifers and, in Idaho, the basalt aquifer and the sedimentary and volcanic aquifer. The chemical quality of the ground water is good to excellent, meeting national drinking water standards. The water is hard or moderately hard. In Idaho, the ground water can be thermal, 170 to 200 degrees F (76 to 95 degrees C), or nonthermal, less than 78 degrees F (25.5 degrees C). Thermal water sources generally are more than 400 feet below the land surface. Nonthermal water wells typically are less than 400 feet deep.

Soils

The dominant soil order in this MLRA is Mollisols. Aridisols are of minor extent. The soils in the area have a mesic or frigid temperature regime, a xeric or aridic moisture regime, and mixed or smectitic mineralogy. They are very shallow to very deep, well drained, and clayey or loamy.

The main soils and their series:

- Argixerolls that formed in colluvium and residuum derived from basalt, tuff, andesite, and greenstone (Ateron, Merlin, Ruckles, Snell, and Tub series)
- Haplargids that formed in colluvium, loess, and residuum from tuff (Brisbois series)
- Haploxerolls that formed in eolian sediments over volcanic sediments (Agency, Anatone, and Deschutes series)
- Palexerolls that formed in loess and colluvium from tuff (Simas series)

Biological Resources

This area supports a shrub-grass association. Big sagebrush, bluebunch wheatgrass, and Idaho fescue are the dominant species. Stiff sagebrush, low sagebrush, and Sandberg bluegrass are dominant on the drier sites. Antelope bitterbrush grows on moist sites. Western juniper is associated with rock outcrop and rubbly areas. With the suppression of wildfires, western juniper has greatly expanded its extent in Oregon.

Major wildlife species include antelope, mule deer, coyote, porcupine, beaver, golden eagle, and Cooper's hawk. Fish species include trout in the perennial streams and rivers; steelhead trout and salmon in the Deschutes and John Day Rivers in Oregon; and warm-water fish, such as bluegill, crappie, perch, catfish, and bass, in ponds and reservoirs.

Land Use

Nearly half of the MLRA is federally owned and managed by the Bureau of Land Management. The rest is mainly in farms or ranches. Most of the area is used for livestock grazing (fig. 10-2). Irrigated agriculture occurs along the major rivers and in the Deschutes Basin in Oregon. Both irrigated and nonirrigated

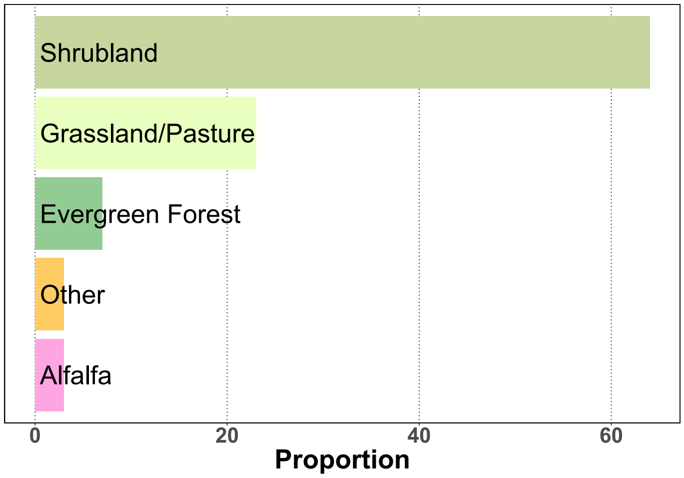

Figure 10-2: Relative proportions (percentages) of land use in MLRA 10.

agriculture occur on the Camas Prairie in Idaho. Alfalfa and small grains are the dominant crops. Specialty crops, such as mint, carrots, onions, and fruits, are grown in local areas.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, loss of nutrients, streambank erosion, mass movement of soil caused by overuse of irrigation water, conservation of soil moisture, and preservation of water quality.

Conservation practices on cropland generally include irrigation water management, water-control structures, irrigation system improvements, nutrient management, critical area plantings, and streambank stabilization. Conservation practices on rangeland and pasture generally include prescribed grazing, spring development, watering facilities, wells, pipelines, fencing, and brush management. Cool-season grasses, both introduced and native, are often planted to improve production and forage quality. Renovation of old pastures may include chiseling, disking, and application of fertilizer.

11—Snake River Plains

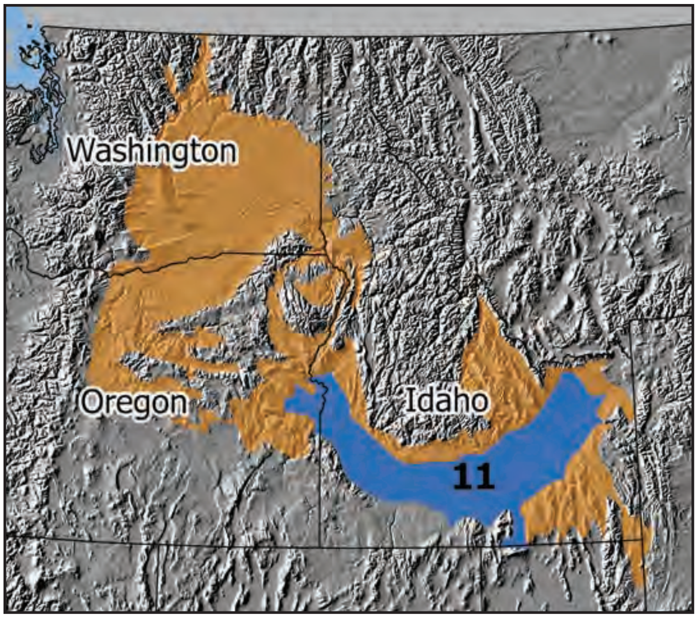

Figure 11-1: Location of MLRA 11, which covers 4,577,600 hectares (11,311,400 acres), within Region B.

This area (fig. 11-1) is in Idaho (94 percent) and Oregon (6 percent). It makes up about 17,674 square miles (45,776 square kilometers). Most of the area is on the Snake River Plain in Idaho, covering nearly all of it. A small area is west of the Snake River in Oregon. The Snake River Plain covers nearly the entire breadth of southern Idaho from east to west. This MLRA is underlain by a lava plain in the eastern half and by ancient lake sediments in the west. It is covered by loess and silty alluvium in most areas. Because it is nearly level to gently sloping and has an adequate water supply and suitable climate, the area is well suited to irrigated agriculture.

Physiography

All of this MLRA is in the Columbia Plateaus province of the Intermontane Plateaus. The western half is in the Payette section, and the eastern half is in the Snake River Plain section. These two sections are essentially young, nearly level to gently sloping lava plateaus. Elevation ranges from 2,100 to 5,000 feet (640 to 1,525 meters). Some of the major streams have cut deep, steep-walled canyons in the basalt flows and terraces. Alluvial fans, terraces, and bottom lands are gently sloping or moderately sloping. The Snake River runs through the center of the MLRA.

Geology

This area consists of lava plains formed from the Idaho batholith and Columbia River Basalt flows. Floods from a breach of glacial Lake Bonneville formed the valley of the Snake River Plain. The present-day Snake River cuts through the glacial outwash, lacustrine deposits, and river alluvium and into the lava plain on the valley floor, leaving broad terraces alongside it. Loess covers most of this MLRA. Alluvial fans encroach on the edges of the plains, where they are bordered by mountains.

Climate

The average annual precipitation is 7 to 12 inches (180 to 305 millimeters) in most of this area. It can be as high as 20 inches (510 millimeters) at the higher elevations in the northeast corner of the area. Spring rains are important to agriculture on the Snake River Plain. Most of the precipitation occurs as rain in fall, winter, and spring. Snowfall is common in winter. Little or no precipitation occurs in summer. The average annual temperature is 41 to 55 degrees F (5 to 13 degrees C). The freeze-free period averages 165 days and ranges from 110 to 220 days. It is shortest in the northeastern part of the area.

Water

Large quantities of surface water are available for irrigation along the Snake River and its tributaries. The surface water is derived primarily from snowmelt runoff. It is soft water of good to excellent quality.

Ground water is plentiful in some of the deep alluvial deposits throughout the area, in the lava north of the Snake River in eastern and south-central Idaho, and in the Columbia River Basalt in Oregon. The ground water comes from the sedimentary and volcanic aquifers under the Snake River Plain in the western half of the area. The water is hard or moderately hard and is of good to excellent quality. It is used extensively for irrigation. In Idaho, the ground water can be thermal, 170 to 200 degrees F (76 to 95 degrees C), or nonthermal, less than 78 degrees F (25.5 degrees C). Thermal water sources generally are more than 400 feet below the land surface. Nonthermal water wells typically are less than 400 feet deep.

Soils

The dominant soil order is Aridisols. The soils in the area dominantly have a mesic or frigid temperature regime, an aridic moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep and generally are well drained. They are silty, loamy, or clayey and commonly are skeletal.

The main soils and their series:

- Argidurids that formed in loess, alluvium, and colluvium from igneous lithologies (Chilcott, Elijah, and Purdam series)
- Argixerolls that formed in loess, silty alluvium, and residuum from basalt (McCarey series)
- Calciargids that formed in loess and silty lacustrine and alluvial sediments (Greenleaf and Power series)
- Haplocalcids formed in loess and silty alluvium (Pancheri and Portneuf series)
- Haplocambids that formed in loess, colluvium, and residuum from basalt (Starbuck series)
- Haplodurids that formed in loess and silty alluvium (Minveno series)

Biological Resources

This area supports an overstory of sagebrush and an understory of grasses. Big sagebrush, winterfat, shadscale, Indian ricegrass, needle and thread, Thurber's needlegrass, and Sandberg bluegrass grow on the lower Snake River Plain. Big sagebrush, threetip sagebrush, bluebunch wheatgrass, Thurber's needlegrass, and arrowleaf balsamroot grow on the middle plain. Bluebunch wheatgrass and big sagebrush grow on the upper plain. Black sagebrush and Gardner's saltbush are dominant on some soils. Phlox, tapertip hawksbeard, biscuitroot, and penstemon also are important.

Major wildlife species include mule deer, antelope, bald eagle, and golden eagle. Fish species include rainbow trout, walleye, brown trout, kokanee, smallmouth bass, perch, black crappie, and sturgeon.

Land Use

Rangeland and irrigated cropland are the major uses in this area (fig. 11-2). Forage production is low, and annual grasses have invaded much of the rangeland in the western part of the area as a result of wildfires. About one-fourth of the area (the plains bordering the Snake River and its tributaries) is irrigated. Potatoes, grain, sugar beets, beans, and alfalfa hay are the principal crops. The area has a wide variety of specialty crops, such as hops, vegetables, vegetable seeds, mint, and onions, especially in Treasure Valley west of Boise. Some areas are used for irrigated pasture.

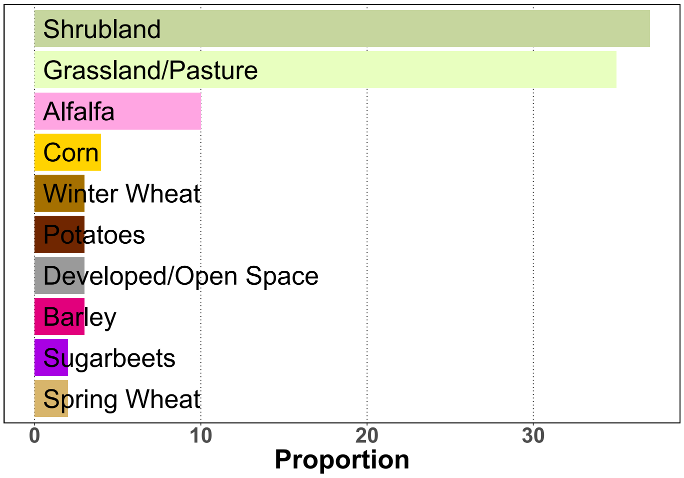

Figure 11-2: Relative proportions (percentages) of land use in MLRA 11.

The major soil resource concerns on cropland are wind erosion, water erosion, and maintenance of the content of soil organic matter and tilth. The major concerns on rangeland are overgrazing and invasion of undesirable plants.

Conservation practices on cropland generally include conservation crop rotations, crop residue management, waste utilization, nutrient management, pest management, filter strips, and irrigation water management. These practices help to control erosion and protect water quality. Conservation practices on rangeland generally include brush management, prescribed grazing, prescribed burning, exclusion from use as needed, and range planting.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water.

12—Lost River Valleys and Mountains

MLRA 12 (fig. 12-1) is entirely in Idaho. It makes up about 6,072 square miles (15,727 square kilometers). Most of the area is defined by steep or very steep mountains and broad valleys. This MLRA is typically cold and dry. It is home to Cryic Aridisols (Calcicryids). Because the area is dry and relatively cold, there is very little agriculture other than ranching.

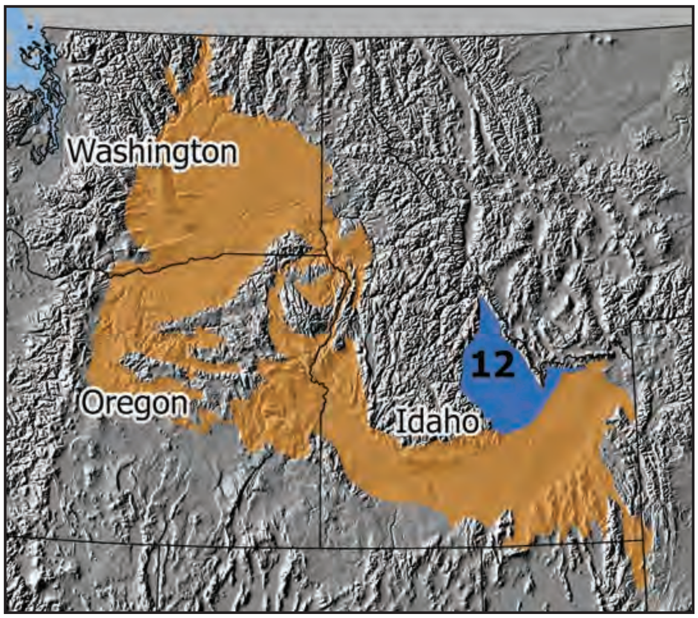

Figure 12-1: Location of MLRA 12, which covers 1,572,700 hectares (3,886,100 acres), within Region B.

The major streams that drain to the north drain into the Salmon River, then the Snake River, and ultimately the Columbia River. The major streams that drain to the south sink near the border between this MLRA and MLRA 11.

Physiography

This area is almost entirely within the Northern Rocky Mountains province of the Rocky Mountain System. It consists of deeply dissected mountain uplands and intermontane basins aligned along a northwest-to-southeast axis. The mountains are not anticlinal ranges. Elevation ranges from 4,000 feet (1,220 meters) in the valleys to more than 12,000 feet (3,660 meters) at the highest mountain crests. Steep or very steep mountains make up about 50 percent of the area. The expansive valleys are level to moderately steep. Broad coalesced alluvial fans extend from the foot of the mountains to the stream terraces in the center of the valleys. The southern end of the area extends out onto a high part of the Snake River Plain section of the Columbia Plateaus province of the Intermontane Plateaus. This young lava plateau is level to steep. Alpine glaciation was extensive in the mountains of this MLRA.

The Lemhi and Pahsimeroi Rivers are major tributaries to the Salmon River. The Big Lost and Little Lost Rivers flow into alluvial sinks in the southeast portion of the MLRA. The East Fork of the Salmon River is in this area. The Salmon River is a major tributary of the Snake River, joining the Snake near the Idaho, Oregon, and Washington borders.

Geology

Mixed sedimentary and metasedimentary rocks and volcanic rocks underlie the mountains. The Idaho batholith and Challis volcanics dominate the northern half of the area, and Paleozoic sediments are more common in the southern half. The valleys and the portion of this area on the Snake River Plain are deeply mantled by recent alluvium and some lacustrine deposits. The rivers are incised with terraces in the valleys, and high alluvial fans occur on the valley floors and Snake River Plain next to the mountains.

Climate

The average annual precipitation is 7 to 25 inches (180 to 635 millimeters) in the valleys and 45 inches (1,145 millimeters) or more on mountain crests. Most of the precipitation occurs in fall, winter, and spring. It is dominantly snow in winter. A few high-intensity, convective thunderstorms occur during summer. The average annual temperature is 35 to 45 degrees F (2 to 7 degrees C) in the valleys but is much lower in the mountains. The freeze-free period averages 110 days and ranges from 65 to 150 days in most of this area. At the higher elevations, however, freezing may occur during every month of the year.

Water

Both surface water and ground water are available in limited supply. The Big Lost and Little Lost Rivers are two of many streams north of the Snake River Plain that do not reach the Snake River. Streamflow infiltrates the basalt aquifer under the Snake River Plain. The only other sources of ground water in this area are valley fill aquifers.

The moderate precipitation provides enough moisture for the growth of grass and shrubs on mountain slopes. The valleys depend on the streamflow of the Salmon, Lemhi, Pahsimeroi, Big Lost, and Little Lost Rivers for livestock and irrigation water. The surface water is derived from snowmelt runoff and of exceptionally high quality. Springs and deep wells in the valleys supply ground water for domestic uses and for irrigation. The ground water is of good to excellent quality and is typically nonthermal, less than 78 degrees F (25.5 degrees C).

Soils

The dominant soil orders in this MLRA are Mollisols and Aridisols. Histosols occur in old oxbows on flood plains. The soils in the area dominantly have a frigid or cryic temperature regime, a xeric or aridic moisture regime, and mixed, carbonatic, or siliceous mineralogy. They generally are very deep, well drained, and loamy, loamy-skeletal, or sandy-skeletal.

The main soils and their series:

Argicryolls that formed in alluvium and colluvium (Latigo and Zeebar series)

Calciargids that formed in colluvium (Dawtonia series)

Calcicryolls that formed in alluvium and colluvium (Zeale)

Haplocalcids that formed in alluvium and colluvium or outwash (Simeroi, Snowslide, Sparmo, Whiteknob, and Zer series)

Natrargids that formed in lacustrine sediments with a mantle of colluvium (Millhi series)

Biological Resources

This area supports desert shrub, shrub-grass, and forest vegetation. Indian ricegrass, needle and thread, shadscale, Gardner’s saltbush, and scarlet globemallow are the major species in the valleys. Wyoming big sagebrush, black sagebrush, low sagebrush, winterfat, bluebunch wheatgrass, Sandberg bluegrass, and a variety of forbs grow on mountain footslopes. Bluebunch wheatgrass, prairie Junegrass, oniongrass, Indian paintbrush, lupine, sedge, big sagebrush, low sagebrush, and rabbitbrush grow on low mountain slopes. Curl-leaf mountain mahogany, Douglas-fir, aspen, and Rocky Mountain juniper grow on mountain slopes. Subalpine fir, whitebark pine, and limber pine grow at the higher elevations.

Major wildlife species include antelope, mule deer, elk, mountain goat, bighorn sheep, coyote, jackrabbit, shore birds, songbirds, and birds of prey. The major game fish are various species of trout.

Land Use

Nearly all of this area is federally owned grassland (fig. 12-2). The grasses and shrubs on the lower slopes and in valleys are grazed. Irrigated land in the valleys is used mostly for hay and pasture, but potatoes and small grains also are grown. The high mountain slopes are forested, and some lumber is produced.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, loss of nutrients, streambank erosion, mass movement of soil caused by overuse of irrigation water, conservation of soil moisture, and preservation of water quality.

Conservation practices on cropland generally include irrigation water management, water-control structures, irrigation system improvements, nutrient management, riparian forest buffers, critical area plantings, and streambank stabilization.

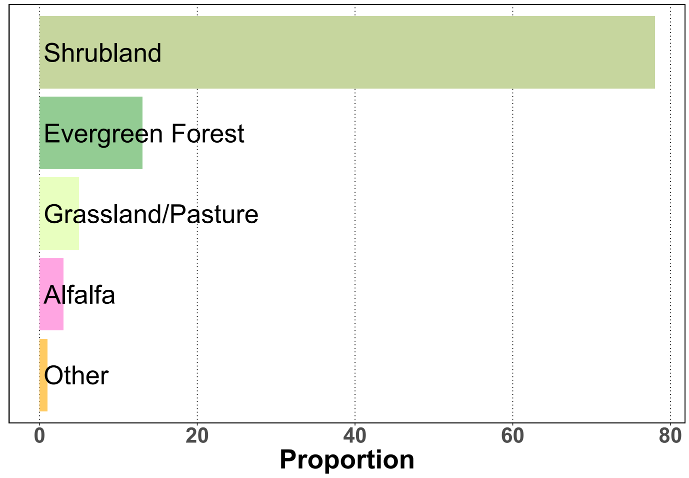

Figure 12-2: Relative proportions (percentages) of land use in MLRA 12.

Conservation practices on rangeland and pasture generally include prescribed grazing, development of springs, watering facilities, wells, pipelines, fencing, and brush management. Cool-season grasses, both introduced and native, are often planted to improve production and forage quality. Renovation of old pastures may include chiseling, disking, and application of fertilizer.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams.

13—Eastern Idaho Plateaus

MLRA 13 (fig. 13-1) is primarily in Idaho (89 percent) but it includes a small part of Utah (7 percent) and Wyoming (4 percent). It makes up about 7,842 square miles (20,311 square kilometers). It is located south and east of the Snake River Plain, mostly on the dissected relict fans and foothills adjacent to the plain and in the major stream valleys. The MLRA is covered with deep loess in most areas. It is used primarily for non-irrigated cropland and rangeland. Because of the unique combination of climate and soils, the area is valuable for the production of small grains such as wheat and barley, especially malting barley. Irrigation water is limited in much of the area but where it is available, especially in the northeastern portion, potatoes are produced in addition to the small grains.

Physiography

Most of this area is in the Great Basin section of the Basin and Range province of the Intermontane Plateaus. This is an area of isolated, fault-block mountain ranges that are dissected. The mountain ranges are aligned almost north to south and are separated by aggraded desert plains. This MLRA is very narrow

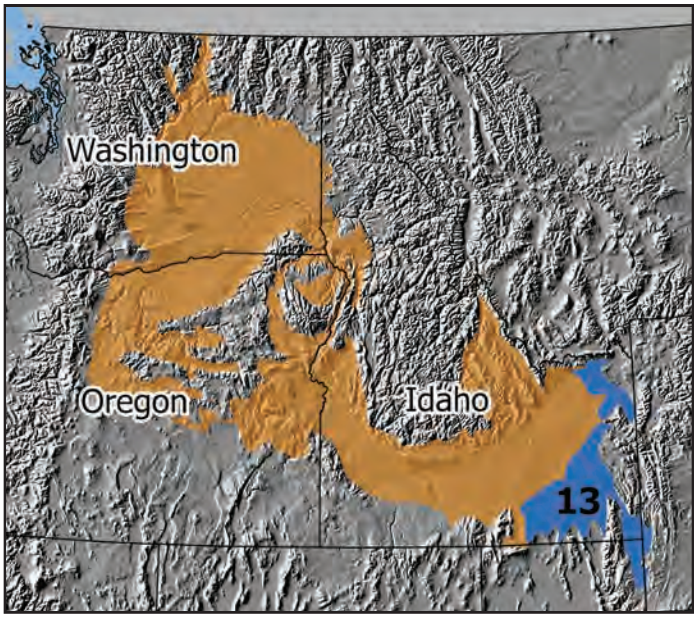

Figure 13-1: Location of MLRA 13, which covers 2,031,100 hectares (5,018,900 acres), within Region B.

where the Snake River crosses it. The portion north of the Snake River, about 20 percent of the area, is in the Snake River Plain section of the Columbia Plateaus province of the Intermontane Plateaus. The plain is a young lava plateau. The southeastern corner and the easternmost valleys of the Snake and Teton Rivers in the area are in the Middle Rocky Mountains province of the Rocky Mountain System. Elevation ranges from 4,500 to 6,600 feet (1,370 to 2,010 meters) on the plateaus and foothills and is as much as 9,500 feet (2,895 meters) on mountain crests. The Bear, Portneuf, Blackfoot, Snake, and Teton Rivers all occur in this MLRA.

Geology

The foothills and dissected plateaus and plains are mantled by loess ranging from a few inches to tens of feet in thickness. The underlying bedrock is mainly sedimentary and metasedimentary rock and some volcanic rock. Lacustrine deposits and deep alluvium fill some level valleys and basins. The plains and plateaus are separated by many rugged but discontinuous mountain ranges of folded sedimentary and metasedimentary rocks. Alluvial fans occur on the plains and valley floors at the foot of the mountains. Terraces occur along most of the larger rivers and creeks. The area was not glaciated.

Climate

The average annual precipitation is mainly 12 to 25 inches (305 to 635 millimeters) but can be as high as 48 inches (1,220 millimeters) at the highest elevations. Most of the precipitation occurs in fall, winter, and spring. It is dominantly snow in winter. A few high-intensity, convective thunderstorms occur in summer. The minimum precipitation occurs from midsummer through autumn. The average annual temperature generally is 36 to 48 degrees F (2 to 9 degrees C), but it is lower in the mountains. The freeze-free period averages 130 days and ranges from 90 to 175 days. On the high mountains, however, freezing may occur every month of the year.

Water

Precipitation provides water for dryland farming and grazing, but careful management is needed to make the best use of the limited amount. Several large streams that flow through the area supply water for irrigation, mainly outside the MLRA. Small but important tracts are irrigated along the Bear, Portneuf, Blackfoot, Snake, and Teton Rivers. The surface water is primarily from snowmelt runoff and is soft and of very good quality.

The ground water is scarce, except near the large streams with valley fill aquifers. The basalt aquifer beneath the Snake River Plain also is a source of ground water. Many wells and springs produce thermal water at temperatures that exceed 170 to 200 degrees F (76 to 95 degrees C). The ground water is hard or moderately hard but is of good quality.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a frigid or cryic temperature regime, a xeric moisture regime, and mixed mineralogy. They generally are deep or very deep, well drained, and loamy.

The main soils and their series:

Argicryolls that formed in loess (Vadnais series)
Haplocryolls that formed in loess (Rin and Tetonia series)
Haploxerolls that formed in loess and alluvium (Kucera, Lanoak, Neeley, Newdale, Rexburg, and Ririe series)
Torriorthents that formed in loess and alluvium (Pocatello series)

Biological Resources

The rangeland in this MLRA supports grass-shrub vegetation. Bluebunch wheatgrass is dominant. There are minor amounts of Idaho fescue and Wyoming big sagebrush. Arrowleaf balsamroot, prairie Junegrass, Sandberg bluegrass, Nevada bluegrass, oniongrass, slender wheatgrass, milkvetch, lambstongue, fawnlily, phlox, penstemon, antelope bitterbrush, rabbitbrush, snowberry, and Oregon grape are other important plants. Stands of Douglas-fir with some aspen and bigtooth maple are scattered in areas on north-facing slopes and on the moister soils. Lodgepole pine and subalpine fir grow at the higher elevations. Major wildlife species include mule deer, moose, elk, beaver, muskrat, mink, rabbit, sage grouse, sharp-tailed grouse, ruffed grouse, blue grouse, and mourning dove.

Land Use

Nearly three-fourths of this area is in farms and ranches (fig. 13-2). The rest, including the Fort Hall Indian Reservation, is federally owned. About one-third of the area is dry-farmed, and wheat and barley are the major crops. Some land along the large streams is irrigated. It is used mainly for alfalfa hay, meadows, and pasture, but some small grains and potatoes also are grown. More than one-half of the area is rangeland. Less than one-tenth of the area, consisting of high mountain slopes, is in forests that produce some timber.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and conservation of soil moisture.

Conservation practices on irrigated cropland generally include conservation crop rotations, crop residue management (such as no-till and mulch till), surface roughening, nutrient management, irrigation water management, and water- and sediment-control basins. Conservation practices on nonirrigated cropland generally include no-till systems that reduce the need for summer fallow, crop residue management, mulch till, deep tillage, cross-slope farming, nutrient management, water- and sediment-control basins, and terraces.

Conservation practices on rangeland and pasture generally include prescribed grazing, spring development, watering facilities, wells, pipelines, fencing, streambank restoration, and brush management. Cool-season grasses, both introduced and native, are often planted to improve production. Renovation of old pastures may include chiseling, disking, and application of fertilizer.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams.

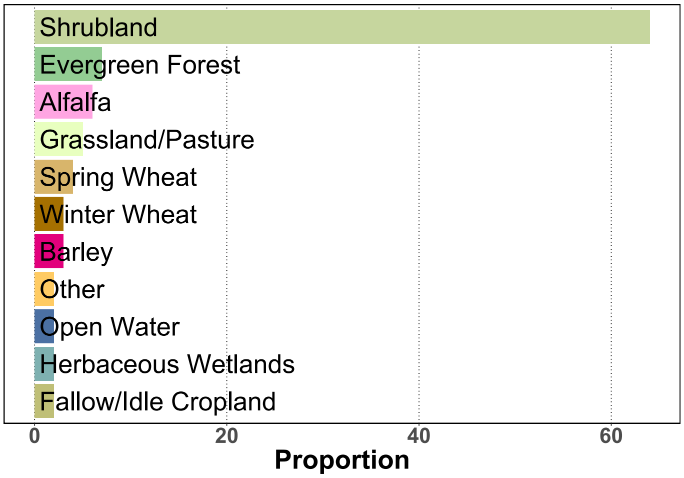

Figure 13-2: Relative proportions (percentages) of land use in MLRA 13.

C—California Subtropical Fruit, Truck, and Specialty Crop Region

Land Resource Region C (fig. C-1) consists of the Coast and Transverse Ranges and Central Valley (Great Valley) of California. The Central Valley refers to the combined Sacramento Valley to the north and the San Joaquin Valley to the south. Irrigation and a favorable climate have enabled this region to be the most productive vegetable, nut, and fruit region in the United States. Region C is lithologically and structurally complex as a result of the tectonic activity at the convergence of the Pacific Ocean plate and North American continental plate. Rock types range in age from Precambrian to Quaternary. Lithologies include granitic and mafic intrusives, volcanic mudflows and pyroclastic rocks, metamorphosed marine sediments, valley alluvium, landslide deposits, marine terrace deposits, lacustrine and estuarine deposits, and fluvial deposits and terraces. Earthquakes are common in this region as the two plates slip past each other along the San Andreas Fault. This region contains six major land resource areas. The extent of these MLRAs and their range in elevations are shown in table C-1.

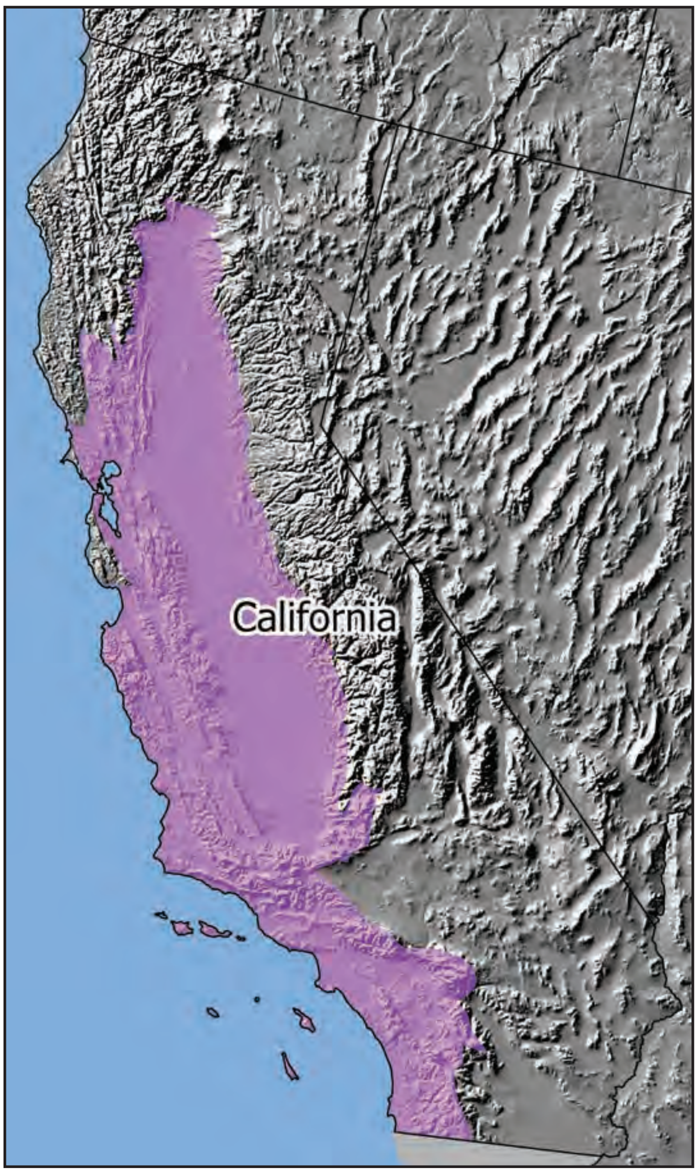

Figure C-1: Location and size of Land Resource Region C, which covers 161,365 square kilometers (62,300 square miles) in California.

The boundary between Regions C and A (fig. 1, page 5) marks the topographic transition from the lower elevation California coastal range and Sacramento Valley to the higher elevation and wetter, cooler forests and an increased extent of Inceptisols in Region A (see Introduction, figs. 2, 6, 7, and 8). The boundary between Regions C and D follows the physio-climatic contact between the Central Valley and the Sierra Nevada mountains. The southern one-third of this boundary marks the contact between the Transverse Mountain Ranges and the Mojave Desert of the Basin and Range (figs. 1, 6, and 7).

The climate in Region C is characterized by a long, warm growing season and low amounts of precipitation. The average annual precipitation ranges from less than 6 inches to 12 inches (150 to 305 millimeters) in the San Joaquin Valley, from 12 to 30 inches (305 to 760 millimeters) in areas along the coast south of San Francisco and in the Sacramento River Valley, and from 15 to 40 inches (380 to 1,015 millimeters) in areas along the coast north of San Francisco. Very little precipitation falls from late April through October. The average annual temperature is 37 to 66 degrees F (3 to 20 degrees C). The lower temperatures occur at the higher elevations. The freeze-free period averages 245 to 345 days in most of this region. It ranges from 125 days in the higher mountains to 365 days in the valleys in the southern part of the region. Temperatures and precipitation for this region are shown in figures 6 and 7. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables C-2 and C-3.

Soils in this region are dominantly Mollisols (Xerolls) in the mountain ranges and Entisols that increase in extent to the south. In the northern half of the Central Basin, Alfisols (Xeralfs) and Vertisols (Xererts) are prominent with lesser amounts of Inceptisols and Mollisols (fig. 2). In the southern half of the Central Basin, Aridisols and Entisols are prominent and contain carbonates (fig. 5, page 9). Restrictive zones of many soil profiles consist of paralithic and lithic bedrock and abrupt textural changes (fig. 9, page 13) as well as duripans and natric and salic horizons (fig. 11, page 15). Argillic horizons occur in areas with stable geomorphic surfaces (fig. 12, page 16). The highest amounts of organic carbon are associated with wetland and mountain soils (fig. 14, page 18). Soils in the region dominantly have a thermic soil temperature regime and a xeric soil moisture regime.

Land use in this region is dominantly shrubland, grassland, and forest (fig. C-2). However, the region also has a wide variety of crops and agricultural enterprises (fig. 8), including

Table C-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km^2	mi^2	m	ft	m	ft	m	ft	m	ft	m	ft
14	8,450	3,260	0	0	0	10	60	220	250	840	940	3,100
15	45,570	17,595	0	0	130	440	430	1,420	840	2,780	1,780	5,860
16	2,140	825	0	0	0	0	0	0	0	0	260	850
17	48,785	18,835	0	0	10	50	60	220	180	600	730	2,400
18	20,870	8,055	20	90	140	460	440	1,440	1,240	4,070	2,570	8,430
19	35,550	13,725	0	0	70	240	560	1,840	1,570	5,140	3,500	11,480

Table C-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
14	12.3	54	14.1	57	14.8	59	15.6	60	16	61	220	286	350/335	365	365
15	10	50	14.1	57	15.2	59	16.4	61	18.1	65	150	217	276/285	362	365
16	14.5	58	15.6	60	16.1	61	14.5	58	16.6	62	305	321	324/330	349	365
17	15.5	60	16.5	62	16.9	62	17.9	64	18.4	65	260	297	316/315	333	365
18	8	46	13.5	56	16.1	61	17.2	63	18.2	65	135	209	273/275	332	365
19	2.7	37	12.7	55	16.8	62	18.4	65	19.8	68	75	179	331/295	365	365

Table C-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
14	270	11	355	14	517/605	20/24	1021	40	1,420	56
15	150	6	277	11	530/585	21/23	981	39	2,250	88
16	310	12	348	14	410/405	16/16	460	18	590	23
17	140	6	180	7	306/360	12/14	598	24	1,250	49
18	220	9	324	13	598/625	24/25	967	38	1,660	65
19	190	8	305	12	440/485	17/19	752	30	1,380	54

vineyards, nuts (e.g., almonds, walnuts, and pistachios), olives, table grapes, stone fruits (e.g., peaches and apricots), salad greens, strawberries, rice, citrus, and avocados. Dairying and beef cattle production are also primary enterprises throughout the region. Evapotranspiration is high in this region, and many of the soils on flood plains and low terraces in the valley of the San Joaquin River are affected by salts and must be skillfully managed for good crop production. The agricultural drainage water in this valley commonly has a high salt load, and the salinity of streams typically increases in a downstream direction. Wind erosion and water erosion are the greatest hazards in the valley portions of this region. Rainfall, irrigation, maintenance of the soil organic matter content, and droughts due to heat or wind are the primary concerns across the region in general. Salinity, the intrusion of saltwater into aquifers, and land subsidence due to ground-water losses are management concerns in the coastal valleys.

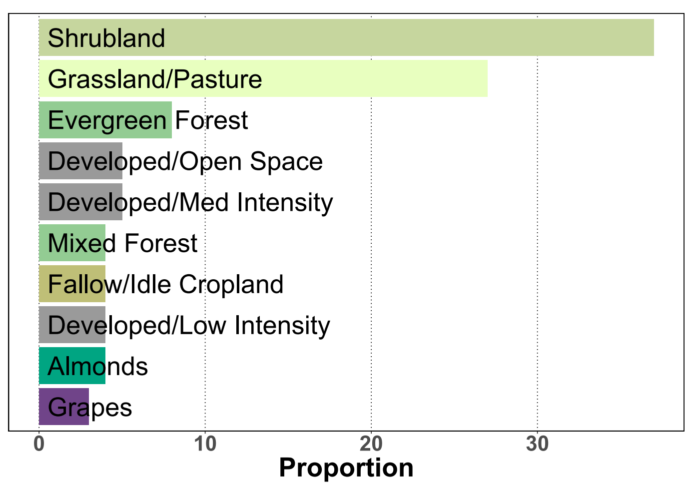

Figure C-2: Relative proportions (percentages) of land uses in Land Resource Region C (National Agricultural Statistics Service, 2018).

14—Central California Coastal Valleys

This area (fig. 14-1) is entirely in California. It has four parts: Napa Valley, Hollister, the city of Salinas, and the agriculturally important Salinas Valley. It makes up about 3,262 square miles (8,450 square kilometers). MLRA 14 is a network of gently sloping valley floors bordered by higher and more sloping terraces and alluvial fans. Most of the area is in farms and ranches. Gently sloping soils in the valleys are used intensively for many kinds of crops.

The boundary between MLRA 14 and MLRA 15 (Central California Coast Range) is somewhat distinct. MLRA 15 surrounds most of the area and is composed of gently sloping to steep, low mountains.

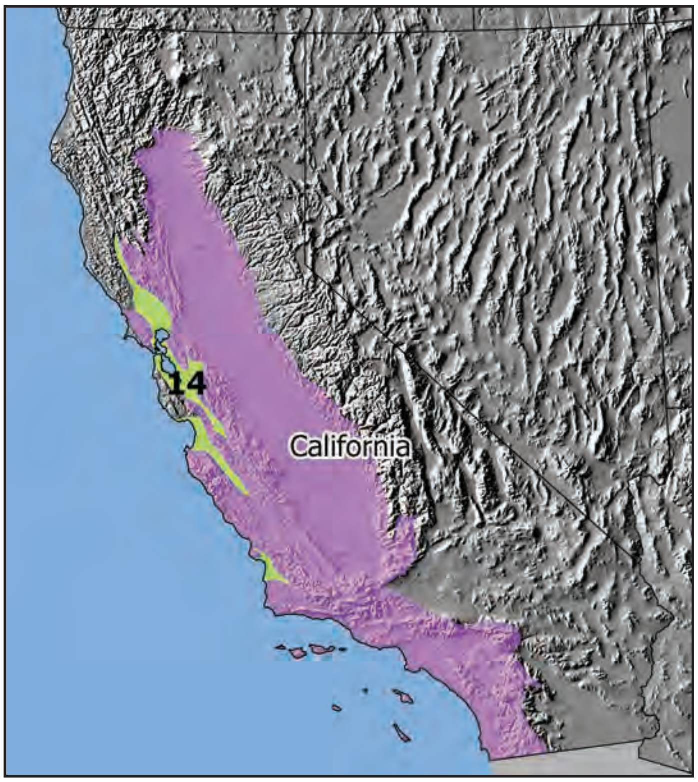

Figure 14-1: Location of MLRA 14, which covers 845,000 hectares (2,087,900 acres), within Region C.

Physiography

MLRA 14 is in the California Coast Ranges section of the Pacific Border province of the Pacific Mountain System. It is a network of gently sloping valley floors bordered by higher and more sloping terraces and alluvial fans and by steep uplands. Elevation ranges from sea level to 1,970 feet (600 meters), but it is less than 985 feet (300 meters) in most of the area.

The Russian River flows through the northern part of the area, and the Napa and Petaluma Rivers empty into San Pablo Bay. The Salinas River is in the southern part of the area. The Hetch Hetchy Aqueduct brings Sierra Nevada mountain water from the Yosemite area to the Bay Area for municipal, public supply, and industrial uses. The aqueduct empties into the Upper Crystal Springs Reservoir, in the San Andreas Fault Zone directly south of San Francisco.

Geology

The coastal valleys in this area, with the possible exception of the Santa Maria Valley to the south, are structural basins. The elongated shape and northwest-southeast orientation of the valleys are strongly controlled by right-lateral strike-slip movement along a regional set of faults that include the San Andreas, Rogers Creek, Hayward, and Calaveras Fault Zones and other potentially active and inactive faults. The San Andreas Fault Zone is a transform boundary where the North American Plate is moving northwest relative to the Pacific tectonic plate to the west. The probability of a large magnitude earthquake is considered to be particularly high along the Rogers Creek-Hayward Fault Zones, which together extend from approximately Healdsburg, southeastward beneath San Pablo Bay, towards Milpitas.

The coastal valleys are partly filled with unconsolidated and semiconsolidated marine sedimentary rocks that were deposited during periodic encroachment of the sea and with unconsolidated nonmarine alluvial, flood-plain, alluvial-fan, and hillslope deposits derived from bedrock weathered from the adjacent uplands. Older, more consolidated eolian, lacustrine, and terrace deposits also occur. The coarser, more permeable nonmarine sand and gravel store relatively large volumes of fresh ground water. These coastal basin aquifers are variably confined, semiconfined, and unconfined and are in areas at risk for saltwater intrusion and overdraft.

Mesozoic and Tertiary bedrock exposed in the hills, foothills, and uplands in this MLRA includes the Sonoma volcanics in and around Napa and Sonoma Valleys; graywackes, chert, ophiolites, and other units of the Franciscan Formation; metamorphics and granitics of the Salinian block flanking the Salinas Valley; and sedimentary formations near the Salinas and Santa Maria Valleys. Landslides are common in steep areas underlain by rocks weakened by faulting and deformation (e.g., Central Belt of the Franciscan Formation) or lack of cementation (e.g., Tertiary sedimentary shale formations).

Climate

The average annual precipitation typically is 14 to 30 inches (356 to 762 millimeters). The higher amounts of precipitation occur at the higher elevations in the area north of San Francisco. Most of the rainfall occurs during low- or moderate-intensity, Pacific frontal storms in winter. This area is very dry from midspring to midautumn. Snowfall is rare. The average annual temperature is 54 to 61 degrees F (12 to 16 degrees C). The freeze-free period averages 315 days and ranges from 265 to

365 days. It is longest near the coast and becomes shorter with elevation.

Water

The low or moderate rainfall and local streamflow are inadequate for present water needs. Water from adjoining MLRAs is brought in for agriculture and for the domestic and industrial needs of the many large cities. For example, most of the public water in the Bay Area is provided by an aqueduct from the Hetch Hetchy Reservoir in the Sierra Nevada mountains. The quality of the water in this reservoir is excellent. The quality of the water in the rivers in valleys is not as good. Agricultural runoff, municipal and industrial wastes, and irrigation return flows are sources of contamination for local surface water.

The major ground water sources in this area are the alluvium and older sediments in the coastal valleys. Surface water infiltrating from irrigated areas mixes with the shallow ground water in this aquifer, so some of the water that is pumped is a combination of surface and ground water. This water is very hard and requires softening for public, municipal, and domestic uses. The yield of ground water in the deeper alluvial deposits, especially in the Santa Clara Valley, is declining, and intrusion of seawater is a concern. Nitrate and pesticide contamination in the shallow aquifer in Salinas Valley also is a concern.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic temperature regime, a xeric moisture regime, and mixed or smectitic mineralogy. They generally are very deep, somewhat excessively drained to somewhat poorly drained, and loamy or clayey.

The main soil series:

- Botella series—Argixerolls that formed in alluvium derived from sedimentary rocks on alluvial fans
- Clear Lake series—Endoaquerts that formed in fine textured alluvium derived from mixed sources in flood basins, on flood plains, and in swales of drainageways
- Cropley series—Haploxererts that formed in alluvium from sandstone and shale on alluvial fans
- Elder series—Haploxerolls that formed in mixed alluvium on alluvial fans and flood plains
- Lockwood series—Argixerolls that formed in alluvium derived from dominantly siliceous shales on alluvial fans and terraces
- Mocho series—Haploxerolls that formed in alluvium derived mostly from sedimentary rocks on flood plains
- Oceano series—Xeropsamments that formed in material weathered from sandy eolian deposits on rolling dune-like topography, near the ocean
- Pleasanton series—Haploxeralfs that formed in mixed alluvium on gently sloping alluvial fans and terraces
- Reyes series—Fluvaquents that formed in mixed alluvium in reclaimed and protected marshes
- Salinas series—Haploxerolls that formed in alluvium weathered from sandstone and shale on alluvial plains, fans, and terraces
- Watsonville series—Argialbolls that formed in mixed alluvium on old coastal terraces and in valleys

Biological Resources

The valleys of MLRA 14 support wetlands, riverines, oak savannas, shrublands, grasslands, and small slivers of tidal estuaries and salt marshes around San Francisco Bay. Much of the MLRA that is not urbanized or under agricultural production is now dominated by naturalized annual grasses and forbs and other non-native and invasive species. Soft chess, wild oats, bromes, fescues, filaree, burclover, yellow star-thistle, mustards, and wild radish are some of the major species. Some remnant perennial grasses and forbs are scattered in areas removed from disturbance. Valley oaks typically occur on stream terraces and drainages on well drained soils, and coyotebrush is a common shrub throughout the area. Major wildlife species include turkey, California quail, mourning dove, meadowlark, blackbird, white-crowned sparrow, white-tailed kite, robin, mockingbird, thrush, brown towhee, and cedar waxwing.

Land Use

Most of the MLRA is in farms and ranches (fig. 14-2). The acreage used for urban development is increasing rapidly. The gently sloping soils in the valleys are intensively used for many kinds of crops. Truck crops, wine grapes, strawberries and other fruits, cut flowers, small grains, hay, and pasture are the principal crops grown on irrigated land. Small grains are the principal crops in dry-farmed areas. Dairy farming is an important enterprise near the large cities. The more sloping fans and foothills, which make up one-fourth or more of the area, are

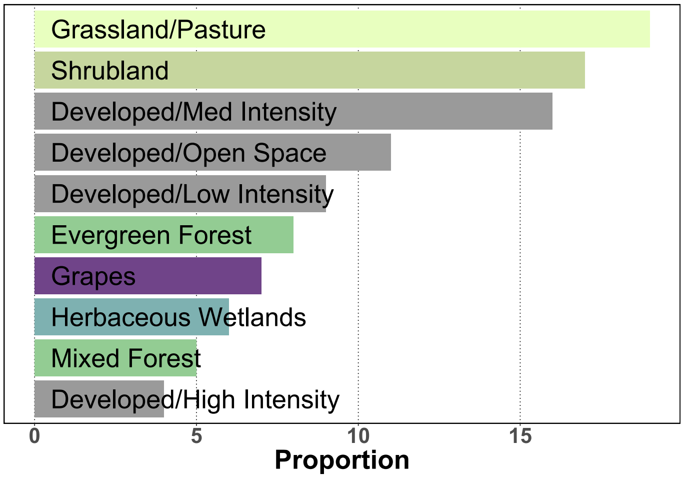

Figure 14-2: Relative proportions (percentages) of land use in MLRA 14.

in rangelands used for livestock grazing. Sites along streams are susceptible to flooding and bank cutting.

The major resource concerns are erosion, maintenance of the content of soil organic matter, and water quality. The erosion hazard is slight on soils in valleys and on terraces and benches of the valleys, except where improper irrigation practices are more damaging than rainfall. If the surface is unprotected in winter, the hazard of sheet and gully erosion is severe on sloping soils on coastal terraces and benches and on upland soils. Salinity and encroachment of seawater into ground water basins are concerns in areas of valleys near sea level.

Important conservation practices for cropland are those that control erosion. These practices include mulching, cover crops, irrigation water management, and tailwater return systems on the steeper irrigated slopes. Important conservation practices for dairy farms are manure-handling systems, including nutrient management. Prescribed grazing, fencing, and water management are the most important practices for rangeland and other grazing land.

15—Central California Coast Range

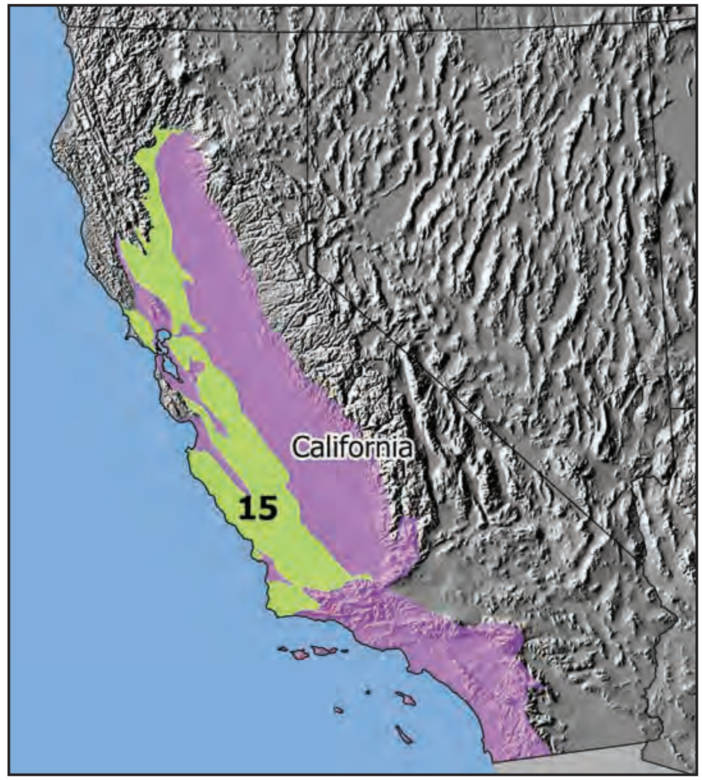

Figure 15-1: Location of MLRA 15, which covers 4,556,800 hectares (11,260,100 acres), within Region C.

MLRA 15 (fig. 15-1) is entirely in California and makes up about 17,594 square miles (45,568 square kilometers). The area is characterized by the geologically complex, gently sloping to steep, low-elevation mountains of the Coast Ranges and primarily supports oak woodlands, oak savannas, chaparral, and grasslands. Most of the area is private land, mainly in farms and ranches.

To the east, MLRA 15 has a distinct boundary with MLRA 17 (Sacramento and San Joaquin Valleys). MLRA 17 includes the valley basins adjacent to the Sacramento and San Joaquin Rivers, fans and flood plains of tributary streams, and terraces and foothills around the edge of the valleys. The valley floor is almost flat, and relief is low even along the borders of the area. The cropland in MLRA 17 represents about one-third of the cropland in California, and the irrigated cropland represents more than four-fifths of the irrigated land in the State. To the south, as temperature increases and precipitation decreases, MLRA 15 has a gradual boundary with MLRA 19 (Southern California Coastal Plains and Mountains). MLRA 19 consists mainly of gently sloping to strongly sloping, dissected coastal and alluvial plains that are bordered by steep hills, narrow mountain ranges, and broad fault blocks of the Transverse Ranges.

Physiography

All of this area is in the Pacific Border province of the Pacific Mountain System. Most of this MLRA is in the California Coast Ranges section of the province. The extreme northern end is in the Klamath Mountains section, and the southwest corner is in the Los Angeles Ranges section. The MLRA is an area of gently sloping to steep, low mountains. The coastal plains are narrow and discontinuous, and stream valleys are narrow and widely separated. Elevation ranges from sea level to 2,650 feet (810 meters) in most of the area. It higher in some of the mountains, including Junipero Serra with an elevation of 5,856 feet (1,785 meters).

Clear Lake and Lake Berryessa are in the northern half of the area. This half is drained by Sacramento River tributaries, such as Cache Creek and Putah Creek. Few perennial streams are in the southern half of the area. The streams in this half typically drain to the Pacific Ocean.

Geology

The landscape and geology of the Coast Ranges are strongly controlled by right-lateral strike-slip movement along the San Andreas and other active and inactive faults that dissect the ranges. The northwest-southeast orientation of the river courses and intervening ridges reflects the area's young geologic age. The area is along a transform boundary, where the Pacific tectonic plate is moving northwest relative to the North American Plate to the east. Recent and historic earthquakes centered in the Coast Ranges attest to the active plate motion and associated seismicity that continue to shape the landscape. These quakes include the 1906 San Francisco earthquake, the Loma Prieta earthquake of 1989, and numerous large earthquakes centered near Parkfield (most recently in September 2004).

Most of the Northern Coast Range is underlain by deformed and metamorphosed sandstones and shales of the Franciscan Formation. These rocks were deposited offshore during the Mesozoic, conveyed eastward towards the Franciscan trench, and then subducted as a series of terranes beneath the old ocean floor at the continental margin. Narrow bands of serpentine-bearing ophiolites, representing remnants of an old ocean floor, separate these Franciscan terranes from the relatively undisturbed marine sedimentary rocks of the Great Valley sequence, which is exposed along the eastern margin of the Northern Coast Range. The Central Belt of the Franciscan Formation consists of a highly disturbed mélange, which was intensely sheared and deformed when strike-slip movement along the San Andreas Fault replaced subduction through the Franciscan trench, beginning roughly 30 million years ago. Mélange consists of relatively resistant metamorphic rocks and boulders "floating" in intensely sheared and weak matrix material. Steep areas underlain by Franciscan mélange tend to be highly prone to landslides.

The geology of the Southern Coast Range is highly varied. It includes bands of the Franciscan Formation along the northeast edge of the San Andreas Fault and along the southeast edge of the Nacimiento Fault in the Santa Lucia Range; Mesozoic granitics of the Salinian block, which were "rafted" hundreds of miles to their present locations in Pinnacles National Monument and elsewhere in the Coast Ranges by movement along the transform boundary; and Tertiary and Pleistocene marine and nonmarine sedimentary formations, including the diatomaceous Monterey Shale, which is a significant source rock for oil reserves.

Climate

The average annual precipitation is typically 11 to 39 inches (157 to 2,108 millimeters). Some areas may receive as little as 6 inches, while areas at higher elevations may receive as much as 88 inches. Snowfall is common in the northern half of the MLRA and rare elsewhere. Precipitation is evenly distributed throughout fall, winter, and spring but is very low in summer. Coastal areas receive some moisture from fog in summer. Most of the rainfall occurs during low- or moderate-intensity, Pacific frontal storms in the period October to May. The average annual temperature is 52 to 65 degrees F (11 to 18 degrees C), decreasing from south to north. The freeze-free period averages 275 days and ranges from 180 to 365 days, decreasing in length with elevation and from south to north.

Water

The low or moderate rainfall and moderate streamflow limit agriculture to dryland farming in most of the area. Reservoirs are used to store surface runoff for use during most of the year when streams are low. Surface water generally is of good quality and suitable for almost all uses.

Ground water is limited in this area. There are some wells in alluvium and older sediments in the major river valleys and in low areas. This water is very hard and typically requires softening prior to use. Igneous rocks in this area have some ground water. Well yields are low since the water is in joints and fractures in the bedrock.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic temperature regime, a xeric moisture regime, and mixed or smectitic mineralogy. They generally are very shallow to deep, somewhat excessively drained or well drained, and loamy or clayey.

The main soil series:

- Altamont series—Haploxererts that formed in material weathered from fine grained sandstone and shale on hills and mountains
- Cieneba series—Xerorthents that formed in material weathered from granitic rock on hills and mountains
- Diablo series—Haploxererts that formed in residuum weathered from shale, sandstone, and consolidated sediments with minor areas of tuffaceous material, on hills
- Dibble series—Haploxeralfs that formed in material weathered from shale, sandstone, and semiconsolidated densic material on eroded hills and fan remnants
- Lopez series—Haploxerolls that formed in colluvium and residuum weathered from hard, fractured diatomaceous shale on hills and mountains
- Los Osos series—Argixerolls that formed in colluvium and residuum weathered from sandstone and shale, on hills and mountains
- Maymen series—Dystroxerepts that formed in residuum and colluvium weathered from shale, schist, greenstone, sandstone, and conglomerate on mountains
- Milsholm series—Haploxerepts that formed in colluvium and residuum weathered from sandstone, mudstone, and shale, on hills and mountains
- Montara series—Haploxerolls that formed in colluvium and residuum weathered from serpentinitic rocks on hills and mountains
- Nacimiento series—Haploxerolls that formed in material weathered from calcareous shale and sandstone on rolling hills
- Shedd series—Xerorthents that formed in residuum weathered from calcareous soft shale on hills

Biological Resources

This area supports a species-rich, ecologically diverse and complex patchwork of habitats across the landscape, which is primarily dominated by oak woodlands, oak savannas, chaparral, and grasslands. The dominant oaks are coast live oak, interior live oak, blue oak, and valley oak. Coast live oak dominates many of the oak woodlands and oak savannas that are closer to the coastline, where temperatures are generally cooler than the interior portions of the MLRA. Blue oak and interior live oak dominate the more interior or drier and hotter portions. Valley oak is relegated to the upper stream terraces and drainageways that have well drained soils, along with California sycamore and California walnut in the southern portions of the MLRA. In the dense oak woodlands, a mix of coast live oak, interior live oak, and canyon live oak and several chaparral shrubs (including scrub oak, poison oak, toyon, and hollyleaf cherry) are common. Chaparral species dominate the shrublands and commonly include chamise, several manzanitas, scrub oaks, ceanothus, coyotebrush, California sagebrush, black sage, and California buckwheat. Naturalized annuals (including soft chess, bromes, fescues, wild oats, filaree, and burclover) and many perennial and annual native forbs (such as California poppy, bluedicks, onions, popcornflowers, tarweeds, phacelias, and lupines) characterize the grasslands and oak savanna understories. Areas at higher elevations and areas with higher precipitation also support some forests, mostly dominated by Douglas-fir, madrone, grand fir, tanoak, and bigleaf maple with a few remnant stands of coast redwoods along the riparian flood plains and canyon draws.

Major wildlife species include black-tailed deer, feral pig, turkey, California red-legged frogs, California tiger salamanders, California condors, blue grouse, valley quail, and band-tailed pigeon. Fish species include trout, largemouth bass, bluegill, minnow, stickleback, channel catfish, bullhead, carp, sculpin, steelhead, salmon, and crappie.

Land Use

More than four-fifths of this area consists of private land, mainly in farms and ranches (fig. 15-2). The rest generally is federally owned. About one-tenth of the area is used for dry-farmed grain, and slightly more than three-fifths is rangeland consisting of grasses, forbs, and brush. Open woodland, also used for grazing, makes up about one-fourth of the area. A small acreage is used for urban development.

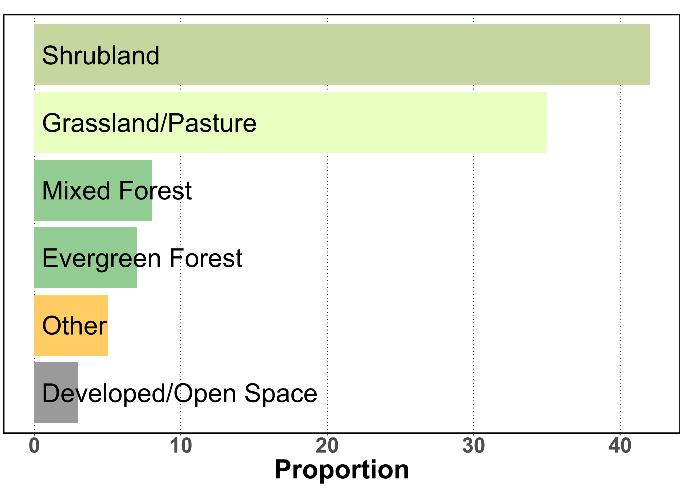

Figure 15-2: Relative proportions (percentages) of land use in MLRA 15.

The major soil resource concerns are erosion, maintenance of the content of soil organic matter, water quality, low infiltration rates resulting from hydrophobic soils, and low-productivity vertic soils that restrict oak regeneration. If the surface is unprotected in winter, the hazard of sheet and gully erosion is severe on sloping soils on terraces and benches and on upland soils.

Important conservation practices for cropland include leaving crop residue on the surface. Prescribed grazing, fencing, and water management are the most important practices on rangeland and other grazing land.

16—California Delta

MLRA 16 (fig. 16-1) is a unique area in California that is best characterized as the junction of the two major rivers that drain the Central Valley—the Sacramento River to the north and the San Joaquin River to the south. In this area, freshwater from the Sierra Nevada mountains mixes with the ocean waters of the Pacific, creating a distinctive landscape of grasslands, marshlands, and sloughs with complex hydrology, vegetation, and soils. Soils are dominantly organic and associated with

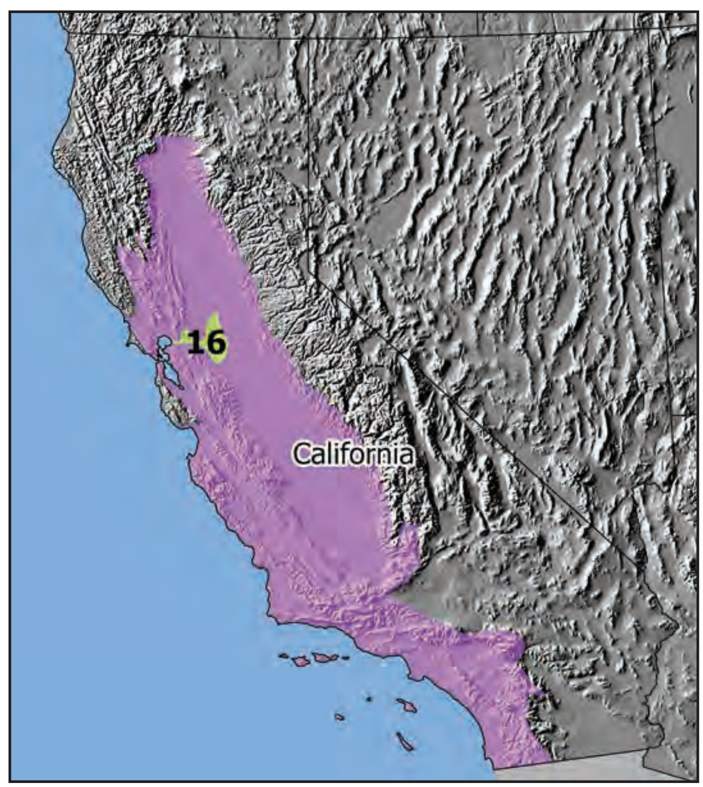

Figure 16-1: Location of MLRA 16, which covers 214,200 hectares (529,300 acres), within Region C.

mineral soils high in organic matter. These very poorly drained and poorly drained soils are surrounded by a system of levees. This MLRA makes up about 827 square miles (2,142 square kilometers).

MLRA 16 has a gradual boundary with MLRA 17 (Sacramento and San Joaquin Valleys). MLRA 17 includes the valley basins adjacent to the Sacramento and San Joaquin Rivers, fans and flood plains of tributary streams, and terraces and foothills around the edge of the valleys.

Physiography

Most of this area is in the California Trough section of the Pacific Border province of the Pacific Mountain System. A small part at the west edge of the area is in the California Coast Ranges section of the same province and division. This MLRA was originally the conjoined flood plain along the Sacramento and San Joaquin Rivers. As sediment from these rivers built up in San Pablo Bay, a delta formed, creating many streams that divide this nearly level area into “islands.” Suisun, Honker, and Grizzly Bays are in the area. The delta is above the San Pablo and San Francisco Bays. Strong levees and drainage systems are needed to keep the islands from flooding. Elevation of the islands ranges from below sea level to slightly above sea level.

Geology

This area is underlain by interbedded marine, estuarine, and fine grained nonmarine sediments, which were transported by the Sacramento and San Joaquin Rivers as they flowed into San Pablo Bay. As the sediments built up, a delta formed and freshwater mixed with saltwater in marshes and on flood plains. The marsh vegetation became covered with new sediments, and the organic matter content in the soils built up over many years to very high levels. When drained and exposed to the air, these peaty, organic soils oxidize, shrink, and then subside.

Climate

The average annual precipitation is 13 to 21 inches (318 to 535 millimeters). Summers are dry. Most of the rainfall occurs during low- or moderate-intensity, Pacific frontal storms in the period October to May. Snowfall is rare in this area. The average annual temperature is 58 to 62 degrees F (14 to 17 degrees C). The freeze-free period averages 345 days and ranges from 330 to 360 days.

Water

Almost all of the water is used for agriculture, recreation, and wildlife habitat. Most of it comes from the many sloughs and waterways that cross the area. Controlling salinity and the intrusion of saltwater is a major concern.

The small amount of ground water used for irrigation on the east side of this area is pumped from the alluvium and older sediments in the Central Valley. This water is hard or very hard. Nitrates from agricultural runoff can contaminate this shallow ground water.

A major pumping plant at Tracy transfers water from the delta into the California and Delta-Mendota Canals, which convey the water south to farms in the Central Valley and Tulare Lake Basin and to southern California cities. During periods of low flow, the plant causes a flow reversal and brackish water from San Pablo Bay can move up into the delta. A system of levees keeps the farmland from flooding.

Soils

The dominant soil orders in the MLRA are Entisols, Histosols, and Mollisols. The soils in the area dominantly have a thermic temperature regime, an aquic moisture regime, and mixed mineralogy. They generally are very deep, poorly drained or very poorly drained, and clayey.

The main soil series:

- Egbert series—Endoaquolls that formed in mixed alluvium in basins of river deltas
- Gazwell series—Endoaquolls that formed in alluvium from mixed rock sources underlain by decomposed hydrophytic plant material, in backswamps along the edge of freshwater marshes
- Joice series—Haplosaprists that formed from hydrophytic plant remains and mixed alluvium in flat saltwater marshes
- Rindge series—Haplosaprists that formed in highly decomposed organic material in freshwater marshes, sloughs, and drainage channels
- Sailboat series—Xerofluvents that formed in stratified alluvium from mixed sources on natural levees and low flood plains
- Scribner series—Endoaquolls that formed in mixed alluvium on the edges of backswamps
- Shima series—Haplosaprists that formed in highly decomposed organic material underlain by coarse textured alluvium from mixed sources, in freshwater marshes and river channels
- Shinkee series—Haplosaprists that formed in highly decomposed organic material underlain by alluvium from mixed sources, in freshwater marshes and river channels
- Suisun series—Haplohemists that formed in hydrophytic plant remains, mainly tules and reeds, mixed with fine mineral sediments in saltwater marshes
- Tamba series—Endoaquepts that formed in highly decomposed organic material and mixed alluvium in flat saltwater marshes
- Venice series—Haplohemists that formed in highly decomposed organic material underlain by coarse textured alluvium from mixed sources, in freshwater marshes and river channels

Biological Resources

This area supports a complex dynamic of marsh vegetation, some salt-tolerant species, some freshwater species, and some brackish water species. Fat-hen saltweed, brassbuttons, alkali bulrush, cattails, tules, saltgrass, and pickleweed characterize the MLRA. Areas where the hydrology has been significantly altered and that are not currently urban or agricultural lands are dominated primarily by a dense cover of non-native and naturalized grasses and forbs.

Major wildlife species include small mammals, river otter, beaver, and various songbirds. Fish species include delta smelt, striped bass, black bass, crappie, sunfish, catfish, salmon, steelhead, varieties of minnows, and sturgeon. The area is extremely important for wintering waterfowl, neotropical migrants, and year-round shore birds.

Land Use

More than one-half of this area is farmed (fig. 16-2). The most important crops are asparagus, sugar beets, potatoes, corn, grain, and hay grown under intensive management. Fruit trees, mainly pear trees, and some grapes are grown on slopes of the protecting levee system. Erosion of the levees by wave action is a continual concern. Subsidence of the peaty and mucky soils also is a concern.

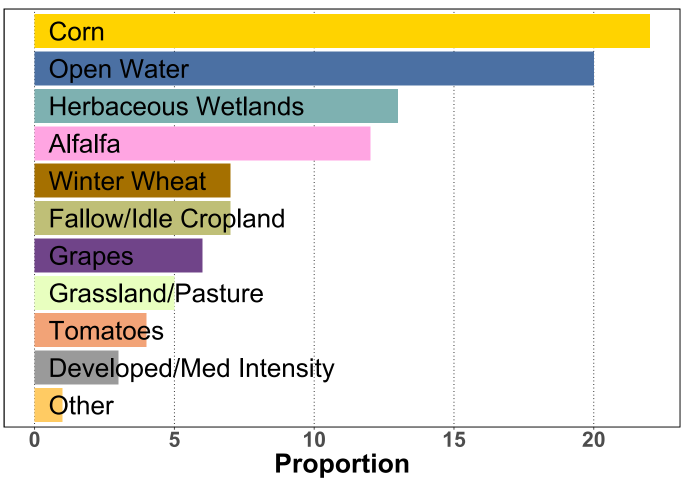

Figure 16-2: Relative proportions (percentages) of land use in MLRA 16.

The major soil resource concern is the subsidence caused mainly by oxidation, wind erosion, and shrinkage of organic soils. The most important conservation practice for cropland is controlling the water table by applying irrigation and drainage water management and by flooding the fields during idle periods. Other important practices are conservation cropping systems, selection of water-tolerant crops for planting, and nutrient and pest management.

17—Sacramento and San Joaquin Valleys

MLRA 17 (fig. 17-1) is entirely in California and makes up about 18,835 square miles (48,783 square kilometers). It is locally known as the Central Valley. MLRA 17 includes the valley basins adjacent to the Sacramento and San Joaquin Rivers, fans and flood plains of tributary streams, and terraces and foothills around the edge of the valleys. The cropland in this MLRA represents about one-quarter of the Nation's food and one-third of the cropland in California, and the irrigated cropland represents more than four-fifths of the irrigated land in the State.

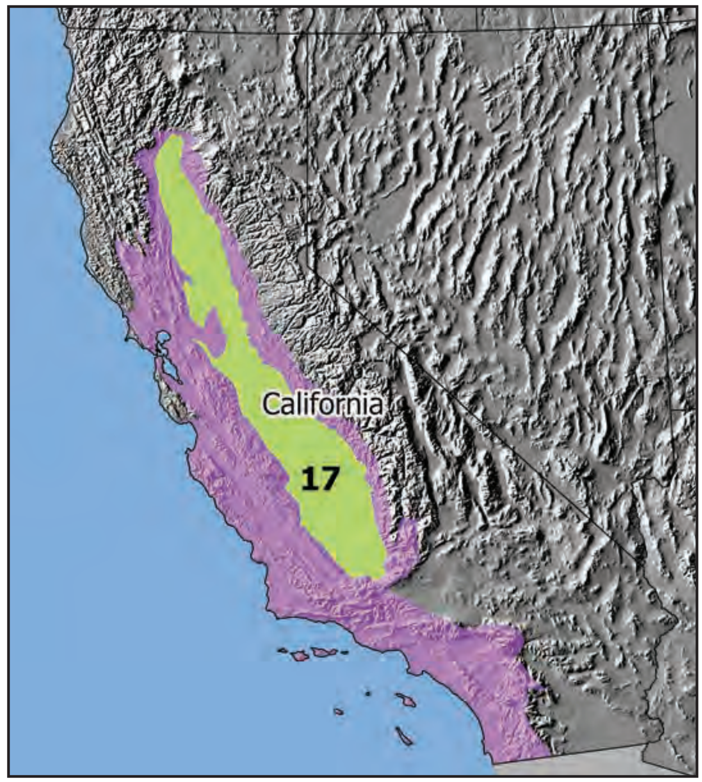

Figure 17-1: Location of MLRA 17, which covers 4,878,300 hectares (12,054,500 acres), within Region C.

To the west, MLRA 17 has a distinct boundary with MLRA 15, which consists of gently sloping to steep, low mountains covered by oak woodlands, oak savannas, chaparral, and grasslands. Most of MLRA 15 is private land, mainly in farms and ranches. To the east, MLRA 17 has a distinct boundary with MLRA 18, which is on the toeslope of the Sierra Nevada mountains. MLRA 18 consists of rolling to steep dissected hills and low mountains. Production of livestock on rangeland is the main enterprise in this area. A significant acreage is brushland or oak-dominated hardwood forest.

Physiography

All of MLRA 17 is in the Pacific Border province of the Pacific Mountain System. Almost all of it is in the California

Trough section. Small areas along the western border are in the California Coast Ranges section. Elevation ranges from sea level to 660 feet (200 meters) in the foothills surrounding the Central Valley. The valley floor is almost flat, and relief is low even along the borders of the area.

The Sacramento and San Joaquin Rivers are in this MLRA. The major water-supply reservoirs on the Sacramento River and its tributaries are just outside the north and east boundaries of the area. Two major canals are in this area—the State-owned California Aqueduct and the Federal Delta-Mendota Canal. They convey water from northern California, from the California Delta, to Buena Vista Lake directly southwest of Bakersfield.

Geology

California's Central Valley is underlain by as much as 9 miles of sediments derived from adjacent uplands and deposited in a variety of marine and nonmarine environments. The Great Valley began to separate from the open ocean roughly 150 million years ago, when subduction of Franciscan marine sediments and volcanics beneath the edge of the old ocean floor raised it and created a barrier to movement of sediments. The oldest sediments were derived in large part from the early Sierra Nevada volcanoes and deposited in a deeper marine environment. The composition of the sediments shifted as the volcanic cover was stripped away, exposing the granites of the Sierra Nevada Batholith to erosion. At the same time, the valley started to fill and deposition was occurring in an increasingly shallow marine environment, particularly in the Sacramento Valley, where shallow marine environments started giving way to nonmarine depositional processes roughly 50 million years ago. The interbedded layers of clays, sands, silts, and gravel strongly influence subsurface hydrology and are a source of gas reserves in the Sacramento Valley and oil and gas reserves in the deeper San Joaquin Valley.

The uppermost sediments reflect a recent history of sedimentation in a variety of nonmarine depositional environments. The finer grained deposits are typically associated with flood plains, basins, and lakes. The coarser grained sands and gravel were deposited in stream channels and across alluvial fans. There also are erosional remnants of gravelly stream terraces and older sedimentary formations, especially along the edges of the valley. Almost all of the surface of this area is covered by recent alluvial deposits. There are some sandy places, but most of the deposits are flood-plain sediments with textures of silt to clay. Some gravel occurs in terraces and abandoned channels along modern streams and rivers draining from the surrounding mountains down into this area. Some marine sediments are buried beneath these thick alluvial deposits. Sutter Butte, in the northern part of the Sacramento River Valley, consists of the eroded remnants of a volcano.

Climate

The average annual precipitation is 6 to 24 inches (143 to 1,198 millimeters) but can be as much as 40 inches in some locations. Summers are long, hot, and dry, and winters are cool and rainy. Most of the rainfall occurs during low- or moderate-intensity, Pacific frontal storms from October to May. Snow is very rare but has occurred in the Sacramento Valley, from Sacramento to points farther north. The average annual temperature is 60 to 65 degrees F (16 to 18 degrees C), decreasing from south to north. The freeze-free period averages 325 days and ranges from 280 to 365 days, decreasing in length with elevation and from south to north.

Water

Because of the low rainfall and relatively small flow from streams, water is scarce in many parts of this MLRA. Water for irrigated crops comes from stream diversions, wells, and canals of organized irrigation districts that obtain most of their water from State and Federal water systems. The Sacramento River supplies the most water for use in this area. The river water is hard but is of good quality and suitable for drinking after minimal treatment. The tributaries of the San Joaquin River draining the Sierra Nevada mountains to the east have water of excellent quality. Water in the lowland streams is often degraded by sediment and salts from agricultural irrigation and drainage and municipal and industrial waste discharges, especially during the summer low-flow season.

The deep alluvium and older sediments filling the Sacramento and San Joaquin Valleys are the sources of ground water in this area. Water beneath the Sacramento Basin is hard. Boron concentrations exceed the national drinking water standard in the southwest corner of the Sacramento Basin. The boron comes from thermal springs in the Coast Ranges and upward seepage of ground water from marine sediments.

Water quality varies in the San Joaquin Basin. The water is much fresher on the east side of the valley as it comes off the granite rocks in the Sierra Nevada mountains. A confining layer called the Corcoran Clay separates the water described above from deeper, confined ground water. The ground water beneath the San Joaquin Basin, like that beneath the Sacramento Basin, is hard, and boron concentrations may exceed the national drinking water standard. Ground subsidence has been significant (more than 20 feet in some areas) on the San Joaquin Valley floor because of historic excessive pumping of ground water aquifers, which has led to the consolidation of aquifers.

Soils

The dominant soil orders are Alfisols, Aridisols, Entisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic temperature regime, an aridic or xeric moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained or moderately well drained, and loamy or clayey. Some soils are shallow to a duripan.

The main soil series:

Capay series—Haploxererts that formed in fine textured alluvium derived from mostly sandstone and shale; on flood basins, alluvial fans, interfan basins, and basin rims

Delhi series—Xeropsamments that formed in wind-modified material weathered from granitic rocks; on flood plains, alluvial fans, and terraces

Grangeville series—Haploxerolls that formed in moderately coarse textured alluvium dominantly from granitic rocks; on alluvial fans and flood plains

Hanford series—Xerorthents that formed in moderately coarse textured alluvium dominantly from granite; on stream terraces, flood plains, and alluvial fans

Kimberlina series—Torriorthents that formed in mixed alluvium from igneous and sedimentary rocks; on flood plains and recent alluvial fans

Milham series—Haplargids that formed in mixed calcareous alluvium weathered from granitic and sedimentary rocks; on alluvial fans, plains, low terraces, and fan remnants

Newville series—Palexeralfs that formed in gravelly alluvium from sedimentary and metamorphic rocks on dissected fan remnants

Panoche series—Haplocambids that formed in loamy calcareous alluvium from sedimentary rocks on alluvial fans and flood plains

Redding series—Durixeralfs that formed in alluvium derived from mixed sources on nearly level or dissected fan remnants

San Joaquin series—Durixeralfs that formed in alluvium derived from mixed but dominantly granitic rocks on undulating low terraces

Willows series—Endoaquerts that formed in alluvium from mixed rock sources in flood basins

Biological Resources

This MLRA currently supports naturalized and native annual grasslands that include some native perennials, scattered trees, and scattered areas of vernal pools. However, it was once a complex landscape of grasslands, valley oak savannas, riparian forests, wetlands, and freshwater marshes. Remnant areas that have not been significantly altered by urbanization, agriculture, or other types of disturbance still exist but are relegated to narrow bands along waterways or are small areas that are not suitable for agriculture. Annual grasslands are primarily dominated by wild barley, wild oats, soft chess, ripgut brome, fescues, burclover, tarweeds, and filaree. The vernal pools within the annual grasslands are filled with endemic flora and fauna specific to the hydrology of these pools. Valley oaks are scattered on upper stream terraces and mixed in with cottonwoods, California sycamores, and a subcanopy of alder, boxelder, and ash along the rivers and streams and in overflow areas. Saltgrass, along with such shrubs as iodinebush and Australian saltbush, grow on saline-sodic soils on terraces and in basins.

Major wildlife species include jackrabbit, coyote, fox, ground squirrel, pocket gopher, and various songbirds. Fish species include salmon, striped bass, steelhead, shad, sturgeon, largemouth bass, smallmouth bass, bluegill, and catfish. Portions of the area are extremely important for wintering waterfowl and seasonally neotropical migrants.

Land Use

More than four-fifths of the area is in farms and ranches (fig. 17-2). The acreage used for urban development is increasing rapidly. Three-fourths or more of the cropland is irrigated. Production of cotton, nuts, grapes, hay, grain, pasture, rice, alfalfa, citrus, and truck crops (including tomatoes) and dairy farms are the principal types of agriculture. The more sloping nonirrigated cropland is used for dry-farmed grain. About a third of the MLRA is in areas of grasses and forbs, brush, and open woodland used mostly for grazing.

The major resource concerns are maintenance of the content of soil organic matter, water quality, irrigation-induced erosion, wind erosion, and irrigation water management. If the plant cover is removed, water erosion is a hazard on the more sloping soils (especially vertic soils hardened by drought on terraces) and the hazard of wind erosion is severe on the sandy, wind-modified soils in the San Joaquin Valley. In areas of low precipitation, maintaining favorable salinity levels in the root zone is a resource concern.

Important conservation practices for cropland are crop rotations, minimum tillage, and the use of crop residue to maintain good tilth and favorable soil structure. Wind abrasion is a critical problem during crop establishment on coarse textured soils. It can be controlled by crop residue management

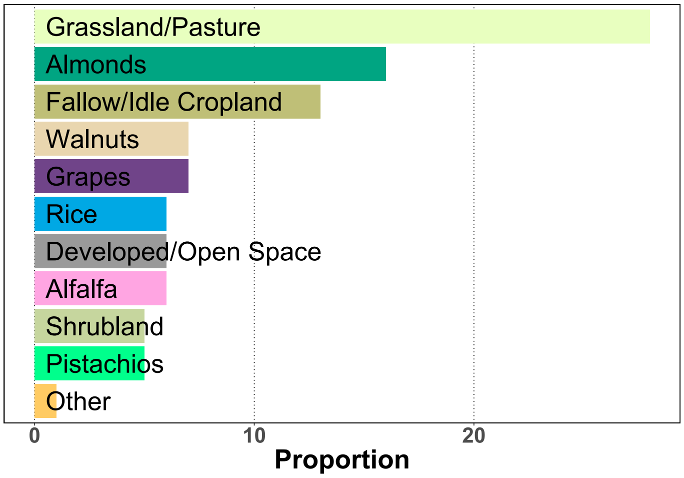

Figure 17-2: Relative proportions (percentages) of land use in MLRA 17.

and windbreaks. Where the amount of rainfall is too low to leach salts from the soils, irrigation water is needed.

Important conservation practices for dairy farms are manure-handling systems, including nutrient management. Important conservation practices for grazing land include prescribed grazing, fencing, and water management.

18—Sierra Nevada Foothills

MLRA 18 (fig. 18-1) is entirely in California, on the toeslope of the Sierra Nevada mountain. It makes up about 8,057 square miles (20,868 square kilometers). The area is characterized by rolling to steep, dissected hills and low mountains primarily dominated by fire-prone oak woodlands, oak savannas, chaparral, and grasslands.

MLRA 18 has a distinct boundary with MLRA 17 to the west. In MLRA 17, the valley floor is almost flat and relief is low even along the borders. To the east, MLRA 18 has a gradual boundary with MLRAs 22A and 22B. MLRA 22A consists of the higher elevations of the Sierra Nevada mountains. Most of this area is dominated by Mesozoic plutonic rocks (dominantly quartz monzonite and granodiorite), otherwise known as the Sierra Nevada Batholith. The soils dominantly have a mesic, frigid, or cryic temperature regime, depending largely on elevation. MLRA 22B is the southernmost extent of the Cascade Range. It consists primarily of Tertiary and Quaternary volcanics (basalt, andesite, dacite, and rhyolite) exposed as prominent peaks and volcanic uplands, surrounded by lower, moderately steep and steep shield and composite volcanoes and cinder cones.

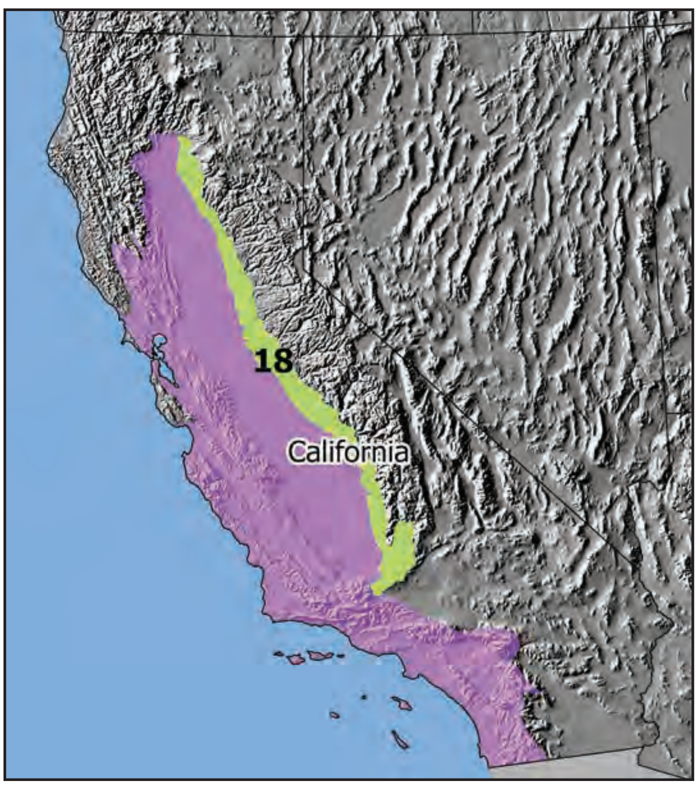

Figure 18-1: Location of MLRA 18, which covers 2,086,800 hectares (5,156,400 acres), within Region C.

Physiography

This MLRA straddles the boundary between two physiographic provinces in the Pacific Mountain System. Most of the western half is in the California Trough section of the Pacific Border province. Most of the eastern half is in the Sierra Nevada Mountains section of the Cascade-Sierra Mountains province. The Sierra Nevada Mountains section is a fault-block mountain range. The fault on the east side of the mountains created a steep face of alpine summits, but the west side has a gentler slope. MLRA 18 is at the toe of the gentle east-to-west slope. The stream valleys are narrow and fairly steep. Elevation generally ranges from 660 to 1,650 feet (200 to 505 meters), but it is 3,950 feet (1,205 meters) on some isolated mountain peaks.

The major streams draining the Sierra Nevada mountains from north to south in the area include the Butte, Feather, Yuba, American, Cosumnes, Mokelumne, Tuolumne, San Joaquin, Kings, and Kern Rivers. Numerous Federal and State water project reservoirs are in this MLRA, including Lakes Oroville, Collins, Englebright, Camp Far West, Folsom, Comanche, Pardee, New Hogan, New Melones, Don Pedro, McClure, Millerton, Pine Flat, Kaweah, Success, and Isabella. These projects supply water for irrigation, industry, and domestic uses during the dry summer months.

Geology

The northernmost end of this area is underlain dominantly by volcanic mudflow and pyroclastic rocks of the Tuscan Formation, which was derived from the eruption of Cascade volcanoes during the Pliocene Epoch, roughly 3 to 4 million years ago. South of Oroville, the foothills are underlain by Mesozoic, metamorphosed marine sedimentary and volcanic rocks that were emplaced as terranes when the subduction trench was in the vicinity of the present-day Sierra Nevada mountains. Discrete granitic plutons are intruded through the older Mesozoic metamorphics in the northern part of the area, and a thin band of Tertiary sedimentary formations is exposed along the eastern edge, from the Cosumnes River south. From around Merced southward, the foothills are underlain dominantly by Mesozoic granites of the Sierra Nevada Batholith, with local exposures of gabbro, metavolcanics, and other metamorphics. Tertiary sedimentary formations and Quaternary alluvial terrace deposits extend westward from the granitics in the vicinity of Bakersfield.

Climate

The average annual precipitation is 13 to 38 inches (228 to 1,591 millimeters), but annual precipitation can range to

65 inches in high-elevation areas. It increases from south to north and with elevation. Summers are hot and dry, and winters are cool and moist. Most of the rainfall occurs during Pacific frontal storms in the period October to May. The average annual temperature is 47 to 65 degrees F (8 to 18 degrees C). The freeze-free period averages 275 days and ranges from 180 to 365 days, decreasing in length from south to north and with elevation.

Water

The moderate rainfall and intermittent streamflow are the major water sources. There are numerous stock ponds throughout the area. The major reservoirs store water for use outside the area. The surface water generally is of very good quality and is suitable for almost all uses with little or no treatment.

Ground water supplies are small and mostly untapped. Some water can be obtained from joints and fractures in the volcanic rocks in the northeast corner of the area. Shallow wells can be developed in the alluvial deposits along the major streams crossing the area. This ground water is similar to the surface water and is suitable for almost all uses with minimal treatment. Some ground water can be obtained from wells in the alluvium and older sediments along the western edge of this area on the fringes of the Central Valley. This water is hard but of good quality.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a thermic temperature regime, a xeric moisture regime, and mixed mineralogy. They generally are very shallow to deep, well drained or somewhat excessively drained, and loamy.

The main soil series:

- Ahwahnee series—Haploxeralfs that formed in material weathered from granitic rocks on footslopes and mountains
- Auberry series—Haploxeralfs that formed in material weathered from acid intrusive igneous rocks on foothills and mountains
- Auburn series—Haploxerepts that formed in material weathered from amphibolite schist on foothills
- Blasingame series—Haploxeralfs that formed in material weathered from basic igneous rocks on foothills
- Coarsegold series—Haploxeralfs that formed in weathered schist on mountains
- Daulton series—Xerorthents that formed in metamorphosed, fine grained, dark-colored slates of the Mariposa Formation, on foothills
- Loafercreek series—Haploxeralfs that formed in colluvium and residuum from metavolcanic rocks, mainly greenschist; on ridgetops and side slopes on metamorphic foothills
- Pentz series—Haploxerolls that formed in colluvium and residuum derived from basic tuff; on hills with mound and swale microrelief and on backslopes of hills
- Toomes series—Haploxerepts that formed in material weathered from tuff breccia, basalt, and andesite on ridges and plateaus
- Walong series—Haploxerolls that formed in material weathered from granitic rocks on foothills

Biological Resources

This area supports a species-rich, ecologically diverse and complex patchwork of habitats primarily dominated by oak woodlands, oak savannas, chaparral, and annual grasslands. The dominant oaks are blue oak, interior live oak, California black oak, and valley oak. Interior live oak dominates many of the oak woodlands while blue oak dominates the warmer and drier oak woodlands and all of the oak savannas. Valley oaks, along with California sycamore, are relegated to the upper stream terraces and drainageways within the MLRA where soils are well drained. In the dense oak woodlands, a mix of foothill pine, interior live oak, and blue oak and several chaparral shrubs (including scrub oak, manzanita, and poison oak) are common. Chaparral species dominate the shrublands and commonly include chamise, several manzanitas, scrub oaks, wedgeleaf ceanothus, yerba santa, and California buckwheat. Naturalized annuals (including soft chess, bromes, fescues, wild oats, filaree, and burclover) and many perennial and annual native forbs (such as California poppy, bluedicks, onions, popcornflowers, tarweeds, phacelias, and lupines) characterize the open grasslands, oak woodlands, and oak savanna understory. Limited stands of ponderosa pine and California black oak with an understory of manzanitas and poison oak are also at the higher elevations.

Major wildlife species include black-tailed deer, mountain lion, coyote, gray fox, raccoon, porcupine, skunk, jackrabbit, ground squirrel, pocket gopher, brown rat, field mouse, valley quail, band-tailed pigeon, red-headed woodpecker, mourning dove, mallard, cinnamon teal, wood duck, and rattlesnake. Fish species include black bass, bluegill, crappie, trout, salmon, steelhead, and catfish.

Land Use

Production of livestock on rangeland is the main enterprise in this area (fig. 18-2). A significant acreage is brushland or oak-dominated hardwood forest. A small acreage is cropland. In the past most of the cropland in the area was used for dry-farmed grain; however, more and more small tracts are now used for nuts, wine grapes, and other kinds of fruit grown under sprinkler, micro, and drip irrigation systems.

The major resource concerns are soil erosion, maintenance of the content of soil organic matter, water quality, and low infiltration rates in hydrophobic soils. The hazard of erosion is moderate or severe if the plant cover is removed by overgrazing,

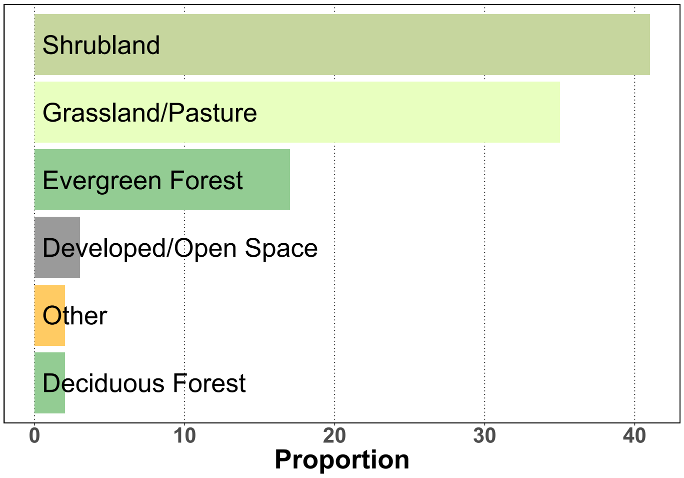

Figure 18-2: Relative proportions (percentages) of land use in MLRA 18.

cultivation, or fire. If the surface is unprotected in winter, the hazard of sheet and gully erosion is severe on the sloping soils on terraces and benches and on upland soils.

Important conservation practices for cropland include crop residue management, cover crops, and irrigation water management. Prescribed grazing, fencing, and stock water development are the most important practices for rangeland and other grazing land.

Important conservation practices in urban land development include controlling erosion on and around sites for houses and roads. The important erosion-control practices are methods of phasing construction that maintain as much of the native vegetation as possible, mulch and geotextile erosion blankets, a temporary cover of vegetation, and sediment-control systems, including sediment-debris basins and traps, silt fences, fiber rolls, and straw wattles.

19—Southern California Coastal Plains and Mountains

MLRA 19 (fig. 19-1) was known for its citrus production before the significant urbanization in the last 100 years. This area, which is entirely in California, is characterized by both the gently sloping to strongly sloping, dissected coastal and alluvial plains as well as the steep, erosive hills and mountains of the Transverse and Peninsular Ranges in Southern California (which were formerly MLRA 20, Southern California Mountains). It consists primarily of annual and perennial grasslands, coastal scrub and chaparral shrublands, and coast live oak savannas and woodlands. The numerous narrow valleys have similar characteristics. The MLRA makes up about 13,727 square miles (35,552 square kilometers).

MLRA 19 has a gradual boundary with MLRA 15 to the north. MLRA 15 is characterized by the geologically complex, gently sloping to steep, low-elevation Coast Ranges that primarily support oak woodlands, oak savannas, chaparral, and grasslands. To the east, MLRA 19 has a rapid transition to MLRA 30 as soil temperature increases and precipitation decreases, resulting in the dominance of creosote bush and white bursage.

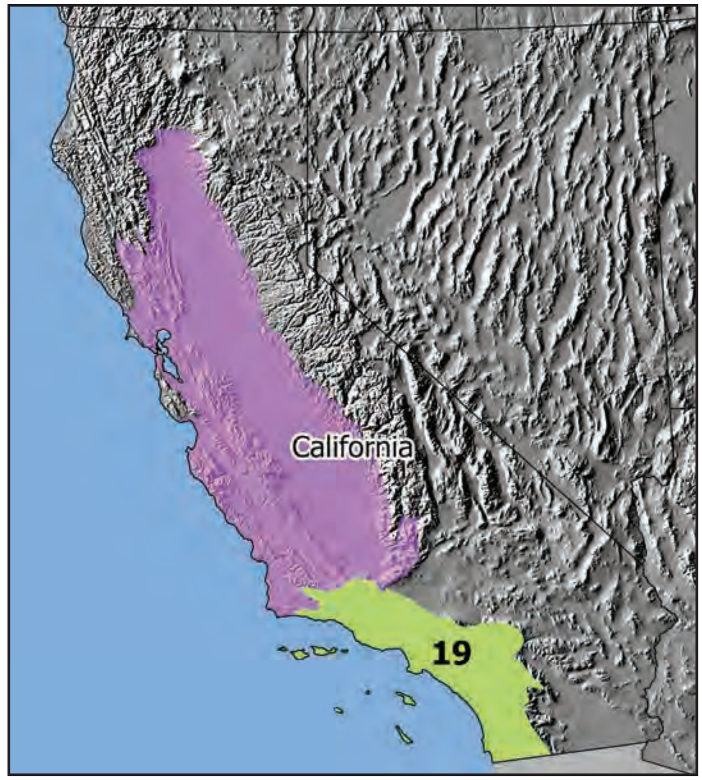

Figure 19-1: Location of MLRA 19, which covers 3,555,200 hectares (8,785,000 acres), within Region C.

Physiography

The northern half of this area is in the Los Angeles Ranges section of the Pacific Border province of the Pacific Mountain System. This part of the MLRA consists mainly of gently sloping to strongly sloping, dissected coastal and alluvial plains bordered by steep hills and mountains. The northwestern end of the MLRA is in the California Coast Ranges section of the same province and system. The mountains in this area are called the Transverse Ranges since their trend is roughly east and west, almost perpendicular to all other mountain ranges in California. In the northwestern end of the area, the Transverse Ranges merge with the Coast Ranges. The southern half of this MLRA, called the Peninsular Range, is in the Lower Californian province of the Pacific Mountain System. From north to south, the Sierra Madre, San Gabriel, San Bernardino, Santa Rosa, and Vallecitos Mountains occur in this area. The eight Channel Islands also occur in this area. Changes in sea level over time have changed the coastal plains into terraces. Stream incision has created abandoned flood plains, or terraces, adjacent to most rivers.

The mountainous portion is an area of narrow mountain ranges and broad fault blocks. Elevation ranges from sea level to 7,900 feet (0 to 2,400 meters) in most of the area. The highest peaks can exceed 12,000 feet (3,660 meters). The strongly sloping to precipitous mountains have unstable slopes and sharp crests. Intermountain valleys are typically narrow and filled with alluvium. Almost all the valleys have streams with actively eroding banks. The valley floors along Calleguas Creek and the Santa Clara River are wide, and colluvial slopes and alluvial fans have formed at the edges of these valleys.

The Los Angeles River is confined to a concrete-lined flood-control channel through the city of Los Angeles. A series of debris dams near the inland border of this MLRA trap the sand, gravel, cobbles, and boulders that are carried by the mountain streams down to the coastal plain. The dams not only reduce the need for dredging in the Los Angeles River but also create a source of sand and gravel for construction. The Santa Clara River enters the ocean near Ventura. This city is protected from flooding by levees. The Santa Clara River is the primary source of sand for the beaches of Los Angeles and other communities to the south. Extensive gravel mining from this river has decreased the amount of coarse material reaching the sea and has led to severe beach erosion. Numerous groins and jetties were built to trap sand moving south in littoral currents and reduce the hazard of beach erosion.

Geology

The coastal plains in this MLRA consist of thick layers of river-laid sediments that tend to become finer textured nearer the ocean. Very coarse sediment is on the colluvial slopes and alluvial fans on the inland border of the MLRA. Lower sea levels have transformed the plains into the marine terraces of today. Southern California is the western boundary of the North American continental plate. The Pacific Plate is being subducted beneath the continental plate in this area. The continental plate is moving up and northwest as the ocean plate slides beneath it. Numerous faults occur in this MLRA, and earthquakes are common as the plates slide past each other.

The Transverse Ranges are geologically very young and bounded by the San Andreas Fault. These mountains primarily consist of uplifted and tilted Cenozoic marine sediments. The far eastern end of this range consists of Precambrian rocks and Mesozoic volcanics. The Peninsular Range is primarily granite. Mesozoic sediments that have been metamorphosed occur at the margins of the granitic intrusives. The valleys are filled with relatively coarse alluvium since most of the sediments have not moved far from their source.

In addition to earthquakes, landslides are a major land-forming process in this MLRA. They frequently occur during rainstorms in winter, when the soils become saturated, and following brush fires after the root systems of brush decay.

Climate

The average annual precipitation ranges from 8 to 53 inches (215 to 1,354 millimeters), increasing with elevation. Most of the rainfall occurs during low- or moderate-intensity, Pacific frontal storms in winter. Rain can turn to snow at the higher elevations. Some snow may fall in winter, but it does not last. Summers are dry, but fog provides some moisture along the coast. The average annual temperature is 38 to 67 degrees F (3 to 19 degrees C). The freeze-free period averages 310 days in the valleys and 245 days in the mountains and ranges from 125 to 365 days along the coast. It decreases in length with elevation. The longest freeze-free period occurs at the lower elevations along the western edge of the area.

The climate on the eight Channel Islands differs somewhat from the climate on the mainland portions of this MLRA. The southern Channel Islands tend to be warmer and drier than their northern counterparts because the California Current (ocean current) is warmer when it reaches the southern islands. Santa Catalina Island has an average annual precipitation of 12 inches (305 millimeters), recorded for over 30 years at Avalon, and an average annual summer temperature of 59 to 74 degrees F (15 to 23 degrees C). The average annual winter temperature, recorded at Avalon, ranges from 49 to 63 degrees F (9 to 17 degrees C). The northern islands have a climate that tends to be moderated by fog. They have slightly higher humidity and lower cloud cover than the adjacent coastal mainland. These northern islands, especially Santa Cruz and Santa Rosa, receive consistent and regular winds prevailing from the northwest. These winds may have higher velocity than the mainland winds.

Water

The low rainfall and intermittent streamflow provide small quantities of surface water for local use. Much of the water for irrigation and nearly all of the water for large urban areas is diverted from the Colorado and Owens Rivers, in eastern California, and from northern California rivers via aqueducts. This imported water is typically of good quality and suitable for drinking after minimal treatment. The competition for water between the populated areas and the agricultural areas has increased the cost of water in southern California. Desalinization is becoming economically viable as the cost of imported surface water increases.

The limited ground water in the alluvial deposits and older sediments under the coastal plains has been heavily exploited. This ground water is generally good in inland areas and suitable for all uses. Declining water tables and the intrusion of saltwater are reducing both the quantity and quality of this water. The level of chloride reduces the usefulness of the water for irrigating salt-sensitive crops.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Mollisols. The soils in the area dominantly have a thermic temperature regime, a xeric moisture regime, and mixed mineralogy. The soils in the valleys generally are deep or very deep, well drained or somewhat excessively drained, and loamy or sandy. The dominant soils in the valleys formed in alluvial sediments. The soils on the foothills and mountains generally are very shallow to deep, well drained or somewhat excessively drained, and loamy or sandy. The dominant soils in the foothills and mountains formed in residuum.

The main soil series in valleys:

Hueneme series—Xerofluvents that formed in stratified alluvium derived from alkaline sedimentary sources on nearly level alluvial plains and basins

Ramona series—Haploxeralfs that formed in alluvium derived mostly from granitic and related rocks on terraces and fans

San Emigdio series—Xerofluvents that formed in dominantly sedimentary alluvium on fans and flood plains

Soboba series—Xerofluvents that formed in alluvium from predominantly granitic rocks, on alluvial fans and flood plains

Tujunga series—Xeropsamments that formed in alluvium from granitic sources on alluvial fans and flood plains

The main soil series on mountains:

Balcom series—Calcixerepts that formed in material weathered from soft, calcareous shale and sandstone on hills

Crouch series—Haploxerolls that formed in material weathered from granitic rock on mountains

La Posta series—Haploxerolls that formed in residuum weathered from granitic rocks on mountains

Las Posas series—Rhodoxeralfs that formed in material weathered from basic igneous rocks on mountains

Saugus series—Xerorthents that formed from weakly consolidated sediments on dissected terraces and foothills

Sheephead series—Haploxerolls that formed in material weathered from mica, schist, gneiss, or granite on mountains

Biological Resources

Valley bottoms and coastal terraces and hills consist primarily of annual and perennial grasslands, coastal scrub and chaparral shrublands, and coast live oak savannas and woodlands. The grasslands and coast live oak savannas support an understory dominated by wild oats, soft chess, red brome, filaree, burclover, needlegrass, tarweed, mustard, and annual lupine interspersed with coastal live oak. Areas of dense oak woodland are intermixed with chaparral species and coastal scrub species, including manzanitas, chamise, ceanothus, scrub oaks, California sagebrush, black sage, purple sage, and California buckwheat. Unique stands of the rare Torrey pine occur on sandy and rocky, nutrient-poor soils in an area between Del Mar and Solana Beach near San Diego and on the Channel Islands. Small areas along the coastline include beach dunes and estuaries; however, these areas have been significantly altered by urbanization.

Mountainous areas support grasslands, chaparral, oak woodlands, pinyon-juniper woodlands, and forest. Most mountainous areas are covered with dense chaparral, oak woodlands, and some small areas of grassland. The chaparral is largely dominated by scrub oak, manzanita, ceanothus, chamise, and redshank, with California buckwheat, black sage, purple sage, and common deerweed as typical associates. Grasslands are dominated by non-native annual grasses, including wild oats, soft chess, cheatgrass, and red brome, as well as many annual and perennial forbs. Scattered perennial grasses also occur; however, they are more common in the areas closer to the coast where the temperatures are cooler in summer. Open stands of Jeffrey pine, Coulter pine, sugar pine, Douglas-fir, incense cedar, pinyon, and juniper are at elevations above 4,000 feet (1,220 meters). At elevations above 8,000 feet (2,440 meters), subalpine conifer forests occur. They consist of lodgepole pine, limber pine, white fir, and western juniper.

The vegetative communities on the Channel Islands are somewhat unique and include native island endemics, such as island hazardia, island malacothrix, cliff malacothrix, liveforever, island manzanita, island scrub oak, island oak, Channel Island poppy, island bush poppy, island buckwheat, island ceanothus, island redberry, island ironwood, and island monkeyflower. Other mainland species on all islands include coastal live oak, California sagebrush, toyon, lemonade berry, coyotebrush, canyon live oak, Bishop pine, Torrey pine, and perennial grasses.

Major wildlife species include deer, feral hog, mountain lion, bighorn sheep, coyote, bobcat, raccoon, skunk, jackrabbit, gray squirrel, ground squirrel, rattlesnake, California condor, turkey vulture, roadrunner, crow, quail, pigeon, blackbird, dove, heron, and coot. Species of concern include cactus wren, California gnatcatcher, Bell's vireo, mountain yellow-legged frogs, red-legged frogs, arroyo toad, and southwestern willow flycatcher.

Land Use

In the valleys, nearly two-thirds of this area consists of urban or built-up land, and the rest is rapidly being converted to urban uses (fig. 19-2). About a third of the area is brushland used for watershed protection. The irrigated crops are subtropical fruits such as avocados, citrus, deciduous fruits, grain, truck crops, grapes, hay, and pasture. Dairy farming and flower seed production are other important enterprises. Some livestock is produced on the rangeland.

In the mountains, less than one-tenth of this area is used for urban development and the rest is in farms, ranches, or other private holdings. Less than one-fifth is open woodland and brushland used for grazing. More than half of the area has a dense brush cover that is not grazed. Most of the larger valleys are used for dry-farmed grain and hay, but in some places fruits are grown under irrigation.

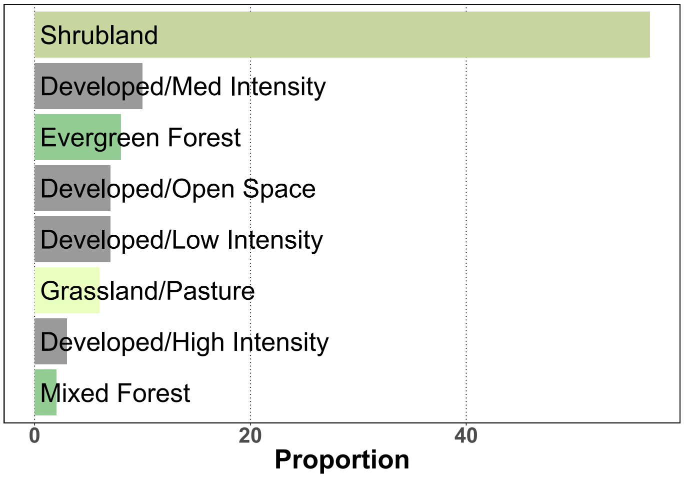

Figure 19-2: Relative proportions (percentages) of land use in MLRA 19.

The major soil resource concerns in the valleys are erosion, maintenance of the content of soil organic matter, water quality, and low infiltration rates in hydrophobic soils created via plant chemical exudates or wildfires. The erosion hazard is slight on soils in valleys, except where improper irrigation practices are more damaging than rainfall. If the surface is unprotected in winter, the hazard of sheet and gully erosion is severe on the sloping soils on coastal terraces and benches and on upland soils. Salinity and the encroachment of seawater into ground water basins are concerns in the valleys at sea level.

The major soil resource concern in the mountains is a severe erosion hazard where the plant cover is depleted or destroyed by overgrazing or fire. Preventing or controlling brush fires is a major concern.

In the valleys, important conservation practices for cropland and dairy farms are irrigation water management and nutrient management. Prescribed grazing, brush management (to reduce fuel loads), fencing, and water management are important practices on rangeland and other grazing land.

In the mountains, important conservation practices are prescribed grazing, fencing, and water management on rangeland and other grazing land; erosion control, irrigation water management, and nutrient management on urban land; erosion control, irrigation water management, and nutrient management on cropland, including orchards; and thinning and control of competing vegetation on forestland.

Figure D-1: Location and size of Land Resource Region D, which covers 1,420,100 square kilometers (548,305 square miles) from Mexico to central Oregon and northern Wyoming. Region D is the largest land resource region.

D—Western Range and Irrigated Region

Land Resource Region D (fig. D-1) is the dryland region that contains all four North American deserts: the Chihuahuan, Sonoran, Mojave, and Great Basin. Death Valley, in the Mojave Desert of southern California, has the hottest recorded temperatures on Earth—130 degrees F (54.4 degrees C). In contrast to the hotter and drier conditions at lower elevations, the high mountains in Region D are cooler and wetter. Mount Whitney, for example, with an elevation of 14,505 feet (4,421 meters), has an alpine tundra climate. Streams and rivers fed by mountain rainfall and snowpack are used to irrigate crops at the lower elevations. Ground water from the intermontane basins is an increasingly important source of water. The physiography of Region D is mainly Basin and Range, characterized by north-south-trending mountain ranges separated by intermontane basins. The Colorado Plateaus and Wyoming Basin are the other two physiographic provinces in Region D. This region contains 24 major land resource areas. The extent of these MLRAs and their range in elevations are shown in table D-1.

The boundary in the north between Regions D and B (fig. 1, page 5) roughly corresponds to the contact between the Basin and Range and the Columbia Plateau with its great extent of lavas. The boundary between Regions D and A marks the physiographic contact between the Basin and Range and the Cascade Range, including the eastward extent of Andisols (fig. 2, page 6). The boundary along the western side of Region D with Region C follows the physio-climatic contact between the Sierra Nevada mountains and the Great Valley southward to its termination. South of the Central Valley, the boundary between Regions C and D is the contact between the tectonically complex mountains of the Transverse Ranges and the much hotter and drier Mojave Desert (figs. 11 and 12, pages 15 and 16). To the southeast, the boundary between Region D and Regions G and I is the physiographic contact between the Basin and Range and the Pecos Valley (Region G) and Edwards Plateau (Region I). The boundary between Regions D and E is physio-climatic, marked by changes in both moisture and temperature (figs. 6 and 7, pages 10 and 11).

Although dryness is the overriding characteristic, the climate of Region D is extremely variable. The average annual precipitation ranges from 2 inches (40 millimeters) at the lowest elevations, where soils have an aridic moisture regime, to greater than 100 inches (2,560 millimeters) on some of the higher mountains, where some soils have a udic moisture regime. In the southeast part of the region, most of the precipitation falls as rain during the warm season. Elsewhere

Table D-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
21	28,525	11,015	630	2,070	1,240	4,080	1,470	4,820	1,850	6,080	3,010	9,870
22A	49,495	19,110	180	590	910	3,000	1,910	6,270	2,990	9,810	4,410	14,470
22B	14,130	5,455	220	720	1,010	3,310	1,520	4,990	1,960	6,440	4,300	14,120
23	53,420	20,625	1,110	3,640	1,290	4,240	1,500	4,940	1,870	6,140	2,960	9,730
24	34,655	13,380	920	3,040	1,250	4,120	1,430	4,700	1,860	6,130	2,970	9,750
25	71,080	27,445	750	2,470	1,420	4,680	1,730	5,670	2,100	6,890	3,460	11,350
26	14,660	5,660	1,150	3,790	1,450	4,760	1,870	6,160	2,370	7,790	3,430	11,250
27	39,915	15,410	1,020	3,370	1,180	3,890	1,350	4,440	1,770	5,810	3,030	9,960
28A	98,270	37,940	1,260	4,140	1,280	4,220	1,550	5,100	2,010	6,620	3,970	13,040
28B	56,625	21,865	1,420	4,680	1,760	5,790	2,000	6,560	2,450	8,040	3,630	11,910
29	67,035	25,885	160	550	1,270	4,170	1,650	5,420	2,060	6,770	4,330	14,220
30	109,505	42,480	0	0	480	1,570	860	2,840	1,380	4,530	3,620	11,890
32	27,875	10,765	1,100	3,630	1,270	4,180	1,510	4,950	1,790	5,870	2,240	7,370
34A	70,150	27,085	1,620	5,330	1,920	6,300	2,070	6,810	2,220	7,280	2,890	9,480
34B	35,730	13,795	1,210	3,970	1,450	4,750	1,750	5,740	2,060	6,770	2,780	9,140
35	181,855	70,215	340	1,140	1,400	4,600	1,760	5,790	2,150	7,050	3,500	11,500
36	49,600	19,150	1,260	4,150	1,750	5,740	2,070	6,810	2,420	7,960	3,870	12,700
38	52,705	20,350	370	1,210	950	3,110	1,480	4,870	1,900	6,230	2,790	9,170
39	55,315	21,360	1,130	3,720	1,670	5,500	2,170	7,120	2,510	8,240	3,840	12,600
40	114,955	44,385	0	0	100	340	410	1,350	780	2,580	2,100	6,890
41	51,965	20,065	750	2,480	1,070	3,510	1,340	4,390	1,630	5,360	3,260	10,690
42A	52,720	20,355	550	1,820	1,000	3,280	1,310	4,290	1,590	5,230	2,660	8,730
42B	41,765	16,125	930	3,050	1,210	3,980	1,400	4,590	1,670	5,490	2,730	8,960
42C	48,145	18,590	980	3,210	1,380	4,550	1,850	6,080	2,170	7,130	3,640	11,940

Table D-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
21	2.3	36	6.5	44	7.8	46	9	48	11.6	53	50	86	101/105	135	185
22A	-3.3	26	2.8	37	8.1	47	14.1	57	17.1	63	35	72	127/135	215	325
22B	-6.6	20	6.4	43	8.9	48	12	54	16.4	61	35	89	130/135	191	355
23	1.6	35	6.4	43	7.4	45	8.8	48	10.8	51	50	80	100/100	130	165
24	2.8	37	8.5	47	9.5	49	10.2	50	12.2	54	70	120	134/135	146	170
25	0.2	32	5.7	42	7.3	45	8.7	48	10.7	51	55	90	108/110	137	170
26	1.8	35	6	43	8.7	48	10.5	51	11.9	53	65	94	125/125	164	190
27	3.3	38	9.2	49	10.8	51	11.7	53	13.4	56	70	135	155/155	169	190
28A	-1.8	29	8.1	47	10.1	50	10.9	52	12	54	45	124	148/150	177	205
28B	-0.6	31	6.2	43	7.5	46	8.7	48	11.1	52	60	94	114/115	131	175
29	-3.3	26	8.7	48	11.1	52	14.7	58	21.7	71	35	134	167/170	222	345
30	1.8	35	15	59	17.8	64	20.8	69	24.7	76	75	224	270/270	326	365
32	4.6	40	6.7	44	7.4	45	7.8	46	8.5	47	110	128	135/135	144	155
34A	1.7	35	3.6	38	5.7	42	6.7	44	8.8	48	55	82	113/110	129	150
34B	4.4	40	7.6	46	9	48	11.7	53	12.9	55	95	134	152/155	183	200
35	1.7	35	9.3	49	11.6	53	14	57	21.1	70	85	144	170/175	210	305
36	0.4	33	6.6	44	8.8	48	11.1	52	13.2	56	75	114	148/145	172	200

Table D-2: Temperature and Freeze-Free Period Statistics—Continued

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
38	8	46	11.5	53	14.4	58	18.7	66	21.8	71	130	166	209/220	279	365
39	0.2	32	7.7	46	9.4	49	12.6	55	15.4	60	55	123	145/150	183	235
40	11.1	52	19.8	68	21.8	71	23.1	74	24.5	76	140	292	331/330	365	365
41	4.7	40	14.6	58	16.4	62	18	64	20.7	69	100	205	226/230	257	315
42A	9.7	49	15.2	59	16.5	62	19.1	66	22	72	175	207	222/225	259	290
42B	9	48	13.2	56	15.7	60	17.2	63	18.2	65	150	188	215/215	239	265
42C	4.5	40	10	50	12	54	14.8	59	17.1	63	125	156	175/180	203	240

Table D-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
21	230	9	319	13	442/465	17/18	626	25	1,440	57
22A	160	7	568	22	1075/1090	42/43	1655	65	2,560	100
22B	330	13	508	20	1008/1055	40/41	1658	65	3,130	123
23	150	6	239	9	278/305	11/12	393	15	1,370	54
24	150	6	205	8	243/275	10/11	391	15	770	30
25	210	8	268	11	324/375	13/15	555	22	1,240	49
26	150	6	220	9	302/335	12/13	512	20	840	33
27	110	4	130	5	187/200	7/8	284	11	570	22
28A	100	4	198	8	286/310	11/12	442	17	1,320	52
28B	150	6	218	9	279/305	11/12	437	17	990	39
29	70	3	134	5	193/210	8/8	311	12	730	29
30	40	2	105	4	154/165	6/7	239	9	780	30
32	140	6	176	7	227/235	9/9	310	12	560	22
34A	150	6	199	8	264/275	10/11	359	14	650	26
34B	150	6	194	8	258/280	10/11	413	16	610	24
35	110	4	181	7	258/275	10/11	385	15	830	32
36	210	8	289	11	379/405	15/16	555	22	1,160	46
38	200	8	334	13	460/465	18/18	588	23	920	36
39	140	6	324	13	438/475	17/19	672	26	1,220	48
40	60	2	88	3	169/185	7/7	313	12	640	25
41	220	9	281	11	357/380	14/15	499	20	1,070	42
42A	220	9	265	10	332/340	13/13	428	17	680	27
42B	180	7	238	9	265/270	10/11	316	12	590	23
42C	270	11	341	13	388/415	15/16	533	21	1,070	42

in the region, most of the precipitation falls during the cool season. Consequently, the region has both ustic and xeric soil moisture regimes in the intermediate rainfall regions. In most of this region, the average annual temperature is 40 to 60 degrees F (4 to 16 degrees C). The mean freeze-free period ranges from 105 days in the north and in some of the higher mountains to 270 days at the lower elevations in the south. Temperatures and precipitation for this region are shown in figures 6 and 7. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables D-2 and D-3.

Soils in the drier areas at lower elevations, if they have been stable long enough to form diagnostic horizons, are Aridisols (i.e., Cambids, Calcids, Argids, and Salids). Where diagnostic horizons have been truncated by erosion, the soils are Entisols (i.e., Orthents). Entisols also occur as Fluvents (where sediments were deposited by water) and Psamments (where sediments were mainly deposited by wind) if the soils are too young to have developed diagnostic horizons other than the ochric epipedon. Mollisols are common in Region D where ustic and xeric grasslands and forests with herbaceous understories have provided enough organic matter for formation of a mollic epipedon. In the forests at higher elevations, Alfisols occur on geomorphically stable sites and Inceptisols occur on less stable sites. A narrow strip of Ultisols occurs in Region D on the eastern Sierra Nevada footslopes along its contact with Region C (fig. 2). Carbonates are common in this region, especially in the drier climates where soils formed in limestone or basalt. Carbonates are notably absent in areas at higher elevations with wetter climates (fig. 5, page 9). Many soils in the region have restrictive zones, such as lithic and paralithic bedrock (fig. 9, page 13) as well as petrocalcic horizons and duripans (fig. 11). Soils with petrogypsic, salic, or natric horizons are in relatively small areas. Soils commonly have argillic horizons on stable geomorphic surfaces and where high amounts of soil carbonate have not reduced clay illuviation (fig. 12). Compared to the other regions, Region D has soils with the lowest concentration of organic carbon (fig. 14, page 18).

Land use is dominated by shrublands with interspersed grasslands and sky island forest ecosystems (fig. D-2; and fig. 8, page 12). Most of the land is used for grazing. Irrigated crops are grown where water is available and soils are suitable. Feed crops for livestock are grown on much of the irrigated land. Peas, beans, and sugar beets are grown in many areas. Cotton and citrus fruits are important crops in southwestern Arizona. The major resource management concerns on cropland include soil moisture availability and productivity and the content of salts and sodium in the soils. Overgrazing is a concern on rangeland. Forest fires are a progressively important concern throughout the entire region.

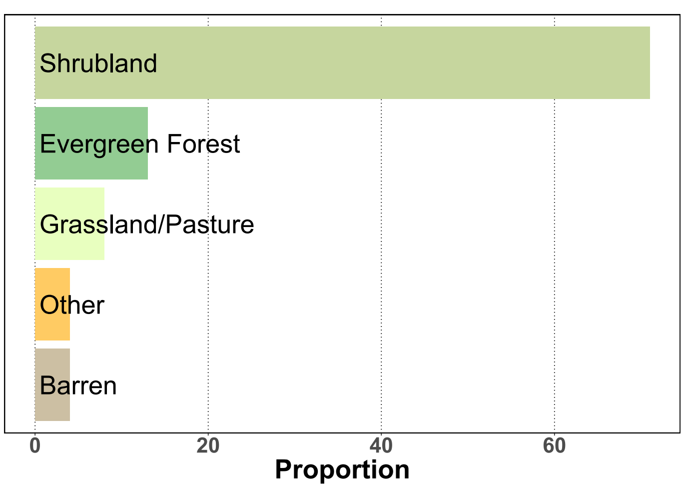

Figure D-2: Relative proportions (percentages) of land uses in Land Resource Region D (National Agricultural Statistics Service, 2018).

21—Klamath and Shasta Valleys and Basins

MLRA 21 (fig. 21-1) is in California (63 percent) and Oregon (37 percent). It makes up about 11,014 square miles (28,527 square kilometers). The area is characterized by externally drained basins that cover a diverse mix of volcanic uplands, reservoirs, lakes, narrow valleys, isolated volcanic peaks, and valleys along the east side of the Cascade and Klamath mountain ranges. The basins all have precipitation patterns that deliver most of the moisture over winter. The relatively equally mixed public and private lands are used for timber production, grazing, recreation, fishing and hunting, dryland grain, irrigated crops, and both irrigated and non-irrigated pasture and hay production.

Figure 21-1: Location of MLRA 21, which covers 2,852,700 hectares (7,049,200 acres), within Region D.

The boundaries of MLRA 21 with MLRA 5 (to the west), MLRA 3 (mainly to the northwest), and MLRA 22B (to the south) are distinct where they contact mountains but are less apparent where the transition between the Klamath Mountains and the valleys and basins is more gradual. The boundary with MLRA 6 (to the north) is less distinct. MLRA 6 has thick deposits of ash and pumice from the eruption of Mount Mazama (commonly known as Crater Lake). The boundary with MLRA 23 (to the east) is apparent at a small scale. MLRA 23 has high plateaus with closed basins and internal drainage.

Physiography

This area is in a transition zone between the Basin and Range province to the southeast, the Cascade and Klamath Mountains to the west and northwest, and the Sierra Nevada mountains to the south. Most of this MLRA is in the Great Basin section of the Basin and Range province of the Intermontane Plateaus. Small areas in the west and northwest parts of the MLRA are in the Middle Cascade Mountains section of the Cascade-Sierra Mountains province of the Pacific Mountain System. The Shasta River Valley portion of this MLRA, near Yreka, is along the western edge of the Cascade Range, near the Klamath Mountains. The Modoc portion of the MLRA is characterized by a vast volcanic upland interspersed with numerous reservoirs, lakes, and narrow stream valleys that comprise the Pit and Klamath River drainages; hydrologically separate, externally drained basins with lakes or periodically dry lakebeds; and isolated volcanic peaks.

Elevation typically ranges from 2,600 to 4,600 feet (795 to 1,400 meters), but many mountain peaks exceed 7,000 feet (2,135 meters) and a few peaks in Oregon exceed 8,000 feet (2,440 meters). Most of the area consists of lava plateaus and several valleys and basins. Steep mountain spurs and rimrock escarpments surround the plateaus. The Klamath River originates in this area.

Geology

The Modoc portion of this MLRA is underlain by Cenozoic volcanic rocks. Surface exposures are dominated by Miocene to Pleistocene flood basalts and rhyolite ash. Andesites, volcanic mudflow deposits, and rhyolitic intrusives also occur. Volcanism and the extrusion of flood basalts occurred as a result of crustal thinning and extension associated with development of the Basin and Range. Valleys are typically underlain by recent alluvial, lacustrine, and dry lakebed (playa) deposits, influenced in some places by diatomaceous materials. Pliocene to Pleistocene nonmarine sedimentary deposits (including fan and stream terrace deposits and old lake deposits) underlie portions of many basins.

The geology of the Shasta River Valley portion of this MLRA is complex, reflecting its location between the Klamath Mountains and the High Cascades. Uplands in the northern and western parts of the area are underlain by Pre-Cenozoic metamorphics and sedimentary formations, while the eastern portion is dominated by Tertiary and Quaternary volcanics.

Climate

The average annual precipitation is typically 9 to 25 inches (241 to 1,439 millimeters). It is highest, as much as 57 inches, in small areas at high elevations on the western and southwestern edges of this MLRA. Higher precipitation zones also occur in the scattered mountain ranges throughout the rest of this area. Most of the rainfall occurs during low- or moderate-intensity, Pacific frontal storms in winter. At the higher elevations, rain generally turns to snow. Snow may fall at the lower elevations in winter but does not last. Summers are dry. The average annual temperature is 37 to 53 degrees F (3 to 12 degrees C). The freeze-free period averages 130 days and ranges from 70 to 185 days.

Water

The timing of precipitation (mostly in winter), combined with the somewhat limited precipitation amounts and water storage capabilities, limits the supply of water for agriculture. In the narrower valleys, the irrigated land is on alluvial fans where surface runoff from the mountains can be diverted to fields. Some terraces along the major drainages also are irrigated. The surface water is of excellent quality and suitable for drinking.

Ground water is scarce in the dense lava rocks underlying much of the area. Some irrigation water is obtained from fracture and rubble zones and layers of sand and gravel within the lava. In addition, some is obtained from the basin fill aquifers between the mountain ranges. The water is suitable for irrigation.

Soils

The dominant soil orders are Mollisols and Andisols. Small areas of Inceptisols and Histosols are in the basins. The soils dominantly have a mesic or frigid temperature regime, a xeric moisture regime, and mixed or smectitic mineralogy. Basin soils are influenced in some places by diatomaceous materials. The soils in the area generally are well drained, but they may be poorly drained or very poorly drained in the basins. They generally are loamy, clayey, or sandy and are shallow to very deep.

The main soil series:

- Booth series—Palexerolls that formed in residuum and colluvium derived from tuff or basalt; on mountains, hills, and plateaus
- Fordney series—Haploxerolls that formed in alluvium or lacustrine deposits derived from volcanic rocks with an influence of volcanic ash; on lake terraces, stream terraces, and fan remnants
- Lather series—Haplohemists that formed in organic material with thin layers of silt; on drained marshes
- Lorella series—Argixerolls that formed in material weathered from tuff and basalt on hills, mountains, escarpments, and rock benches
- Orhood series—Argixerolls that formed in material derived from extrusive igneous rock on mountains and hills
- Petescreek series—Haploxerolls that formed in material weathered from andesite tuff or basalt on mountains and hills
- Pokegema series—Haploxerands that formed in mudflow deposits containing andesitic rocks and ash; on plateaus
- Royst series—Argixerolls that formed in colluvium and residuum derived from lava rocks, including a small amount of ash; on hillslopes and scarp slopes on lava flows

Salisbury series—Durixerolls that formed in mixed materials weathered from metamorphic sediments, rhyolite, tuff, and basalt on dissected terraces
Tulana series—Humaquepts that formed in lacustrine sediments with high amounts of diatoms and amorphous material; on relict lake bottoms
Woodcock series—Haploxerands that formed in colluvium and mudflows from glacial deposits derived from volcanic rocks and volcanic ash; on mountains, plateaus, hillslopes, escarpments, and glacial outwash plains

Biological Resources

This area has a cover of shrubs interspersed with annual and perennial grasses. Sagebrush, bitterbrush, Idaho fescue, and bluebunch wheatgrass are the dominant species. The basins and meadows support sedges, wiregrass, slender wheatgrass, creeping wildrye, and bluegrass. Mountain, Wyoming, big basin, and low sagebrush; rabbitbrush; bitterbrush; and mountain mahogany are the main shrubs. Other herbaceous species include Nevada bluegrass, Sandberg bluegrass, Thurber's needlegrass, and numerous perennial and annual forbs. Western juniper is common, and scattered ponderosa pines are on the lower foothills. The higher elevations support ponderosa pine, Douglas-fir, white fir, and California red fir with an understory of bitterbrush and ceanothus. Major wildlife species include elk, mule deer, antelope, golden eagle, red-tailed hawk, prairie falcon, great horned owl, barn owl, sage grouse, and chukar.

Land Use

Most of the privately and publicly owned land in this area is grazed (fig. 21-2). A small acreage is used for irrigated potatoes, grain, seed crops, hay, or pasture or for dry-farmed grain. Trees are harvested for lumber in some forested areas.

The major soil resource concerns on cropland are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, conservation of soil moisture, and the quality of irrigation water. The hazard of water erosion is slight in most of the basin areas but can be high in the steeper areas if the surface is bare. In some areas the hazard of wind erosion is high, especially when the surface is disturbed during periods of highest wind velocities. Maintaining good drainage is the principal management concern in the valley basins. Some sites need protection from overflow, and others are affected by alkali. Overgrazing and the invasion of undesirable species are management concerns on rangeland. Surface compaction and sedimentation of streams are the major management concerns on forestland.

Conservation practices on cropland generally include irrigation water management, water-control structures, irrigation system improvements, and nutrient management. Conservation practices on rangeland and pasture generally include prescribed grazing, water developments, brush management, and woody residue treatment. Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control compaction, the erosion caused by concentrated flow, and sediment delivery to streams.

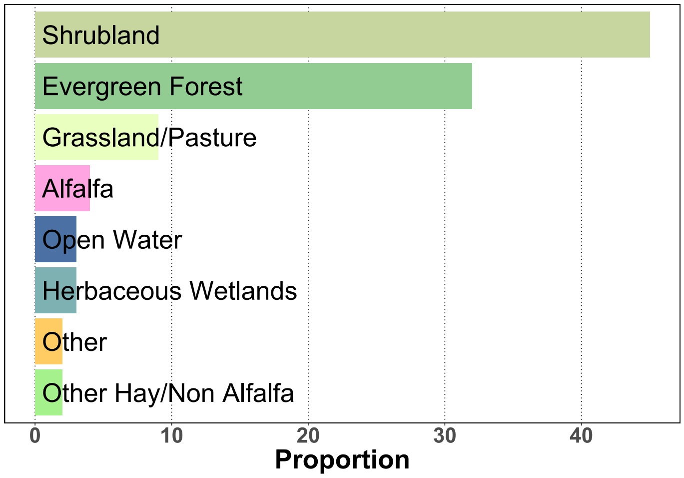

Figure 21-2: Relative proportions (percentages) of land use in MLRA 21.

22A—Sierra Nevada Mountains

MLRA 22A (fig. 22A-1) is in California (98 percent) and Nevada (2 percent). It makes up about 19,111 square miles (49,497 square kilometers). The area consists of the higher

Figure 22A-1: Location of MLRA 22A, which covers 4,949,700 hectares (12,230,800 acres), within Region D.

elevations of the Sierra Nevada mountains. It is characterized by hilly to steep mountain relief and occasional mountain valleys. Most of this area is dominated by the Sierra Nevada Batholith.

To the west, MLRA 22A has a gradual boundary with MLRA 18, which is on the toeslope of the Sierra Nevada mountains. MLRA 18 is an area of rolling to steep dissected hills and low mountains with soils dominated by a thermic temperature regime. Production of livestock on rangeland is the main economic enterprise in this MLRA, which has significant acreage of brushland and oak-dominated hardwood forest.

To the north, MLRA 22A has a distinct geologic boundary with MLRA 22B (Southern Cascade Mountains). MLRA 22B is made up primarily of Tertiary and Quaternary volcanics (basalt, andesite, dacite, and rhyolite) exposed as prominent peaks and volcanic uplands, surrounded by lower, moderately steep and steep shield and composite volcanoes and cinder cones.

To the east, MLRA 22A has a gradual boundary with MLRA 26. MLRA 26 consists of the foothills of the Sierra Nevada mountains plus the smaller mountain ranges and adjacent valleys to the east that are in the rain shadow of the Sierras.

MLRA 22A has a gradual boundary with MLRA 29, where it transitions to the alluvial fans of the western edge of the Great Basin. The soils in MLRA 29 dominantly have a thermic temperature regime and an aridic moisture regime and support salt-desert shrub communities and associated vegetation.

To the south, MLRA 22A has a gradual boundary with MLRA 30. The soils in MLRA 30 dominantly have a thermic temperature regime and an aridic moisture regime and support thin stands of desert vegetation.

Physiography

This MLRA lies entirely within the Sierra Nevada Mountains section of the Cascade-Sierra Mountains province of the Pacific Mountain System. It has a strongly asymmetric mountain range with a long, gentle western slope and a steep eastern escarpment. It is 50 to 80 miles (80 to 130 kilometers) wide and runs in an approximately north-south direction through eastern and central California for more than 400 miles (645 kilometers).

Elevation ranges from 1,500 to 9,000 feet (455 to 2,745 meters) in most of the area. The highest peaks can exceed 12,000 feet (3,660 meters). Mount Whitney, at an elevation of 14,494 feet (4,419 meters), is the highest point in the lower 48 States. The strongly sloping to precipitous mountains have unstable slopes and sharp crests. Valleys are typically narrow and are filled with alluvium. Almost all of the valleys have streams with actively eroding banks. The American, Carson, Kern, San Joaquin, Truckee, Walker, and Yuba Rivers originate in this area.

Geology

Most of this area is dominated by Mesozoic plutonic rocks (dominantly quartz monzonite and granodiorite), otherwise known as the Sierra Nevada Batholith. The northern half of the range is flanked on the west by the western metamorphic belt, an area of strongly deformed and metamorphosed sedimentary and volcanic rocks of Paleozoic and Mesozoic age. Farther south, some of these metamorphic rocks are within the batholith on the western edge or along the crest of the range. Volcanic activity of minor extent has produced Miocene-age lava flows. The valleys are filled with relatively coarse alluvium since most of the sediments have not moved far from their source.

Gold occurs as lode deposits in Mesozoic metamorphic rocks of the western foothills, where heat generated from the intrusion of the Sierra Nevada Batholith mobilized and concentrated the gold in quartz veins. The most productive districts are in the Mother Lode gold belt in the northern and central parts of the Sierra Nevada mountains. Placer deposits of gold, which account for more than 40 percent of California's total gold output, are in Tertiary stream gravel in the northwestern part of the Sierra Nevada mountains and in recent stream channels. In these stream channels, gold-bearing rocks eroded from areas near the Sierra Crest are transported towards the valleys of the Sacramento and San Joaquin Rivers.

Pleistocene to Recent glaciers have shaped the Sierra Nevada mountains by scouring out cirques, U-shaped valleys, and other glacial erosional features; depositing poorly sorted till in glacial moraines; and influencing streamflow patterns by contributing variable amounts of runoff and periodically forming ice dams and lakes. The intermontane valleys are filled with coarse glacial deposits and coarse alluvium since most of the deposits have not moved far from their source.

Climate

The average annual precipitation is typically 22 to 65 inches but can range from 7 to 100 inches (176 to 2,471 millimeters). It is lowest in the lower valleys and foothills and highest on the mountain peaks. The amount of precipitation increases with elevation and from south to north. Summers are dry but have occasional thunderstorms. Much of the winter precipitation occurs as snow. The average annual temperature is 27 to 62 degrees F (-3 to 17 degrees C), decreasing with elevation. The freeze-free period averages 205 days and ranges from 65 to 345 days, decreasing in length with elevation. It is longest at the lower elevations along the western edge of the area.

Water

The abundant rainfall and snowfields on the higher mountain slopes provide water for forestland and rangeland. They also meet part of the water needs of the lower adjacent areas by supplying water to many perennial rivers. Much of the water is stored in large reservoirs and used in the valleys of the Sacramento and San Joaquin Rivers and in heavily populated southern California. Most of the public water supplies are obtained from surface water. This water is of good quality and suitable for drinking after minimal treatment. Fecal coliform and Giardia contamination of the surface water has been a concern at high elevations.

There are no principal aquifers in the Sierra Nevada mountains. Some ground water is obtained from alluvium on valley floors. The fractures and joints in bedrock are the only other sources of ground water. The ground water is suitable for almost all uses but is little used in this area.

Soils

The dominant soil orders are Alfisols, Entisols, Inceptisols, Mollisols, and Ultisols. The soils in the area dominantly have a mesic, frigid, or cryic temperature regime, depending largely on elevation; a xeric moisture regime; and mixed mineralogy. They generally are very shallow to deep, well drained or somewhat excessively drained, and loamy or sandy. The dominant soils formed in residuum and colluvium on hills and mountains. Large areas of rock outcrop are throughout the MLRA. They are on broad expanses on ridge crests and peaks above the timberline, above an elevation of 7,875 feet (2,400 meters).

The main soil series at the lower elevations (below 3,900 to 4,900 feet, or 1,190 to 1,495 meters):

- Chaix series—Dystroxerepts that formed in material weathered from acid intrusive igneous rock, mainly granite or granodiorite, on mountains
- Cohasset series—Haploxeralfs that formed in material weathered from volcanic rock on volcanic ridges and mountains
- Holland series—Haploxeralfs that formed in material weathered from granitic rock on foothills and low mountains
- Mariposa series—Haploxerults that formed in material weathered from metasedimentary rocks on mountains
- Sites series—Haplohumults that formed in material weathered from metabasic and metasedimentary rocks on mountains

The main soil series at the higher elevations:

- Cagwin series—Xeropsamments that formed in material weathered from granitic rock on mountains
- Lithnip series—Cryorthents that formed in residuum and colluvium derived from tuff, tuff-breccia, and andesite, on mountains
- Musick series—Haploxeralfs that formed in colluvium over residuum from intrusive igneous rocks, on foothills and mountains
- Toem series—Xeropsamments that formed in colluvium and residuum from granitic rocks on mountains
- Waca series—Vitrixerands that formed in material weathered from andesitic tuff on mountains

Biological Resources

This area is dominated by Sierran mixed conifer forest vegetation. The main species are ponderosa pine, Douglas-fir, incense cedar, white pine, sugar pine, white fir, California red fir, Jeffrey pine, lodgepole pine, and mountain hemlock. Bristlecone pine grows in protected draws at elevations above 8,850 feet (2,700 meters). Bluegrass, hairgrass, sedges, wiregrass, clovers, and wild iris grow in montane meadows. Manzanita, ceanothus, sagebrush, blue wildrye, fescues, bluegrasses, and mountain brome are common understory species in open stands of timber.

Major wildlife species include black-tailed deer, mountain lion, bighorn sheep, coyote, bobcat, gray fox, raccoon, skunk, jackrabbit, gray squirrel, rattlesnake, California condor, turkey vulture, roadrunner, crow, quail, band-tailed pigeon, and blackbird. Fish species include rainbow, brown, brook, cutthroat, and golden trout; anadromous salmonids; and northern pike minnow.

Land Use

About three-fourths of this area is federally owned land, primarily in national forests and parks (fig. 22A-2). The rest of the area is privately owned forestland, farms, and ranches. About 83 percent of the area is forestland used for timber, recreation, wildlife habitat, and watershed. Approximately 7 percent is pasture or range. The area has very little cropland. The cropland is used mainly for deciduous fruits, grain, or hay. Livestock grazing is confined to mountain meadows, which are grazed during summer, and to areas with open stands of timber.

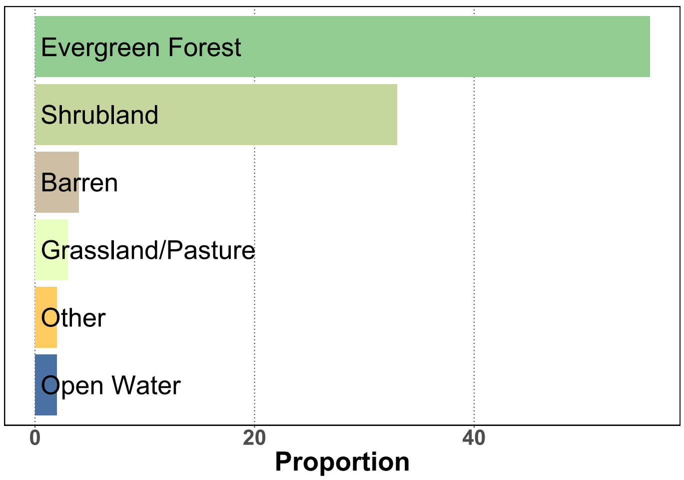

Figure 22A-2: Relative proportions (percentages) of land use in MLRA 22A.

The major resource management concerns for upland soils at intermediate elevations are low pH (moderate or strong acidity) and fertility. The uplands are hilly to mountainous and subject to erosion where soils are disturbed by logging, fires, overgrazing, or cultivation. The hazard of erosion is highest on the moderately coarse textured, granitic soils. In areas of shallow soils, soil depth and a low available water capacity are limitations.

The upland soils at high elevations have severe climatic limitations. They also have low pH (moderate or strong acidity) and low fertility. Erosion is a hazard on these high-elevation, mountainous slopes where soils are disturbed by fires and logging operations. Most of the soils are stony and have a low available water capacity.

In the mountain valleys, water management is needed to prevent stream downcutting and gullying and to maintain satisfactory moisture conditions for the growth of desirable plant species. Drainage can be a problem for many soils. Preventing or controlling wildland fires is a major management concern. Older or improperly designed roads contribute sediment to streams. Other management concerns include compaction resulting from farming activities, the impacts of catastrophic wildfire on forestland, and maintenance of the content of soil organic matter. Hydraulic mining for gold has significantly altered the soils and hydrologic function of many areas within this MLRA and creates a resource concern for those areas.

Conservation practices for all kinds of land in this MLRA include measures that control erosion on access roads and measures that protect riparian areas. The most important conservation practices on forestland are those that improve forest health, reduce the chance of catastrophic wildfire, and protect wildlife habitat. These practices include tree and shrub establishment, forest stand improvement, forest harvest trails and landings, critical area planting, and reduction of the extent of understory fuels.

Conservation practices on cropland and pasture generally include irrigation water management, water-control structures, protection of riparian areas, control of streambank erosion, and nutrient and pesticide management. Prescribed grazing, fences, and water management are the most important practices on rangeland and other grazing land.

Conservation practices in rapidly expanding areas used for urban development generally include properly designing roads, improving forest health, and reducing the chance of catastrophic wildfire and thus protecting wildlife habitat.

22B—Southern Cascade Mountains

Figure 22B-1: Location of MLRA 22B, which covers 1,413,000 hectares (3,491,500 acres), within Region D.

MLRA 22B (fig. 22B-1) is entirely in California. It makes up about 5,456 square miles (14,130 square kilometers). The area is the southernmost extent of the north-south-trending Cascade mountain range. It consists mostly of rolling volcanic mountains and intermontane basins.

To the west, MLRA 22B has a distinct geologic boundary with MLRA 5, which has mountains underlain mainly by sandstone and shale. To the north and east, it has a distinct geologic boundary with MLRA 21. MLRA 21 is characterized by externally drained basins that cover a diverse mix of volcanic uplands, reservoirs, lakes, narrow valleys, isolated volcanic peaks, and valleys along the east sides of the Cascade and Klamath mountain ranges. To the south, MLRA 22B has a geologically distinct boundary with MLRA 22A. Most of MLRA 22A is dominated by Mesozoic plutonic rocks (dominantly quartz monzonite and granodiorite), otherwise known as the Sierra Nevada Batholith.

Physiography

This MLRA lies within the southern end of the Middle Cascade Mountains section of the Cascade-Sierra Mountains province of the Pacific Mountain System. A small area in the southeast part of the MLRA is in the Great Basin section of the Basin and Range province of the Intermontane Plateaus. This MLRA is the southernmost extent of the Cascade Mountains trending north to south. It lies east of the Trinity Mountains and the Northern Sacramento Valley and west of the Modoc Plateau and the Great Basin and is bordered on the north by Butte Valley and the central Cascades. It extends to the Sierra Nevada mountains to the south.

Elevation generally ranges from about 1,500 feet (455 meters) in the foothills to 8,200 feet (2,500 meters). It is as high as 14,162 feet (4,318 meters) on Mount Shasta. The McCloud and Sacramento Rivers originate in this area, and the Pit River flows through the area from east to west.

Geology

The southern Cascades are made up primarily of Tertiary and Quaternary volcanics (basalt, andesite, dacite, and rhyolite) exposed as prominent peaks and volcanic uplands that are surrounded by lower, moderately steep and steep shield and composite volcanoes and cinder cones. Prominent peaks and recently active volcanic areas in this portion of the southern Cascades include the Medicine Lake Highlands and Medicine

Lake Volcano, Mount Lassen, and Mount Shasta. The Medicine Lake Highlands and Medicine Lake Volcano are on the border with the Modoc Plateau and characterized by silicic to basaltic eruptions as recent as 200 to 300 years ago. Mount Lassen is composed of andesite and dacite with some glacial deposits. It most recently erupted from 1914 to 1921. Mount Shasta is an active stratovolcano with two eruptive centers that have produced pyroclastic flows, andesitic lava flows, and debris flows. Active glaciers and associated deposits extend downslope from the summit of Mount Shasta.

Paleozoic to Mesozoic metamorphics, sedimentary formations, and volcanics are flanked on the east by a thin band and stringers of Eocene sandstones, shales, and conglomerates. They are exposed in the west-central portion of the MLRA, in a band that extends southward from the Siskiyou County line to the uplands east of Shasta Lake. Quaternary alluvial, fluvial, and lacustrine deposits have accumulated in small depressions on lava flows, in larger depressions between lava flows, and in stream valleys and basins.

Climate

The average annual precipitation in this MLRA is typically 20 to 65 inches but can range from 13 to 123 inches (176 to 2,471 millimeters). It is lowest in the lower valleys and highest on the mountain peaks. The precipitation occurs mainly from fall to spring, mostly as snow. Winter precipitation is from Pacific storms that are frontal in nature. The amount of precipitation decreases from west to east. Summers are typically warm and dry, but there are occasional thunderstorms. The average annual temperature is 27 to 61 degrees F (-3 to 16 degrees C). The freeze-free period averages 215 days and ranges from 85 to 350 days. The lowest annual temperatures and the shortest freeze-free periods occur in the mountains.

Water

The abundant rainfall and snowfields on the higher mountain slopes provide water for forestland and rangeland. They also meet part of the water needs of the lower adjacent areas by supplying water to perennial streams. The major amounts of snow during wet, cold storms in winter provide considerable runoff for the summer water supply. The surface water is of high quality and has few impurities.

Ground water is in fractures, in rubble zones, and in sand and gravel layers interbedded in the lava flows. Some also is in the alluvial fill in valleys. The use of ground water is minimal in this MLRA. Recharge to the aquifers exceeds withdrawals.

Soils

The dominant soils in this area are Alfisols, Andisols, Entisols, Inceptisols, and Mollisols. The soil temperature regimes are mostly mesic in the foothills and frigid in the mountains. They are cryic at the highest elevations. The soils on uplands are mostly well drained and have a xeric moisture regime. The soils in basins are somewhat poorly drained or poorly drained and have a xeric to aquic moisture regime.

The main soil series:

- Gasper series—Haploxeralfs that formed in tephra on lava plateaus and hills
- Jiggs series—Vitrixerands that formed in rhyolite on sloping to steep mountainous uplands
- Jimmerson series—Palexeralfs that formed in old tephra deposits and material from lava flows; on lava plateaus and hills
- Lyonsville series—Haploxeralfs that formed from dacite, rhyolite, and other light-colored volcanic rocks on sloping to very steep, dissected plateau-like uplands
- McCarthy series—Haploxerands that formed in material weathered from andesitic mudflows; on gently sloping to very steep slopes of dissected plateau-like areas
- Outland series—Haploxeralfs that formed in material weathered from andesite or pyroclastic rock on plateaus and mountain backslopes
- Ponto series—Vitrixerands that formed in volcanic ash deposited over semiconsolidated glacial outwash on toeslopes and alluvial terraces
- Scarface series—Vitrixerands that formed in tephra on lava plateaus and hills
- Sheld series—Vitrixerands that formed in volcanic ash deposits over colluvium and material weathered from tuff, tuff breccia, or extrusive igneous bedrock on mountains
- Windy series—Vitrixerands that formed in material weathered from andesitic mudflows

Biological Resources

This MLRA has three main vegetation types—low-elevation mixed conifer (ponderosa pine) forest, mixed conifer forest, and upper montane California red fir (*Abies magnifica*) forest. The oak grasslands of the foothills on the western slopes grade into a mixed conifer forest where ponderosa pine is the dominant species and incense cedar and California black oak are important associated species. Important understory plants include sticky whiteleaf manzanita, whitethorn ceanothus, and poison oak. At the higher elevations on the western slopes, the mixed conifer forest consists of white fir, sugar pine, ponderosa pine, incense cedar, Douglas-fir, California black oak, and Oregon white oak. The understory species include snowbrush ceanothus, bitter cherry, sharpleaf snowberry, pinemat manzanita, and Sierra gooseberry. The upper montane forest communities at the higher elevations consist dominantly of red fir and lodgepole pine. The communities on the eastern slopes are dominated by Jeffrey pine and ponderosa pine with an understory of antelope bitterbrush, big sagebrush, and greenleaf manzanita.

Throughout areas of these forest types are woodland, wet, and drier meadows. Wet meadows consist mainly of perennial sedges, rushes, and grasses. Woodland meadows consist mainly of scattered grasses and forbs interspersed with lodgepole pine, willows, quaking aspen, and black cottonwood. The shorthair sedge type occurs on the drier meadow sites. It consists mainly of shorthair sedge, Brewer's lupine, western needlegrass, and spike trisetum.

Major wildlife species include black-tailed deer, mule deer, mountain lion, coyote, bobcat, yellow-bellied marmot, marten, fisher, Sierra Nevada red fox, wolverine, and porcupine. Birds include eagles, hawks, owls, woodpeckers, falcons, osprey, quail, northern goshawk, and blue grouse. Species of concern include the California and northern spotted owls. Fish species include rainbow, brown, brook, and redband trout; anadromous salmonids; and northern pike minnow.

Land Use

More than half of the area is federally owned, primarily in national forests (fig. 22B-2). The rest is privately owned forestland, farms, and ranches. About 72 percent of the land consists of forests used for timber, recreation, wildlife habitat, and watershed. Approximately 17 percent is pasture and range, and less than 2 percent is cropland.

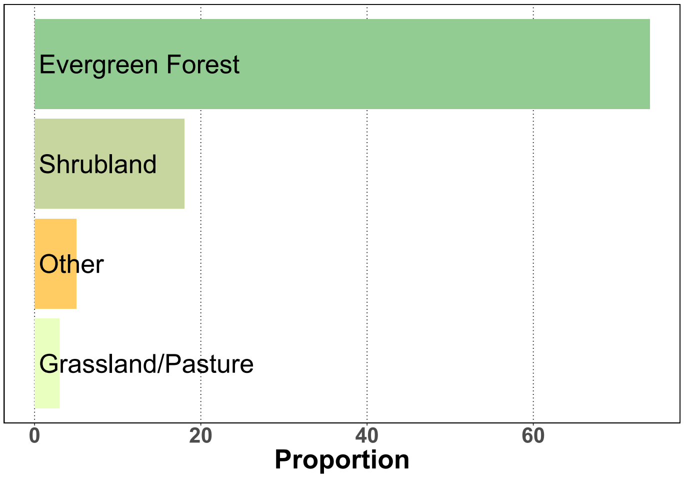

Figure 22B-2: Relative proportions (percentages) of land use in MLRA 22B.

The major soil resource concern is the hazard of water erosion, which can be severe if soils are disturbed by logging, fires, overgrazing, or cultivation. Other management concerns include compaction resulting from farming activities, the impacts of catastrophic wildfire on forestland, and maintenance of the content of soil organic matter. The soils in the mountain valleys and meadows are susceptible to gullying and streambank erosion. The older or improperly designed roads contribute sediment to streams.

Conservation practices on all kinds of land in this MLRA include measures that control erosion on access roads and protect riparian areas. Conservation practices on forestland generally include forest stand improvement, forest site preparation, reforestation, control of erosion on roads and log landings, control of competing understory vegetation, streambank and shoreline protection, riparian area management, stream corridor habitat protection and improvement, wetland wildlife management (such as beaver habitat restoration), and prescribed grazing.

Conservation practices on cropland and pasture generally include irrigation water management, water-control structures, protection of riparian areas, control of streambank erosion, and nutrient and pesticide management. Prescribed grazing, fences, and water management are the most important conservation practices on rangeland and other grazing land.

23—Malheur High Plateau

MLRA 23 (fig. 23-1) is in Oregon (68 percent), Nevada (24 percent), and California (8 percent). It makes up about 20,625 square miles (53,419 square kilometers). The area is dominated by relatively young, uplifted, internally drained volcanic plateaus with isolated fault-block mountain ranges.

To the south and east, the lava-plateau topography of MLRA 23 transitions to a series of north-south-trending mountain ranges separated by aggraded desert valleys with extensive playas (MLRAs 24 and 27). To the west, the area has a gradual boundary with MLRA 21. MLRA 21 is characterized by externally drained basins that cover a diverse mix of volcanic uplands, reservoirs, lakes, narrow valleys, isolated volcanic peaks, and valleys along

Figure 23-1: Location of MLRA 23, which covers 5,341,900 hectares (13,200,000 acres), within Region D.

the east side of the Cascade and Klamath mountain ranges. The basins are all characterized by precipitation patterns that deliver most of the moisture over winter.

Physiography

All of this MLRA is within the Intermontane Plateaus. The southern two-thirds of the area is in the Great Basin section of the Basin and Range province. Almost all the northern third is in the Harney section of the Columbia Plateaus province, and a small part of this third is in the Payette section of the same province. Elevation ranges from 3,900 to 6,900 feet (1,190 to 2,105 meters) in most of the MLRA, but it exceeds 9,000 feet (2,745 meters) on some mountains.

This area consists primarily of nearly level to moderately steep plateaus, basins, and valleys bordered by long, gently sloping alluvial fans. North-south-trending, fault-block mountain ranges separate some basins. Volcanic plateaus rise sharply above the valleys. Drainage patterns are not yet established on the youngest lava plateaus. The area has no major rivers. It consists mostly of closed basins.

Geology

Most of this area consists of young (6 to 17 million years old) andesite and basalt layers. Older volcanic rocks and marine and continental sediments are exposed in the mountain ranges. These north-south-trending ranges are uplifted fault blocks. The basins between the mountains and lava plateaus are filled with a mixture of Quaternary alluvium, continental sediments, and volcanic ash. The long alluvial fans consist of coarser alluvium near the mountains and fine grained sediments at their distal ends. Playas or shallow lakes are common in the lowest areas within the closed basins.

Climate

In most of this area, the average annual precipitation is 6 to 52 inches (156 to 1,331 millimeters). The precipitation is fairly evenly distributed throughout fall, winter, and spring but is low in summer. Snow can occur throughout the area in winter. The average annual temperature is 35 to 51 degrees F (2 to 11 degrees C), decreasing with elevation. The freeze-free period averages 105 days and ranges from 35 to 175 days, decreasing in length with elevation and latitude.

Water

Surface water is scarce, except in areas at the higher elevations where precipitation is greater. Streamflow is erratic and depends mostly on runoff from melting snow. Most of the water is used for irrigating grain and hay for cattle feed. Irrigated areas are on alluvial fans and pluvial lake terraces. Surface water from mountain runoff is generally of excellent quality. As the water seeps through the alluvial fan deposits, salts left in the soil as a result of evapotranspiration are dissolved. In wetter years, when springs discharge this seepage water at the toe of the fan, water quality is degraded. As the surface water evaporates en route to a playa, the salt concentrations increase, making the water unsuitable for all uses.

The large supply of ground water in the gravel- and sand-filled valleys and basins is mostly untapped. The basin fill deposits in Oregon have soft to moderately hard water. The ground water near the alluvial fans typically has lower levels of total dissolved solids than the ground water near playas. The volcanic rocks are considered aquifers but are little used. Water can be found in layers of rubble, cracks, and tubes within the lava. Layers of alluvium and continental sediments occurring between the andesite and basalt flows also may contain ground water.

Soils

The dominant soil orders in this MLRA are Aridisols and Mollisols. The soils in the area dominantly have a mesic or frigid temperature regime, an aridic bordering on xeric or xeric bordering on aridic moisture regime, and mixed or smectitic mineralogy. The soils on uplands generally are well drained, loamy or clayey, and shallow or moderately deep. The soils in the basins may be poorly drained or salt and sodium affected, or both. Locally, large areas have an ashy particle-size class and glassy mineralogy.

The main soil series:

Actem series—Argidurids that formed in alluvium and colluvium derived from volcanic rocks on hills and lava plateaus

Anawalt series—Haplargids that formed in colluvium and residuum derived from volcanic rocks with some loess and volcanic ash influence in the surface layer; on lava plains, plateaus, hills, and mountains

Ausmus series—Natrargids that formed in alluvium and lacustrine deposits derived from volcanic rocks and volcanic ash; on low lake terraces

Brace series—Argidurids that formed in slope alluvium, colluvium, and residuum derived from welded rhyolitic tuff and basalt; on structural benches, hills, and lava plateaus

Bucklake series—Argixerolls that formed in colluvium and residuum derived from basalt or andesite on plateaus and mountains

Carryback series—Palexerolls that formed in colluvium and residuum derived from basalt, andesite, and tuff on tablelands

Felcher series—Haplocambids that formed in colluvium derived from volcanic rocks on plateaus, hills, canyonlands, and mountains

Ninemile series—Argixerolls that formed in residuum and colluvium derived from volcanic rocks; on hills, mountains, and plateaus

Poujade series—Natrargids that formed in lacustrine deposits derived from volcanic rocks with surficial eolian mantles of loess or sand; on low lake terraces

Raz series—Haplodurids that formed in slope alluvium, colluvium, and residuum derived from basalt and tuff on lava plateaus

Biological Resources

Sagebrush-bunchgrass plant communities are extensive throughout the entire MLRA. Species include Wyoming big sagebrush, basin big sagebrush, mountain big sagebrush, low sagebrush, and Lahontan sagebrush in association with several needlegrass species, Idaho fescue, bluebunch wheatgrass, and basin wildrye. Bitterbrush and spiny hopsage may also occur with the sagebrush-bunchgrass communities. Salt- and sodic-affected areas support greasewood, saltbush, and saltgrass. Silver sage is common on fine textured soils with intermittent water tables. Limited areas at the highest elevations include aspen, mountain mahogany, and juniper species.

Major wildlife species include elk, mule deer, bighorn sheep, antelope, migratory birds and waterfowl, golden eagle, red-tailed hawk, prairie falcon, great horned owl, long-eared owl, common barn owl, sage grouse, chukar, meadowlark, and vesper sparrow.

Land Use

About 75 percent of this area is federally owned. Native rangeland vegetation covers much of the area, and livestock production on rangelands is the principal agricultural activity (fig. 23-2). A small percentage of the area is used for irrigated alfalfa hay, grain, hay for winter feed, or pasture.

The major soil resource concerns are control of wind erosion and reduction of the content of salts and sodium in areas used to produce crops or hay. Conservation practices on cropland generally include irrigation water management, crop residue management, and toxic salt reduction. Prescribed grazing, brush management, and development of watering facilities are important conservation practices on rangeland.

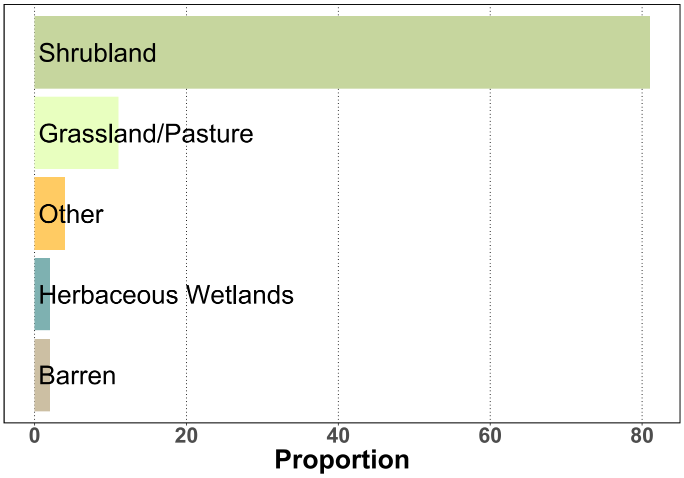

Figure 23-2: Relative proportions (percentages) of land use in MLRA 23.

24—Humboldt Basin and Range Area

MLRA 24 (fig. 24-1) is in Nevada (76 percent) and Oregon (24 percent). It makes up about 13,381 square miles (34,657 square kilometers). The area is characterized by a series of widely spaced, north-south-trending, uplifted fault-block mountain ranges that are separated by wide valleys filled with alluvium and lacustrine materials. Precipitation and elevation increase toward the extensive lava plateaus to the east and west.

Figure 24-1: Location of MLRA 24, which covers 3,465,700 hectares (8,563,900 acres), within Region D.

MLRA 24 has a gradual boundary with MLRAs 23, 25, and 27. The externally drained plateaus of MLRA 24 contrast with the internally drained plateaus and basins of MLRA 23. Directly to the east in MLRA 25, precipitation increases and mean annual temperature decreases, resulting in a shorter growing season and increased available soil moisture. To the southwest in MLRA 27, soil temperatures warm and elevations decrease, giving way to extensive playas, visible shorelines, and piedmont slopes dominated by Bailey's greasewood.

Physiography

This MLRA is in the Great Basin section of the Basin and Range province of the Intermontane Plateaus. Elevation ranges from 3,950 to 5,900 feet (1,205 to 1,800 meters) in most of the area, but it is more than 8,850 feet (2,700 meters) on some mountain peaks. The Humboldt River flows through this area on its way to the Humboldt Sink.

Geology

Most of this MLRA consists of wide valleys filled with deposits of alluvium washed in from the adjacent mountain ranges. Vast playas consisting of lacustrine sediments derived from Pleistocene pluvial lakes occur in the lowest areas in valleys with closed drainage systems. Most of the valleys, however, are drained by tributaries to the Humboldt River. Mesozoic and Paleozoic volcanic rocks and marine and continental sediments are exposed in the mountain ranges. Some young andesite and basalt layers (6 to 17 million years old) occur at the margins of the mountains. These north-south-trending ranges are uplifted fault blocks. Alluvial fans consist of coarser alluvium near the mountains and fine grained sediments at their distal ends.

Climate

The average annual precipitation is typically 6 to 15 inches (159 to 736 millimeters) in most of the area but can range to 30 inches at the highest elevations. It is much higher, however, in the mountain ranges. Most of the rainfall occurs during high-intensity, convective thunderstorms in spring and autumn. Precipitation occurs mainly as snow in winter. Summers are dry. The average annual temperature is 37 to 54 degrees F (3 to 12 degrees C). The freeze-free period averages 135 days and ranges from 100 to 175 days, decreasing in length with elevation.

Water

The low precipitation provides a small amount of water. Most of the water is used for irrigating grain and hay grown for cattle feed. Limited amounts of surface water are available from perennial and intermittent streams that carry snowmelt from the mountains. Late-season surface water supplies are deficient due to inadequate annual precipitation. Diversions from the Humboldt River are common. Rye Patch Reservoir, on the lower reaches of the Humboldt River in the southwest corner of this area, is the only large irrigation storage reservoir in the MLRA. Surface water from mountain runoff is generally of excellent quality. As the water seeps through the alluvial fan deposits, salts left in the soil as a result of evapotranspiration are dissolved. In the wetter years, when springs discharge this seepage water at the toe of the fan, local surface water quality can be degraded.

Limited quantities of ground water in valley fill are being rapidly developed for irrigation of crops. This water is typically of good quality and generally meets the national drinking water standards. In some areas of geothermal activity or in shallow alluvial-lacustrine and volcanic deposits, high levels of arsenic exceed the national drinking water standards. Ground water from the basin fill aquifers is slightly hard.

Soils

Roughly one-third of the soil series in MLRA 24 have a typic aridic soil moisture regime. The dominant soil orders in the area are Aridisols and Entisols. Torripsamments, Natrargids, and Nadurargids are common throughout the lower elevations. Inceptisols and Mollisols also are important. The soils in the area dominantly have a mesic temperature regime, a typic aridic or aridic bordering on xeric moisture regime, and mixed mineralogy.

The main soil series:

- Beoska series—Natrargids that formed in alluvium derived from mixed rocks with surficial mantles of loess and volcanic ash; on fan remnants
- Boton series—Torriorthents that formed in a thin layer of loess and alluvium derived from mixed rocks influenced by volcanic ash over lacustrine sediments; on lake plains and basin floor remnants
- Broyles series—Haplocambids that formed in alluvium derived from mixed rocks with a thin surficial mantle of loess and volcanic ash; on fan remnants, fan skirts, fan aprons, inset fans, beach plains, and alluvial flats
- McConnel series—Haplocambids that formed in alluvium derived from mixed rocks with a component of loess and volcanic ash over lacustrine deposits or alluvium; on inset fans, fan aprons, beach plains, beach terraces, lake terraces, fan skirts, drainage channels, barrier bars, and offshore bars
- Orovada series—Haplocambids that formed in loess with a high content of volcanic ash over alluvium derived from mixed rocks; on fan skirts, fan remnants, fan aprons, inset fans, calderas, and draws
- Oxcorel series—Natrargids that formed in alluvium derived from mixed rocks with surficial deposits of loess; on fan remnants and plateaus
- Roca series—Haplargids that formed in colluvium and residuum derived from volcanic and sedimentary rocks; on hills, structural benches, and mountains
- Wendane series—Halaquepts that formed in alluvium derived from mixed rocks, loess, and volcanic ash; on alluvial flats, stream terraces, and flood plains
- Weso series—Haplocambids that formed in alluvium derived from mixed rocks, with a loess mantle that has a high content of volcanic ash; on beach plains, relict lagoons, fan skirts, inset fans, and fan piedmont remnants

Biological Resources

This area is characterized by shrub-grass vegetation. Basin floors support salt-desert shrub communities. Shadscale and bud sagebrush associated with Indian ricegrass and bottlebrush squirreltail are dominant on the drier sites. Black greasewood and basin wildrye are locally important on low terraces and flood plains. Winterfat is prevalent on very deep, fine textured soils. Sagebrush communities dominate the higher piedmont slopes and mountains. Low sagebrush is common on soils that are shallow to a clay horizon. Black sagebrush and big sagebrush also occur throughout the area. Thurber's needlegrass, bluebunch wheatgrass, basin wildrye, squirreltail, Sandberg bluegrass, forbs, and Douglas rabbitbrush are common associated plants. Idaho fescue and snowberry are locally important on sites with favorable amounts of moisture, and limited extents of singleleaf pinyon and Utah juniper are in high rocky areas.

Major wildlife species include mule deer, coyote, bobcat, beaver, muskrat, jackrabbit, cottontail, pheasant, chukar, Hungarian partridge, sage grouse, quail, ducks, and geese. The Humboldt River supports some warm-water fish. Trout inhabit some of the mountain streams.

Land Use

About three-fourths of this area is federally owned. The rest is used for farms, ranches, industrial enterprises (mining), and some urban and transportation purposes (fig. 24-2). Livestock grazing on native range is the principal agricultural enterprise. About 3 percent of the area, generally consisting of narrow strips along the major streams and margins of valleys, is used for irrigated hay, grain, pasture, alfalfa seed, and potatoes. The hay produced in the area is used principally as winter feed for resident livestock.

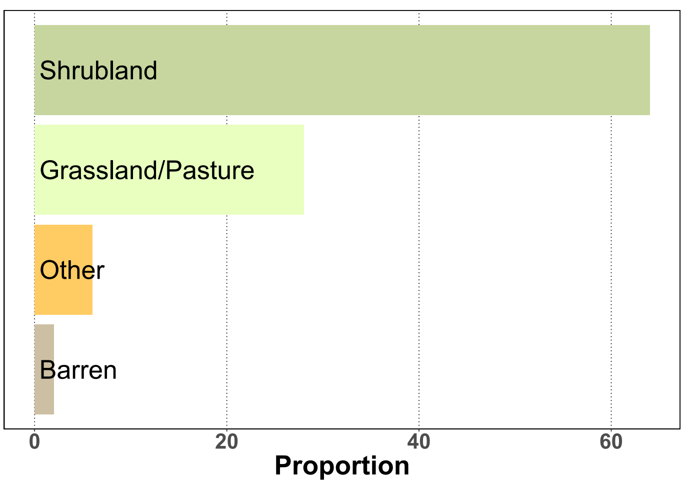

Figure 24-2: Relative proportions (percentages) of land use in MLRA 24.

The major soil resource concerns are control of wind erosion and reduction of the content of salts and sodium in areas used for crops or pasture. The main management considerations include proper grazing practices and the efficient use of surface and ground water. Conservation practices on cropland generally include irrigation water management, crop residue management, and toxic salt reduction. Important practices on rangeland include prescribed grazing, brush management, and development of watering facilities.

Areas dominated by non-native annual grass are characterized by a drastically altered fire return interval that results in near elimination of the native shrub communities. Fuels management, protection of intact native vegetation, and development of successful restoration techniques are important management considerations for this area.

25—Owyhee High Plateau

This area (fig. 25-1) is in Nevada (56 percent), Idaho (30 percent), Oregon (12 percent), and Utah (2 percent). It makes up about 27,443 square miles (71,078 square kilometers). MLRA 25 is characteristically cooler and wetter than the neighboring MLRAs of the Great Basin. The western boundary is marked by a gradual transition to the lower and warmer basins of MLRA 24. The boundary to the south-southeast, with MLRA 28B, is marked by gradual changes in geology marked by an increased dominance of singleleaf pinyon and Utah juniper and a reduced presence of Idaho fescue. The boundary to the north, with MLRA 11, is a rapid transition from the lava plateau topography to the lower elevation Snake River Plain.

Physiography

All of this area lies within the Intermontane Plateaus. The southern half is in the Great Basin section of the Basin and Range province. This part of the MLRA is characterized by isolated, uplifted fault-block mountain ranges separated by narrow, aggraded desert plains. This geologically older terrain has been dissected by numerous streams draining to the Humboldt River.

Figure 25-1: Location of MLRA 25, which covers 7,107,800 hectares (17,563,600 acres), within Region D.

The northern half of the area lies within the Columbia Plateaus province. This part of the MLRA forms the southern boundary of the extensive Columbia Plateau basalt flows. Most of the northern half is in the Payette section, but the northeast corner is in the Snake River Plain section. Deep, narrow canyons draining into the Snake River have been incised into this broad basalt plain.

Elevation ranges from 3,000 to 7,550 feet (915 to 2,300 meters) on rolling plateaus and in gently sloping basins. It is more than 9,840 feet (3,000 meters) on some steep mountains. The Humboldt River crosses the southern half of this area.

Geology

The dominant rock types in this MLRA are volcanic. They include andesite, basalt, tuff, and rhyolite. In the north and west parts of the area, Cretaceous granitic rocks are exposed among Miocene volcanic rocks in mountains. A Mesozoic igneous and metamorphic rock complex dominates the south and east parts of the area. Upper and Lower Paleozoic calcareous sediments, including oceanic deposits, are exposed with limited extent in the mountains. Alluvial fan and basin fill sediments occur in the valleys.

Climate

The average annual precipitation in most of this area is typically 11 to 22 inches (215 to 1,247 millimeters). It increases to as much as 49 inches (1,245 millimeters) at the higher elevations. Rainfall occurs in spring and sporadically in summer. Precipitation occurs mainly as snow in winter. The precipitation is distributed fairly evenly throughout fall, winter, and spring. The amount of precipitation is lowest from midsummer to early autumn. The average annual temperature is 33 to 51 degrees F (1 to 11 degrees C). The freeze-free period averages 130 days and ranges from 65 to 190 days, decreasing in length with elevation. It is typically less than 70 days in the mountains.

Water

The supply of water from precipitation and streamflow is small and unreliable, except along the Owyhee, Bruneau, and Humboldt Rivers. Streamflow depends largely on accumulated snow in the mountains. Surface water from mountain runoff is generally of excellent quality and suitable for all uses.

The basin fill sediments in the narrow alluvial valleys between the mountain ranges provide some ground water for irrigation. The alluvial deposits along the large streams have the most ground water. Based on measurements of water quality in similar deposits in adjacent areas, the basin fill deposits probably contain moderately hard water. The water is suitable for almost all uses. The carbonate rocks in this area are considered aquifers, but they are little used. Springs are common along the edges of the limestone outcrops.

Soils

The dominant soil orders in this MLRA are Aridisols and Mollisols. The soils in the area dominantly have a mesic or frigid temperature regime and an aridic, aridic bordering on xeric, or xeric moisture regime. Soils with aquic moisture regimes are limited to drainage or spring areas, where moisture originates or runs on and through. These soils are of a very limited extent throughout the MLRA. They generally are well drained, clayey or loamy, and shallow or moderately deep.

Most of the soils formed in mixed parent material. Volcanic ash and loess mantle the landscape. Surface soil textures are loam and silt loam with ashy texture modifiers in some areas. Argillic horizons occur on the more stable landforms. They are exposed nearer the soil surface on convex landforms, where ash and loess deposits are more likely to erode. Soils that formed in carbonatic parent material in areas that receive less than 12 inches of precipitation are characterized by calcic horizons throughout the profile, while soils in areas that receive more than 12 inches of precipitation do not have calcic horizons in the upper part of the profile. Soils that formed on stable landforms at the lower elevations are dominated by ochric horizons. Soils that formed at the middle and upper elevations are characterized by mollic epipedons. Soils in drainage areas at all elevations that receive moisture running on or through them are characterized by thicker mollic epipedons.

The main soil series:

- Arbidge series—Argidurids that formed in old alluvium and loess from extrusive igneous rocks and volcanic ash; on fan terraces, plug domes, calderas, tablelands, stream and lacustrine terraces, and alluvial plains
- Bruncan series—Argidurids that formed in mixed silty alluvium and loess from basalt and volcanic ash; on tablelands, calderas, structural benches, plains, and buttes
- Cleavage series—Argixerolls that formed in residuum or colluvium derived from rhyolite, welded tuff, chert, shale, quartzite, sandstone, or conglomerate and other igneous or sedimentary rocks; on plateaus, hills or mountain crests, summits, shoulders, ridges, and side slopes
- Donna series—Durixerolls that formed in alluvium derived from mixed rocks with a component of loess and volcanic ash; on fan piedmont remnants
- Enko series—Haplocambids that formed in alluvium derived from mixed rocks with a component of loess and volcanic ash; on fan remnants, inset fans, fan aprons, fan skirts, and swales
- Hunnton series—Argidurids that formed in alluvium derived from mixed rocks with a component of loess and volcanic ash; on fan remnants, ballenas, and plateaus
- Stampede series—Durixerolls that formed in eolian material and alluvium derived from volcanic rock such as tuff or from mixed rocks; on fan remnants and lava plateaus

Sumine series—Argixerolls that formed in residuum and colluvium derived from mixed rocks; on hills, mountains, and plateaus
Vanwyper series—Haplargids that formed in residuum and colluvium derived from mixed rocks; on hills, plateaus, and mountains
Wieland series—Haplargids that formed in alluvium derived from mixed rocks, loess, and volcanic ash; on fan remnants, ballenas, and plateaus

Biological Resources

This MLRA supports shrub-grass vegetation. Lower elevations are characterized by Wyoming big sagebrush associated with bluebunch wheatgrass, western wheatgrass, and Thurber's needlegrass. Other important plants include bluegrass, squirreltail, penstemon, phlox, milkvetch, lupine, Indian paintbrush, aster, and rabbitbrush. Black sagebrush occurs but is less extensive. Singleleaf pinyon and Utah juniper occur in limited areas. With increasing elevation and precipitation, vast areas characterized by mountain big sagebrush or low sagebrush/early sagebrush in association with Idaho fescue, bluebunch wheatgrass, needlegrasses, and bluegrass become common. Snowberry, curl-leaf mountain mahogany, ceanothus, and juniper also occur. Mountains at the highest elevations support whitebark pine, Douglas-fir, limber pine, Engelmann spruce, subalpine fir, aspen, and curl-leaf mountain mahogany.

Major wildlife species include mule deer, bighorn sheep, pronghorn, mountain lion, coyote, bobcat, badger, river otter, mink, weasel, golden eagle, red-tailed hawk, ferruginous hawk, Swainson's hawk, northern harrier, prairie falcon, kestrel, great horned owl, short-eared owl, long-eared owl, burrowing owl, pheasant, sage grouse, chukar, gray partridge, and California quail. Reptiles and amphibians include western racer, gopher snake, western rattlesnake, side-blotched lizard, western toad, and spotted frog. Fish species include bull, red band, and rainbow trout.

Land Use

About three-fourths of this area is federally owned. The rest is mainly in farms and ranches (fig. 25-2). Livestock production on rangeland is the main agricultural enterprise. Some valleys are used for irrigated pasture and hay. Open forests on mountain slopes at high elevations are grazed by livestock and wildlife.

Major soil resource concerns include accelerated erosion, runoff, and sedimentation following disturbances such as wildfire. Forest health and rangeland quality, including health of native vegetation important for rangeland and wildlife habitat and restoration of mining lands, are additional concerns.

Conservation practices on cropland generally include irrigation water management, pasture and hayland seeding, and weed control. The efficiency of irrigation water use can be improved by sprinkler systems and installation of gated pipe, field runoff management, and water source development. The plant species selected for seeding on pasture and hayland need to be suited to the various soil and environmental conditions. Weed control may include the removal of noxious and invasive plants followed by seeding with adapted forage species. Forest health can be enhanced by practices that include thinning, site preparation, forest stand improvement, and properly locating and constructing forest roads and landings. Rangeland quality can be maintained or improved by developing livestock watering facilities, reseeding, prescribed burning, proper fencing, and weed control.

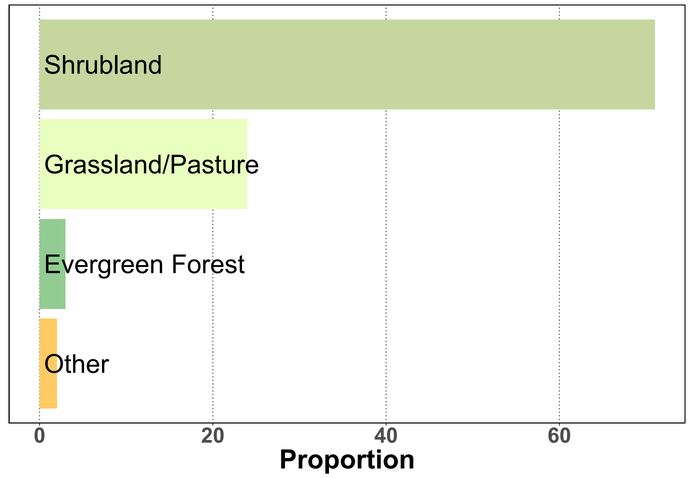

Figure 25-2: Relative proportions (percentages) of land use in MLRA 25.

26—Carson Basin and Mountains

MLRA 26 (fig. 26-1) is in Nevada (70 percent) and California (30 percent). It makes up about 5,661 square miles (14,662 square kilometers). This area includes the foothills of the Sierra Nevada mountains plus the smaller mountain ranges and adjacent valleys to the east that are within the rain shadow of the Sierras. The physiography transitions from the Basin and Range to the Sierra Nevada mountains, which are a barrier to moisture moving inland from the Pacific Ocean.

To the west, MLRA 26 has a gradual boundary with MLRA 22A. Elevation and precipitation increase enough to support the merchantable timber species that characterize MLRA 22A. To the east-northeast, MLRA 26 has a gradual boundary with MLRA 27. Soil temperature increases and soil moisture decreases, resulting in vast areas dominated by Bailey's greasewood and shadscale, which are characteristic of MLRA 27. To the southeast, MLRA 26 has a gradual boundary with MLRA 29. Increases in summer precipitation support the warm-season grasses characteristic of MLRA 29.

Physiography

Almost all of this area is in the Great Basin section of the Basin and Range province of the Intermontane Plateaus.

Figure 26-1: Location of MLRA 26, which covers 1,466,200 hectares (3,623,000 acres), within Region D.

Isolated north-south-trending mountain ranges are separated by aggraded desert plains. The mountains are uplifted fault blocks with steep side slopes. Most of the valleys are drained by three major rivers flowing east across this MLRA. A narrow strip along the western border of the area is in the Sierra Nevada Mountains section of the Cascade-Sierra Mountains province of the Pacific Mountain System. The Sierra Nevada mountains are primarily a large fault block that has been uplifted with a dominant tilt to the west. This structure leaves an impressive wall of mountains directly west of this area. Parts of this eastern face, but mostly just the foothills, mark the western boundary of the MLRA. Elevation ranges from 3,900 to 6,550 feet (1,190 to 1,995 meters) in valleys and is as high as 13,100 feet (3,995 meters) on mountain crests.

The Truckee River originates at Lake Tahoe and runs through Reno, Nevada, on its way east to its terminus just outside this area in Pyramid Lake. The headwaters of the Carson River run through Carson City, Nevada. This river flows to its terminus just outside this area in the Carson Sink, below the Lahontan Reservoir. The East and West Walker Rivers join to form the Walker River in the southern tip of this area. The Walker River flows into Weber Reservoir and then to its terminus, Walker Lake. All rivers terminate outside of the MLRA.

Geology

Mesozoic and Tertiary intrusives are common in this MLRA. These rocks are granitic near the Sierra Nevada mountains on the west side but are typically andesite and basalt in the rest of the area. There are some young tuffaceous sediments in this MLRA, and a complex of Mesozoic sediments and volcanic rocks occurs on the edges of uplifted fault blocks. Alluvium fills the valleys between the mountains. The major rivers in the area have reworked the alluvium, forming prominent terraces and flood plains.

Climate

The average annual precipitation is typically 9 to 20 inches (229 to 508 millimeters). It increases to as much as 33 inches as elevation increases. Most of the rainfall occurs during high-intensity, convective storms in spring and autumn. Precipitation is mostly snow in winter. Summers are dry. The average annual temperature is 35 to 53 degrees F (2 to 12 degrees C). The freeze-free period averages 115 days and ranges from 40 to 195 days, decreasing in length with elevation.

Water

The low precipitation in the valleys provides little water, but a few large rivers that have their source in high mountains outside the area supply water for irrigation and other uses along the course of the rivers. The reservoirs used principally for storing irrigation water in Nevada include Washoe Lake in the headwaters of the Carson River and Weber Reservoir. Those in California include Bridgeport Reservoir and Topaz Lake on the Walker River. Surface water from mountain runoff is generally of excellent quality and suitable for all uses.

Limited quantities of ground water in valley fill are being rapidly developed for urban, industrial, and agricultural uses. The alluvial deposits along the larger streams contain the most ground water. This water is of good quality. The basin fill aquifer typically has moderately hard to very hard water.

Soils

The dominant soil orders in this MLRA are Aridisols and Mollisols. The soils in the area dominantly have a mesic temperature regime, an aridic or xeric moisture regime, and mixed or smectitic mineralogy. They generally are well drained, are clayey or loamy and commonly skeletal, and are very shallow to moderately deep.

The main soil series:

Acrelane series—Argixerolls that formed in residuum and colluvium derived from granodiorite and similar granitic rocks; on hills and mountains

Borealis series—Durixeralfs that formed in eolian volcanic ash and in residuum derived from basalt; on plateaus

Brantel series—Torripsamments that formed in volcanic ash on valley floors, lake terraces, fan terraces, alluvial fans, volcanic flows and tablelands, inset fans on hills, mountainous uplands, and areas around cinder cones

Duco series—Argixerolls that formed in colluvium and residuum derived dominantly from volcanic rocks; on structural benches, hills, and mountains

Graufels series—Haploxerolls that formed in residuum and colluvium derived from granitic rocks; on hills and mountains
Haybourne series—Haplocambids that formed in alluvium derived from granitic rocks or from mixed sources; on inset fans, alluvial fans, fan remnants, ballenas, lake terraces, fan skirts, and fan aprons
Ister series—Argixerolls that formed in residuum derived mainly from andesite, basalt, or rhyolite; on side slopes of mountains and hills
Loomer series—Argixerolls that formed in colluvium and residuum derived from volcanic rocks; on hills and mountains
Mottsville series—Haploxerolls that formed in alluvium derived from granitic rocks on alluvial fans, fan remnants, and fan aprons
Wassit series—Haplargids that formed in residuum and colluvium derived from volcanic rocks and influenced by eolian volcanic ash; on hills and mountains

Biological Resources

This area supports shrub-grass vegetation characterized by big sagebrush. Low sagebrush and Lahontan sagebrush occur on some soils. Antelope bitterbrush, squirreltail, desert needlegrass, Thurber's needlegrass, and Indian ricegrass are important associated plants. Green ephedra, Sandberg bluegrass, Anderson peachbrush, and several forb species also are common. Juniper-pinyon woodland is typical on mountain slopes. Jeffrey pine, lodgepole pine, white fir, and manzanita grow on the highest mountain slopes. Shadscale is the typical plant in the drier parts of the area. Sedges, rushes, and moisture-loving grasses grow on the wettest parts of the wet flood plains and terraces. Basin wildrye, alkali sacaton, saltgrass, buffaloberry, black greasewood, and rubber rabbitbrush grow on the drier sites that have a high concentration of salts.

Major wildlife species include mule deer, coyote, beaver, muskrat, jackrabbit, cottontail, raptors, pheasant, chukar, blue grouse, mountain quail, and mourning dove. Fish species include trout and catfish. The Lahontan cutthroat trout in the Truckee River is a threatened and endangered species.

Land Use

About two-thirds of this area is federally owned. The rest is used mainly for farming, ranching, urban development, industrial enterprises, and transportation. Grazing of livestock on native grasses and shrubs is the principal agricultural enterprise (fig. 26-2). About 2 percent of the total area, principally in valleys along the major streams, is used for irrigated hay, grain, tame pasture, onions, potatoes, and garlic. About one-tenth of the area is forestland on mountain slopes. Some areas formerly used for farming are being converted to urban uses.

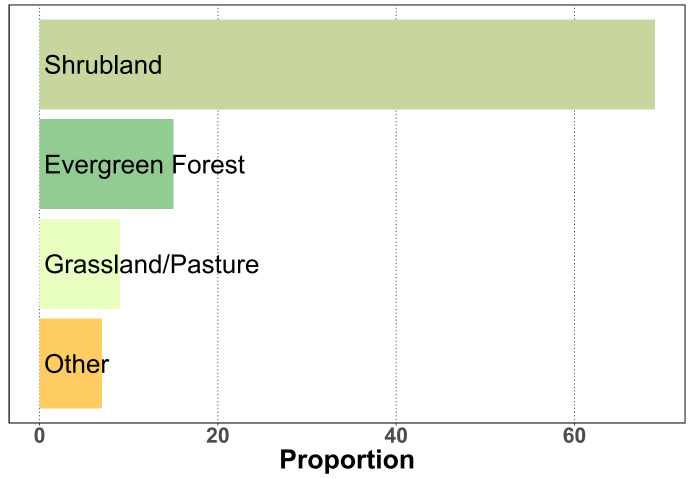

Figure 26-2: Relative proportions (percentages) of land use in MLRA 26.

The major soil resource concerns are maintenance of the content of organic matter and productivity of the soils and the accelerated erosion resulting from recreational activities and construction. In some areas the content of salts and sodium in the soils is a concern. Forest and rangeland health is an additional management concern.

Conservation practices on cropland generally include irrigation water management and crop residue management. Prescribed grazing, brush management, and watering facilities are important on rangeland. In areas of forestland, forest stand improvement, forest site preparation, properly located forest trails and landings, and firebreaks can help to reduce the effects of catastrophic wildfires and the damage caused by insects and disease.

27—Fallon-Lovelock Area

MLRA 27 (fig. 27-1) is almost entirely in Nevada. Less than 1 percent is in California. The MLRA makes up about 15,411 square miles (39,914 square kilometers). It is characterized by isolated, north-south-trending, uplifted fault-block mountain ranges that are separated by broad, hydrologically closed basins. The entire area occurs in the rain shadow of the Sierra Nevada mountains and is influenced by Pleistocene Lake Lahontan, which was at its most recent high level about 12,000 years ago. Extensive playas occur throughout this area and are the result of the drying of ancient Lake Lahontan.

To the west, MLRA 27 has a gradual boundary with MLRA 26. As soil moisture increases and soil temperature decreases, salt-desert shrub vegetation is replaced by the sagebrush-bunchgrass communities of MLRA 26. To the northeast, MLRA 27 has a very gradual boundary with MLRA 24. Soil moisture increases gradually, visible shorelines disappear, and piedmont slopes are no longer dominated by Bailey's greasewood. To the east, MLRA 27 borders MLRA 28B. As precipitation and

Figure 27-1: Location of MLRA 27, which covers 3,991,400 hectares (9,862,800 acres), within Region D.

elevation change, the vegetation changes from dominantly salt-desert shrub to Wyoming big sagebrush and Thurber's needlegrass. To the south, MLRA 27 borders MLRA 29. Changes in precipitation patterns support the warm-season grasses characteristic of MLRA 29.

Physiography

This area is in the Great Basin section of the Basin and Range province of the Intermontane Plateaus. Isolated mountain ranges trending north to south are separated by broad, aggraded desert plains and valleys. The mountains are uplifted fault blocks with steep side slopes. The mountains and valleys are dissected by the major rivers and their tributaries. Elevation generally ranges from 3,300 to 5,900 feet (1,005 to 1,800 meters) in valleys, but on some mountain peaks it is more than 7,870 feet (2,400 meters).

The major rivers in the area are, from north to south, the Humboldt, Truckee, Carson, and Walker Rivers. The Humboldt River terminates in the Humboldt Sink, the Truckee River terminates in Pyramid Lake, the Carson River terminates in the Carson Sink (after flowing through the Lahontan Reservoir), and the Walker River terminates in Walker Lake (after flowing through the Weber Reservoir).

Geology

Almost half of this MLRA has surface deposits of alluvial valley fill influenced by lacustrine sediments. The rest has andesite and basalt rocks of different ages. Mesozoic and Tertiary intrusives are concentrated along the western border, and volcanic rocks (17 to 43 million years old) are common in the eastern part of the area. In addition, some scattered outcrops of Mesozoic sedimentary and volcanic rocks and tuffaceous sedimentary rocks are in the mountains within the interior.

Climate

The average annual precipitation is 4 to 11 inches (102 to 279 millimeters). It is as much as 21 inches (533 millimeters) at the highest elevations. Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. The amount of precipitation is very low from summer to midautumn. The precipitation in winter occurs mainly as snow. The average annual temperature is 39 to 56 degrees F (4 to 13 degrees C). The freeze-free period averages 155 days and ranges from 110 to 195 days, decreasing in length with elevation.

Water

Water for irrigation is obtained principally from diversions on the four large rivers in the area and from water stored in the Lahontan, Rye Patch, and Weber Reservoirs. The irrigated areas are mainly near Fallon, Lovelock, and Yerington. The surface water is generally suitable for most uses, but local water-quality problems result from high concentrations of total dissolved solids and sediment loads in irrigation return flows. Pyramid and Walker Lakes are terminal lakes. Much of the Truckee and Walker Rivers is diverted for irrigation. As a result, the level of Pyramid Lake decreases and levels of dissolved salts increase. The increase in salts causes problems for the native Lahontan cutthroat trout.

Ground water is scarce and of poor quality in the major valleys. Limited supplies of ground water of good or fair quality in some of the outlying valleys are used for irrigation. The basin fill aquifers have very soft to very hard water.

A volcanic rock aquifer in western Churchill County, in the Carson Sink desert, has ground water suitable for most uses. Arsenic levels, however, exceed the drinking water standard.

Soils

The dominant soil orders are Aridisols and Entisols. The soils in the area dominantly have a mesic temperature regime, an aridic moisture regime, and mixed mineralogy. They generally are well drained, are loamy or sandy and commonly skeletal, and are shallow to very deep. Accumulations of salts, tufa deposits, and eolian sediments with soluble salts influence most of the soils in this MLRA.

The main soil series:

Bluewing series—Torriorthents that formed in alluvium derived from mixed rocks; on fan remnants, beach plains, alluvial fans, and inset fans

Cleaver series—Argidurids that formed in alluvium derived from igneous rocks on fan remnants
Dorper series—Natrargids that formed in alluvium derived from mixed rock sources with a component of loess and volcanic ash; on fan remnants
Genegraf series—Natrargids that formed in alluvium derived from volcanic rock on fan remnants
Hawsley series—Torripsamments that formed in alluvium and water-reworked eolian sand derived from mixed rocks; on sand sheets
Isolde series—Torripsamments that formed in eolian sand derived from mixed rocks on dunes
Mazuma series—Torriorthents that formed in alluvium and lacustrine deposits derived from mixed rocks; on basin-floor remnants, lagoons, beach plains, alluvial flats, fan skirts, and stream terraces
Singatse series—Torriorthents that formed in residuum and colluvium derived mainly from volcanic rocks; on hills and mountains
Theon series—Haplargids that formed in residuum and colluvium derived from volcanic rocks on hills and mountains
Trocken series—Torriorthents that formed in alluvium derived from mixed rocks on alluvial fans, fan remnants, inset fans, fan skirts, longshore bars, barrier beaches, beach terraces, and lake terraces

Biological Resources

This MLRA supports extensive areas of salt-desert shrub vegetation. Shadscale and Bailey's greasewood are widespread, occurring both individually and together. Grasses are generally sparse, although Indian ricegrass is prominent, especially on the sandy soils. Fourwing saltbush, winterfat, spiny hopsage, wolfberry, ephedra, dalea, and bud sagebrush are common shrubs. Basin wildrye, creeping wildrye, alkali sacaton, saltgrass, black greasewood, rubber rabbitbrush, and big saltbush are important plants on saline bottom lands and terraces. A few tule marshes support cattail, bulrushes, sedges, and rushes. Big sagebrush and Lahontan sagebrush, along with scattered Utah juniper and singleleaf pinyon, are associated with Thurber's needlegrass, desert needlegrass, Sandberg bluegrass, and squirreltail and can occur on the higher piedmont slopes and mountains.

Major wildlife species include feral horse, mule deer, antelope, kit fox, bobcat, black-tailed jackrabbit, antelope ground squirrel, kangaroo rat, bushy-tailed woodrat, desert mouse, Pacific rattlesnake, gopher snake, whip-tailed lizard, sagebrush lizard, sage grouse, chukar, loggerhead shrike, Brewer's sparrow, sage thrasher, blue-grey gnat-catcher, and American kestrel. The Lahontan cutthroat trout and cui-ui are two threatened and endangered fish species in the lower reaches of the Truckee River.

Land Use

More than two-thirds of this area is federally owned land, large tracts of which are used for training and testing purposes by the Armed Forces. The rest is in farms and ranches. Livestock production on rangeland is the principal agricultural enterprise (fig. 27-2). A small percentage of the area is used for irrigated alfalfa (including alfalfa seed), grain, garlic, or onions.

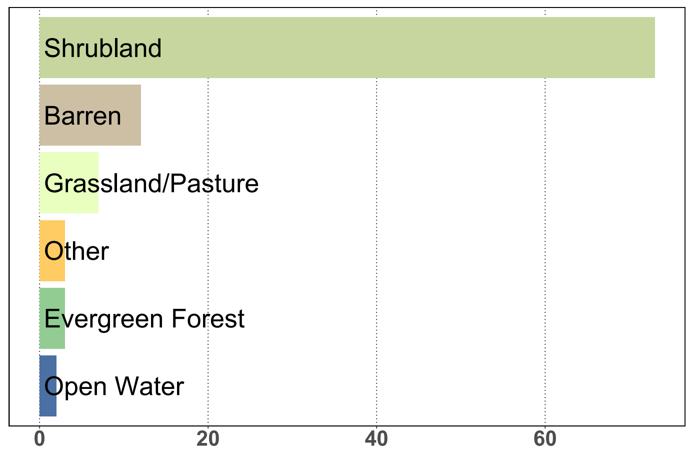

Figure 27-2: Relative proportions (percentages) of land use in MLRA 27.

The major soil resource concerns are wind erosion and the content of salts and sodium in the soils. Conservation practices on cropland generally include irrigation water management, toxic salt reduction, and crop residue management. These practices help to reduce the hazard of wind erosion and increase the available water capacity of the soils. Conservation practices on rangeland generally include development of watering facilities and prescribed grazing.

28A—Ancient Lake Bonneville

This area (fig. 28A-1) occurs in Utah (82 percent), Nevada (16 percent), and Idaho (2 percent). It makes up about 37,942 square miles (98,270 square kilometers). MLRA 28A is part of the Basin and Range province and consists of the basins of glaciopluvial, Late-Pleistocene Lake Bonneville along with the mountain ranges that the ancient lake surrounded. About 15 percent of the area consists of adjacent pluvial lake basins that were concurrent with Lake Bonneville along its western margins. This MLRA is characterized dominantly by remnant lacustrine-affected landforms and soil parent material.

MLRA 28A shares its northwestern boundary with MLRA 25, which has no Lake Bonneville influence and is mostly within the Columbia Plateau region. MLRA 28A is characterized by broad, extensive, closed basins while MLRA

Figure 28A-1: Location of MLRA 28A, which covers 9,826,900 hectares (24,283,000 acres), within Region D.

25 is characterized by narrow basins and externally drained alluvial valleys. MLRA 28A has dominantly sedimentary and metamorphic geology while MLRA 25 is dominantly volcanic. Climatically, MLRA 28A is in transition from xeric to ustic moisture patterns while MLRA 25 is in a strongly xeric precipitation pattern. MLRA 28A has extensive areas with less than 200 millimeters of mean annual precipitation while MLRA 25 does not have any areas with less than 200 millimeters of mean annual precipitation.

MLRA 28A shares its northern boundary with MLRA 11, which has no Lake Bonneville influence and lies dominantly within the Columbia Plateau region. MLRA 11 does not have mountain ranges. It has dominantly extrusive igneous geology affecting valleys with alluvium and eolian deposits. Climatically, MLRA 11 has a stronger xeric precipitation pattern.

MLRA 28A also shares its northern boundary with MLRA 13, which has no Lake Bonneville influence and lies dominantly within the Snake River Plain and the Middle Rocky Mountains. Climatically, MLRA 13 has a stronger xeric precipitation pattern and is dominantly cooler with extensive soils having frigid and cryic temperature regimes. It has few areas with less than 300 millimeters of mean annual precipitation and few Aridisols.

MLRA 28A shares its southern boundary with MLRA 29. The boundary was established where the influence from ancient Lake Bonneville is evident.

MLRA 28A shares its eastern boundary with MLRA 47, which has no Lake Bonneville influence but lies dominantly within the Middle Rocky Mountains and high uplifts of the Colorado Plateau. MLRA 47 is characterized dominantly by mountain landforms and high plateaus with narrow, externally drained alluvial drainageways. Climatically, it is mostly cooler with extensive soils having frigid and cryic temperature regimes. MLRA 47 has few areas with less than 300 millimeters of mean annual precipitation and few Aridisols.

MLRA 28A shares its western boundary with MLRA 28B, which has no Lake Bonneville influence but lies dominantly within higher elevation pluvial lake areas of the Great Basin. Climatically, MLRA 28B is in a strongly xeric precipitation pattern. The basins in MLRA 28B have greater than 200 millimeters of mean annual precipitation while basin areas in MLRA 28A are extensive with less than 200 millimeters of mean annual precipitation. Basin soils are dominantly cool mesic in MLRA 28B and warm mesic in MLRA 28A.

Physiography

MLRA 28A is the farthest eastern extent of the Great Basin section of the Basin and Range province of the Intermontane Plateaus. It is an area of nearly level basins between widely separated mountain ranges trending north to south. The mountains are uplifted fault blocks with steep side slopes that are skirted with long, gently sloping piedmont slopes transitioning into remnant lake terraces and basin floors. A large salt-desert playa is south and west of the Great Salt Lake. Most of the valleys in this MLRA are closed basins containing sinks or playa lakes. Elevations range from 4,200 to 6,550 feet (1,280 to 2,000 meters) in the basins and from 6,550 to 13,159 feet (2,000 to 4,013 meters) in the mountains.

Geology

The uplifted mountains have exposed some Precambrian rocks at their margins. Most of the mountains in the interior of this MLRA consist of tilted blocks of marine sediments of Cambrian to Mississippian age. This area has no rocks representing the Mesozoic Era. Outcrops of Tertiary volcanic rocks are scattered throughout the area but are concentrated in the southern portion. The Great Salt Lake is all that remains of ancient Lake Bonneville, which covered this area during the most recent ice age. Remnant lake terraces rise nearly 1,000 feet above the basin floors and are along the flanks of mountain ranges, indicating the former extent of this immense ice-age lake.

Climate

The mean annual precipitation is 4 to 44 inches (101 to 1,130 millimeters). MLRA 28A has a xeric moisture pattern that is in transition to ustic, with the highest percent of summer precipitation in the southern portions of the area. The dominant precipitation occurs in winter and spring; the driest months are from June to September. The average annual temperature is 30 to 53 degrees F (-1 to 12 degrees C), decreasing with elevation. The number of freeze-free days averages 165 and ranges from 110 to 215, decreasing with elevation.

Water

The major rivers that drain into the Great Salt Lake basin are the Bear, Jordan, Weber, and Sevier Rivers. Numerous other streams drain higher elevation ranges and terminate either in the Great Salt Lake or in closed basins. Water sources depend on high mountain snowfall that melts and fills reservoirs. Water quality is generally good except near the center of closed basins, where salinity and sodicity can be problems.

Soils

The dominant soil orders in this MLRA are Aridisols, Entisols, and Mollisols. The soils in the area dominantly have a mesic or frigid temperature regime, an aridic or xeric moisture regime, and mixed mineralogy. They generally are well drained or somewhat excessively drained, loamy or loamy-skeletal, and very deep.

The main soils and their series:

Poorly drained Aquisalids that formed in alluvium and lacustrine sediments on lake plains and basin floors (Saltair series)

Calcixerolls that formed in alluvium on alluvial fan remnants and lake terraces (Abela series); that formed in alluvium and lacustrine sediments on lake terraces (Collinston and Sterling series)

Haplocalcids that formed in residuum on hills and mountains (shallow Aft series); that formed in alluvium and colluvium on fan remnants, alluvial fans, and hills (Hiko Peak series); that formed in alluvium and lacustrine sediments on alluvial flats, lake terraces, and lake plains (Taylorsflat series); that formed in lacustrine sediments on lake terraces (Thiokol series)

Moderately deep Haploxerolls that formed in residuum on mountain slopes (Middle series)

Natrargids that formed in alluvium and lacustrine sediments on alluvial flats and lake plains (Skumpah and Uvada series)

Very deep Torrifluvents that formed in alluvium on flood plains (Green River series)

Torriorthents that formed in alluvium on inset fans and beach plains (Cliffdown series); that formed in alluvium mixed with lacustrine sediments on alluvial flats, lake terraces, and lake plains (Timpie and Tooele series)

Torripsamments that formed in sandy eolian material on dunes (Yenrab series)

Biological Resources

In the desert zone where the average annual precipitation is less than about 8 inches (200 millimeters), the soils support shadscale, winterfat, black sagebrush, and associated grasses, such as Indian ricegrass and squirreltail. Greasewood and Nuttall's saltbush grow on soils having a high content of salts or sodium. In the semi-desert zone, where the average annual precipitation is 8 to 12 inches (200 to 300 millimeters), the soils support big sagebrush, shadscale, winterfat, and associated grasses, such as bluebunch wheatgrass, Indian ricegrass, and bluegrasses. In the upland zone, where average annual precipitation is 12 to 16 inches (300 to 400 millimeters), the soils support Utah juniper, singleleaf pinyon, big sagebrush, bluebunch wheatgrass, bluegrasses, and needle and thread. In the mountain zone, where the average annual precipitation is 16 to 22 inches (400 to 560 millimeters), the soils support mountain big sagebrush, antelope bitterbrush, Douglas-fir, Engelmann spruce, curl-leaf mountain mahogany, mountain brome, slender wheatgrass, and snowberry. In minor areas where mean annual precipitation is greater than 22 inches (560 millimeters), the soils support subalpine fir, white fir, aspen, limber pine, bristlecone pine, and needlegrass. A large, nearly barren area west of the Great Salt Lake has a very sparse cover of pickleweed, seepweed, and greasewood. Major wildlife species in this MLRA include mule deer, elk, desert bighorn sheep, antelope, jackrabbit, American kestrel, red-tailed hawk, prairie falcon, sage grouse, and coyote.

Land Use

About three-fifths of this area is federally owned land, large tracts of which are used for training and testing purposes by the Armed Forces and the Nuclear Regulatory Commission. A large area west and southwest of the Great Salt Lake is a salty playa. The rest of the area is in farms and ranches (fig. 28A-2). Livestock production on rangeland is a principal agricultural enterprise in the west. Production of desert shrubs and grasses is very low. In most of the area, the extent of the livestock industry is determined largely by the amount of hay, pasture, and grain that can be produced under irrigation from limited water supplies.

About 5 percent of the area is irrigated cropland or hayland used for alfalfa, small grain (wheat, barley, oats, and triticale),

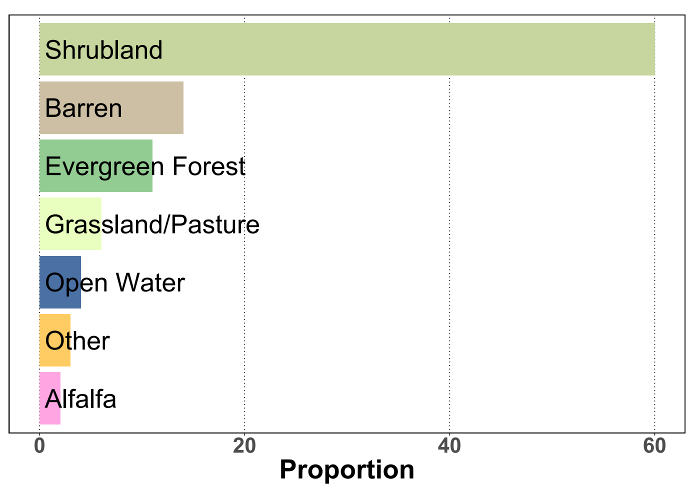

Figure 28A-2: Relative proportions (percentages) of land use in MLRA 28A.

Austrian winter peas, corn for grain or silage, potatoes, vegetables (onions, pumpkins, sweet corn, peas, and squash), and fruits (apples, peaches, pears, apricots, and cherries). A small portion of the irrigated land is used for pasture. About 5 percent is used for production of dryland winter wheat and safflower.

The management concerns on rangeland include forage production and the efficient use of range vegetation. The rangeland in the area is increasingly impacted by invasive non-native plants. The management concerns on dry-farmed cropland include productivity, wind erosion, water erosion, moisture management, and weed control. The management concerns on irrigated cropland and hayland include productivity, the efficient use of limited water supplies, control of irrigation-induced erosion, and nutrient and pest management. Tilth, soil compaction, and maintenance of the content of soil organic matter are additional concerns on irrigated and dry-farmed cropland. The management concerns on irrigated pasture include productivity, proper grazing use, efficient use of limited water supplies, nutrient management, and weed control.

Conservation practices on rangeland generally include brush management, rangeland seeding, prescribed grazing, fencing, development of watering facilities, and erosion control. Conservation practices on dry-farmed cropland generally include terraces, sediment-control basins, summer fallow tillage, crop residue management, pest management, and nutrient management. Conservation practices on irrigated cropland and hayland include irrigation system improvement, irrigation water management, no-till hayland planting, forage harvest management, nutrient management, windbreaks, and pest management. Conservation practices on irrigated pasture generally include irrigation system improvement, irrigation water management, pasture planting, development of watering facilities, fencing, prescribed grazing, nutrient management, and pest management.

28B—Central Nevada Basin and Range

MLRA 28B (fig. 28B-1) is entirely in Nevada and makes up about 21,863 square miles (56,626 square kilometers). It includes one of the world's largest open-pit mines, the Ruth Copper Pit, directly west of Ely. The area consists of nearly level, aggraded desert basins and valleys between a series of mountain ranges trending north to south.

To the north, MLRA 28B borders MLRAs 24 and 25. A decrease in singleleaf pinyon and Utah juniper marks the transition. To the east, MLRA 28B has a gradual boundary with MLRA 28A. Soils become warmer and drier, and salt-desert shrub vegetation dominates. The southern part of MLRA 28A is characterized by increased summer precipitation and the presence of warm-season grasses that do not grow in MLRA 28B. The northern part of MLRA 28A is heavily influenced by ancient Lake Bonneville, which did not affect MLRA 28B.

Figure 28B-1: Location of MLRA 28B, which covers 5,662,600 hectares (13,992,500 acres), within Region D.

To the south, MLRA 28B borders MLRA 29, where summer precipitation patterns provide enough soil moisture to support warm-season grasses.

Physiography

This area is in the Great Basin section of the Basin and Range province of the Intermontane Plateaus. The basins are bordered by long, gently sloping to strongly sloping alluvial fans. The mountains are uplifted fault blocks with steep side slopes. They are not well dissected because of the low amount of rainfall in the area. Many of the valleys in this MLRA are closed basins containing sinks or playas. Elevation ranges from 4,900 to 6,550 feet (1,495 to 1,995 meters) in the valleys and basins and from 6,550 to 11,900 feet (1,995 to 3,630 meters) in the mountains. The MLRA has no major rivers. The Duck River is north and east of Ely.

Geology

The mountains in the south and west parts of this area are dominated by andesite and basalt rocks that formed during the Miocene and Oligocene Epochs. Paleozoic and older carbonate rocks are prominent in the mountains to the north and east. Outcrops of older Tertiary intrusives and very young tuffaceous sediments are scattered throughout the MLRA. The valleys consist mostly of alluvial fill, with lake deposits at the lowest elevations of the closed basins. The alluvial valley fill consists of cobbles, gravel, and coarse sand near the mountains in the apex of the alluvial fans. Sands, silts, and clays are on the distal ends of the fans.

Climate

The average annual precipitation is typically 9 to 17 inches (229 to 432 millimeters). Some high-elevation mountains have as much as 39 inches (991 millimeters). The majority of precipitation falls in the form of snow in winter across all elevations. However, occasional spring rains and summer convection storms contribute to overall soil moisture. The driest period is from midsummer to midautumn. The average annual temperature is 31 to 52 degrees F (-1 to 11 degrees C). The freeze-free period averages 125 days and ranges from 80 to 170 days, decreasing in length with elevation.

Water

Water is scarce. Most streams are small and intermittent and depend on sources in the higher mountains. A few small reservoirs have been constructed throughout the area for storage of water for irrigation and recreational purposes. The surface water from the mountains is generally of good quality, and its use is not limited. Irrigation return flows raise the levels of dissolved salts and suspended sediments in some streams, causing some contamination. Both surface water and ground water are used for irrigation.

Shallow wells in the basin and valley fill aquifers provide almost all of the ground water used in this area. On the alluvial fan deposits near the mountains, where the valley fill aquifers are recharged, ground water has much lower levels of dissolved salts. The ground water becomes almost saline near the playas far away from the recharge zone.

The carbonate rock in this area is considered an aquifer. Use of this aquifer is limited because of the expense of drilling deep wells. Water from the carbonate rock is hard or very hard and suitable for most uses.

Soils

The dominant soil orders are Aridisols, Entisols, and Mollisols. The soils in the area dominantly have a mesic or frigid temperature regime, an aridic or xeric moisture regime, and mixed or carbonatic mineralogy. They generally are well drained, loamy or loamy-skeletal, and shallow to very deep.

The main soil series:

- Cavehill series—Haplocalcids that formed in residuum and colluvium derived from limestone, calcareous sandstone, and dolomite with surficial deposits of loess; on hills, mountains, and rock pediments
- Katelana series—Torriorthents that formed in alluvium derived dominantly from limestone over lacustrine sediments; on lake plains, lagoons, alluvial flats, and lower margins of fan skirts
- Kunzler series—Haplocalcids that formed in alluvium derived from mixed rocks on linear and concave parts of fan remnants, fan skirts, inset fans, lake plains, beach plains, and axial stream terraces
- Palinor series—Haplodurids that formed in alluvium derived mainly from limestone and dolomite; on fan remnants and ballenas
- Pookaloo series—Haplocalcids that formed in residuum and colluvium derived from limestone, dolomite, and calcareous siltstone; on mountains and hills
- Segura series—Argixerolls that formed in residuum and colluvium derived from welded tuff, andesite, quartzite, conglomerate, and rhyolite on mountains
- Sheffit series—Torriorthents that formed in alluvium over lacustrine deposits derived from mixed rocks and volcanic ash; on lake plains and alluvial flats
- Urmafot series—Durixerolls that formed in alluvium derived from mixed rocks on fan remnants and partial ballenas
- Wintermute series—Haplocalcids that formed in mixed alluvium derived from limestone, dolomite, and slate; on fan remnants, fan skirts, and beach plains
- Zimbob series—Torriorthents that formed in residuum and colluvium derived from limestone and dolomite; on hills and mountains

Biological Resources

This area supports, in progression from lower to higher elevations and precipitation, saltbush-greasewood, big sagebrush, pinyon-juniper woodland, and white fir-limber pine woodland. Black greasewood and shadscale, in association with bud sagebrush, spiny hopsage, ephedra, winterfat, fourwing saltbush, Indian ricegrass, and squirreltail, characterize the saltbush-greasewood type. With an increase in moisture, shadscale and the associated plants are replaced by needlegrasses, bluegrasses, bluebunch wheatgrass, basin wildrye, sagebrush, and forbs. Mountain big sagebrush, Wyoming big sagebrush, and black sagebrush dominate. In the pinyon-juniper woodland, bitterbrush, serviceberry, black sagebrush, mountain big sagebrush, and snowberry grow in association with Utah juniper and singleleaf pinyon. The highest elevations support thickets of curl-leaf mountain mahogany and small amounts of mixed conifer forest with limber pine, bristlecone pine, or white fir. On bottom lands, basin wildrye, creeping wildrye, alkali sacaton, wheatgrasses, bluegrasses, sedges, and rushes are typical. Black greasewood, rubber rabbitbrush, and basin big sagebrush grow on the drier sites. Inland saltgrass, alkali sacaton, black greasewood, rubber rabbitbrush, and basin wildrye typify the vegetation on strongly saline-alkali soils.

Major wildlife species include mule deer, coyote, bobcat, beaver, jackrabbit, cottontail, sage grouse, chukar, and quail. Fish species include trout, dace, shiners, and suckers.

Land Use

More than nine-tenths of this area is federally owned. The rest is mainly in farms and ranches. Livestock grazing of native grasses and shrubs on rangeland is the principal agricultural

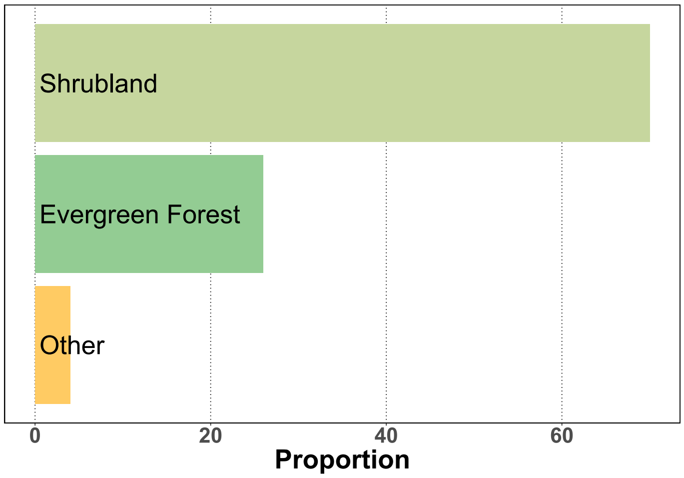

Figure 28B-2: Relative proportions (percentages) of land use in MLRA 28B.

enterprise (fig. 28B-2). In most of the area, the extent of the livestock industry is determined largely by the amount of hay, pasture, and grain that can be produced under irrigation using the small supply of local water. The irrigated land makes up 1 percent or less of the total area. About one-fifth of the area is pinyon-juniper woodland on mountain slopes.

The major soil resource concerns are the hazard of wind erosion, the content of salts and sodium in the soils, management of soil moisture, and forest and rangeland health. Other management concerns are the efficient use of rangeland vegetation and limited water supplies and control of erosion in critical areas.

Conservation practices on cropland generally include irrigation water management, crop residue management, and toxic salt reduction. Conservation practices on rangeland include prescribed grazing, brush management, and development of watering facilities. Pasture and hay provide seasonal feed for livestock. Other management concerns include encroachment by pinyon and juniper from the surrounding mountains and hills and the spread of non-native annuals.

29—Southern Nevada Basin and Range

MLRA 29 (fig. 29-1) is in Nevada (73 percent), California (26 percent), and Utah (1 percent). It makes up about 25,883 square miles (67,035 square kilometers). The area is in the Great Basin, which is characterized by broad, nearly level, aggraded desert basins and valleys between a series of mountain ranges trending north to south.

To the south, MLRA 29 has a distinct boundary, marked by an increase in soil temperature, with MLRA 30. The rapid transition is typified by the dominance by creosote bush and white bursage. To the north, MLRA 29 borders MLRA 28B. The transition is marked by the absence of summer precipitation and

Figure 29-1: Location of MLRA 29, which covers 6,703,500 hectares (16,564,800 acres), within Region D.

the loss of warm-season grasses (galleta and blue grama) as a prominent part of the plant community.

Physiography

This area is in the Great Basin section of the Basin and Range province of the Intermontane Plateaus. Owens Valley and Death Valley in California mark the farthest western extent of the Great Basin section. The area's basins are bordered by sloping fans and terraces. Its mountains are uplifted fault blocks with steep side slopes. They are not well dissected because of the low amount of rainfall. Most of the valleys in this MLRA are closed basins containing sinks or playa lakes.

Elevation ranges from 1,950 to 5,600 feet (595 to 1,705 meters) in the valleys. On some high mountain peaks, it is more than 9,400 feet (2,865 meters). The intermittent and ephemeral streams in Nevada typically end in dry playa lakes. The Owens River and Owens Lake are in this MLRA.

Geology

The mountains in this area are dominated by Pliocene and Miocene andesite and basalt rocks. Paleozoic and Precambrian carbonate rocks are prominent in some areas. Outcrops of older Tertiary intrusives and very young tuffaceous sediments (Pliocene and Miocene) are in scattered areas in the western and eastern thirds of this MLRA. The valleys consist mostly of alluvial fill, but playa deposits are at the lowest elevations in the closed basins. The alluvial valley fill consists of cobbles, gravel, and coarse sand near the mountains in the apex of the alluvial fans. Sands, silts, and clays are on the distal ends of the fans.

Climate

The annual precipitation averages 5 to 12 inches (127 to 305 millimeters) but can be as high as 29 inches (737 millimeters). Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Sporadic storms occur throughout July and August. The annual temperature averages 26 to 58 degrees F (-3 to 14 degrees C) but can be as high as 71 degrees F (22 degrees C) in some years. Temperature decreases with elevation. The freeze-free period averages 205 days and ranges from 80 to 335 days, decreasing in length with elevation.

Water

Precipitation is sparse. Most of the streams are small and intermittent and depend on sources in the higher mountains. The surface water from the mountains is generally of good quality, and its use is not limited near the mountains. The quality of this water is naturally degraded by dissolved salts picked up as streams cross areas of valley fill to their terminus in a playa lake. Irrigation return flows raise the levels of dissolved salts and suspended sediments in some streams, causing some contamination. Historically, the Owens River flowed into Owens Lake in this MLRA. Today, most of the Owens River is diverted into the Haiwee Reservoir, bypassing Owens Lake, and then diverted into the Los Angeles Aqueduct for use as drinking water in southern California coastal cities.

Ground water in this area is scarce but is being rapidly developed. Most of the ground water in the California portion of the MLRA is controlled by Los Angeles and not available for local use. Shallow wells in the basin and valley fill aquifers provide almost all of the ground water used in this area. On the alluvial fan deposits near the mountains, where the valley fill aquifers are recharged, ground water has much lower levels of dissolved salts. The ground water becomes almost saline near the playa lakes far from the recharge zone.

A volcanic rock aquifer is in the south-central part of this MLRA. It is used very little. The carbonate rocks in this area also are considered aquifers. Use of these aquifers is limited. Water from the carbonate rocks is hard or very hard and suitable for most uses.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. Mollisols also are important in the mountainous areas. The soils in the area dominantly have a mesic temperature regime, an aridic or xeric moisture regime, and mixed mineralogy. They generally are very shallow to very deep, well drained or somewhat excessively drained, and loamy-skeletal or sandy-skeletal.

The main soil series:

Bellehelen series—Argixerolls that formed in residuum and colluvium derived from volcanic rocks; on hills and mountain slopes

Blacktop series—Torriorthents that formed in material derived from extrusive basic igneous rocks; on hills, mesas, pediments, mountains, and plateaus

Downeyville series—Haplargids that formed in residuum and colluvium derived from volcanic rocks; on hills, mountains, rock pediments, plateaus, and mesas

Gabvalley series—Haplargids that formed in residuum and colluvium derived from volcanic rocks with a component of volcanic ash; on hills, plateaus, mesas, and mountains

Koyen series—Haplocambids that formed in mixed loamy alluvium derived dominantly from volcanic rocks with a high component of loess; on fan piedmonts, fan remnants, fan skirts, alluvial fans, inset fans, basin floors, basin-floor remnants, sand sheets, and alluvial flats

Kyler series—Torriorthents that formed in residuum and colluvium derived from limestone and dolomite; on mountains and hills

Stewval series—Haplargids that formed in residuum and colluvium derived from volcanic rocks; on hills, mountains, mesas, plateaus, and pediments

Unsel series—Haplargids that formed in alluvium derived from mixed rocks on fan remnants and fan skirts

Ursine series—Haplodurids that formed in alluvium derived mainly from limestone; on fan remnants

Wardenot series—Torriorthents that formed in alluvium derived from mixed rocks; on alluvial fans, fan piedmonts, fan skirts, alluvial flats, and inset fans

Zadvar series—Argidurids that formed in alluvium derived from volcanic rocks; on fan remnants

Biological Resources

This area supports desert shrub vegetation. The lowest elevations support salt-desert shrub communities and associated vegetation. Important species include shadscale, bud sagebrush, winterfat, spiny hopsage, greasewood, galleta grass, Indian ricegrass, and needlegrass. With increased elevation and reduced soil salinity, black sagebrush becomes dominant on sedimentary parent material. Wyoming big sagebrush is dominant on volcanic parent material. Associated species include ephedra, winterfat, Indian ricegrass, needle and thread, and galleta. Mountain big sagebrush and low sagebrush occur on mountain backslopes in association with or higher on the slope than mixtures of Utah juniper and singleleaf pinyon or curl-leaf mountain mahogany. An important biotic characteristic of this MLRA, separating it from other MLRAs in the Great Basin, is the widespread occurrence of warm-season perennial grasses, primarily galleta.

Major wildlife species include mule deer, coyote, kit fox, bobcat, jackrabbit, cottontail, kangaroo rat, snakes, lizards, golden eagle, hawks, and chukar. Fish species include brook trout, brown trout, and bass.

Land Use

Nearly all of this area is federally owned land, much of which is used for training and testing purposes by the Armed Forces and the Nuclear Regulatory Commission. Less than 1 percent of the area, mostly in the valleys, is irrigated. Much of the irrigated acreage is used for hay and grain for livestock (fig. 29-2). High mountain areas consist of pinyon-juniper woodland. Native grasses and shrubs in areas of rangeland are grazed by livestock.

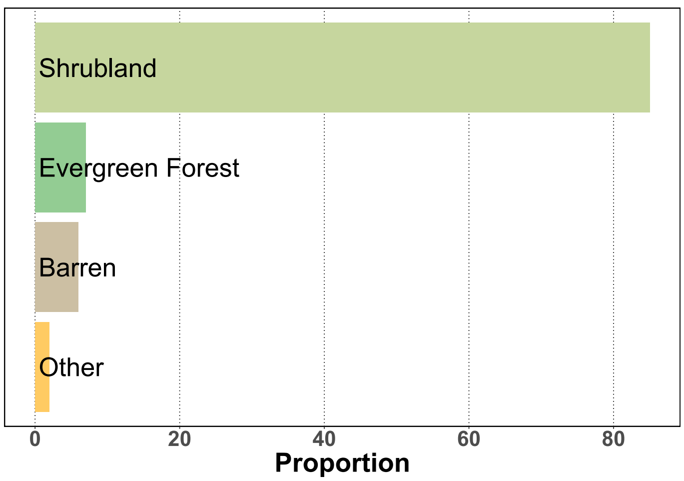

Figure 29-2: Relative proportions (percentages) of land use in MLRA 29.

The major soil resource concerns in this area are control of wind erosion and reduction of the content of salts and sodium in the soils. Management concerns include proper use of rangeland, erosion control, and efficient use of the scarce water supplies.

Conservation practices on cropland generally include irrigation water management and toxic salt reduction. In addition, windbreaks and crop residue management can reduce the hazard of wind erosion and increase the available water capacity of the soils. Development of watering facilities and prescribed grazing are important practices on rangeland.

30—Mojave Basin and Range

This area (fig. 30-1) occurs in California (57 percent), Nevada (32 percent), Arizona (10 percent), and Utah (1 percent). It makes up about 42,280 square miles (109,503 square kilometers). MLRA 30 is the transition from the hot Sonoran Desert in the south to the cool Great Basin Desert in the north. Physiographically, it mostly is within the northern portion of the Sonoran Desert section of the Basin and Range province (Fenneman and Johnson, 1957). Climate and vegetation diversity, due to the random orientation of mountains and basins coupled with extreme gradients, makes up the central concept of MLRA 30. This area has both low and high deserts that mostly occur within short distances. The low, hot deserts are in hot, sediment-filled, flat-bottom basins while the high, cool deserts are in adjacent mountain ranges with steep, bedrock slopes extending to high elevations.

Figure 30-1: Location of MLRA 30, which covers 10,950,300 hectares (27,058,800 acres), within Region D.

The landscapes are a result of massive thrust faults at the boundaries of the Pacific and North American Plates as well as normal faulting caused by the stretching and rifting of the North American Plate surface. Due to the proximity of these tectonic forces to the Sierra Nevada Batholith and the Pacific Plate, mountain ranges do not have a uniform southwest to northeast pattern as in the Great Basin further north. Instead, the mountain ranges tend to trend in all directions. The MLRA geographically ranges from Death Valley south to Joshua Tree and from the southern Sierra Nevada and Transverse Ranges east to the Hualapai Mountains, Grand Wash Cliffs, Music Mountains, and Shivwits Plateau in western Arizona and Utah.

MLRA 30 grades into MLRA 40 to the south, where the basins become wider and the ranges smaller, specifically around Cadez Lake and basin. To the east, MLRA 30 borders MLRAs 35 and 38 at the Hualapai Mountains, Grand Wash Cliffs, and the Music Mountains. MLRA 35 represents the Colorado Plateau and is associated with uplifted horizontal stratigraphy. MLRA 38 represents the transition between the Colorado Plateau and the Sonoran Basin and Range.

Physiography

MLRA 30 intersects three sections of the Basin and Range province of the Intermontane Plateaus: the Great Basin, the Mexican Highland, and the Sonoran Desert. The landscapes are controlled by the massive Sierra Nevada Batholith and mountains, the San Andreas Fault, and the continental rifting between the Sierra Nevada and the Colorado Plateau. North-south-trending mountains with narrow, long basins, valleys, and old lakebeds make up most of the Great Basin section, or northern portion of the MLRA. The major portion of the MLRA, consisting of the Sonoran Desert section, has isolated, short mountain ranges trending in all directions with the Transverse Ranges of the San Gorgonio, Angeles Crest, and Tehachapi Mountains generally oriented perpendicular to the northern Basin and Range topography (Peterson, 1981). The internal mountains of the MLRA are separated by a variety of aggraded desert plains, piedmont slopes, and lake beds. Many of the mountains are fault blocks that dipped down to one side due to continental rifting and rose with regional uplift. In the north, most of the basins are elongated and deeper than they are wide and have shorter alluvial fans that coalesce with dry lakebeds between most of the ranges.

MLRA 30 has valley and basin floors ranging from 3,950 to -282 feet (1,204 to -86 meters) above sea level, with the lowest elevation in the world at Badwater Basin in Death Valley. At the other extreme, the area has mountain ranges with peaks that exceed 11,100 feet (3,385 meters). Mount Whitney, with the highest elevation in the continental United States, at 14,505 feet (4,421 meters), forms part of the area's northwest boundary with the Pacific Mountain Region. These two elevation extremes occur within 80 miles of each other. The Mojave hosts numerous examples of these elevation and landform gradients, such as from Badwater to Telescope Peak; from Salton Sea to Mount San Antonio; from Eureka Valley, at 2,974 feet (906 meters), to Last Chance Mountain, at 8,456 feet (2,577 meters); from Saline Valley, at 1,132 feet (345 meters), to New York Butte, at 10,668 feet (3,252 meters); and from the Spring Mountains to surrounding valleys near or below 3,500 feet.

Geology

Most of this area is underlain by Quaternary (Late Pleistocene; 100,000 to 10,000 years ago) alluvial deposits on alluvial fans, piedmont slopes, and valley floors. Recent alluvial fans and fan remnants typically grade from boulder-strewn deposits and coarse desert pavement near the fan apex to finer grained sands, silts, and clays at the distal ends. Basins typically have a playa or dry lake at or near their low point. Eolian landforms are common around basin perimeters.

MLRA 30 has mountains of diverse age and geochemistry. The massive deposits of Permian to Tertiary granodiorite and quartz monzonite that make up the Sierra Nevada are similar throughout the Mojave, such as at Joshua Tree National Park, Eureka Peak, and Quail Mountain. There are also Proterozoic gneiss and schist and Tertiary to Holocene basalts, rhyolite, dacite, and andesite. Isolated deposits of Tertiary and Mesozoic limestone are in several mountain ranges, such the New York, Providence, and Funeral Mountains. Older, Paleozoic limestones, sandstones, and shale are in southern Nevada, and isolated Miocene to Pleistocene sandstones and conglomerates are in California.

Climate

The Pacific Mountain Physiographic Division creates a strong orographic effect that limits the amount of coastal humidity and precipitation entering the Mojave. Precipitation occurs primarily in winter and early spring. Drought years are common, and high amounts of annual precipitation often occur in single storm events. The relative humidity is low, and evaporation is high. Summers are hot and dry with irregular and sparse, high-intensity, convective thunderstorms. These storms are usually of short duration, occur primarily east of the meridian 117^{o} west, and are most common in July and August (Hereford et al., 2006). The moisture from these summer storms usually has little long-term influence on soil moisture control sections. Very high surface temperatures and steady winds cause rapid evaporation.

The average annual precipitation is 2 to 28 inches (47 to 714 millimeters). The average annual temperature is 37 to 76 degrees F (3 to 24 degrees C). The average maximum snowfall ranges from 0 inches in the lowest deserts to more than 30 inches (760 millimeters) at the highest elevations of the Spring Mountains directly west of Las Vegas.

Water

The public water supply and irrigation water for agriculture are obtained almost entirely from the Colorado and Mojave Rivers. The Virgin and Muddy Rivers and large springs at Moapa and Ash Meadows contribute to major surface water sources in the area. Ground water is available and extensively used in Las Vegas, Pahrump, and Amargosa Valley. Water for livestock on rangeland is provided from springs and wells or is hauled to watering sites. Ground water is the only water available in Death Valley, and this water has high levels of chloride. Mountain ranges tend to separate ground water basins (valley fill deposits) in the Mojave Desert. Total dissolved solids are lowest at the outer edges of the basins, where recharge occurs from surface runoff in the mountains.

Soils

The dominant soil orders are Aridisols and Entisols. The soils in this area are generally well drained to excessively drained, fine-loamy to sandy-skeletal, and shallow to very deep. Torriorthents, Torrifluvents, Haplosalids, and Torripsamments occur in basins and on valley floors. Haplargids, Haplodurids, Paleargids, and Haplocalcids are on older alluvial fans and terraces. Shallow Torriorthents, shallow Haplocambids, and Torripsamments are on lower mountains.

The soils dominantly have a thermic and hyperthermic temperature regime and a typic aridic moisture regime. The soils at lower elevations, below 1,640 feet (500 meters), and on south-facing mountain slopes typically have a hyperthermic temperature regime, with a mean annual soil temperature (MAST) of 59 to 72 degrees F (15 to 22 degrees C). Few soils at the higher elevations have a frigid or cryic temperature regime (MAST of less than 8 degrees C, or 46 degrees F).

The main soils and their series:

Haplocalcids that formed in alluvium on alluvial fans, fan aprons, mesas, and terraces (Gunsight, Huevi, Tonopah, and Weiser series)

Petrocalcids that formed in alluvium on alluvial fans, fan aprons, mesas, and terraces (Bard, Cave, and Mormon Mesa series)

Torriorthents that formed in alluvium on fan pediments, alluvial fans, fan aprons, and flood plains (Arizo, Carrizo, Hesperia, and Yermo series)

Torriorthents that formed in residuum and colluvium on limestone and dolomite hills and mountains (St. Thomas series), on volcanic hills and mountains (Sunrock series), and on granite hills and mountains (Dalvord and Goldroad series)

Torripsamments that formed in alluvium on alluvial fans, fan aprons, mesas, and terraces (Cajon series)

Biological Resources

The intermingling of hot and cold deserts adds to the diverse bio-geographics of the Mojave Basin and Range. The Mojave supports a wide variety of plant communities and ecological systems, from rare subalpine mesic meadows and isolate mesquite bosques to widespread creosote bush-white bursage desert scrub, patches of desert pavement, and isolated sand dunes (Randall et al., 2010). The Creosotebush - Burrobush Bajada & Valley Desert Scrub Alliance dominates this MLRA. Intermountain basins support several vegetation alliances and associations within the North American Desert Alkaline-Saline Wet Scrub Group, where chenopod scrub species (such as four-winged saltbush, cattle saltbush, iodinebush, and Mojave seablite) dominate. At the higher elevations, the Blackbrush Mojave Desert Scrub Alliance transitions to pinyon-juniper woodlands.

Typical wildlife species include coyote, kit fox, jackrabbit, cottontail, squirrel, roadrunner, Gambel's quail, mourning dove, burrowing owls, snakes (including sidewinders and other rattlesnakes), tarantulas, and tortoise. Some water bodies contain various species of pupfish.

Land Use

About four-fifths of this area is federally owned. Much of the remainder is owned by local government. Most of the land has a cover of desert vegetation (fig. 30-2). The area is used only locally for grazing because of low forage production and the lack of water for livestock. On sites intensively used for recreation, especially where motorcycles and off-road vehicles are driven, the hazards of wind erosion and water erosion are severe.

Major soil resource concerns on rangeland are the productivity and sustainability of the soils and the hazards of wind and water erosion. Compaction, tilth, management of soil moisture, and wind erosion are the major soil resource concerns on irrigated cropland.

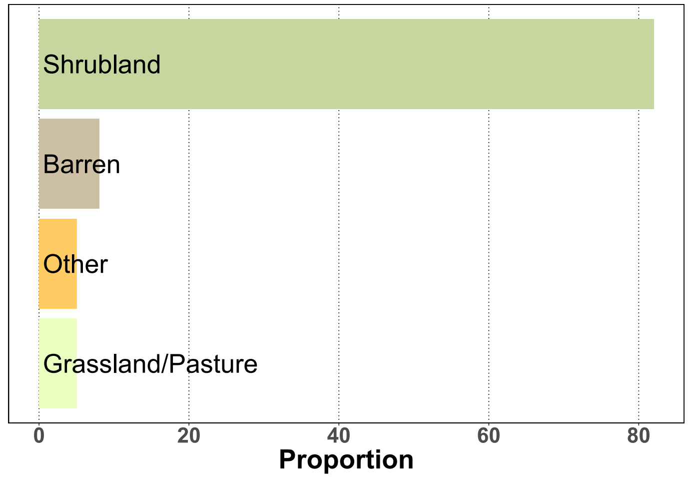

Figure 30-2: Relative proportions (percentages) of land use in MLRA 30.

Conservation practices on irrigated cropland generally include irrigation system improvement, irrigation water management, nutrient management, and pest management. Conservation practices on rangeland include prescribed grazing, development of watering facilities, and erosion control.

32—Northern Intermountain Desertic Basins

MLRA 32 (fig. 32-1) is in Wyoming (95 percent) and Montana (5 percent). It makes up about 10,763 square miles (27,875 square kilometers). It consists of a syncline between anticlinal mountain ranges that encompasses both the Bighorn and Wind River Basins. The Bighorn Basin is bordered by MLRA 43B (Central Rocky Mountains) to the east, west, and south and MLRA 46 (Northern and Central Rocky Mountain Foothills) to the north. The Wind River Basin is bordered by MLRA 43B to the north, MLRA 46 to the west, and MLRA 34A (Cool Central Desertic Basins and Plateaus) to the south and east.

Physiography

The northern two-thirds of this MLRA, in the Bighorn Basin, is in the Middle Rocky Mountains province of the Rocky Mountain System. This part of the MLRA is an elevated, dissected basin surrounded by mountain ranges to the east, west, and south. The Owl Creek and Bridger Mountains separate the northern two-thirds of the MLRA from the southern third. The southern third is in the Wind River Basin, an elevated, dissected plain with mountains to the north, west, and south. This part of the MLRA is in the Wyoming Basin province of the Rocky Mountain System. Some isolated low mountains are in each part of the MLRA. Elevation ranges from 3,600 to 7,300 feet (1,100 to 2,240 meters). Piedmont plains and pediments slope from the

Figure 32-1: Location of MLRA 32, which covers 2,787,500 hectares (6,888,100 acres), within Region D.

mountains to the stream terraces of the Wind River and Bighorn Basins. The plains are eroded to the clay shale bedrock in some areas, and there are areas of badlands.

The Beaver and Wind Rivers join to form the Bighorn River in the southern third of this area. The Bighorn River cuts through the Owl Creek Mountains and continues into the northern part of the MLRA. The Shoshone and Greybull Rivers join the Bighorn River in the northern part of the area. Clark's Fork of the Yellowstone River exits the area in the northwest corner.

Geology

The surface of this area is covered with old deposits of sand and gravel washed into the basins by the streams and rivers draining the surrounding mountains. The present-day rivers and streams have excavated old pediment surfaces, forming terraces. Alluvial fan deposits grade into the valley fill pediments. The igneous and sedimentary rocks exposed in the adjacent mountains occur beneath the surface of the Bighorn Basin. Tertiary sandstones and shales are exposed where the overlying alluvium has eroded away. Older sandstones, shales, and carbonate rocks are exposed as steeply dipping beds on the mountainsides. The core of most of the mountain ranges is granite. The granite may be exposed at the higher elevations along the margin of the basins.

Climate

The average annual precipitation in most parts of the basins is 7 to 12 inches (176 to 310 millimeters). It is as high as 22 inches (560 millimeters) in the higher areas within the basins. The maximum precipitation from frontal storms occurs in spring and fall. The surrounding mountain ranges block many of the regional precipitation events. The average annual temperature is 40 to 47 degrees F (4.6 to 8.5 degrees C). The temperature can vary widely within short periods because of the drainage of cooler mountain air into the basins. The freeze-free period averages 133 days and ranges from 110 to 155 days.

Water

The low and erratic precipitation provides only a small amount of the surface water used in this area. The Wind and Bighorn Rivers and their tributaries bring good-quality irrigation water into the area from the bordering mountains. A few reservoirs store water, but most of the surface water used is diverted directly from the streams. Supplies become scarce late in the growing season, from July through September.

Deep artesian wells provide some water for irrigation on the eastern side of the Bighorn Basin. These wells are finished either in sandstone units in the Dakota Formation or in the carbonate rocks of the Madison Group. The well water is very hard. Ground water occurs in the alluvial basin fill deposits near the surface. This water can be soft to very hard. It is not used in the area.

Soils

The dominant soil orders are Aridisols and Entisols. The soils in the area dominantly have a mesic temperature regime, an aridic moisture regime, and mixed mineralogy. They generally are shallow to very deep, well drained, and loamy.

The main soils and their series:

- Haplargids that formed in alluvium and slope alluvium on alluvial fans, fan remnants, and stream terraces (Griffy, Hiland, and Wallson series)
- Haplocalcids that formed in alluvium and colluvium on alluvial fans, fan remnants, and stream terraces (Emblem and Trook series)
- Haplocambids that formed in alluvium and colluvium on alluvial fans, fan remnants, stream terraces, and basin-floor remnants (Kinnear, Pavillion, and Zigweid series)
- Natrargids that formed in alluvium or colluvium over residuum on alluvial fans, stream terraces, hills, fan remnants, and strath terraces (Effington, Muff, and Uffens series)
- Torrifluvents that formed in alluvium on flood plains, alluvial fans, and stream terraces (Lostwells and Youngston series)
- Torriorthents that formed in alluvium and colluvium on alluvial fans, fan remnants, stream terraces, and hills (Apron and Kishona series); that formed in residuum and colluvium on hills, escarpments, eroded fan remnants, side slopes, dip slopes, scarp slopes, and pediments (Greybull, Oceanet, Persayo, Shingle, and Worland series)

Biological Resources

This area supports shrub-grass vegetation. Big sagebrush, Gardner's saltbush, rhizomatous wheatgrasses, Indian ricegrass, and needle and thread are the dominant species. Black sage, Gardner's saltbush, and bluebunch wheatgrass are common on shallow soils in the uplands. Major wildlife species include antelope, coyote, jackrabbit, and sage grouse.

Land Use

Nearly one-half of this area is federally owned. The rest is in farms and ranches. Most of the land is used for grazing (fig. 32-2). The rangeland consists of desert shrubs and short grasses. About 5 percent of the area is irrigated. Most of the irrigated areas are used for alfalfa and other feed crops, but dry beans, malt barley, sugar beets, and corn are important cash crops.

The major soil resource concerns are water erosion, water quality, rangeland health, and soil quality. Conservation practices on cropland include irrigation water management and installation of water-conserving irrigation systems.

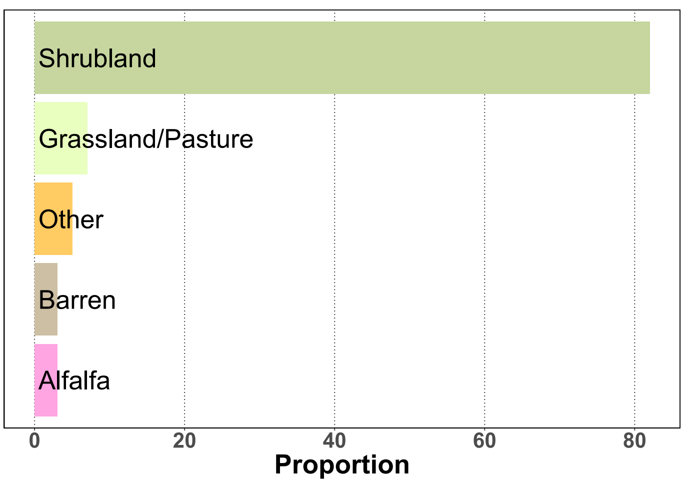

Figure 32-2: Relative proportions (percentages) of land use in MLRA 32.

34A—Cool Central Desertic Basins and Plateaus

This area (fig. 34A-1) is in Wyoming (88 percent), Colorado (11 percent), and Utah (1 percent). It makes up about 27,085 square miles (70,149 square kilometers). It is dominated by sedimentary basin-floor remnants. This MLRA is bordered by MLRA 46 (Northern and Central Rocky Mountain Foothills) to the north, west, and southwest; MLRA 32 (Northern Intermountain Desertic Basins) to the north; MLRA 58B (Northern Rolling High Plains, Southern Part) to the northeast; MLRA 49 (Southern Rocky Mountain Foothills) to the east; and MLRA 48A (Southern Rocky Mountains) to the southeast.

Figure 34A-1: Location of MLRA 34A, which covers 7,014,900 hectares (17,334,100 acres), within Region D.

Physiography

About 95 percent of this area is in the Wyoming Basin province of the Rocky Mountain System and 5 percent is in the Middle Rocky Mountains province of the same system. The Wyoming Basin is bounded on most sides by mountains. The Owl Creek Mountains, Big Horn Mountains, and Wind River Range are to the north; the Wasatch Mountains are to the west; and the Laramie and Sierra Madre Mountains are to the east. The part of the MLRA in Colorado is bounded on the south and west by the Uinta Mountains and Danforth Hills and on the east by the Elkhead Mountains. In most of the MLRA, elevation ranges from 5,300 feet (1,620 meters) to 9,500 feet (2,890 meters). Small mountainous areas have elevations as high as 9,200 feet (2,805 meters). The Popo Agie, Sweetwater, Laramie, Green, and North Platte Rivers run through the northern part of this MLRA, and the Little Snake and Yampa Rivers run through the southern part.

Geology

This area is dominated by residual basin-floor geologic materials. Shale and sandstone are the dominant rock types. The Tertiary-age Bridger, Green River (Laney Member), Wasatch, Wind River, and Browns Park Formations dominate. Cretaceous-age formations occur as small areas throughout the MLRA. The dominant Cretaceous formations are the Lewis and Lance Formations and members of the Mesa Verde Group. Quaternary alluvial and eolian deposits occur throughout the MLRA. Glacial deposits occur primarily on outwash terraces in the vicinity of Pinedale, Wyoming. The small mountain ranges in this MLRA are made up of Precambrian igneous and metamorphic rocks.

Climate

The average annual precipitation generally is 8 to 12 inches (199 to 305 millimeters) but ranges from 6 to 26 inches (150 to 650 millimeters). Much of the precipitation occurs as snow from October through April and as rain from May through September. These precipitation events result from cold fronts moving through the area. Occasional convective thunderstorms produce small amounts of rain during the period June through September. The driest period is usually June through August. The average annual temperature generally is 40 to 44 degrees F (4.4 to 6.6 degrees C) but ranges from 35 to 48 degrees F (1.7 to 8.8 degrees C). The freeze-free period averages 103 days and ranges from 55 to 150 days.

Water

Water is scarce in much of the MLRA. Irrigation water is available, however, along the few rivers that bring water from the adjoining mountains. Numerous reservoirs store snowmelt runoff for later use in the growing season. The surface water is of good quality. It is suitable for almost all uses with minimal treatment.

Ground water supplies are meager and little developed in much of this area. Two aquifers are in the part of this area in Wyoming. One is a sand and gravel aquifer that is equivalent to the High Plains (Ogallala) aquifer farther east. Water from the sand and gravel aquifer is moderately hard. It is used for public and domestic supply, livestock, and irrigation. Water is also at greater depths in the structural basin aquifer, which is the most extensive and widely used aquifer in this area. This aquifer has lenticular beds of sandstone, coal, and shale that can exceed 5,000 feet in thickness. Its water generally is unsuitable for public supplies. It is used for domestic supply, livestock, and some irrigation.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The dominant soil temperature regime is frigid, and the dominant soil moisture regime is aridic. The soils receiving less than 8 inches (205 millimeters) of precipitation annually have an aridic moisture regime. The soils receiving 8 to 14 inches (205 to 355 millimeters) have an aridic moisture regime that borders on ustic. The soils receiving 14 to 16 inches (355 to 405 millimeters) have an ustic moisture regime that borders on aridic. Some soils with a mesic temperature regime occur at the lowest elevations in the southern part of the MLRA. Soils with mixed or smectitic mineralogy are dominant. Many of the soils are shallow or moderately deep to shale or sandstone bedrock. Many formed in slope alluvium or residuum derived from shale or sandstone. Soils that formed in stream- or river-deposited alluvium are near the major waterways. Most of the soils are well drained and calcareous.

The main soils and their series:

- Calciargids (Bosler, Cushool, Rawlins, and Rock River series)
- Calciustepts (Kindt, Rencot, and Rentsac series)
- Haplargids (Alcova, Diamondville, Forelle, and Ryan Park series)
- Haplocalcids (Brownsto, Langspring, and Luhon series)
- Haplocambids (Chaperton, Kemmerer, and Poposhia series)
- Haplustalfs (Overlandtrail, Swingstation, and Ulric series)
- Haplustepts (Littlesage series)
- Natrargids (Abston, Rallod, and Tisworth series)
- Torrifluvents (Battlement and Havermom series)
- Torriorthents (Blackhall, Blazon, and Haterton series)
- Torripsamments (Crestman and Kandaly series)

Biological Resources

Vegetation varies from one precipitation zone to another. The salt desert zone occurs in small areas receiving less than 8 inches (205 millimeters) of annual precipitation. The representative plant species are Gardner's saltbush, mat saltbush, greasewood, shadscale, bud sagebrush, winterfat, Indian ricegrass, and western wheatgrass. Wyoming big sagebrush may occur but only as a few widely spaced plants.

A semi-desert grass-shrub zone, the largest in the MLRA, is characterized by a vast sagebrush steppe. This zone occurs in the areas receiving 8 to 16 inches (205 to 405 millimeters) of annual precipitation. The representative vegetation includes Wyoming big sagebrush, early sagebrush, antelope bitterbrush, bluebunch wheatgrass, western wheatgrass, prairie Junegrass, needle and thread, and Indian ricegrass. Utah juniper may occur in small areas. Cottonwood and willow grow in riparian zones along the major perennial streams and rivers.

A small zone on the high plains grasslands near Laramie, Wyoming, is dominated by cool-season grasses, such as bluebunch wheatgrass, green needlegrass, muttongrass, and western wheatgrass. Big sagebrush is conspicuously absent from this area.

A lower foothill-mountain zone along the southern boundary of Wyoming and in Colorado is on the higher hills and mesas receiving more than 12 inches (305 millimeters) of annual precipitation. This zone is characterized by forested areas of Utah juniper with lesser amounts of pinyon pine and with an understory of Gambel oak, Wyoming big sagebrush, mountain mahogany, muttongrass, needle and thread, prairie Junegrass, and Indian ricegrass.

Major wildlife species in the area include white-tailed prairie dog, white-tailed jackrabbit, desert cottontail rabbit, coyote, red fox, badger, pronghorn, mule deer, elk, sage grouse, golden eagle, bald eagle, screech owl, common raven, sage sparrow, Brewer's sparrow, western rattlesnake, and bull snake.

Land Use

More than two-thirds of this area is federally owned. The rest is in private ranches. Most of the land is used for grazing by sheep and cattle (fig. 34A-2). Hunting also is an important land use. The rangeland consists of shrubs and cool-season grasses.

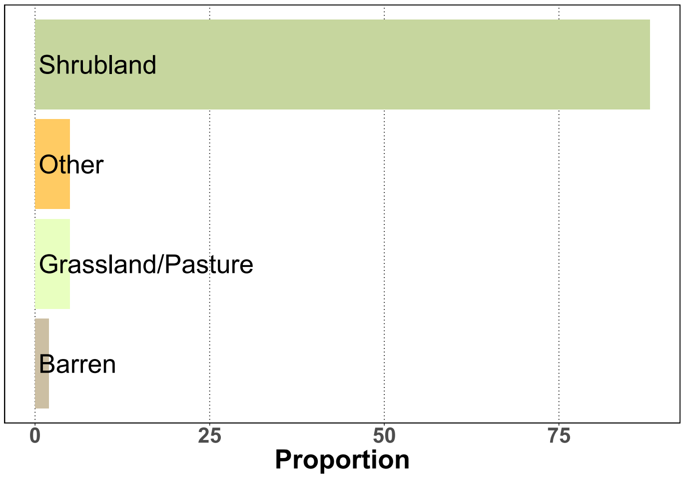

Figure 34A-2: Relative proportions (percentages) of land use in MLRA 34A.

Figure 34B-1: Location of MLRA 34B, which covers 3,573,100 hectares (8,829,100 acres), within Region D.

About 2 percent of the area is cropland. Areas of irrigated hay and pasture occur mostly along the few large rivers and streams. Nonirrigated small grain crops are grown in small areas near Craig, Colorado, where the annual precipitation is more than 13 inches (330 millimeters), the freeze-free period is more than 75 days, the soils commonly are deep, and grain-marketing facilities are nearby.

The major resource concerns are soil erosion, salinity, and water quality of streams and rivers. The availability of water for crops and livestock limits agricultural production. The main management concerns on rangeland are wind erosion, gully erosion, invasive species, and declining rangeland health. The main concerns on cropland are salinization and declining water tables.

Conservation practices for rangeland generally include erosion control, fencing, development of watering facilities, brush management, rangeland seeding, and proper grazing management. Important conservation practices for cropland are those that reduce the hazard of erosion and improve the efficiency of irrigation water use. Conservation practices for hayland and pasture are improvement of the efficiency of irrigation systems, irrigation water management, and forage harvest management.

34B—Warm Central Desertic Basins and Plateaus

MLRA 34B (fig. 34B-1) consists of broad intermountain basins bounded by plateaus and steep escarpments. It is bordered by MLRA 47 (Wasatch and Uinta Mountains) to the north and west; MLRA 48A (Southern Rocky Mountain Foothills) to the east; and MLRAs 35 (Colorado Plateau) and 36 (Southwestern Plateaus, Mesas, and Foothills) to the south. This area is in Utah (68 percent) and Colorado (32 percent). It makes up about 13,796 square miles (35,731 square kilometers).

Physiography

This area is in the Uinta Basin (60 percent) and Canyon Lands (35 percent) sections of the Colorado Plateaus province of the Intermontane Plateaus. A small part of the area is in the Wyoming Basin and Middle Rocky Mountains provinces of the Rocky Mountain System. The northern part of the MLRA occurs in the Uinta Basin section, which is bounded by the Uinta Mountains to the north, the Wasatch Range to the west, the Roan Plateau to the south, and the Flat Tops to the east. The southern part of the MLRA occurs in the northern third of the Canyon Lands section. This section is bounded by the Roan Plateau to the north, the Wasatch Plateau to the west, the southern end of the San Rafael Swell to the south, and the western slope of the Rocky Mountains to the east. Elevation ranges from 4,000 feet (1,210 meters) to 9,100 feet (2,780 meters).

The Colorado, Green, Gunnison, Price, and Uncompahgre Rivers run through the southern part of this MLRA. The Duchesne, Green, Strawberry, and White Rivers run through the northern part.

Geology

Most of this area is covered by residual basin-floor materials and materials washed in from the surrounding mountains and plateaus. Shale and sandstone are the dominant rock types. The Tertiary-age Green River, Uinta, and Duchesne River Formations dominate the northern part of the MLRA. The southern part is dominated by Cretaceous-age materials with lesser amounts of Jurassic and Triassic materials. The dominant Cretaceous formations are Mancos Shale, Dakota sandstone, and members of the Mesa Verde Group. The dominant Jurassic formations are the Morrison, Entrada, and Navajo. The dominant Triassic formations are the Chinle and Moenkopi. Quaternary alluvial, eolian, and glacial deposits occur in both the northern and southern parts of the MLRA. Glacial deposits occur primarily on outwash terraces along the Uncompahgre and Gunnison Rivers in Colorado and on outwash terraces from the Uinta Mountains north of Duchesne, Utah. Permian Kaibab Limestone occurs on the crest of the San Rafael Swell, an Eocene anticline west of Green River, Utah, that is about 100 miles long from north to south and about 40 miles wide. Tertiary-age granodiorite intrusives occur off the southwest tip of this anticline.

Climate

The average annual precipitation in most of this area ranges from 8 to 16 inches (194 to 413 millimeters), but a small part of the area receives as much as 24 inches (610 millimeters). Much of the precipitation occurs during high-intensity, convective thunderstorms in the period July through September. May and June are usually drier. Precipitation is more evenly distributed throughout the year in the northern part of the MLRA than in the southern part, where there is a significant peak in late summer. The northern part of the MLRA receives more precipitation as snow in winter than the southern part. The average annual temperature ranges from 40 to 55 degrees F (4.4 to 12.9 degrees C). The freeze-free period averages 148 days and ranges from 95 to 200 days.

Water

Precipitation is sparse in this area. There is a significant area of irrigated hayland and cropland in the Duchesne, Price, and San Rafael basins in the part of this MLRA in Utah. The surface water is of good quality and is pumped or diverted from the rivers for irrigation. Water-supply concerns in these basins include Native American water rights and coal and oil-shale development. The Upper Colorado, White, and Gunnison Rivers in Colorado are used to irrigate hay meadows, orchards, and cropland. The river water is generally of good quality, except for short reaches that are contaminated with trace elements and metals from mining and naturally occurring sources. Water rights, salinity control, and water transfers to the eastern side of the Continental Divide are water-supply concerns in Colorado.

There are two sources of ground water in this MLRA. One is unconsolidated valley fill in the northern part of the area, and the second is a sandstone aquifer in the southern part. Dakota sandstone, the Morrison Formation, and Entrada Sandstone are the Colorado equivalent of the sandstone aquifer in Utah. Water from the unconsolidated valley fill aquifer is of good quality and used for both public supply and irrigation. Water from the sandstone aquifer also is used for public supply and irrigation, but its quality varies considerably. The ground water near recharge zones has the best quality. Deeper water may be saline.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. Mollisols occur at the higher elevations, particularly in the northern part of the MLRA. The dominant soil temperature regime is mesic, and the dominant soil moisture regime is aridic. The soils receiving less than 8 inches (205 millimeters) of precipitation annually have an aridic moisture regime. The soils receiving 8 to 12 inches (205 to 305 millimeters) have an aridic moisture regime that borders on ustic. The soils receiving 12 to 16 inches (305 to 405 millimeters) generally have an ustic moisture regime that borders on aridic. Some soils at the highest elevations in the northern part of the MLRA have a frigid temperature regime and an ustic moisture regime. The dominant soil mineralogy is mixed. The soils that formed in material weathered from Mancos Shale tend to have active or semiactive clay activity classes. Most of the soils formed in colluvium, slope alluvium, or residuum derived from shale or sandstone. Soils that formed in alluvium are near the major waterways, and soils that formed in colluvium are generally on slopes of more than 20 percent. Many of the soils are shallow or moderately deep to shale or sandstone bedrock. Most are well drained and calcareous. The soils at the lower elevations generally have significant amounts of calcium carbonate, salts, and gypsum.

The main soils and their series:

- Argiustolls (Cortyzack series)
- Calciargids (Barx, Mesa, and Solirec series)
- Haplargids (Montrose series)
- Haplocalcids (Clapper, Shalako, Strych, and Walknolls series)
- Haplocambids (Gilston, Killpack, and Vickel series)
- Haplustolls (Moonset series)
- Natrargids (Motto and Uffens series)
- Torrifluvents (Green River and Ravola series)
- Torriorthents (Cadrina, Chipeta, Gerst, Killpack, and Persayo series)

Biological Resources

This MLRA has three major land resource units: the desert-salt desert zone, the semi-desert zone, and the upland-foothill zone. The largest and most dominant unit is the desert-salt desert zone. This zone occurs at the lower elevations receiving less than 8 inches (205 millimeters) of annual precipitation. The representative vegetation includes Castle Valley saltbush, Gardner's saltbush, mat saltbush, greasewood, shadscale, bud sagebrush, winterfat, Indian ricegrass, Salina wildrye, and galleta. Cottonwood and willows grow in riparian areas.

The semi-desert zone occurs as a narrow 8- to 12-inch (205- to 305-millimeter) precipitation band. This zone has two vegetative subzones. The more extensive subzone includes Wyoming big sagebrush, black sagebrush, shadscale, fourwing saltbush, mormon tea, Indian ricegrass, and galleta. The other subzone occurs mostly in the area of the San Rafael Swell in Utah. It is similar to the other subzone but lacks Wyoming big sagebrush and has more Utah juniper trees. Wyoming big sagebrush and pinyon pine may occur but only as a few widely scattered plants.

The upland-foothill zone occurs as a 12- to 16-inch (305- to 405-millimeter) precipitation band. Utah juniper and pinyon pine forests are dominant in this zone. The representative vegetation includes Utah juniper, pinyon pine, Wyoming big sagebrush, black sagebrush, prairie Junegrass, muttongrass, and needle and thread. Gambel oak, Utah serviceberry, antelope bitterbrush, mountain mahogany, and bluebunch wheatgrass grow at the higher elevations.

Major wildlife species include coyote, kit fox, white-tailed prairie dog, white-tailed jackrabbit, pronghorn, mule deer, elk, American kestrel, sage grouse, turkey vulture, screech owl, mourning dove, pinyon jay, common raven, sage sparrow, bald eagle, golden eagle, western rattlesnake, bullsnake, fence lizard, sagebrush lizard, Colorado pike minnow, razorback sucker, bonytail, and humpback chub.

Land Use

More than three-fourths of this area is federally owned. Most of the area is used for recreation or livestock grazing (fig. 34B-2). Different types of surface or sprinkler irrigation are used in many of the valleys. The major crops grown throughout the area are silage corn, grain corn, alfalfa, and small grains. Cantaloupe and melons are grown near Green River, Utah, and lettuce, onions, dry beans, peppers, and other small vegetable crops are grown in the Grand Valley and Uncompahgre areas. Many tracts of rangeland and cropland have been, and are continuing to be, subdivided for community development.

The major soil resource concerns are salinity, sodicity, leaching of selenium and salts into supplies of surface and ground water, irrigation-induced erosion, and subsidence resulting from gypsum dissolution. Wind erosion is a hazard on light textured soils during periods when annual crops are grown and during periods of plant germination. It also is a hazard in areas of salt-desert shrub communities. The main management concerns on rangeland are wind erosion, gully erosion, invasive species, and declining rangeland health. The main management concerns in cultivated areas include salinization, declining water tables, and inadequate supplies of irrigation water.

Conservation practices on rangeland generally include erosion control, fencing, development of watering facilities, brush management, rangeland seeding, and proper grazing management. Conservation practices on cropland include improvement of the efficiency of irrigation systems, irrigation water management, and crop residue management. Conservation practices on hayland and pasture include improvement of the efficiency of irrigation systems, irrigation water management, and forage harvest management.

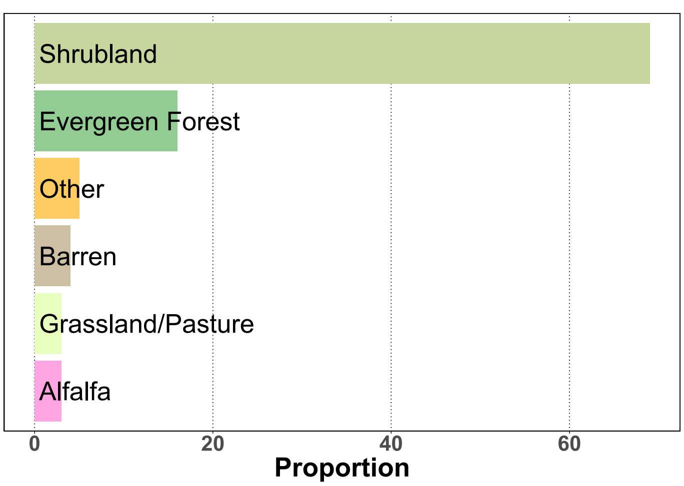

Figure 34B-2: Relative proportions (percentages) of land use in MLRA 34B.

35—Colorado Plateau

This area (fig. 35-1) occurs in Arizona (52 percent), Utah (24 percent), New Mexico (23 percent), and Colorado (1 percent). It makes up about 70,215 square miles (181,855 square kilometers). MLRA 35 covers approximately 60 percent of the Colorado Plateau province. It generally consists of flat-lying to gently tilted Mesozoic and Paleozoic sedimentary formations that have been uplifted, allowing the Colorado River and its tributaries to cut deep canyons through the geologic layers. The major landforms include gently sloping to strongly sloping plains, volcanic plugs, steep scarps, and deeply incised canyons. The Colorado Plateau shows the power of wind and water to erode soil and rock over time. Not only are deeply incised

Figure 35-1: Location of MLRA 35, which covers 18,185,500 hectares (44,937,300 acres), within Region D.

canyons evidence of erosion, but isolated mesas and buttes also testify to the enormous amount of material removed by the Colorado River and its tributaries.

MLRA 35 is bordered to the south by the Mogollon Rim and associated volcanic landforms of the Mogollon Transition area (MLRA 39). The Mogollon Rim is a long, erosional escarpment stretching diagonally across Arizona and into New Mexico. It marks the boundary where the horizontal stratigraphy of the Colorado Plateau falls into the faulted and broken landscape of the Mogollon Transition. Volcanic landforms, such as the San Francisco Peaks and White Mountains, are in MLRA 39 while horizontal sedimentary formations, such as the Kaibab and Chinle Formations, are in MLRA 35.

Part of the western boundary of MLRA 35 is shared with MLRA 30 (Mohave Basin and Range). A principal difference is the change from flat-lying sedimentary beds of the Colorado Plateau region to faulted block mountains and valleys of the Basin and Range province. The boundary with MLRA 30 lies at the base of the Grand Wash Cliffs and the Music Mountains to the south, the entrance to the Grand Canyon in the central area, and the base of the Shivwits Plateau in the north. MLRA 30 is marked by the lower alluvial Hualapai Valley and has a drier climate with thermic temperatures. In contrast, MLRA 35 lacks thermic temperatures except within the Grand Canyon.

The northwest boundary of MLRA 35 is shared with the southern part of MLRA 47, which is dominated by fault-bounded, lava-capped plateaus, such as the Markagunt and Paunsaugunt, with the exception of the Table Cliffs Plateau, which is limestone capped. The underlying sedimentary strata in MLRA 47 are the same geologic units as those of the Colorado Plateau. MLRA 47 has mostly higher elevations and cooler temperatures.

The eastern boundary of MLRA 35 is shared with MLRA 42B (Southern Rio Grande Rift). The boundary lies near the base of various ridges that roughly parallel the rift. MLRA 42B has Quaternary and Tertiary geology associated with the rifting and filling of large tectonic basins along the Rio Grande Valley.

Physiography and Geology

There are four major subdivisions of MLRA 35, each with unique characteristics: the Western Colorado Plateau, the Central Colorado Plateau, the Northwest New Mexico Highlands, and the San Juan Basin.

The Western Colorado Plateau subdivision is strongly characterized by its limestone and dolomite cap, known as the Kaibab Formation. Physiographically, it is affected by the combination of regional uplift and the deeply incised Colorado River at the Grand Canyon. The Grand Canyon is surrounded by adjacent plateaus: the Kaibab Plateau on the North Rim, the Arizona Strip with the Shivwits Plateau to the northwest, and the Coconino Plateau on the South Rim. Marble Canyon is a narrow northerly extension of the Grand Canyon. The Coconino Transition represents a northwesterly extension of the Mogollon Rim that is more protected from monsoonal moisture. The Coconino Transition is largely Redwall Limestone and has isolated volcanic and granitic soils.

The Central Colorado Plateau subdivision can be considered the heart of MLRA 35. It is dominated by Mesozoic sedimentary geology, mostly sandstone and shale. It begins to the north with the canyons and plateaus surrounding the confluence of the Green and Colorado Rivers in Utah and extends south to the Little Colorado River Basin in Arizona. It includes the sand sheet of the Green River Desert; the mesas and benches of the Blue Hills; the structural anticlines, monoclines, and structural benches of the Circle Cliffs; a large laccolith thrust through a shallow syncline called the Henry Mountains; the Kaiparowits Plateau with its Cretaceous sandstones overlying escarpments of soft marine shales; the Chinle Valley, a broad basin; the Grand Staircase with its series of cliffs and structural benches; Black Mesa Navajo Mountain, a series of broad mesas with one large laccolith; and the Paria and Kaibeto Plateaus. The soils are continually stripped of their cover and, due to uplift forces, most positions are erosional in nature. The overwhelmingly shallow soils are predominantly being exuded. They are continually being uplifted, weathered from rock, and transported regionally from the MLRA.

The Northwest New Mexico Highlands subdivision is primarily nonmarine sedimentary hills and mountains that have been affected by regional uplift of the Colorado Plateau. Physiographically, it represents higher elevations than the Central Colorado Plateau subdivision to the west and lower elevations than the volcanic mountains of MLRA 39 to the south. The highlands include Nacimiento sediments derived from Cenozoic relict lakebeds; the Chuska Mountains, a mountain ridge of upturned sedimentary beds and sandstone; the Defiance Plateau with its uplifted sedimentary beds of Permian sandstone and Triassic shale; the Zuni Mountains, an area of tilted ridges of mountains and various structurally contorted sedimentary formations; Bidahochi sediments with broadly scattered low mesas and hills; and a diverse collection of small basins, mountains, and valleys. Parent material is nonmarine sediments and mixed sedimentary rock in the southeast. The highlands have shallow soils and rock outcrops on structural benches and mesas.

The San Juan Basin subdivision is almost exclusively marine shale sediments, including Menefee Shale and Lewis Shale. Physiographically, it represents elevations lower than the New Mexico Highlands at the Chuska Mountains to the west, the Nacimiento Mountains to the east, and Mount Taylor and the Zuni Mountains to the south. This subdivision includes the San Juan River corridor, the Bisti Lowlands with the Chaco River Valley and surrounding shale basin, and Chaco Mesa with its extension of Menefee Shale. This subdivision has shallow soils and, near the Chaco River and major rivers to the north, deeper alluvial soils. The expanse is affected by regional uplift of the Colorado Plateau.

Climate

The average annual precipitation is 5 to 32 inches (115 to 815 millimeters). About half of the precipitation falls from July through September. April, May, and June are the driest months. Most of the rainfall occurs during high-intensity, convective thunderstorms in late summer. Light snow falls in winter, but it does not remain very long. Monsoonal moisture from the Gulf of Mexico greatly influences the southeastern portion of the MLRA, while monsoonal moisture from the Gulf of California and the Pacific Ocean greatly influences the southwestern portion.

The average annual temperature is 35 to 70 degrees F (2 to 21 degrees C), decreasing to the north and at the higher elevations. The freeze-free period averages 215 days and ranges from 105 to 320 days, decreasing in length to the north and at the higher elevations.

Water

Water is scarce throughout the area. Many streams and rivers are ephemeral. The Little Colorado River drains the largest segment of the area, but its flow is intermittent. The majority of river flow through MLRA 35 originates from watersheds of surrounding mountains and plateaus to the north and east, including the Colorado River, the Green River, and the Animas and San Juan Rivers. Water stored in small reservoirs is used for irrigation, but supplies are often inadequate. Some irrigation water is obtained from erratic streamflow. The surface water is suitable for almost all uses. A high sediment load is the primary water-quality concern.

Ground water is the primary source of drinking water in many areas. In some places, some irrigation water is obtained from deep wells. Ground water occurs in aquifers of the Coconino Sandstone, Navajo Sandstone, and Dakota sandstone and is soft to hard. Lower levels of total dissolved solids and fresher water occur near the recharge zones for these consolidated sediments. Very salty water occurs at depth and away from the recharge zones. Highly mineralized water leaks into these aquifers from older and younger marine sediments above and below the sandstone aquifers.

Some irrigation water is pumped from the valley fill in the San Juan River basin. It has a higher salt content than the river water but otherwise is very similar in quality. Use of the valley fill water is limited because seepage of salty water from the adjacent rocks containing soluble salts increases the sodium sulfate content.

Soils

The dominant soil orders are Aridisols and Entisols in much of the area. Alfisols and Mollisols are at the higher elevations. The soils in the area range from shallow to very deep. Shallow soils are most common on the tops of plateaus, ridges, and backslopes of cuestas. The dominant soil temperature regime is mesic. The soil moisture regime ranges from typic aridic to aridic ustic in most of the area. Soils are thermic in the Grand Canyon and other low-lying areas near the Mohave Desert. Frigid and cryic soils, with ustic and udic moisture regimes, occur at the highest elevations.

The main soil series:

- Begay series—Haplocambids that formed in mixed eolian deposits and alluvium on mesas, cuestas, hills, and fan remnants
- Epikom series—Haplocambids that formed in alluvium on plateaus and mesas
- Luzena series—Argiustolls that formed in residuum and colluvium on mesas, hills, and mountains
- Lykorly series—Haplustalfs that formed in mixed eolian deposits and alluvium on mesas, cuestas, hills, bajadas, and fan terraces
- Mellenthin series—Haplocalcids that formed in mixed residuum and colluvium on benches, hills, and ridges
- Menefee series—Ustorthents that formed in mixed residuum and colluvium on mesas and mountains
- Millett series—Calciargids that formed in alluvium on fan terraces, piedmonts, and plains
- Moenkopie series—Torriorthents that formed in mixed alluvium and residuum
- Penistaja series—Haplargids that formed in mixed eolian deposits and alluvium on mesas, cuestas, hills, bajadas, and fan terraces
- Rizno series—Torriorthents that formed in mixed residuum and colluvium on mesas, hills, benches, cuestas, and plateaus
- Sheppard series—Torripsamments that formed in eolian deposits on benches, dunes, and terraces
- Vessilla series—Ustorthents that formed in mixed eolian deposits and alluvium on ridges, hills, and mesas
- Winona series—Haplocalcids that formed in eolian deposits over alluvium

Biological Resources

This area supports desert shrub and woodland vegetation. At high elevations, pinyon-juniper woodland and sagebrush have an understory of galleta, blue grama, black grama, and western wheatgrass. Galleta grass, alkali sacaton, Indian ricegrass, bottlebrush squirreltail, and needlegrass intermixed with fourwing saltbush and winterfat are at the lower elevations. Greasewood and shadscale are part of the plant community on salty soils. Blackbrush may be dominant at the lower elevations.

Major wildlife species include elk, mule deer, antelope, mountain lion, coyote, fox, bobcat, badger, skunk, rabbit, prairie dog, bats, eagles, hawks, owls, crow, woodpecker, bluebird, and swallow.

Land Use

About one-third of this area is federally owned. About three-fourths is rangeland (fig. 35-2). The rangeland is grazed by sheep and cattle. About 1 percent of the area, along the valleys of the major streams, is irrigated cropland. Alfalfa, small grains for hay, and corn for silage are the chief crops. Less than one-tenth of the area, in scattered small tracts on Indian reservations, is dry-farmed. Corn is the chief crop in the dry-farmed areas. More than one-tenth of the area is juniper and pinyon-juniper woodland. Firewood and pinyon nuts are products of this woodland, which also is grazed by cattle and sheep. If areas are overgrazed, juniper invades the grassland. Severe gullying, overgrazing, and the lack of a dependable water supply are land use limitations. Because of the mild climate and nearby recreational opportunities, the irrigated cropland near towns, such as Moab and Kanab, is being converted to housing developments.

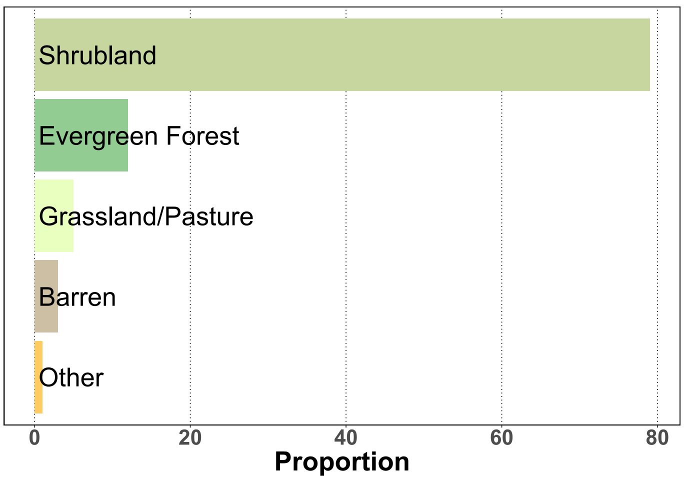

Figure 35-2: Relative proportions (percentages) of land use in MLRA 35.

The major soil resource concerns are maintenance of the content of soil organic matter, soil productivity, wind erosion, water erosion, salinity, and sodicity. These factors, and the low rainfall, result in soils that have little or no resilience after disturbance and a very low tolerance for soil loss by erosion.

Conservation practices on rangeland generally include brush management, rangeland seeding, prescribed grazing, prescribed burning, fencing, development of watering facilities, and erosion control. Conservation practices on cropland and hayland are crop rotations, crop residue management, minimum tillage, nutrient and pest management, land leveling, ditch lining, irrigation water management, soil salinity management, and pasture and hayland management.

36—Southwestern Plateaus, Mesas, and Foothills

This area (fig. 36-1) is in Colorado (45 percent), New Mexico (40 percent), and Utah (15 percent). It makes up about 19,151 square miles (49,601 square kilometers). This MLRA is bordered by MLRA 34B (Warm Central Desertic Basins and

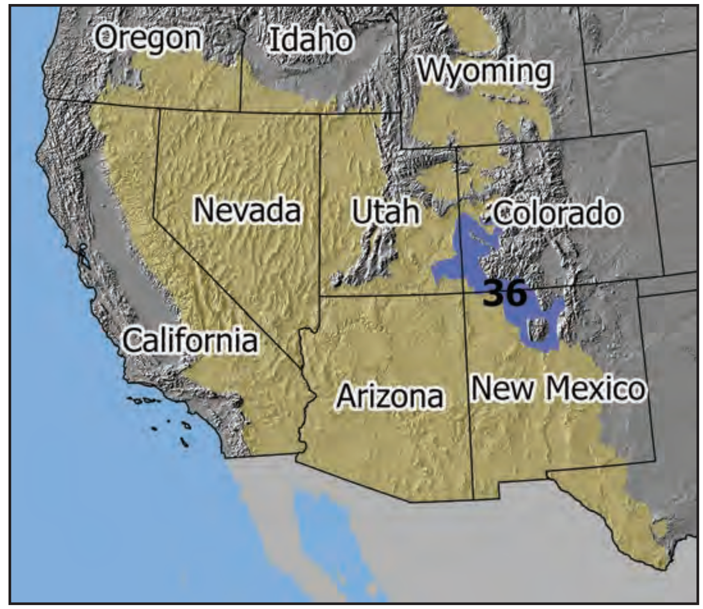

Figure 36-1: Location of MLRA 36, which covers 4,960,100 hectares (12,256,500 acres), within Region D.

Plateaus) to the north; MLRA 35 (Colorado Plateau) to the west and southwest; MLRA 42C (Central New Mexico Highlands) to the southeast; and MLRA 48A (Southern Rocky Mountain Foothills) to the east.

Physiography

Almost all of this area lies within the Intermontane Plateaus. It is mainly in the Canyon Lands and Navajo sections of the Colorado Plateaus province, is partly in the Mexican Highland section of the Basin and Range province, and extends marginally into the Southern Rocky Mountains province of the Rocky Mountain System. Landforms in most areas are controlled by the underlying sedimentary rock formations, but fluvial landforms are in the Rio Grande Rift Basin at the southeastern extent of the MLRA. Elevation commonly is 5,700 to 8,000 feet (1,750 to 2,420 meters). It generally is highest (as much as 10,000 feet, or 3,048 meters) in areas of the foothills and high mesas that border the Southern Rocky Mountains. Relief generally is less than 1,500 feet (455 meters).

The upper reaches of the Rio Grande and San Juan Rivers and their tributaries are in the part of this MLRA near the Colorado and New Mexico State lines. Rio Puerco and Rio Chama are in the part of the MLRA in New Mexico. The Dolores and San Miguel Rivers are in the part in Colorado, and a short reach of the Colorado River crosses this MLRA near the Utah and Colorado State lines.

Geology

Most of the area is characterized by generally horizontal beds of Jurassic, Cretaceous, and Tertiary sedimentary rocks.

Representative formations are the Morrison Formation; Dakota sandstone, Mancos Shale, Cliff House Sandstone, and other members of the Mesa Verde Group; the Animas Formation; and the San Jose Formation. The sedimentary rocks have been eroded into plateaus, mesas, hills, and canyons. Thick deposits of eolian material of Pleistocene age mantle the top of the mesas in some areas. Small areas of Tertiary and Quaternary volcanic rocks, including cinder cones and lava flows, are in the Rio Grande Rift Basin in New Mexico. Wide valleys in the rift basin have accumulated deep alluvial sediments, and fan remnants are common.

Climate

The average annual precipitation ranges from 8 to 46 inches (205 to 1,160 millimeters). It is dominantly 11 to 22 inches (289 to 555 millimeters). Much of the rainfall occurs during convective storms in late summer; about 20 to 35 percent of the total precipitation falls in July and August. This proportion increases from north to south within the area. About 15 to 25 percent of the precipitation is snow. Snowpacks are generally light and do not persist throughout winter, except at the higher elevations. The average annual temperature ranges from 33 to 56 degrees F (0.4 degree to 13.2 degrees C). The freeze-free period averages 138 days and ranges from 75 to 200 days. The shortest freeze-free periods occur in the northern part of the area and at high elevations.

Water

Water commonly is scarce in areas away from the major streams. The Dolores, Animas, and San Juan Rivers, which are perennial streams in the northern end of the area, are major sources of irrigation water. The headwater streams of the Rio Grande have water of excellent quality. The Navajo, Heron, and El Vado Reservoirs store water for irrigation and recreation in this area. The San Juan River is a high-quality, cold-water fishery stream in northwestern New Mexico. It is used for municipal and industrial supplies as well as irrigation. High salt loads from southern tributary streams affect water quality in this area. The quality of some surface water has been degraded by the effects of upstream mining activities in the late 1800s. This mining occurred mainly in the upper reaches of the streams outside this MLRA.

Ground water is the primary source of drinking water in many areas. Some irrigation water is obtained from deep wells. Cretaceous and Jurassic sediments (Dakota and Morrison Formations and Entrada Sandstone) provide some ground water of variable quality in southwestern Colorado. The ground water in New Mexico is in Tertiary sandstone and older sediments. It is soft to hard and generally exceeds the national drinking water standard for total dissolved solids. Because of high sodium and sulfate levels, the water is of limited use for drinking in many areas. Fresher water with lower levels of total dissolved solids is near the recharge zones for these consolidated sediments. Very salty water is at depth and away from the recharge zones. Highly mineralized water leaks into these aquifers from older and younger marine sediments above and below the sandstone aquifers.

Some irrigation water is pumped from the valley fill in the larger river valleys. It has a higher salt content than the river water but otherwise is very similar in quality. Seepage of salty water from the adjacent rocks containing soluble salts can increase the sodium sulfate content, which limits the use of the valley fill water.

Soils

The dominant soil orders in this MLRA are Alfisols, Aridisols, Entisols, Inceptisols, and Mollisols. The soil moisture regime is mainly ustic, but an aridic regime that is marginal to ustic occurs in some areas. The soil temperature regime is mesic or frigid. Mineralogy is dominantly mixed or smectitic.

The main soils and their series in the warmer areas:

- Calciargids that formed in alluvium, slope alluvium, eolian deposits, and colluvium on alluvial fans, fan remnants, bajadas, pediments, and stream terraces (Fernando, Sedillo, Silva, and Witt series)
- Haplargids that formed in slope alluvium, colluvium, eolian deposits, and residuum on cuestas, fan remnants, mesas, and hills (Bond, Hagerman, Prieta, and Romberg series)
- Haplustalfs that formed in slope alluvium, eolian deposits, colluvium, and alluvium on hills, cuestas, mesas, fan remnants, and stream terraces (Montecito, Orlie, Pulpit, and Wetherill series)
- Haplustepts that formed in slope alluvium, eolian deposits, colluvium, and residuum on hills, fan remnants, cuestas, and mesas (Berryman, Gladel, and Kachina series)
- Torriorthents that formed in slope alluvium, colluvium, alluvium, and residuum on hills, escarpments, fan remnants, alluvial fans, and stream terraces (Florita, Sandoval, Zia, and Zyme series)
- Ustorthents that formed in slope alluvium, eolian deposits, and residuum on hills, escarpments, mesas, and mountain slopes (Bodot, Menefee, and Vessilla series)

The main soils and their series in the cooler areas:

- Argiustolls that formed in slope alluvium, colluvium, eolian deposits, and residuum on structural benches, hills, mountain slopes, cuestas, and fan remnants (Beje, Granath, and Herm series)
- Haplustalfs that formed in slope alluvium, colluvium, and residuum on hills, mountain slopes, and canyon walls (Echolake, Ishkoten, and Sheek series)
- Haplustepts that formed in slope alluvium, colluvium, and residuum on hills, mountain slopes, and canyons (Archuleta and Carracas series)

Biological Resources

The potential vegetation at the lower elevations is grass and sagebrush. Pinyon-juniper woodland and ponderosa pine forests are at mid elevations. Forests of Rocky Mountain Douglas-fir and white fir are at the higher elevations. Common plants include Wyoming big sagebrush, western wheatgrass, galleta, needle and thread, and blue grama at the lower elevations; twoneedle pinyon, Utah juniper, Indian ricegrass, mountain mahogany, ponderosa pine, Gambel oak, Arizona fescue, and muttongrass at mid elevations; and Rocky Mountain Douglas-fir, white fir, mountain muhly, common snowberry, Parry's oatgrass, and mountain brome at the higher elevations.

Major wildlife species include mule deer, elk, coyote, black bear, mountain lion, black-tailed jackrabbit, Gunnison's prairie dog, badger, pinyon jay, black-billed magpie, mountain chickadee, red-breasted nuthatch, white-breasted nuthatch, collared lizard, fence lizard, and western rattlesnake. Reservoirs and rivers provide most of the fish habitat in this area. Those at the higher elevations have cold-water species, such as rainbow trout and brown trout, and those at the lower elevations have warm-water species, such as bass, bluegill, crappie, and catfish.

Land Use

Nearly all of this area supports natural vegetation and is used as grazing land or forestland (fig. 36-2). Cropland also is a significant land use. Where irrigation water is available, irrigated crops, such as wheat, barley, beans, oats, and alfalfa, and hay are grown. An area in Colorado and Utah is used as nonirrigated cropland. The major crops grown on this nonirrigated cropland are beans and winter wheat. The pinyon-juniper woodlands are a source of fuel wood. At the higher elevations, commercial timber, principally ponderosa pine and Rocky Mountain Douglas-fir, is harvested.

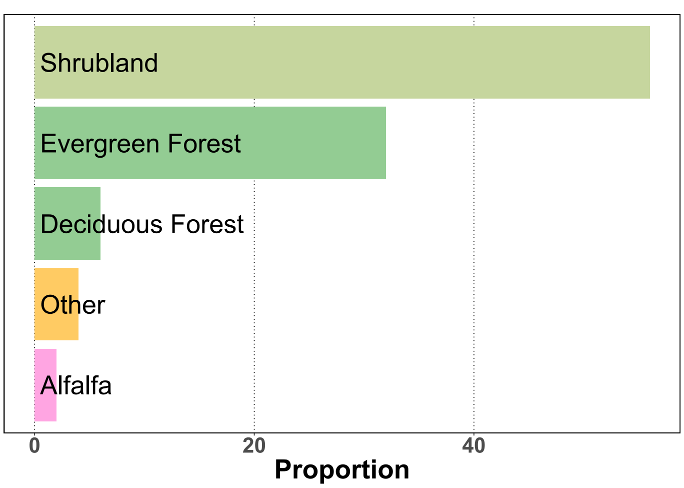

Figure 36-2: Relative proportions (percentages) of land use in MLRA 36.

The major soil resource concerns are wind erosion, water erosion, maintenance of soil productivity, and management of soil moisture. Conservation practices on cropland generally include crop residue management, minimum tillage, and irrigation water management. Proper grazing use is a concern on grazing lands. The primary concerns in timbered areas are controlling erosion along roads and skid trails and minimizing surface compaction during timber harvesting.

38—Mogollon Transition South

This area (fig. 38-1) makes up about 20,350 square miles (52,706 square kilometers), from west-central Arizona (85 percent), through the central part of the State, to west-central New Mexico (15 percent). MLRA 38 represents the transition between the Colorado Plateau region and the Basin and Range province. It is a landscape dominated by mountain and hill landforms that generally trend northwest to southeast. The landscapes are complex due to the extreme amount of tectonic pressure from the uplifting of the Colorado Plateau to the north and the rifting of the Basin and Range to the south. MLRA 38 consists mostly of rangeland. Vegetation and soils are highly aspect driven, and the geology and physiography of the region are complex.

For much of its extent, the MLRA has the Mogollon Rim as its northern boundary. The Mogollon Rim is an escarpment that defines the southern edge of the Colorado Plateau and extends approximately 200 miles east from western Arizona to the border with New Mexico. The western boundary of the MLRA is in west-central Arizona where the Hualapai Mountains transition to the Mojave Basin and Range (MLRA

Figure 38-1: Location of MLRA 38, which covers 5,270,600 hectares (13,023,900 acres), within Region D.

30). The southern boundary runs northwest to southeast where the contiguous mountains of the Mogollon Transition meet the broader basins and isolated ranges of the Sonoran Basin and Range (MLRA 40) and the Madrean Archipelago (MLRA 41). The eastern boundary is defined by the landforms and geology of the Southern Rio Grande Rift (MLRA 42B).

Physiography

This area is in the Mexican Highland section of the Basin and Range province of the Intermontane Plateaus. It consists of mountains, plateaus, canyons carved by erosion, and sediment-filled valleys created by tectonic structural troughs. The area's many mountain ranges include the Pinal Mountains, south of Globe, Arizona; the Sierra Ancha and Mazatzal Mountains in central Arizona; and the Big Burro and Mimbres Mountains in western New Mexico. Elevation ranges from 3,000 to 5,500 feet (915 to 1,675 meters) in most areas and from 5,100 to 7,500 feet (1,555 to 2,285 meters) in the mountains and on high plateaus.

Geology

The geology of MLRA 38 is diverse. Rock types and ages range from Precambrian granite to Tertiary lakebed deposits and Quaternary volcanic rock formations. Precambrian granitoid and metamorphic rocks are in the mountains in the western and southwestern parts of the MLRA along with areas of intense volcanism scattered throughout. To add to the area's richness, a string of valleys, such as the Verde Valley and Tonto Basin, are filled with Tertiary lacustrine and alluvial deposits. Mixed in with igneous and metamorphic geologies are some Permian-age sedimentary formations, such as the Schnebly Hill sandstone formation near Sedona, Arizona.

A less extensive, but economically important, geologic component is the igneous intrusion into the Paleozoic sedimentary formations in the Copper Corridor. Secondary faulting in the area served as conduits for copper-rich mineral solutions, the basis for copper mining in Arizona.

Climate

The average annual precipitation is 8 to 34 inches (204 to 872 millimeters). The summer monsoon season brings moist air from the Gulf of California and Gulf of Mexico. The mountainous areas, such as the Mogollon Rim, receive most of this moisture. Thunderstorms are usually brief and intense and can result in flash floods. The monsoonal influence is strongest in the eastern portion of the MLRA, where summer precipitation exceeds winter precipitation. In the western part of the MLRA, winter rainfall originating from storms in the Pacific Ocean makes up most of the annual precipitation. The average annual air temperature is 47 to 71 degrees F (8 to 22 degrees C). The freeze-free period averages 255 days and ranges from 145 to 365 days, decreasing in length with increasing elevation.

Water

This MLRA supplies water for much of the adjoining irrigated land. Many of the larger streams are perennial with several ephemeral drainages connected throughout. Much of the water is stored in reservoirs near or below the southern edge of the area and is used for irrigation and municipal water supplies in the Sonoran Basin and Range (MLRA 40) to the south. Small natural and artificial lakes at the higher elevations are used for fishing and other kinds of recreation. Annual runoff into all reservoirs is highly variable, causing smaller lakes and reservoirs to dry up during drought years. The surface water is of good quality and suitable for most uses with minimal treatment. A high load of suspended sediment is one of the primary water-quality concerns in this MLRA. The Verde, Black, and Salt Rivers are tributaries to the Gila River, which is a major water source for Phoenix, Arizona.

Ground water is limited and generally occurs at great depth in alluvial deposits along some of the larger streams in the area. The quality of ground water varies considerably, depending on the composition, location, and depth of the alluvium. Some alluvium has evaporite deposits and some has high levels of sulfate, and some springs yield saline water. The median concentration of total dissolved solids is generally suitable for almost all uses in this area. Very little runoff or precipitation is available to recharge the alluvial aquifers, so ground water levels have declined. A few windmills furnish water for livestock and wildlife. The area has some earthen water tanks. The fractures and joints in the igneous, metamorphic, and sedimentary bedrock have small amounts of ground water.

Soils

The dominant soil orders are Mollisols, Entisols, and Aridisols. The soils in the area dominantly have a thermic to mesic temperature regime, an aridic to ustic moisture regime, and smectitic or mixed mineralogy. They range from very shallow to very deep and are mostly well drained to somewhat excessively drained.

The main soils and their series:

- Aridic Argiustolls that formed on fan terraces, mesas, hills, and mountains (Thunderbird, Showlow, and Abrazo series)
- Aridic Lithic Argiustolls that formed in volcanic parent material on lava plateaus, mesas, hills, and mountains (Cabezon, Luzena, and Muzzler series)
- Typic Haplargids that formed on fan terraces and basin floors (Topawa and Vekol series)
- Aridic Lithic Haplustolls that formed on hills (Tortugas and Venezia series)
- Cumulic Haplustolls that formed on flood plains and alluvial fans (Lynx and Manzano series)
- Lithic Torriorthents that formed on hills and mountains (Cellar and House Mountain series)

Biological Resources

This area supports forest, savanna, desert shrub, and grassland vegetation. Pine-oak woodlands are at the higher elevations, where ponderosa pine, Douglas-fir, live oak, New Mexico locust, Mexican pinyon, buckbrush, and manzanita grow with an understory of muhlys, bluegrasses, sedges, pine dropseed, and squirreltail. Evergreen woodland savannas are at intermediate elevations, where Mexican blue oak, Emory oak, Arizona white oak, alligator juniper, oneseed juniper, jojoba, and turbinella oak are the dominant species, and beardgrass, sideoats grama, blue grama, Texas bluestem, plains lovegrass, sprucetop grama, threeawns, and needlegrass characterize the understory. Whitethorn, soaptree yucca, fourwing saltbush, mesquite, and ocotillo grow on the drier soils at the lower elevations. The understory at these elevations consists of Rothrock's grama, blue grama, black grama, alkali sacaton, curly-mesquite, plains bristlegrass, bush muhly, and lemon grass.

Major wildlife species include mule deer, white-tailed deer, mountain lion, coyote, bobcat, raccoon, skunk, white-throated woodrat, white-footed mouse, gopher snake, king snake, western diamondback rattlesnake, western whiptail lizard, side-blotched lizard, tree lizard, red-tailed hawk, Cooper's hawk, golden eagle, prairie falcon, raven, turkey vulture, meadowlark, ladder-back woodpecker, ash-throated flycatcher, canyon wren, and rough-winged swallow.

Land Use

Over one-half of this MLRA is federally owned, and tribal lands make up almost a quarter. Most of the area is used for livestock grazing (fig. 38-2). Copper mining is also economically important.

The major soil resource concerns include maintenance of soil organic matter, productivity of vegetative cover, and the hazard of water erosion. Conservation practices on rangeland include fencing and development of watering facilities, which improve grazing management systems; brush management, which removes undesirable and introduced invasive species; and erosion control, which helps to prevent gullying and concentrated waterflow.

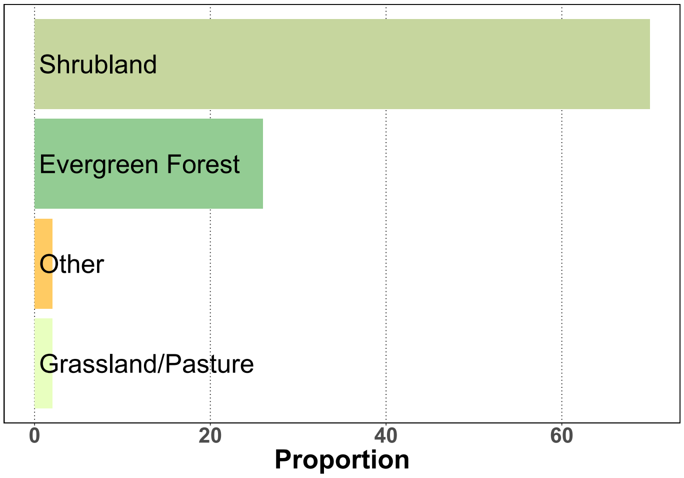

Figure 38-2: Relative proportions (percentages) of land use in MLRA 38.

39—Mogollon Transition North

This area (fig. 39-1) occurs in New Mexico (53 percent) and Arizona (47 percent). It makes up about 21,358 square miles (55,316 square kilometers). MLRA 39 is a high-elevation, mountainous landscape that occurs along the southern portion of the Colorado Plateau region above the Mogollon Rim. The majority of this MLRA is volcanic with numerous basalt lava flows, cinder cones, and large volcanic mountains. MLRA 39 is north of the Mogollon Rim and extends from the San Francisco volcanic field in central Arizona to the Mogollon-Datil volcanic field in west-central New Mexico. Notable volcanic features include Humphrey's Peak in the San Francisco volcanic field, Baldy Peak in the White Mountains, and the Zuni-Bandera lava flows with adjacent Mount Taylor in New Mexico. The higher elevation landforms of MLRA 39 receive the highest amount of precipitation and snowpack in Arizona and contain the largest density of perennial water in the Southwest, water that is an important source of irrigation and drinking water throughout Arizona.

Figure 39-1: Location of MLRA 39, which covers 5,531,600 hectares (13,668,900 acres), within Region D.

For much of its extent, MLRA 39 has the Mogollon Rim as its southern boundary. The Mogollon Rim is an escarpment that defines the southern edge of the Colorado Plateau and extends approximately 200 miles from western Arizona to the border with New Mexico. The western boundary of the MLRA is in west-central Arizona where the Chino Valley transitions to the Juniper and Santa Maria Mountains in MLRA 38. The northern boundary marks the change from volcanic geology to the sedimentary geology of MLRA 35. The eastern boundary is defined by the landforms and geology of the Southern Rio Grande Rift (MLRA 42B).

Physiography

This MLRA primarily occurs in the Colorado Plateau region and is mostly characterized by volcanic landforms, such as cinder cones, volcanoes, and numerous basalt flows. Some flows are recent, such as the Bonito Lava Flow at Sunset Crater, which occurred about 1,000 years ago. Elevation on average ranges from 4,000 to 7,500 feet (1,220 to 2,135 meters), but there are many high mountains, such as the two highest points in Arizona—Baldy Peak (11,403 feet; 3,476 meters) and Humphreys Peak (12,670 feet; 3,863 meters). The Black, Blue, and Little Colorado Rivers are the major rivers in this MLRA.

Geology

Cenozoic volcanic rocks are an important feature of this area. These rocks are from large, central-type volcanoes, such as the San Francisco Peaks near Flagstaff, Arizona, and from smaller, coalescing volcanoes that produced extensive sheets of lavas and pyroclastic rocks. These lava flows cap sedimentary rock formations, including the Kaibab Limestone and Coconino Sandstone. Relief results more from the cutting of deep canyons into moderately flat terrain than from the deformation of mountains and valleys.

Climate

The average annual precipitation is 6 to 48 inches (143 to 1,218 millimeters). Winter storms are frequent in the mountains, and snow accumulation can exceed 100 inches (2,540 millimeters). Snowmelt is the main source of water for most of the major rivers in Arizona. The summer monsoon season brings moist air from the Gulf of California and Gulf of Mexico. Mountainous areas, such as the Mogollon Rim, receive most of this moisture. Thunderstorms are usually brief and intense and can result in flash floods. The monsoonal influence is strongest in the eastern portion of the MLRA, where summer precipitation exceeds winter precipitation. In the western portion, winter rainfall, originating from storms in the Pacific Ocean, makes up most of the annual precipitation. The average annual air temperature is 32 to 60 degrees F (0 to 16 degrees C). The freeze-free period averages 135 days and ranges from 60 to 205 days, decreasing in length with increasing elevation.

Water

This area has important watersheds that provide water to the central part of Arizona. Several of the larger streams, such as the Black, White, Verde, and Salt Rivers, and a few of their larger tributaries maintain perennial flow. Much of the water is stored in reservoirs and used for irrigation or municipal water supply in the MLRAs to the south. The municipal water supply for Flagstaff and Williams in Arizona is in part obtained from small reservoirs. This MLRA has several lakes and reservoirs. Small natural or artificial lakes at the higher elevations are used for fishing and other kinds of recreation. Annual runoff into all reservoirs is highly variable, and most of the smaller lakes and reservoirs are dry during some years. The surface water is suitable for almost all uses. High sediment load is the primary water-quality problem.

There is a general deficiency of moisture during the growing season, and irrigation is used to produce crops. Limited amounts of ground water for livestock and domestic use generally are only in faulted and fractured bedrock. Fresher water with lower levels of total dissolved solids is near the recharge zones for the bedrock aquifers. Very salty water is at depth and away from the recharge zones. Some springs yield saline water.

Soils

The dominant soil orders are Mollisols, Alfisols, and Entisols. Most of the soils in this area have a frigid or mesic temperature regime, depending mainly on elevation; the soils at the highest elevations have a cryic temperature regime.

The main soils and their series:

- Argiustolls that formed in intrusive and extrusive volcanic materials, dominantly basalt (Cabezon, Thunderbird, and Datil series)
- Argic Cryoborolls and Cryorthents (Baldy series) at the highest elevations of the White Mountains in Arizona
- Haplustalfs that formed in eolian material and alluvium (Flugle and Celacy series); that formed in residuum (Jacks series)
- Haplustolls that formed in alluvium or slope alluvium (Lynx and Manzano series)
- Ustorthents that formed in tephra (Kana`a series)

Biological Resources

This area includes grasslands on deeper soils; mixed shrub-grasslands on shallow, rocky soils; and timber on soils that are shallow to bedrock. Ponderosa pine occurs in the largest portion of the intermediate elevations in the area. At the higher elevations, spruce and fir dominate. Areas at the highest elevations, above 11,000 feet (3,350 meters), support alpine vegetation. At the lower elevations, ponderosa pine grades into stands of pinyon-juniper on north-facing slopes and into woodland of mixed oak, pine, and juniper on south-facing slopes. The principal grasses are fescues, bluegrasses, bromegrass, and muhly at the higher elevations; needlegrass, western wheatgrass, bottlebrush squirreltail, and muttongrass at intermediate elevations; and grama grasses, spike muhly, Junegrass, cane bluestem, and needlegrass at the lower elevations.

Land Use

About two-thirds of this area is federally owned. Forestry, ranching, and recreation are the dominant land uses (fig. 39-2). This area a popular destination for hunting, fishing, skiing, boating, camping, and hiking. Many tracts of rangeland are subdivided for community development. The main management concerns on rangeland are proper distribution of grazing, invasion of brushy species, and soil erosion.

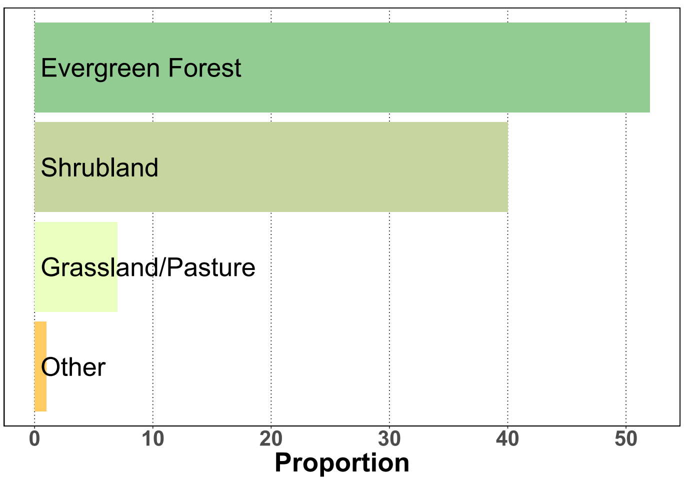

Figure 39-2: Relative proportions (percentages) of land use in MLRA 39.

The major soil resource concerns include loss of soil organic matter, loss of vegetative productivity, and soil erosion by water. Conservation practices on rangeland include fencing and development of watering infrastructure, which facilitate grazing management systems; brush management, which removes undesirable and introduced invasive species; and erosion control, which helps to prevent gullying and concentrated waterflow.

40—Sonoran Basin and Range

This area (fig. 40-1) occurs in Arizona (72 percent) and California (28 percent). It makes up about 44,384 square miles (114,955 square kilometers). MLRA 40 is a subdivision of the Basin and Range province, which spans from the sky island mountain ranges of southeastern Arizona (in MLRA 41) to the Peninsular Ranges of southern California. It is considered the United States portion of a broader Sonoran Desert that wraps around the Gulf of California and extends south into the States

Figure 40-1: Location of MLRA 40, which covers 11,495,500 hectares (28,405,900 acres), within Region D.

of Sonora and Baja California, Mexico. It is characterized by isolated, short mountain ranges surrounded by broad, alluvium-filled desert basins. This area contrasts with the relatively larger mountain ranges and smaller basins of the Mogollon Transition and Mojave Desert MLRAs to the north.

Important features include the flood plains of the lower Gila and Colorado Rivers plus the Salton Trough, with its desert alluvial slope and delta plain. This MLRA is characterized by bimodal precipitation patterns due to the intercept of desert orography and coastal weather patterns. This precipitation pattern, coupled with hot summers and mild winters, promotes rich biological diversity. The majority of this MLRA is used for rangeland with limited grazing during periods of favorable moisture. Crop production is concentrated in areas with access to irrigation.

Physiography

This area encompasses the southern two-thirds of the Sonoran Desert and Salton Trough sections of the Basin and Range province of the Intermontane Plateaus. It is characterized by small, isolated mountain ranges with numerous long, uninterrupted alluvial fans. Mountain ranges tend to be short, fault-block ranges trending southeast to northwest that rise abruptly from the smooth or gently sloping desert valley floors. Many of the valley floors contain active drainages that flow into the Gila River and, eventually, the lower Colorado River. Others are closed drainages, such as the Salton Sea, an iconic terminal sink basin in the Imperial Valley. Common landforms include mountains, alluvial fans, alluvial fan remnants, and alluvial valleys, which consist of active drainages and fluvial terraces.

A few internally drained basins terminate as playas and dry lakes with Pleistocene-age lake terraces. Mountain ranges include the Kofa, Picacho, and Chocolate Mountains, with elevations ranging from 980 to 3,600 feet (300 to 1,100 meters). The elevational extremes grade from 275 feet (84 meters) below sea level to 4,590 feet (1,400 meters) above.

Geology

This area developed from a combination of tectonic activity and intense volcanism. The tectonic pressures have produced many short, fault-block mountain ranges that descend into wide, alluvium-filled basins. Much of the tectonic activity occurred during the Laramide orogeny (75 to 50 million years ago) and the following Tertiary extension, beginning during the Oligocene (25 million years ago) and continuing until the Early Miocene (15 million years ago). Mountain ranges that initially formed during the Laramide orogeny tend to run along a northwest-southeast axis, while the younger ranges that formed during the Tertiary extension commonly trend along a southwest-northeast axis.

Most of this area is covered by deep alluvium washed in from adjacent mountains. These deposits of silt, sand, and gravel are very young in the present-day drainageways and much older on the valley floors and terraces. This MLRA also has many mountain ranges consisting of igneous rocks, with some granites older than a billion years. Most of the andesite and basalt flows are much younger, of Tertiary age, having formed in the past 50 million years. Some basalts, however, formed around 4 million years ago, and another series of intrusive volcanics appeared in the Late Cretaceous to Early Tertiary Periods.

Mountainous areas to the west are principally underlain by Mesozoic granites and Pre-Cenozoic metamorphics of the Southern California Batholith, which comprise the Peninsular Range of California and Mexico. Uplands east of the Imperial Valley are underlain by Precambrian to Mesozoic igneous and metamorphic rocks and Tertiary volcanic and sedimentary rocks.

The Salton Trough, in the western half of this MLRA, was formed by oblique right-lateral strike slip motion along the South Branch of the San Andreas, Imperial Valley, and San Jacinto Fault Zones. Aligned from northwest to southeast, these zones pass through the western, south-central, and northeastern parts of the Imperial Valley, respectively.

Climate

In this MLRA the climate is strongly influenced by the California Gulf, as warm air flows from the south and is pushed to the north and west. Stable, high-pressure air masses can last long periods of time, allowing for hot temperatures. The average annual temperature is 52 to 76 degrees F (11 to 24 degrees C).

The average annual precipitation is 2 to 24 inches (61 to 598 millimeters). Precipitation is bimodal throughout the MLRA. In the east, annual precipitation occurs mostly in summer and relative humidity is very low except during the summer monsoon season. Summer rainfall occurs during high-intensity, convective thunderstorms, mainly from July to September. Summer rains are highest in the east and are generated by moist air circulating from the Gulf of California. Winter rainfall comes with Pacific frontal storms from December to March. It is relatively highest in the west as the frontal storms dissipate and move eastward; however, the western part of the MLRA is among the driest in the continental United States, receiving at most an average of 2 inches of rain annually and in many years no precipitation. The ratio of summer to winter precipitation shifts (from 60:40 to 20:80) from east to west. In the driest part of the MLRA, measurable precipitation can be absent for up to 36 months. Rare snowfall occurs at the highest elevations in the north and east.

Water

The Colorado River bisects the MLRA, providing surface water for agricultural and municipal use. Several canals carry water from the Colorado River for municipal and agricultural use to both California and Arizona. Some of these canals are part of the Central Arizona Project. This system diverts water at Lake Mead, in the northwest corner of the MLRA, and transports it to the population centers of central and southern Arizona. Other rivers in the MLRA, such as the Salt, Gila, and Bill Williams, drain watersheds from adjacent MLRAs into the Colorado River. Water for irrigation and other uses is stored in reservoirs; there are no uncontrolled perennial watercourses. The surface water from the mountains is generally of good quality but quickly becomes degraded as ephemeral streams cross various soil and geologic deposits and pick up evaporation-induced mineral concentrations and dissolved salts.

Soils

The soils within this MLRA mostly have a hyperthermic temperature regime; thermic soils are at the highest elevations. The soil moisture regime is aridic, and the moisture subclasses include aridic, typic, and ustic. Soils have mixed mineralogy and formed in all types of parent material. The soils at the lowest elevations within the Imperial Valley and Salton Trough have saline-sodic properties. Three soil orders are mapped in MLRA 40: Aridisols, Entisols, and Vertisols.

Common soil series:

- Carsitas series—Torripsamments that formed in alluvium from granitoid and gneissic rocks on alluvial fans, fan aprons, valley fills, and dissected remnants of alluvial fans and in drainageways
- Casa Grande series—Natrargids that formed in old mixed alluvium on fan remnants and relict basin floors
- Coachella series—Torrifluvents that formed in sediments from igneous rocks in lacustrine basins on relict basin floors

Denure series—Haplocambids that formed in alluvium on alluvial fans, stream terraces, and relict basin floors
Glenbar series—Torrifluvents that formed in stratified stream alluvium on flood plains and alluvial fans
Gunsight series—Haplocalcids that formed in calcareous alluvium from mixed sources on fan remnants and stream terraces
Hyder series—Torriorthents that formed in alluvium from rhyolite and related volcanic rocks on hills and mountains
Imperial series—Torrifluvents that formed in calcareous alluvium from mixed sources in old lake beds on flood plains and relict basin floors
Mohall series—Calciargids that formed in fan and stream alluvium from mixed sources on fan remnants, stream terraces, and relict basin floors
Orita series—Haplargids that formed in alluvium from mixed sources on fan remnants and terraces
Rositas series—Torripsamments that formed in sandy eolian material on sand sheets and dunes

Biological Resources

The Sonoran Desert is biologically rich across both space and time. Across landscapes, the diversity is visually evident as precipitation patterns, slope aspects, and soils change. A single point can change dramatically with seasons, as both summer and winter communities flourish. Biological diversity is greatest at the higher elevations and precipitation zones. Diversity diminishes and plant communities become open and simple at the lowest elevations and precipitation zones.

Several species of plants and animals are unique to this MLRA. The saguaro cactus is probably the most notable. At the highest elevations, mesquite and blue paloverde are common across the landscape. Tree species transition from east to west as elevation and precipitation amounts decrease. Along the gradient of decreasing precipitation, mesquite gives way to ironwood, blue paloverde gives way to yellow paloverde, and ironwood gives way to smoketree.

Trees grow prolifically across uplands at the high precipitation zone, are restricted to water courses (washes) in the mid precipitation zone, and are only able to grow within the largest washes as annual precipitation and elevation decrease in a westward progression. Similarly, the diverse desert shrub community transitions from a complex cactus-shrubland to an open creosote bush-white bursage community. At the higher elevations, triangle-leaf bursage, desert wolfberry, ocotillo, cholla, desert saltbush, mesquite, brittlebush, burroweed, pricklypear, desert broom, and creosote bush are the dominant desert shrubs. At the lowest elevations, a salt-tolerant shrub community prevails with iodinebush as the dominant species.

Major wildlife species include mule deer, desert bighorn sheep, blacktailed jackrabbit, javelina, coyote, fox, raccoon, bats, rattlesnake, bull snake, coach whip, king snake, and quail. Unique animals include desert pupfish, desert tortoise, Sonoran pronghorn, Coachella Valley fringe-toed lizard, and Le Conte's thrasher.

Land Use

Most of this MLRA is open desert. Arable soils within basins and on terraces of the Colorado, Santa Cruz, and Gila Rivers are used extensively as irrigated cropland, although urbanization has greatly reduced the acreage of cropland (fig. 40-2). Market vegetables such as onions, broccoli, lettuce, and table grapes share the irrigated cropland areas, along with commodities such as cotton and alfalfa. Orchards, producing dates and citrus, are also scattered throughout this MLRA.

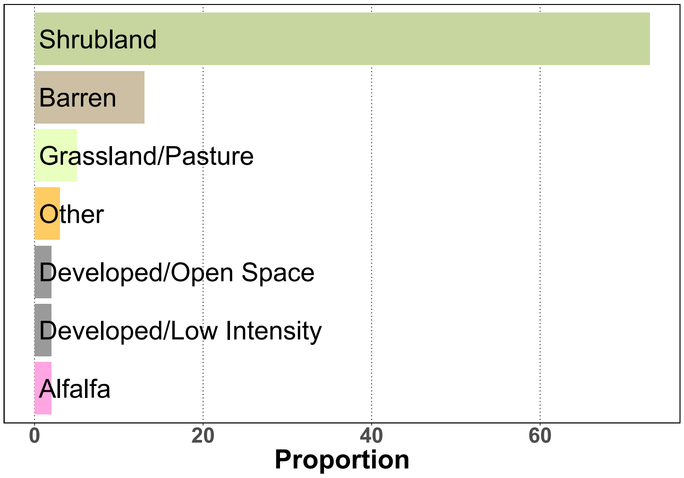

Figure 40-2: Relative proportions (percentages) of land use in MLRA 40.

Open-range livestock grazing is largely limited to the eastern half of the MLRA as desert conditions restrict ranching in the western reaches. Recreational activities, mostly confined to cooler months, include off-highway vehicle recreation, birding, and backpacking. Boating and fishing are major activities along the Colorado River and desert reservoirs. During the mild winter months, from November through April, camping heavily impacts the MLRA as temporary cities of recreational vehicles sprawl through the desert. Past prospecting and mineral mining were extensive in the mountains but are currently reduced.

The dominant resource concern on cropland is insufficient water due to inefficient irrigation. Other common resource concerns on cultivated land include water quality degradation due to excessive salts in surface water and ground water; impacts on air quality from emissions of particulate matter and its primary precursor, soil erosion due to wind; and water erosion from irrigation. Conservation practices on cropland include irrigation water management, surface and subsurface irrigation systems, conservation crop rotations, and cover crops.

On rangeland, the dominant resource concern is reduced livestock production due to inadequate water and forage. Other common resource concerns on rangeland include excessive dust from degraded lands that have low plant cover with depleted soil biological systems. Conservation practices on rangeland include prescribed grazing management with associated facilitating practices such as fences and livestock water developments. Additional ecosystem treatment practices may include rangeland planting and mechanical treatments such as brush management.

41—Madrean Archipelago

This area (fig. 41-1) occurs in Arizona (67 percent) and New Mexico (33 percent). It makes up about 20,065 square miles (51,967 square kilometers). MLRA 41 represents the northernmost extent of the Sierra Madre Occidental ("Mother Mountains of the West"). The Sierra Madre Occidental is a massive, rugged mountain system that runs northwest from the Rio Grande de Santiago, in the State of Jalisco, Mexico, through the States of Sonora and Chihuahua, and ends in Arizona and New Mexico. In Mexico, this mountain system runs parallel to the Pacific Coast. As it crosses into the United States and confronts the tectonic folding and rifting of the Basin and Range province, the land mass geographically breaks into smaller, isolated mountain ranges, called sky islands. The central concept of this MLRA is a series of inland islands extending from their mainland, the Sierra Madre Occidental, and surrounded by a sea of desert grassland.

To the west, the Madrean Archipelago borders the Sonoran Basin and Range where several sky islands in southern Arizona grade into Sonoran Desert basins; to the north it borders the contiguous mountains and geology of the Mogollon Transition area; and to the east, in New Mexico, it borders the geology of the Rio Grande Rift, specifically the Santa Fe group of formations. MLRA 41 is primarily a rangeland subdivision with small amounts of irrigated cropland.

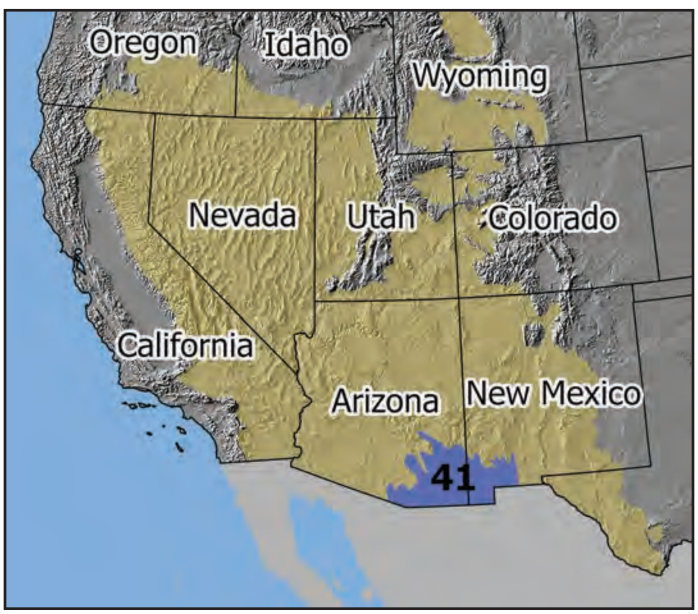

Figure 41-1: Location of MLRA 41, which covers 5,196,700 hectares (12,841,300 acres), within Region D.

Physiography

Most of this area is in the Mexican Highland section of the Basin and Range province of the Intermontane Plateaus. The western one-fifth of the area is in the Sonoran Desert section of that same province and division. This MLRA has mountain ranges that trend southeast to northwest and relatively smooth basins between the mountains. Among the many mountain ranges are the Chiricahua, Dragoon, Swisshelm, and Pedregosa Mountains. Most basins are open drainages; however, distinct closed basins occur in the Playas and Sulphur Springs Valleys. The largest dry lakes are Willcox Playa near Willcox, Arizona, and Lordsburg Playa near Lordsburg, New Mexico. In general, elevation ranges from 2,620 to 4,920 feet (800 to 1,400 meters) in the basins to 5,900 feet (1,800 meters) in the mountains. Some mountain peaks are much higher, such as Mount Graham, in Arizona, at 10,717 feet (3,267 meters).

Geology

This MLRA is an area of intensive volcanism. Isolated outcrops of granite are more than 1 billion years old. Most of the existing landforms, however, are remnants of fault-block mountains and basins that evolved during the Tertiary extension, beginning during the Oligocene Epoch (25 million years ago) and continuing until the Early Pleistocene Epoch (2 million years ago). This Late Tertiary mountain building produced the steeply dipping, sharply broken fault blocks of Paleozoic and Mesozoic strata. Concurrently, volcanism resumed and remained active until 0.5 million years ago.

Climate

Bimodal precipitation, with nearly equal summer and winter precipitation, characterizes this MLRA. About 60 percent of the precipitation occurs during high-intensity, convective thunderstorms in July, August, and September. A second rainy season occurs from December to March as Pacific frontal storms bring low-intensity storms. In winter, snowfall is common at the highest elevations and occasionally reaches the valley floors during the coldest storm fronts.

The average annual precipitation is 9 to 42 inches (227 to 1,067 millimeters). The average annual air temperature is 40 to 69 degrees F (4 to 21 degrees C). The freeze-free period averages 245 days and ranges from 160 to 335 days, decreasing in length with elevation.

Water

There are no significant lakes or reservoirs in this area. Although there is no river that carries unimpeded perennial surface water flow, there are several perennially flowing reaches of the San Pedro and Gila Rivers. These large rivers have continuous, perennial subterranean water that sustains riparian vegetation. Large and small washes provide ephemeral flow with intensity reflective of precipitation events. Surface water quality is generally satisfactory, but some reaches are considered impaired according to the Clean Water Act.

Cultivated crops are grown under irrigation. Most water for irrigation is obtained by pumping ground water from deep wells in the alluvial aquifers. Surface water for irrigation is obtained from irrigation districts along the San Pedro and Gila Rivers. Some of the more significant aquifers are in the Avra Valley, Altar Valley, Safford Basin, and Wilcox Basin. There has been a noticeable decline in the level of ground water in all aquifers. Very little runoff or precipitation is available to recharge alluvial aquifers in the area. The quality of the ground water varies considerably, depending on the composition, location, and depth of the alluvium. Some alluvium has evaporite deposits, and some has volcanic rocks, which create high levels of sulfate.

Soils

The six soil orders mapped in MLRA 41, in descending dominance, are: Aridisols, Entisols, Mollisols, Vertisols, Alfisols, and Inceptisols. The soils dominantly have a thermic to mesic temperature regime and an aridic and/or ustic moisture regime. The break between the thermic and mesic soil temperature regimes is at an elevation of about 6,500 feet.

Common soil series:

- Banshee series—Paleargids that formed in mixed alluvium from prehistoric lakes and marshes and fan alluvium
- Bernardino series—Calciargids that formed in fan alluvium from igneous and sedimentary rock
- Bonita series—Haplotorrerts that formed in alluvium from basalt and related pyroclastic rock on plateaus, fan piedmonts, and relict basin floors
- Borderland series—Calciusterts that formed in mixed alluvium from basalt and volcanic rocks on alluvial fans and relict seeps
- Combate series—Torrifluvents that formed in fan alluvium from granite on flood plains and alluvial fans
- Crystalgyp series—Haplogypsids that formed in mixed alluvium or residuum from gypsiferous sedimentary rocks on dissected relict lake beds
- Gardencan series—Haplustalfs that formed in fan alluvium from granite and gneiss on alluvial fans and fan remnants
- Luckyhills series—Haplocalcids that formed in mixed calcareous fan alluvium
- Magoffin series—Haplustolls that formed in slope alluvium and residuum from andesite, rhyolite, basalt, and felsic volcanic breccia on hills and mountains
- Oversight series—Haplustepts that formed in mixed fan alluvium on alluvial fans and fan remnants
- Wampoo series—Durustolls that formed in old alluvium from dominantly basic igneous sources

Biological Resources

Because of its geographic location, geology, and physiology, MLRA 41 is extremely biologically diverse with over 5,300 documented species of flowering plants alone. There are species intergrading from the distant north (Rocky Mountains), northeast (Great Plains), east (Chihuahuan Desert), south (Sierra Madre Occidental), and west (Sonoran Desert). Species have origins ranging from temperate to subtropical climates. The sky island mountain ranges act as biological islands with uniquely isolated populations among the sea of desert grasslands. This MLRA supports desert shrublands, semi-desert grasslands, savanna, and forests along a gradient of increasing elevation, from basins to mountains.

Land Use

Most of the MLRA is used for livestock grazing (fig. 41-2). Arable soils within basins are extensively used as irrigated cropland. Cotton, corn, alfalfa, small grains, nut and fruit orchards (pistachios, pecans, apples, peaches, and cherries), and wine grapes are some of the common crops. Several of the highest mountains are sites for astronomical telescopes. Recreational uses of rangeland include hunting, birding, and backpacking. Many tracts of privately owned rangeland and cropland are subdivided for suburban community development.

The dominant resource concern on cropland is insufficient amounts and inefficient use of irrigation water. The other main concern on cultivated land is impacts on air quality from dust. Conservation practices on cropland include irrigation water management, irrigation systems, conservation crop rotations, and cover crops.

Common resource concerns on rangeland include inadequate plant community structure and function due to degraded

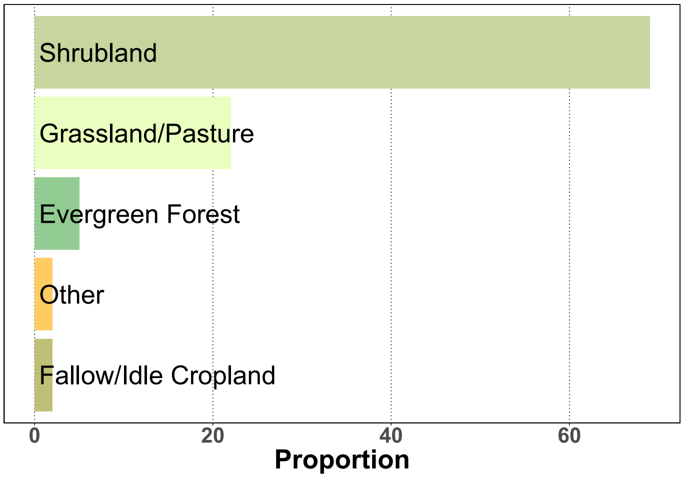

Figure 41-2: Relative proportions (percentages) of land use in MLRA 41.

plant condition; colonization of invasive species, such as Lehmann lovegrass (*Eragrostis lehmanniana*); and soil erosion. Conservation practices on rangeland include prescribed grazing, watering facilities, brush management, and mechanical treatment of grazing land.

42A—Trans-Pecos Mountains, Plateaus, and Basins

This area (fig. 42A-1) occurs in Texas (90 percent) and New Mexico (10 percent). It makes up about 20,356 square miles (52,722 square kilometers). MLRA 42A is defined by the Trans-Pecos Rift, which consists of three basic subdivisions: 1) mountain ranges, both sedimentary and igneous, such as the Glass and Davis Mountains; 2) plateaus, such as the Otero and Marfa Plateaus; and 3) basins, such as the Valentine and Salt Basins. The basins within the MLRA can be both inter- and intra-montane basins, derived from tectonic processes creating horst and graben landscapes. The Salt Basin is at the heart of this MLRA. It is a long chain of wide, nearly level alluvial flats that extend many miles along the basin floor between detached mountain chains. The alluvial flats are mostly rangeland and are important for livestock production.

MLRA 42A represents the southeasternmost portion of Land Resource Region D. It is a subdivision of the Basin and Range province that extends from Otero Mesa, in southern New Mexico, to Big Bend, Texas. To the east it borders MLRA 70B (Pecos and Canadian River Basins) at the contact between a bedrock-controlled mountain front and alluvial or piedmont slopes of the Pecos River Valley. MLRA 42A consists of broken mountains and plateaus while MLRA 70B is a broad, extensive lowland, uninterrupted by large areas of higher, bedrock-controlled terrain.

Figure 42A-1: Location of MLRA 42A, which covers 5,272,200 hectares (13,027,900 acres), within Region D.

In southeastern Brewster County, Texas, the boundary between MLRA 42A and MLRAs 81A (Edwards Plateau, Western Part) and 81D (Southern Edwards Plateau) is at the eastern edge of the Basin and Range faulting zone and the western extent of the Edwards Plateau. At this boundary the topography transitions from tectonic faulting to downcutting by the Rio Grande. As one moves east onto the Edwards Plateau, the soil moisture regime grades from typic aridic to ustic aridic. In addition, the precipitation pattern on the southern Edwards Plateau is bimodal (maximum precipitation in spring and fall) while precipitation in the Trans-Pecos mostly occurs during the summer monsoon season (with the peak from July through September).

The southern boundary of MLRA 42A follows the Rio Grande from the mouth of Reagan Canyon to Redford, Texas. To the west, the MLRA is bordered by the geology and physiography of the Southern Rio Grande Rift (MLRA 42B). This occurs below the Sierra Vieja Rim, where broken bedrock terrain transitions to gravelly piedmont slopes and river flood plains, and below the Quitman Mountains, the Hueco Mountains scarp, and the Otero Mesa scarp in New Mexico. The northern boundary of MLRA 42A with the Central New Mexico Highlands (MLRA 42C) occurs along the inflection point with the steep terrain and cooler temperatures of the Sacramento Mountains and the scarp rim of the Guadalupe Mountains.

Physiography

MLRA 42A lies within the Mexican Highland and Sacramento sections of the Basin and Range province of the Intermontane Plateaus. The area consists of steep mountains, dissected and undissected plateaus, and nearly level basin floors. The original flat tops of volcanic plateaus were capped by igneous flows, then strongly dissected by stream erosion, resulting in steep, rugged side slopes. Mountain ranges extend for distances ranging from 15 to 50 miles and rise 2,000 to 5,000 feet above the adjacent basin floors. Most ranges and basins are elongated from north to south, although the Glass Mountains and Apache Mountains extend west to east. The lowest elevation (1,550 feet, or 472 meters) in the MLRA is at the mouth of Reagan Canyon on the Rio Grande below La Linda, Texas. The highest elevation (8,378 feet, or 2,554 meters) is the summit of Mount Livermore in Jeff Davis County, Texas. About 10 percent of the MLRA has a slope gradient of less than 1 percent (basin floors), 55 percent has slopes between 1 and 8 percent (piedmont slopes and undissected plateaus), 17 percent has slopes of 8 to 20 percent (dissected plateaus), and 17 percent has slopes of more than 20 percent (mountains).

The 300-mile Trans-Pecos Rift stretches from the Sacramento Mountains south to the Rio Grande (Pearson, 1988). Faults are still active. Earthquakes occurred at

Valentine, Texas, in 1931 and Alpine, Texas, in 1994. Fault scarps that cross piedmont slopes are visible on IFSAR (Interferometric Synthetic Aperture Radar) slope maps (Muehlberger et al., 1978). Between 1934 and 1958, the floor of the Salt Basin at the Figure 2 Ranch headquarters dropped by 4 inches (Brown et al., 1978).

Five major plateaus occur within this MLRA: 1) the Otero-Diablo Plateau, which rises gradually westward from the floor of the Salt Basin and crests along the Hueco and Finlay Mountains in Hudspeth County, Texas; 2) the Culberson Plateau, which lifts westward from the Pecos Valley and extends to the Guadalupe and Delaware Mountains; 3) the Marfa Plateau, which is a large intermontane basin south of the Davis Mountains that has a floor of tuff and alluvium; 4) the Presidio Plateau, which extends north and east from the Sierra Vieja-Chinati Mountains and ends at the dissected piedmont slope originating from the Chinati super-volcano; and 5) the block-faulted western extremity of the Stockton Plateau in eastern Brewster County, Texas.

Piedmont slopes occur between mountain fronts and basin floors and are dominated by skeletal and loamy alluvium eroded from the surrounding mountains and plateaus. Basin floors have low relief and low slope gradient and are in the general location of water and sediment deposition. Large basins within this MLRA include the Salt, Valentine, Marfa, and Tornillo Basins (Pearson, 1988). Crow Flats in Otero County, New Mexico, is a northern extension of the Salt Basin that reaches the Sacramento Mountains. Eagle Flat Basin is a small bolson near Sierra Blanca. Bedrock fensters occur within basins. Where they occur, the soils form that contrast with surrounding piedmont slopes and basin floors.

Geology

The mountain ranges are composed of rocks with different ages and diverse lithology. Bedrock underlying the mountains and plateaus ranges in age from Precambrian to Tertiary; all geologic periods are represented. Periods of mountain formation include the Grenvillian (1,250 to 980 million years ago); the Ouachita-Marathon (325 to 275 million years ago), which was responsible for folded strata within the Marathon Uplift; the Laramide (68 to 50 million years ago); and the Basin and Range extension (24 million years ago to present). In terms of geological structure, plateaus are typically monoclines and cuestas, mountains are eroded remnants of horst blocks, and basins are downthrown grabens that are partially filled with sediment.

Permian- and Cretaceous-age formations are exposed in many of the hills and mountains, including the Hueco, Collins, Cornucopia, Brokeoff, Patterson, Bitterwell, Rustler, Apache, Glass, Van Horn, Beach, Baylor, Sierra Diablo, Pine, Del Norte, and Dead Horse. Mountains composed of Pennsylvanian, Permian, and Cretaceous sandstone include the Van Horn, Devils Ridge, Carrizo, Delaware, Marathon Uplift, Indio, and southern Quitman.

Magmatism within the Trans-Pecos volcanic field occurred 48 to 17 million years ago and included the eruption of 17 volcanic calderas. The super-eruption of the Chinati Volcano in southern Presidio County ranks as the 21st most violent in earth history (Mason et al., 2004). This volcano belched out the Mitchell Mesa Ignimbrite and the Tascotal Formation and Perdiz conglomerate, which are dissected remnants of the piedmont slope built from the erosion of the volcano. Eruptions from the Paradise Mountain caldera in Jeff Davis County are the 27th and 28th largest in earth history (Mason et al., 2004). Volcanic mountains are the Davis, Chisos, Bofecillos, Chinati, Sierra Vieja, Van Horn, Eagle, and northern Quitman. Common igneous rock types include rhyolite, basalt, tuff, and conglomerate as well as intrusive bodies. Syenite and other intrusive rocks make up about 290,000 acres, including Sierra Blanca, Cornudas Peaks, Spring Mountain-Mount Livermore, Elephant Mountain, and Nine Point Mesa (Potter, 1996).

Limestone and sandstone of Permian age (Hueco, Capitan, and San Andres Formations) and Cretaceous age underlie the Otero-Diablo Plateau. Paleozoic rocks are composed of shale, chert, sandstone, and limestone in the Marathon Basin, with a combined thickness of about 21,000 feet (McBride, 1988) and covering 350,000 acres. The Permian-age Castile Formation outcrops on the Culberson Gypsum Plain and extends from the Black River southward to the Apache Mountains, covering more than 700,000 acres in Culberson County, Texas, and Eddy County, New Mexico.

Tectonic basins are partially filled with alluvium derived from the surrounding mountains. The alluvial fill is 10,000 feet thick in the Salt Basin south of Dell City, Texas. Alluvial gypsite within the Salt Basin is soil parent material for 250,000 acres in Culberson and Hudspeth Counties, Texas, and Otero County, New Mexico. The Maravillas and Stillwell Basins in southern Brewster County, Texas, are small grabens, filled with carbonatic alluvium derived from the surrounding limestone horst blocks.

Geologic erosion has removed material, ranging in thickness from ½ mile to 2 miles, from Trans-Pecos Mountains and Plateaus landscapes since the end of the Cretaceous 65 million years ago (Udden, 1907). The erosive forces responsible for that loss are still in place, ready to remove soil that is unprotected by vegetative cover.

Climate

The average annual precipitation is 9 to 26 inches (224 to 660 millimeters). The average annual air temperature is 50 to 72 degrees F (10 to 22 degrees C). Annual water deficit ranges from 0 to 950 millimeters.

In general, precipitation is low and temperatures are warm in this MLRA. The Trans-Pecos is the driest portion of Texas. Rainfall is greater in the mountains where temperatures, potential evapotranspiration, and annual water deficit are lower. Only the summit of Mount Livermore in the Davis Mountains does not experience a water deficit. The low elevations are drier and much hotter, such as along the Rio Grande in southern Brewster and Presidio Counties where potential evapotranspiration exceeds precipitation by more than 900 millimeters (36 inches).

Two-thirds of the variation in water balance, resulting from differences in elevation, is due to temperature (and potential evapotranspiration) and one-third is due to precipitation. With each 1,000-foot increase in elevation, mean annual temperature cools 2.5 degrees F (1.4 degrees C) and annual precipitation increases 2.5 inches (63.5 millimeters). For each 50 miles north, temperature cools 1 degree F. Annual precipitation increases 1 inch for every 50 miles east.

Five seasons characterize the MLRA: winter, from December to February; spring, March and April; pre-summer, May and June; monsoon, July to September; and fall, October and November. About 80 percent of annual rainfall occurs between May and October, mainly from convectional thunderstorms. Winter and spring are typically dry with just 13 percent of annual precipitation. Heavy snow is rare. Winter can be windy, and the very gusty west winds combined with dry vegetation in spring fuel wildfires. The dry air during winter and spring results in wide temperature swings; residents may experience four seasons in a day.

Depending on elevation, the frost-free season extends from March-April to October-November, although the growing season does not begin until summer rains arrive. From May to July, wind direction switches from westerly to easterly, eventually ushering in moisture from the Gulf of Mexico. The hottest temperatures of the year are in pre-summer. Higher humidity and clouds associated with monsoon thunderstorms result in cooler temperatures during July and August. During those months, daily high temperature (30-year average) is less than 90 degrees F (32 degrees C) at Marfa, Alpine, and Fort Davis in Texas. Unlike the Sonoran Desert, rainfall in the Trans-Pecos increases during pre-summer. The area receives beneficial rainfall and experiences early vegetation growth in some years. Monsoons begin about the beginning of July, sometimes earlier, and last until September. Fall has mild temperatures and light wind.

The tremendous diversity of landscapes and landforms in the MLRA distinguishes it from its neighbors. Big Bend National Park exhibits this diversity and is a macrocosm for the entire MLRA. Chisos Basin has the fewest number of days (0) with high temperatures (more than 100 degrees F, 37.8 degrees C) while, less than 30 miles away, Boquillas Ranger Station has the highest number of days (98.1) with high temperatures. Another striking contrast between these locations is the number of days with 1 inch of rain. Chisos Basin has the most, 4.7 days, while Boquillas Ranger Station has the third fewest, 1.7 days.

Water

The limited precipitation is insufficient to support rain-fed agriculture. Crop production is possible only where ground or surface water is available. Livestock water is provided by ground water pumped by windmills, which are increasingly being converted to solar powered.

Permian and Cretaceous carbonate rocks in the MLRA are usually productive aquifers with good water quality. The Bone Spring-Victorio Peak Aquifer is a porous limestone formation extensively pumped within Dell Valley. The West Texas Igneous Aquifer contains high-quality ground water, although sometimes in limited quantity. The related West Texas bolson aquifers are used for crop production in Lobo Valley. A portion of the Edwards-Trinity Aquifer extends into southern Brewster County from MLRA 81A (Edwards Plateau, Western Part). Ground water in the Delaware Mountains is either very deep or not available at all. Water containing dissolved gypsum from the Castile Formation is not potable for humans or livestock. The Ordovician-age Marathon limestone exposed in the Marathon Uplift yields good-quality water for domestic use and livestock. The associated shale and chert formations, however, do not have aquifers with usable water.

The Salt Basin alluvial aquifer is internally drained with no major streams flowing through or into it. The Rio Grande flows along the southern boundary of the MLRA, making a 90-degree bend as it passes through Mariscal Canyon. Major tributaries of the Rio Grande include Cibolo, Alamito, Terlingua, Tornillo, and Maravillas Creeks. Streams originating within the MLRA and draining into the Pecos River include the Delaware River, Salt Creek, and Cottonwood Creek.

The Davis Mountains and Glass Mountains, which have elevated terrain, relatively low temperatures, and high precipitation, recharge the Igneous Aquifer and Capitan Reef Complex Aquifer, respectively (Sharp, 2001). Springs important for the initial settlement of the area include Pena Colorada, Burgess, Rustler, San Solomon, and Independence.

Soils

The soil climate in MLRA 42A is diverse. It ranges from mesic, wet ustic in the high Davis Mountains to hyperthermic, extreme aridic along the Rio Grande. It includes mesic, thermic, and hyperthermic soil temperature regimes and has soil moisture regimes spanning from typic ustic through dry ustic, moist aridic, and typic aridic to extreme aridic. The diverse soil climate in combination with diverse parent materials has resulted in several Trans-Pecos soil series.

Mollisols and Alfisols with an ustic moisture regime are in the rugged terrain of the woodlands and savannas of the Davis, Chisos, and Chinati Mountains and the Sierra Vieja as well as the surrounding Mixed Prairie grasslands. Soil series with mollic epipedons include Musquiz, Murray, Berrend, Balmorhea, Phantom, Volco, and Pardo. Aridisols, Vertisols, and Entisols with an aridic soil moisture regime dominate the Desert Grassland and Hot Desert Shrub vegetative zone. Ochric epipedons occur in the Leyva, Paisano, Coyanosa, Buckear, Vicente, Lomapaloma, and Castolon series.

The soils in the mountains are typically shallow and skeletal (Brewster, Mainstay, Lingua, Reduff, Scotal, Holguin, Leyva, Terlingua, Studybutte, Altuda, Bissett, and Blackgap series). However, some moderately deep or deep soils have formed in colluvium on steep mountainside landforms (Liv and Ohtwo series). Soils with petrocalcic horizons (Paisano, Philder, Delnorte, Crossen, Ojinaga, Boracho, and Espy series) formed on stable undulating pediments and piedmonts, in thermic and hyperthermic climate zones. Soils with argillic horizons that formed in the residual, colluvial, and alluvial parent materials on stable geomorphic surfaces (even where slope gradient ranges to 40 percent) include the Puerta, Madrone, Loghouse, Liv, Mainstay, Musquiz, Berrend, and Leyva series. Haplogypsids and Petrogypsids formed on hypergypsic residuum, alluvium, and eolian sand derived from gyprock of the Castile Formation as well as gypsite deposited within the Salt Basin (Elcor, Hollebeke, Pokorny, Joberanch, Curvus, and Peligro series).

Torripsamments with hypergypsic mineralogy gyp dunes on the lee side of Salt Basin lakebeds include the Harses and Lark series. Torripsamments with mixed or siliceous mineralogy include the Aguena series on the Culberson sand sheet. Soils of the Crossen, Cienega, Stovall, and Michigan series occur in a downslope sequence as alluvium derived from limestone becomes finer. Soils that formed in residuum weathered from tuffaceous bedrock in Green Valley include the Reduff, Scotal, and Holguin series. Haplocambids that formed in sodic pedisediment and stream alluvium on terraces and flood plains in Green Valley include the Borunda, Straddebug, Tornillo, Butcheknife, and Martillo series. Skeletal alluvium derived from igneous rock on fan remnants and stream terraces is the parent material for the Loghouse, Chilicotal, Rockpens, Corazones, and Chillon series. Hyperthermic soils on the Rio Grande flood plain downstream of Redford, Texas, that were formerly used for cotton production (Castolon, Vicente, and Lomapelona series) now lie within Big Bend National Park.

Biological Resources

Climate, soil parent material, relief, and disturbance, in that order, control the composition and productivity of vegetation. Forest, woodland, savanna, grassland, grassland with shrubs, shrubland, and dwarf shrubland occur with definite ranges of annual water deficit. Vegetative zones include Mountain Savannah, Mixed Prairie, Dry Mixed Prairie, Desert Grassland, Hot Desert Shrub, and Very Hot Desert Shrub.

The Mountain Savannah vegetative zone is mostly at elevations of more than 6,500 feet. The climax vegetation is mainly oak savanna dominated by muhly and grama and includes gray, Grave, Gambel, Emory, and silverleaf oaks as well as alligator juniper, oneseed juniper, Mexican pinyon, ponderosa pine, and Texas madrone, in increasing amounts, at the higher elevations.

The Mixed Prairie vegetative zone is mostly at elevations of 4,500 to 6,500 feet. This zone includes intermountain prairies and valleys and rolling to steep hills and mountainsides. Characteristic plants include sideoats grama, cane bluestem, blue grama, black grama, and oaks. Much of this zone has been invaded by woody species such as acacias, catclaw mimosa, junipers, and mesquite.

The Dry Mixed Prairie vegetative zone occurs mostly at elevations of 4,000 to 5,500 feet. The climate and soils support mostly grasslands with mid and short grasses and scattered shrubs and forbs. Characteristic plants include black grama, blue grama, sideoats grama, curlyleaf muhly, sand dropseed, New Mexico feathergrass, winterfat, sotol, javelina bush, and banana yucca.

The Desert Grassland vegetative zone is mostly at elevations of 3,500 to 4,500 feet. The climate and soils support a sparse cover of grasses and shrubs. Characteristic plants include black grama, burrograss, tobosa, butterflybush, fourwing saltbush, and littleleaf sumac. Much of this zone has been invaded by woody species such as creosote bush, tarbush, acacias, and mesquite.

The Hot Desert Shrub vegetative zone occurs mostly along the Rio Grande. Elevations range from 2,000 to 3,500 feet. Soils are classified as hyperthermic. Except on flood plains and drainages, this climate supports a sparse cover of vegetation in a widely spaced pattern with an abundance of barren soil or desert pavement. Most of this vegetative zone is not suited to common rangeland improvement practices, such as seeding, brush control, and prescribed fire. Characteristic plants include Chino grama, false grama, fluffgrass, creosote bush, whitethorn acacia, ocotillo, yuccas, lechuguilla, leatherstem, candelilla, and cacti.

The Very Hot Desert Shrub vegetative zone is a narrow area along the Rio Grande. Elevations range from river level to 2,000 feet. Creosote bush dwarf shrubland is common. Plants within this very hot desert shrub zone have various forms (tree, shrub, grass, and forb) and include both annuals and perennials (Cornelius et al., 1991). They have all adapted to extreme water deficit.

Among the many gypsophiles that grow on the Castile Formation are gypsum grama, gyp dropseed, and gypsum ringstem. Calciphiles on limestone bedrock include ratear coldenia, Big Bend silverleaf, and guayule. Hyperthermophiles that indicate the Hot Desert Shrub vegetative zone include Chino grama, false grama, candelilla, and leatherstem. Ocotillo grows on very shallow soil regardless of soil climate, from the Mixed Prairie vegetative zone to the Very Hot Desert Shrub vegetative zone.

While this region is dominated by native plants, invasive exotic species have altered some landscapes. Giant reed (*Arundo donax*) and saltcedar (*Tamarix* spp.) now dominate the stretch along the Rio Grande in this MLRA. The flood plain along the upper stretch of the river is dominated by saltcedar, named for its ability to draw salts from the soil and excrete them through the leaves onto the soil surface. Competition is almost nonexistent because native plants, except for halophytes, are unable to survive the salty conditions. Below Santa Elena Canyon, giant reed begins to codominate with saltcedar. Giant reed also pushes out native vegetation and is very hard to control. It is fire-tolerant and is not consumed by native insects or animals. Lehmann lovegrass is an exotic grass with a very high germination rate and a fire tolerance. It invades upland sites, particularly after brush control, and quickly becomes a monoculture.

The greatest number of unique elements in the mammal fauna of Texas occur in the Trans-Pecos region. Almost one-third of the 92 mammal species that inhabit the Trans-Pecos are primarily restricted in distribution to that region. Mammals include black bears, cougars, coyotes, bobcats, foxes, raccoons, ringtails, badgers, skunks, porcupines, javelinas, rabbits, gophers, and mice.

Big game animals are an important source of income for landowners and recreation for sportsmen. Desert mule deer are the most common big game. They are a subspecies of the more common mule deer to the north and west. White-tailed deer also inhabit several mountain ranges. Carmen Mountain whitetail is a subspecies of white-tailed deer. The only place they exist in the United States is south Brewster County, Texas. Pronghorn antelope, a true North American native, also inhabits this MLRA. They provide a service to landowners by eating toxic plants that are a risk to domestic animals. Desert bighorn sheep are a subspecies of bighorn sheep that inhabit the southwest United States, including West Texas. Due to an aggressive reintroduction program, they are returning to much of their former range in this area. Elk is another species that was reintroduced to this MLRA. Despite once being native, they have the status of an exotic today. A true exotic, aoudad (or Barbary sheep) have adapted extremely well to this area after introduction from North Africa. Unlike much of Texas, this area is primarily low-fenced. However, there are a few high-fenced ranches with exotic species from all over the world. This MLRA also contains one of the only free-range herds of scimitar-horned oryx in Texas. These species are now extinct in their native continent of Africa.

Upland game birds, such as scaled quail, Gambel's quail, Montezuma quail, turkey, and dove are hunted in this area. Ciénegas, riparian corridors, and dirt water tanks scattered throughout the MLRA provide habitat for many types of waterfowl. The Rio Grande is an important route for migratory birds, such as ducks, geese, and sandhill cranes, and many species of shorebirds. This route is a branch of the Central Flyway and provides critical wintering habitat for some species. Common non-game birds in this MLRA include vultures, killdeers, nighthawks, woodpeckers, hummingbirds, horned larks, flycatchers, kingbirds, vireos, jays, ravens, swallows, wrens, thrashers, warblers, pyrrhuloxia, meadowlarks, and roadrunners. Birds of prey include owls, northern harriers, Cooper's hawk, Swainson's hawk, red-tailed hawk, and kestrels. Roughly three-quarters of the bird species in Texas inhabit this region.

There are many reptiles in this MLRA. Snakes make up the largest group, followed by lizards and then turtles. There are several poisonous snakes, including copperheads and a variety of rattlesnakes. Amphibians consist of frogs and toads. Fish such as gar, shad, minnows, shiners, catfish, chub, and mosquitofish inhabit waters throughout the area.

Land Use

Nearly all the MLRA is rangeland and currently used for livestock grazing, wildlife habitat, and recreation (fig. 42A-2). Because forage production is low, large acreages are necessary for sustainable ranching enterprises. Sale of trespass rights (hunting leases) is an important source of revenue for landowners. Sheep and goat production was important until the 1960s, but now cow-calf and stocker enterprises, mainly mixed zebu stock, dominate the area.

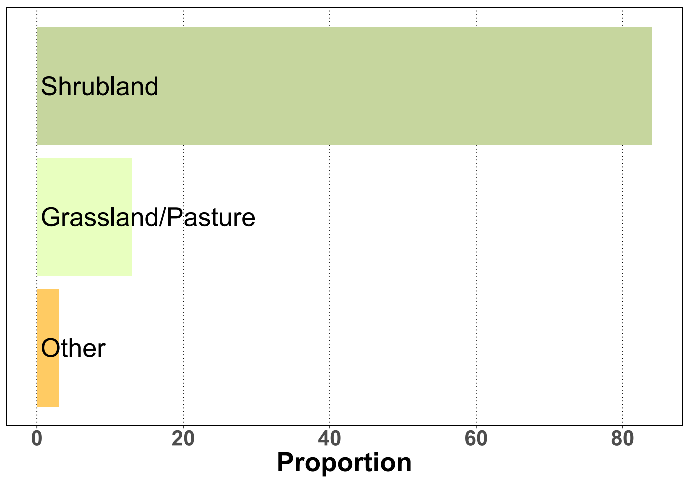

Figure 42A-2: Relative proportions (percentages) of land use in MLRA 42A.

Due to low rainfall, only irrigated cropland is practiced in the MLRA; dryland farming is not possible. Ground water is pumped from various aquifers located mainly within bolsons, including Dell, Lobo, Wild Horse, and Belding Valleys. Dominant crops are pecans, alfalfa, cotton, and small grains.

42B—Southern Rio Grande Rift

This area (fig. 42B-1) occurs in New Mexico (90 percent) and Texas (10 percent). It makes up about 16,125 square miles (41,763 square kilometers). MLRA 42B consists primarily of basins and mountain ranges. The basins are composed of deep alluvial fill defined by landforms characteristic of riverine deposits along the valley floor, bordered by extensive piedmonts ascending to the mountain fronts. The mountain ranges, of both sedimentary and igneous origin, supply sediment and watershed to the basin.

MLRA 42B is a subdivision of the Basin and Range province associated with the southern portion of the Rio Grande Rift Valley. The rift valley is a string of alluvium-filled basins that include the Albuquerque, Palomas, and Mesilla Basins, which are all connected by the Rio Grande, and the enclosed Tularosa

Figure 42B-1: Location of MLRA 42B, which covers 4,176,300 hectares (10,319,800 acres), within Region D.

Basin. Although this MLRA is dominated by rangeland, water from the Rio Grande is easily diverted within the basins, providing a source of agricultural and municipal water to an otherwise dryland region. La Bajada, the southern escarpment of the Cerros del Rio volcanic plateau, marks a distinct physical and climatic boundary that separates the northern and southern portions of the Rio Grande Rift Valley. From here, MLRA 42B extends south to Presidio, Texas, where the Rio Grande Rift tapers off between the Trans Pecos Rift and the border with Mexico.

The MLRA is bordered to the west by the Colorado Plateau and the mountains of the Mogollon transition area along with the western edge of the Santa Fe geologic group of formations. To the east, it is bordered by the Sacramento and Hueco Mountains as well as Chupadera and Otero Mesas.

Physiography

MLRA 42B is entirely in the Mexican Highland section of the Basin and Range province of the Intermontane Plateaus. This area is distinguishable by three basic components: 1) the north-south-trending, externally drained Rio Grande Rift Valley; 2) internally and externally drained, adjacent deep alluvial-fill intermontane basins and piedmonts; and 3) steep, north-south-trending, fault-block sedimentary mountains and old volcanic igneous hills and mountains. Elevation in the rift valley ranges from 1,551 meters (5,090 feet) at the northern boundary near Bernalillo, New Mexico, to 787 meters (2,582 feet) at Presidio, Texas. The highest elevation in the MLRA is around 2,743 meters (9,000 feet) at the Organ Needle in the Organ Mountains and Salinas Peak in the San Andres Mountains.

Geology

The north-south-trending Rio Grande Rift is the result of extensional rifting created from the Laramide orogeny. Eighty million years ago, the Farallon oceanic plate was subducted beneath the North American Plate. The compressional forces from this subducted plate created the proto-Rocky Mountains, and the subsequent extensional forces created the Basin and Range. As the subducted oceanic slab traveled west to east, extensive areas of volcanic activity created the Tertiary-age Organ Mountains, Sierra Blanca in the Sacramento Mountains, and the Sierra de las Uvas. Ongoing lateral forces widened the rift, thinning the surficial mantle. Isolated basins, such as the Albuquerque, Palomas, Engle, Hatch-Rincon, Jornada, and Mesilla, formed and were later joined into the Rio Grande. The rift's thinning mantle allowed magma closer to the surface to cool quickly, forming the Potrillo Mountains and the Aden-Afton, Pedro Armendariz, and Carrizozo lava flows. These forces also created north-south-trending, fault-block mountains, such as the San Andres, Caballo, and Franklin Mountains. These mountains are dominantly Permian- and Pennsylvanian-age sedimentary deposits of limestone, dolomite, and gypsum. The alluvial fill from these mountains formed the Jornada del Muerto, the gypsum-rich Tularosa Basin, and the Hueco Bolson.

Climate

The average annual precipitation is 7 to 23 inches (185 to 580 millimeters). Most of the rainfall occurs during high-intensity, convective thunderstorms from July through September. The average annual temperature is 51 to 65 degrees F (11 to 18 degrees C), decreasing to the north and with higher elevations.

Water

This MLRA has scarce surface water and low precipitation. The Rio Grande is the only perennial river. La Luz Creek, Tularosa Creek, and Malpais Springs, which flows from the Sacramento Mountains, are the only perennial water sources in the Tularosa Basin. Elephant Butte Dam controls flooding downstream and stores Rio Grande water for farmers in New Mexico, Texas, and Mexico.

Ground water in deep basin fill provides water for public supply, domestic use, livestock, and irrigation. Sand and gravel sediments in unconsolidated basin fill are the primary aquifers in this MLRA. Ground water within the Rio Grande Valley is generally of suitable quality. Ground water in piedmonts of the Sacramento Mountains is tolerable for irrigation. Water quality in the Tularosa Basin is unacceptable for most uses.

Soils

The dominant soil orders in MLRA 42B are Aridisols and Entisols and, at the higher elevations, Mollisols. The soil temperature regime in most of the MLRA is typic aridic thermic grading into ustic aridic and aridic ustic thermic as elevation increases. Ustic aridic and aridic ustic mesic regimes are in the San Andres and Organ Mountains and the Sierra de las Uvas.

Soil mineralogy is dominantly mixed, with carbonatic mineralogy in limestone-derived soils and gypsic and hypergypsic mineralogies in the Tularosa and Jornada Basins. Soils are generally very deep and nongravelly, except where they have petrocalcic horizons on the valley floor, basins, and piedmonts. Soils are generally shallow and very gravelly in the hills and mountains. Soils with high water tables and aquic conditions mainly occur in the Rio Grande Valley and in the hypergypsic dune areas in the Tularosa Basin.

The main soil series:

Berino series—Moderately aged Typic Calciargids that formed in alluvial sediments from mixed sources and have argillic and calcic horizons

Cacique series—Argic Petrocalcids more than 2 million years old that formed in Rio Grande sediments and have a very thick petrocalcic horizon

Deama series—Lithic Calciustolls that have carbonatic mineralogy and formed in limestone in the San Andres Mountains

Gila series—Young Typic Torrifluvents that formed in alluvial sediments on the flood plain of the Rio Grande Valley

Matador series—Gypsic Aquisalids that formed in gypsum and have high water tables and high sodium contents

Tencee series—Old Typic Petrocalcids that formed from mixed gravelly sources and have a petrocalcic horizon

Transformer series—Oxyaquic Torripsamments that formed in gypsum sands with high water tables in the Barchan dune system in the Tularosa Basin

University series—Young Typic Torripsamments that formed in eolian-modified alluvial sediments on the border of the Rio Grande Valley

Biological Resources

MLRA 42B supports four primary vegetative communities: desert shrub-desert grassland, pinyon-juniper, gypsiferous-saline soils, and isolated riparian. The desert shrub-desert grassland is characterized by dropseed, black grama, creosote bush, honey mesquite shrubs, and soaptree yucca; desert willow and Apache plume are in drainageways. The pinyon-juniper communities consist of oneseed juniper, alligator juniper, and Mexican pinyon pine with an understory of blue grama, sideoats grama, and New Mexico feathergrass. The communities of gypsiferous-saline soils consist of four-wing saltbush, iodinebush, seepweed, alkali sacaton, and gypsum grama grasses. The isolated riparian areas occur in the southern rift valley, most of which is in agriculture. Their plant communities consist of cottonwood, bosque, coyote willow, inland saltgrass, screwbean mesquite, and the invasive saltcedar.

Land Use

Most of the acreage in MLRA 42B is government owned. The rest of the land is in farms, ranches, or other private holdings (fig. 42B-2). Most of the rangeland has low carrying capacity. Irrigated cropland is mainly in the Rio Grande Valley and Tularosa Basin. Pecans, chilis, and cotton are the principal crops. Alfalfa and other feed and forage crops are also grown.

The major resource concerns are wind and water erosion, salinization of irrigated cropland, low species diversity, and invasive species on rangeland and in riparian areas. In this arid and semiarid MLRA, potential evaporation is often 10 times greater than precipitation. Most of the soils have low resistance to erosive forces because of low organic matter content in surface layers. The vegetative cover on rangeland is typically sparse, providing little protection against wind and water erosion.

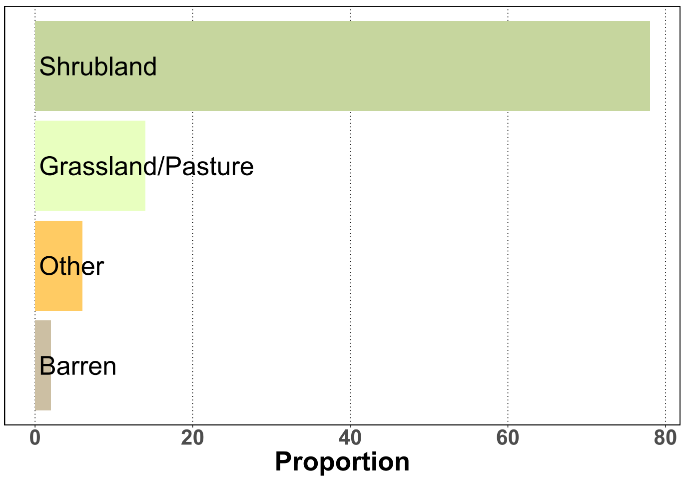

Figure 42B-2: Relative proportions (percentages) of land use in MLRA 42B.

Conservation practices on rangeland include development of livestock watering structures, such as pipelines and solar pumps, to facilitate grazing management systems; fencing, which also facilitates grazing management; and brush management, which removes undesirable and introduced species. Conservation practices on irrigated cropland include minimum or no-till operations, which improve soil structure and increase organic matter content; improved irrigation systems, such as drip and micro sprinklers, which increase both yields and water use efficiency; and management of riparian systems, such as removal of saltcedar and Russian olive and replanting of native species.

42C—Central New Mexico Highlands

This area (fig. 42C-1) is in New Mexico (99 percent) and Texas (1 percent). It makes up about 18,588 square miles (48,144 square kilometers). MLRA 42C is the high-elevation

Figure 42C-1: Location of MLRA 42C, which covers 4,814,400 hectares (11,896,500 acres), within Region D.

portion of central New Mexico where four major physiographic provinces converge: Basin and Range, Southern Rocky Mountains, Great Plains, and Colorado Plateau. It contains parts or characteristics of each province, although tectonically, as a region, it is the easternmost extent of the Basin and Range province and, more specifically, a structural expression of the Rio Grande Rift. It consists mostly of rangeland with some forested areas associated with numerous disconnected mountain ranges, such as the Guadalupe, Sacramento, and Manzano Mountains. Other major physiographic features include Galisteo Basin of the enclosed Estancia Basin, the structural Chupadera and Glorieta Mesas, and the piedmonts of the Buchanan and Guadalupe Mesas.

Boundary Concepts

This MLRA shares boundaries with five other MLRAs: 42A, 42B, 48A, 70A, and 70B. It is bordered by several large basins. The Tularosa Basin and Rio Grande Rift Valley are to the west, and the Pecos River Basin is to the east. The MLRA meets the southern extent of the Rocky Mountains to the north and the Trans-Pecos Rift to the south.

MLRA 70A (High Plateaus of the Southwestern Great Plains) shares a short boundary with MLRA 42C in its far northeastern corner, at the bottom of escarpments from the elevated Canadian Plateaus to its east. It is an area of transition from the Southern Rocky Mountains to the Southern Great Plains. It is characterized by high-elevation, low-relief plateau surfaces of mostly Cretaceous-age bedrock and sediments that gently slope eastward. Parent materials are primarily from marine shales, basaltic flows from Jemez Lineament-derived volcanics, or thin, dry deposits of high-plain piedmonts derived from Sangre de Cristo alluvium. In contrast, MLRA 42C does not have Cretaceous shale parent materials. Volcanic features in MLRA 42C are confined within the fault-block Basin and Range structures, and the piedmont deposits on its eastern flank are derived from Central New Mexico mountain ranges. The proximity to seasonal moisture patterns tied to circulation from the Gulf of Mexico is more pronounced in MLRA 70A than in MLRA 42C, resulting in higher precipitation during spring. This additional moisture in the cooler months gives MLRA 70A an aridic ustic soil moisture regime; most of MLRA 42C has an ustic aridic regime.

MLRA 70B (Pecos and Canadian River Basins) shares its western boundary with MLRA 42C. This boundary generally has three parts in MLRA 42C: the northern, southern, and middle sections. The northern section occurs where the Pecos Basin borders plateaus and piedmonts descending from highlands that stretch from Glorieta Mesa to Gallinas Peak. The southern section occurs along the margin of the Sacramento and Guadalupe Mountains where the primarily bedrock-controlled soils transition to the deeper alluvial piedmont soils of MLRA 70B. In the middle section, evaporite-bearing shales of the Permian Redbeds of the Artesia Group surface within the basin and form an intermittent boundary where they meet contrasting landscapes. In several areas, however, the boundary is subtle and more complicated.

A relatively short section of the boundary, in the northeast part of MLRA 42C along the Pecos River where it transitions from a mountain valley stream system to a basin, is centered where the Pecos River begins to enter smaller valleys, such as Anton Chico, and is characterized by a landscape shift from the elevated plateaus and plains of MLRA 42C to the basins of MLRA 70B. Here, MLRA 42C is on the more tectonically elevated landscapes that have exposed older Permian limestone whereas MLRA 70B is on materials from younger geologic formations, primarily from Triassic red beds of sandstones and mudstones. The exception is the redbed shale and evaporite (gypsum) of the Late-Permian Artesia Group where they appear on basin surfaces in MLRA 70B.

Elevated piedmont slopes that descend from Central New Mexico mountain ranges would form a continuous surface with the Southern High Plains of Texas except that they are punctuated by incisions of the Pecos River Basin. These features of MLRA 42C occur on surfaces above and outside of the basin, and therefore predate the basin's formation. In the time since the basin formed, there have also been piedmont-type deposits that occur entirely within the basin, and although they share some similarities, such as secondary carbonates and even petrocalcic layers, these basin piedmont remnants are in MLRA 70B. There are no locations where these two types of piedmont surfaces overlap or contact one another.

At the western margin of the Pecos Basin, the MLRA 70B soils are distinguishable from piedmonts of MLRA 42C in that they are on erosional landforms and therefore are typically over bedrock with parent materials highly influenced by bedrock properties. Hues are typically redder than 7.5YR, fragments are sedimentary rock, and oneseed juniper has historically been present at this site. At the boundary between MLRAs 70B and 42C, the following key can be used to determine in which MLRA a site is located:

1. If the site is bedrock controlled (“bedrock” does not include a petrocalcic or indurated caliche layer) with contact to sandstone or shale within a depth of 150 centimeters or has a dominance of sandstone or shale in any gravel or cobbles, then it is in MLRA 70B; if it is not, then go to item 2.
2. If the soil profile has colors of 5YR or redder throughout and contains any amount of shale or sandstone fragments of similar hues, then the site is in MLRA 70B; if hues are yellower than 5YR, then go to item 3.
3. If the landscape slopes 5 percent or more towards the Pecos River, then the site is in MLRA 70B; if the landscape slopes less than 5 percent, then the site is in MLRA 42C.

MLRA 42A (Trans-Pecos Mountains, Plateaus, and Basins) meets the southern portions of MLRA 42C at the base of the Sacramento and Guadalupe Mountains. Between these mountain ranges, the boundary with MLRA 42A occurs where Otero Mesa grades into the rugged topography of the Collins Hills. Abundant pinyon and juniper communities are at the higher elevations.

MLRA 42B (Southern Rio Grande Rift) encompasses the lower half of the Rio Grande Rift Valley from La Bajada, south of Santa Fe, into Texas. It includes the Tularosa Basin. It is essentially the entire western border of MLRA 42C to the margins of the Otero Mesa fault block. Along the Tularosa Basin, the boundary is at the contact between landforms derived from basin fill and bedrock-controlled landscapes of the Sacramento and Oscura Mountains. The Carrizozo lava flows and the volcanic soils of Little Black Peak remain in MLRA 42B. At Mockingbird Gap, where the Oscura Mountains split off from the San Andres Mountains, landforms from Precambrian materials of the Oscura escarpment are in MLRA 42C and all other fault-block-derived landforms to the south and west remain in MLRA 42B. Moving north from here, the boundary occurs where deeper Rift Valley sediment-derived landforms in MLRA 42B transition to bedrock-controlled landforms of the fault-thrusted terrain in MLRA 42C. At the northern boundary of MLRA 42B, at La Bajada, the boundary with MLRA 42C is where volcanic landforms of the Caja del Rio meet those of the Galisteo Basin, which has soils derived from sedimentary plateau bedrock.

MLRA 48A (Southern Rocky Mountains) shares a boundary with the northernmost extent of MLRA 42C along a convergence of terrain about 60 miles long. At this junction, an obvious boundary exists where an escarpment from Glorieta Mesa descends to Glorieta Pass, the point at which Glorieta Creek flows west and the Pecos River Basin drains to the southeast. The boundary with MLRA 42C is at the edge of the plateau margin of Glorieta Mesa while the escarpment slopes below are within MLRA 48A. Otherwise, the landscapes that are constructed by igneous-intrusive bedrock (granite, gneiss, and schist) are also in MLRA 48A. Any fan piedmont slopes descending from these foothills or other parts of the Rocky Mountains towards Santa Fe or the Estancia Basin are outside of MLRA 42C.

Geology and Physiography

This area is in the Sacramento section of the Basin and Range province of the Intermontane Plateaus. It is characterized by block-faulted ranges separated by intermountain basins and contains a vast but tangled mosaic of alternating and contrasting landscapes. Mountain ranges in this area are built by uplift of crustal blocks, which erode sediment into basins below. Some of the basins, such as the Estancia Basin, are internally drained and accumulate evaporites at their lowest points, features characteristic of the Basin and Range. Where landscapes are neither mountains nor basins, they transition to either tablelands and mesas capped by sedimentary rocks or to piedmont slopes of Quaternary-age or Tertiary-age alluvial deposits. The larger landscape features in the north include Glorieta Mesa, Galisteo Basin, Cerrillos Hills, South Mountains, Sandia Mountains, Manzano Mountains, Estancia Basin, and Guadalupe and Buchanan Mesas. Those in the central part are the Gallinas Mountains, Chupadera Mesa, Oscura Mountains, Carizzo Mountains, and Capitan Mountains. Those in the south are the White Mountains, Sacramento Mountains, Otero Mesa, and Guadalupe Mountains. Notable high points are Sierra Blanca Peak at 11,973 feet (3,649 meters) near Ruidoso, New Mexico; Sandia Crest at 10,678 feet (3,254 meters) above Albuquerque; and Guadalupe Peak at 8,749 feet (2,667 meters), the highest point in Texas, in the Guadalupe Mountains National Park. The lowest points are near Carlsbad, New Mexico, where the Permian-age dolomite fault block dips down to meet the valley border of the Pecos River Basin, around 3,200 feet in elevation.

Climate

Rainfall in this area is highest in summer. Mountainous areas can receive snowpack in winter, which leads to soil moisture in the spring and water for stream channels at lower elevations. However, winter snowpack can be variable, especially in a warming climate, and may become less reliable. Monsoonal plumes of moisture from the Gulf of Mexico fuel the summer thunderstorms, which are mostly brief and intense. During extended wet monsoons, rain can be spread over longer weather windows and lead to deeper moistening of the soils. There is a subtle moisture pattern across the MLRA showing an expansion of the growing-season rainfall into spring and fall with an easterly direction. This effect can be complicated to the south and east by the proximity to Chihuahuan Desert air that tends to be hotter and drier. In contrast, the northern part of the MLRA is affected by colder air masses from the southern Rocky Mountains.

The average annual precipitation is 11 to 41 inches (279 to 1,031 millimeters), occurring mostly in summer. The average annual temperature is 42 to 63 degrees F (6 to 17 degrees C). The freeze-free period averages 190 days and ranges from 135 to 250 days, decreasing in length as elevation increases.

Water

Water is scarce throughout the area because of the low and erratic precipitation and the lack of surface water sources. The northern two-thirds of this MLRA does not have perennial streams, and many of the waterways lead to an enclosed basin. Estancia Basin has a large reservoir of brackish water that, due to historic withdrawals, is encroaching on the thin ring of freshwater at the basin margins. Much of the surface water used in this MLRA is from western tributaries to the Pecos River, which cross a few parts of the MLRA in the northeast. The surface water is generally of good quality because it has not been subjected to agricultural return flows. Other major perennial streams and rivers that are sourced from watersheds of the southern mountains of MLRA 42C include Rio Bonito, Rio Ruidoso, Tularosa Creek, and Rio Peñasco.

There are some local water-quality concerns where wastewater from oil and gas development or potash mining is discharged into the surface water. Permian limestone aquifers underlie the northeastern and southeastern parts of this MLRA. Most of the water from these aquifers is not of very good quality, but some karstic reservoirs of good quality exist. Interbedded evaporite deposits often render the water high in salinity. Another source of ground water is the alluvial deposits in the valleys along the few large streams. The water from these deposits is of good enough quality to be used for domestic and livestock supplies and for some limited irrigation. Small amounts of ground water are in fractures and joints in the bedrock on uplands.

Soils

The dominant soil orders in this MLRA are Aridisols, Entisols, and Mollisols. Most of the soils are Argids, Calcids, Ustolls, or Orthents. Generally, the soil moisture regime is aridic bordering on ustic, but areas of pinyon-juniper woodland and savanna at the higher elevations can be ustic bordering on aridic. Soils have a mesic temperature regime and mixed or carbonatic mineralogy. They are typically well drained and are moderately coarse textured to moderately fine textured. Some high clay soils are in isolated areas near shale sources or in playas. Some overblown or sandy areas occur leeward of basin floors or large stream valleys.

The main soil series:

- Clovis series—Calciargids that formed in deep loamy alluvium on piedmonts and other uplands
- Deama series—Shallow Calciustolls that formed from limestone materials with carbonatic mineralogy
- Dean series—Haplocalcids that formed in limestone alluvium with carbonatic mineralogy and carbonates throughout
- Harvey series—Haplocalcids that formed from alluvium and loess from sedimentary rocks
- Laporte series—Shallow Haplustolls that formed from limestone materials on rocky, steep slopes
- Otero series—Torriorthents that formed on uplands in calcareous eolian and alluvial materials
- Pastura series—Shallow Petrocalcids that overlie degrading petrocalcic horizons
- Penistaja series—Haplargids that formed in alluvium from sedimentary bedrock on mesas and uplands
- Tapia series—Calciargids that formed in deep loamy alluvium with petronodes on piedmonts and other uplands
- Tortugas series—Shallow Haplustolls that formed from calcareous sedimentary bedrock on rocky, steep slopes
- Willard series—Haplocalcids that formed from silty lacustrine deposits in old lake basins
- Witt series—Calciargids that formed in deep, silty eolian deposits on alluvial piedmonts and other uplands

Biological Resources

At the higher elevations, the soils can support plant communities of juniper-pinyon savanna and pinyon-juniper woodland. The diverse understory is dominated by sideoats grama, little bluestem, blue grama, bottlebrush squirreltail, western wheatgrass, pinyon ricegrass, Bigelow sagebrush, and winterfat. The soils at the lower elevations support a mixed grassland prairie of little bluestem, grama grasses, western wheatgrass, galleta, and New Mexico feathergrass with common shrubs such as sagebrush and sumac. Alkaline soils favor fourwing saltbush, winterfat, and alkali sacaton, which are also common shrub species in bottom lands. Bottom lands at the lower elevations are dominated by western wheatgrass. Areas at the higher elevations also have bluestems and Arizona fescue.

Major wildlife species include antelope, badger, porcupine, skunk, jackrabbit, cottontail, prairie dog, kangaroo rat, ground squirrel, pocket gopher, pocket mouse, sparrow hawk, red-tailed hawk, golden eagle, Swainson’s hawk, Cooper’s hawk, marsh hawk, prairie falcon, scaled quail, burrowing owl, raven, western kingbird, meadowlark, horned lark, warbler, mourning dove, box turtle, rattlesnake, western coachwhip snake, Texas horned lizard, and plains spadefoot toad.

Land Use

Most of this MLRA is grassland and managed for cattle and sheep (fig. 42C-2). Land ownership is about four-fifths private and one-fifth Federal or State. Large areas adjacent to the mountains are forested and include some timber harvesting, mostly for fuelwood. Conservation practices on rangeland generally include prescribed grazing, fencing, brush management, and development of watering facilities. A small percentage of the area is irrigated cropland. Most of this cropland is in the Estancia Basin, but smaller areas occur along streams or on bottom land where ground water can be mined. Conservation practices on cropland generally include conservation tillage, crop residue management, and irrigation water management. The major soil resource concerns are wind erosion, water erosion, maintenance of the content of soil organic matter, and management of soil moisture.

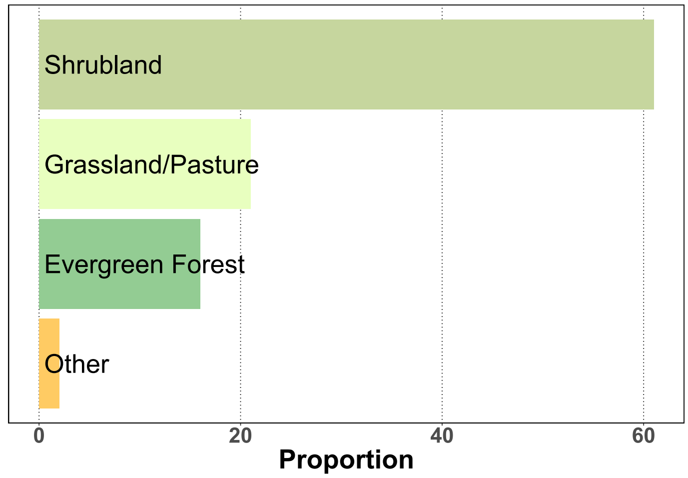

Figure 42C-2: Relative proportions (percentages) of land use in MLRA 42C.

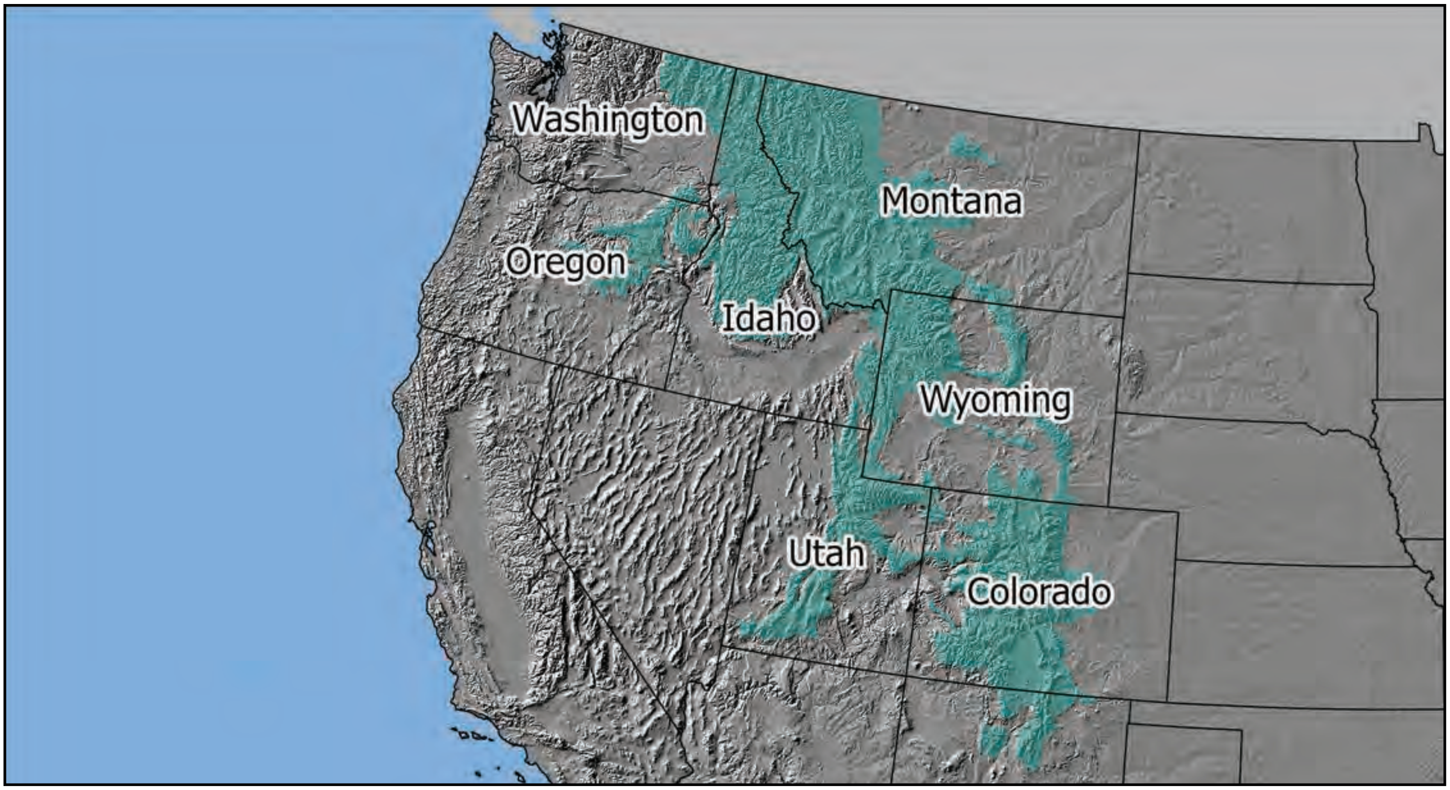

Figure E-1: Location and size of Land Resource Region E, which covers 616,625 square kilometers (238,080 square miles) of mountainous terrain from New Mexico to Canada.

E—Rocky Mountain Range and Forest Region

Land Resource Region E (fig. E-1) is a sprawling chain of rugged mountains, broad valleys, and high plateaus from New Mexico to Canada. Most of the mountain chains are northwest-southeast-trending, some have an east-west trend, and many others lack alignment. The mountains, which have 46 peaks above 14,000 feet in elevation, consist of a variety of volcanic and sedimentary rock types. Many have been raised so high by tectonic uplift that erosion has removed overlying younger strata, thus exposing their Precambrian igneous and metamorphic cores. The mountains were glaciated several times and display U-shaped valleys, cirques, moraines, glacial lakes, block fields, rock glaciers, and patterned ground. Region E contains 11 major land resource areas. The extent of these MLRAs and their range in elevations are shown in table E-1.

The boundary between Regions E and D (fig. 1, page 5) is physio-climatic: the mountains of Region E are higher, steeper, cooler, wetter, and more forested. These conditions also pertain to the boundary between Region E and the grassland-dominated Region G. The boundary between Regions E and F marks the contact between the mountain foothills (Region E) and the cropland on the glacial deposits of the northern High Plains. The boundary between Regions E and B is roughly the boundary between the Northern Rocky Mountains physiographic province and the lava-field-dominated Columbia Plateaus physiographic province. Other differences between Regions E and B include a change in soils from dominantly Inceptisols and Andisols in the Northern Rocky Mountains to Mollisols and Aridisols with increased amounts of carbonate in Region B (figs. 2 and 5, pages 6 and 9). More cropland and warmer, drier climates also occur across the boundary with Region B (see Introduction, figs. 6, 7, and 8).

The climate in Region E results in soils that dominantly have a frigid soil temperature regime and ustic, xeric, and udic soil moisture regimes. The average annual precipitation ranges from 6 inches (160 millimeters) in some of the valleys to more than 100 inches (2,540 millimeters) on some of the mountain peaks. The average annual temperature ranges from 22 to 60 degrees F (5.6 to 16 degrees C). The mean freeze-free period is 90 days or less in the high mountains, where freezing temperatures occur every month of the year. Some areas on the highest mountains are covered by glaciers. The ground is permanently frozen in these areas. The freeze-free period on the foothills in the southern part of the region is as long as 190 days in some years. Temperatures and precipitation for this region are shown in

Table E-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
43A	91,125	35,185	250	820	740	2,450	1,260	4,130	1,910	6,280	3,180	10,440
43B	192,025	74,140	410	1,360	1,430	4,690	2,070	6,790	2,740	9,000	4,200	13,790
43C	33,480	12,930	470	1,560	1,120	3,680	1,470	4,830	1,870	6,140	2,990	9,800
44A	15,615	6,030	530	1,740	680	2,250	940	3,090	1,320	4,340	2,150	7,060
44B	15,420	5,955	1,110	3,650	1,300	4,280	1,590	5,220	2,020	6,630	2,950	9,670
46	48,660	18,790	940	3,100	1,180	3,890	1,480	4,860	2,360	7,760	3,300	10,840
47	52,520	20,280	1,150	3,790	1,870	6,160	2,340	7,670	2,980	9,790	4,100	13,470
48A	131,885	50,920	1,310	4,300	2,180	7,150	2,670	8,780	3,350	11,000	4,390	14,410
48B	6,415	2,475	2,220	7,280	2,410	7,930	2,610	8,580	2,900	9,520	3,410	11,190
49	19,715	7,610	1,490	4,890	1,730	5,700	1,980	6,520	2,360	7,750	3,120	10,230
51	9,760	3,770	2,170	7,120	2,290	7,540	2,330	7,660	2,500	8,200	3,340	10,960

Table E-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
43A	-2.1	28	2.8	37	5.4	42	8.1	46	11.9	53	50	89	125/125	156	215
43B	-5.6	22	0.8	34	3.4	38	6.4	43	10.9	52	35	65	85/90	125	180
43C	-0.4	31	4.8	41	6.4	43	7.8	46	10.5	51	40	75	111/110	141	185
44A	1.5	35	5	41	6.9	44	7.8	46	8.6	47	75	109	136/130	148	175
44B	0.3	32	2.8	37	5.8	43	7.2	45	8	46	60	76	115/110	130	150
46	0.7	33	3.1	38	5.7	42	7.4	45	9.7	50	50	83	119/115	139	155
47	-3.7	25	2.5	37	5.7	42	8.5	47	15.6	60	35	87	107/110	141	240
48A	-5.1	23	0.9	34	4.3	40	7.9	46	12.8	55	35	81	102/105	141	195
48B	0.5	33	2.6	37	3.1	38	3.6	38	4.7	40	70	81	87/90	95	110
49	0.9	34	4.7	41	7.9	46	9.8	50	11.4	52	75	108	136/135	156	165
51	2.4	36	5.4	42	5.8	42	6.3	43	7.7	46	100	106	112/115	125	140

Table E-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
43A	230	9	476	19	875/935	34/37	1,462	58	2,820	111
43B	200	8	362	14	657/685	26/27	1,053	41	2,480	97
43C	300	12	444	17	648/710	25/28	1,088	43	1,940	76
44A	260	10	357	14	503/555	20/22	821	32	1,440	57
44B	220	9	272	11	356/365	14/14	472	19	940	37
46	160	6	296	12	387/400	15/16	527	21	1,090	43
47	180	7	333	13	562/595	22/23	906	36	1,700	67
48A	180	7	383	15	572/630	23/25	956	38	1,860	73
48B	260	10	318	13	389/415	15/16	557	22	930	36
49	310	12	390	15	457/460	18/18	543	21	820	32
51	180	7	200	8	228/250	9/10	334	13	840	33

figures 6 and 7. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables E-2 and E-3.

Soils in Region E are dominantly Alfisols (Cryalfs) and Entisols (Orthents) on the upper mountain slopes and crests. Inceptisols (Cryepts and Ustepts) and Mollisols (Cryolls and Ustolls) formed on the mountain slopes and in the valleys in the southern Rocky Mountains. Northward into the middle and northern Rocky Mountains, the xeric soil moisture regime replaces the ustic regime and Xerepts and Xerolls occur. Volcanic ash deposits also become more common northward, resulting in increasing extents of Andisols (fig. 2). Carbonates are less abundant in Region E than in neighboring land resource regions, with the exception of areas in southwestern Montana at lower elevations that have a drier climate and limestone soil parent material (fig. 5). Many soils in Region E have restrictive zones of lithic and paralithic bedrock and densic material (fig. 9, page 13). Argillic horizons indicate at least moderate landscape stability in the region despite the steep slopes (fig. 12, page 16). Organic carbon accumulation in the forest soils of Region E is greater than in the more arid neighboring land resource regions, but still less than the forest soils of the Pacific Northwest (fig. 14, page 18).

Land use is dominantly forest, followed by shrubland and grassland or pasture (fig. E-2 and fig. 8). The mountain slopes generally are forested, and the valleys are dominated by shrubs and grasses. Grazing is the leading land use in the valleys and mountains, but timber production is important on some of the forested mountain slopes. Recreation is an important use throughout the region. Some of the valleys are irrigated, and some are dry-farmed. Grain and forage for livestock are the main crops. Beans, sugar beets, peas, and seed crops are grown where soils, climate, and markets are favorable. The major

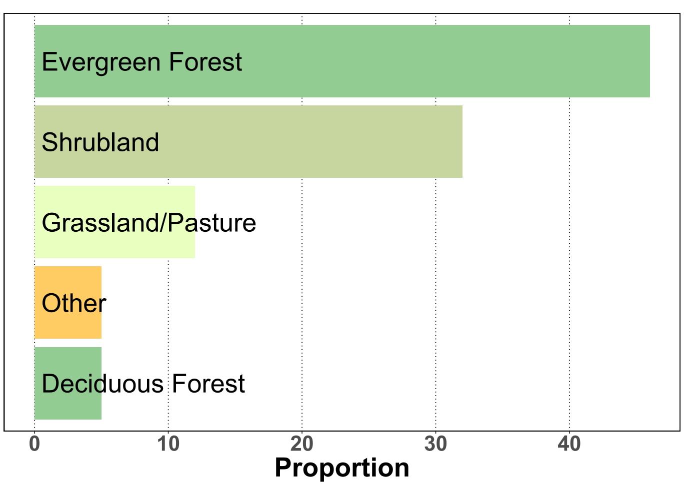

Figure E-2: Relative proportions (percentages) of land uses in Land Resource Region E (National Agricultural Statistics Service, 2018).

resource concerns are water erosion; steep slopes; shallow, rocky soils; and a short growing season.

43A—Northern Rocky Mountains

This area (fig. 43A-1) is in Montana (44 percent), Idaho (33 percent), and Washington (23 percent). It makes up about 35,183 square miles (91,124 square kilometers). This MLRA is characterized by rugged, glaciated mountains; thrust- and block-faulted mountains; and hills and valleys. It is bordered by Canada to the north; MLRAs 8 (Columbia Plateau) and 9 (Palouse and Nez Perce Prairies) to the west; MLRA 43B (Central Rocky Mountains) to the south; and MLRA 46 (Northern and Central Rocky Mountain Foothills) to the east.

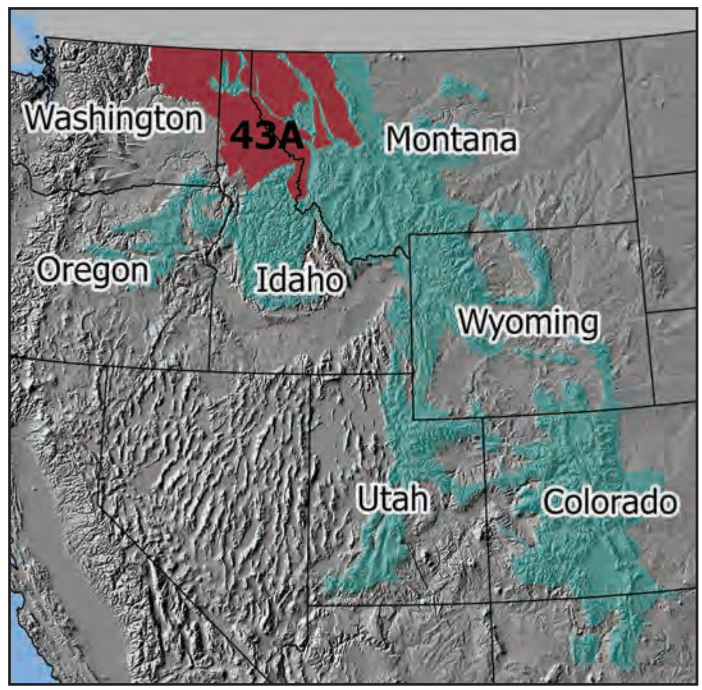

Figure 43A-1: Location of MLRA 43A, which covers 9,112,400 hectares (22,517,200 acres), within Region E.

Physiography

This area is mainly in the Northern Rocky Mountains province of the Rocky Mountain System; a small part is in the Walla Walla Plateau section of the Columbia Plateaus province of the Intermontane Plateaus.

Elevation is about 1,800 to 3,500 feet (550 to 1,065 meters) in the valleys and about 5,000 to 7,000 feet (1,525 to 2,135 meters) on most mountain peaks. It is 10,110 feet (3,082 meters) on Kintla Peak, which is in Glacier National Park, near the Canadian border. Steep-gradient rivers have cut deep canyons. Natural and manmade lakes are common in the area. Numerous rivers originate in or flow through this area, including, from west to east, the Sanpoil, Columbia, Pend Oreille, Kootenai, St. Joe, Thompson, and Flathead Rivers.

Geology

This area is underlain primarily by stacked slabs of layered sedimentary bedrock. The bedrock formations range from Precambrian to Cretaceous in age. They consist of shale, sandstone, siltstone, limestone, argillite, quartzite, gneiss, schist, dolomite, basalt, and granite. The formations have been faulted and stacked into a series of imbricate slabs by regional tectonic activity. Pleistocene glaciers carved a rugged landscape that includes sculpted hills and narrow valleys filled with till and outwash.

Climate

The average annual precipitation is 25 to 60 inches (635 to 1,525 millimeters) in most of this area, but it is as much as 111 inches (2,820 millimeters) in the mountains and as little as 10 to 15 inches (255 to 380 millimeters) in the western part. Summers are dry. Most of the precipitation during fall, winter, and spring is snow. The average annual temperature is 32 to 51 degrees F (0 to 11 degrees C) in most of the area, decreasing with elevation. In most of the area, the freeze-free period averages 133 days and ranges from 50 to 215 days. It is longest in the low valleys of Washington, and it decreases in length with elevation. Freezing temperatures occur every month of the year on high mountains, and some peaks have a continuous cover of snow and ice.

Water

The moderate precipitation and many perennial streams and lakes provide ample surface water. About 90 percent of the water used within this area is diverted from streams to irrigate high-mountain hay meadows. The remaining 10 percent is used mainly by the mining and timber industries. The surface water is of good quality. This area supplies water to the adjoining MLRAs for irrigation and other uses. Springs in the valleys provide some water for livestock and domestic use.

Shallow wells in the alluvium and glacial outwash in intermountain valleys and in some fractured zones in bedrock provide water for domestic use and livestock. Elsewhere, the supplies of ground water are small and mostly untapped.

Soils

The dominant soil orders in this MLRA are Andisols, Inceptisols, and Mollisols. Many of the soils are influenced by Mount Mazama ash deposits. The soils in the area have a frigid, cryic, or mesic temperature regime; an ustic, xeric, or udic moisture regime; and dominantly mixed mineralogy. They are shallow to very deep, are very poorly drained to well drained, and have most of the soil texture classes.

The main soils and their series at the higher elevations:
- Dystrocryepts (Jeru, Priestlake, and Prouty series)
- Haplocryepts (Holloway, Risingwolf, and Waldbillig series)
- Vitricryands (Manley series)

The main soils and their series at the lower elevations:
- Eutrudepts (Courville, Mitten, and Tevis series)
- Haploxerepts (Aits series)
- Haploxerolls (Bigarm, Donavan, and Spokane series)
- Haplustepts (Repp, Wildgen, and Winkler series)
- Udivitrands (Bouldercreek, Honeyjones, and Huckler series)
- Vitrixerands (Nevine series)

Biological Resources

In the northern part of the Northern Rocky Mountains, Grand fir, Douglas-fir, western redcedar, western hemlock, western larch, lodgepole pine, subalpine fir, ponderosa pine, whitebark pine, and western white pine are the dominant overstory species. Species vary according to precipitation, temperature, elevation, and landform aspect. The understory vegetation also varies depending on climatic and landform factors.

Major wildlife species include white-tailed deer, mule deer, elk, moose, black bear, grizzly bear, coyote, fox, and grouse. Fish, mostly in the trout and salmon families, are abundant in streams, rivers, and lakes.

Land Use

More than one-half of this area is federally owned and administered by the U.S. Department of Agriculture, Forest Service. Much of the privately owned land is controlled by large commercial timber companies. The forested areas are used for wildlife habitat, recreation, watershed, livestock grazing, and timber production (fig. 43A-2). Meadows provide summer grazing for livestock and big game animals. Less than 3 percent of the area is cropland.

The major soil resource concerns are water erosion, soil productivity, and surface compaction. Water resource concerns

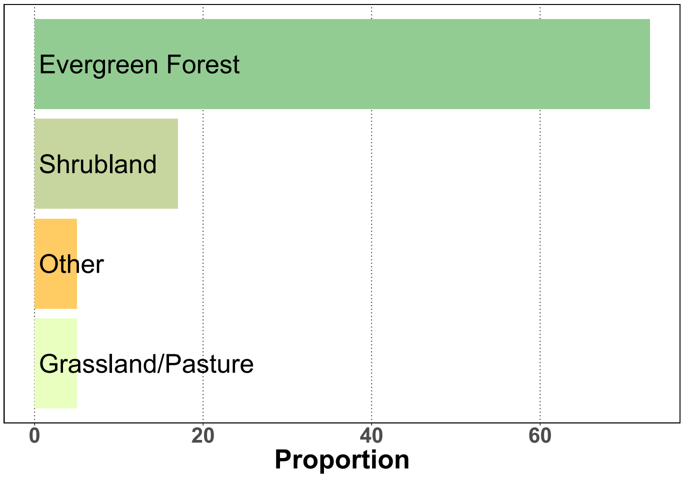

Figure 43A-2: Relative proportions (percentages) of land use in MLRA 43A.

include degradation of water quality. Plant resource concerns are plant productivity, health, and vigor; noxious and invasive plants; and the hazard of wildfires. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control compaction, the erosion caused by concentrated flow, and sediment delivery to streams.

43B—Central Rocky Mountains

This MLRA (fig. 43B-1) is in Montana (39 percent), Idaho (32 percent), and Wyoming (29 percent). It makes up about 74,142 square miles (192,026 square kilometers). It is characterized by rugged, glaciated mountains, thrust- and block-faulted mountains, hills, plateaus, and valleys. The Continental Divide runs through it. The area is bordered by MLRA 43A (Northern Rocky Mountains) to the north; MLRAs 9 (Palouse and Nez Perce Prairies), 43C (Blue and Seven Devils Mountains), 10 (Central Rocky and Blue Mountain Foothills), and 13 (Eastern Idaho Plateaus) to the west; MLRAs 12 (Lost River Valleys and Mountains) and 46 (Northern and Central Rocky Mountain Foothills) to the south; and MLRA 46, MLRA 32 (Northern Intermountain Desertic Basins), and MLRA 58B (Northern Rolling High Plains, Southern Part) to the east.

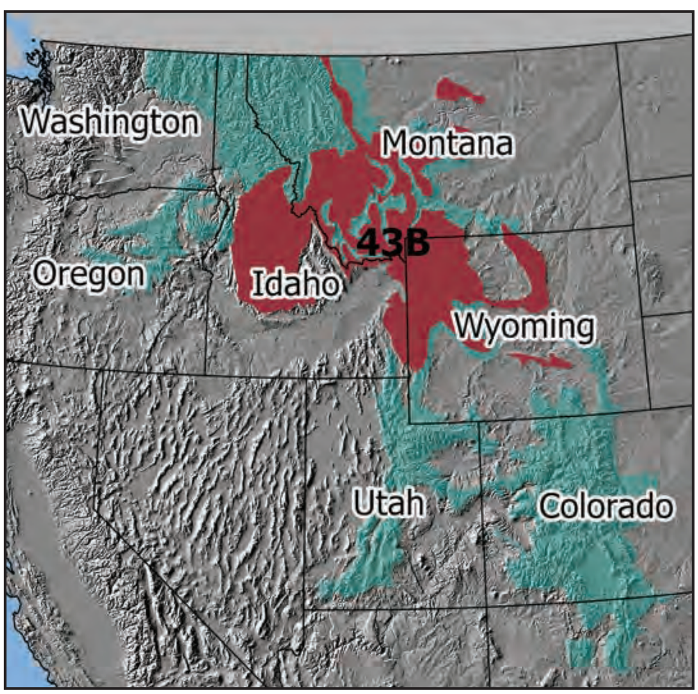

Figure 43B-1: Location of MLRA 43B, which covers 19,202,600 hectares (47,450,500 acres), within Region E.

Physiography

Most of this area is in the Northern Rocky Mountains province of the Rocky Mountain System. Most of the southeastern part in Wyoming is in the Middle Rocky Mountains province of the same division. Steep-gradient rivers have cut deep canyons. Lakes are common, especially in glaciated areas. Most mountain peaks reach an elevation of 6,000 to 8,000 feet (1,830 to 2,440 meters), but peaks exceeding 10,000 feet (3,050 meters) are not uncommon. The highest points in Montana and Wyoming are in this MLRA. They are Granite Peak, which reaches an elevation of 12,799 feet (3,902 meters), and Gannett Peak, which reaches an elevation of 13,804 feet (4,208 meters).

The headwaters of the Columbia and Missouri Rivers are in this MLRA. Rivers draining the western slope of the Continental Divide in this area drain into the Pacific Ocean, and rivers on the eastern side drain into the Gulf of Mexico.

Geology

A variety of rock types from many different geologic eras are exposed in the Rocky Mountains. The rock types include igneous, metamorphic, limestone, and sandstone in the Belt Mountains of Montana; granite in Idaho; quartzite and argillite in the Beaverhead Mountains; and sedimentary rocks in the Big Horn Mountains of Wyoming. Glacial till and outwash are in most mountain valleys. Recent alluvium commonly covers the glacial deposits on the valley floors.

Climate

The average annual precipitation is 25 to 60 inches (635 to 1,525 millimeters) in most of this area; it is as much as 97 inches (2,480 millimeters) at the higher elevations west of the Continental Divide and is 8 to 25 inches (200 to 635 millimeters) in the valleys and at lower elevations at the edges of the area. Summers are typically dry, except for brief but intense convective thunderstorms that occur most afternoons in the mountains. Most of the precipitation during fall, winter, and spring is snow.

The average annual temperature is 22 to 52 degrees F (-5.6 to 10.9 degrees C). The freeze-free period averages 108 days and ranges from 35 to 180 days. It is longest in the lower valleys and shortest in the mountains. Freezing temperatures occur every month of the year in the mountains, and some peaks have a continuous cover of snow and ice.

Water

Moderate precipitation and many perennial streams and lakes provide ample surface water. About 75 percent of the water used within this area is diverted from streams to irrigate hay meadows. Some of the water is used by the mining and logging industries or for public supplies in tourist centers. The surface water is of good quality. This area supplies water to the adjoining MLRAs for irrigation and other uses. Springs in the valleys provide some water for domestic use and livestock.

Shallow wells in the alluvium and glacial outwash on valley floors provide water for domestic use, livestock, and some irrigation. Elsewhere, the supplies of ground water are small and mostly untapped.

Soils

The dominant soil orders in this area are Alfisols, Inceptisols, and Mollisols. The soils in the area dominantly have a cryic or frigid temperature regime and an ustic, udic, or xeric moisture regime. Soils on mountain side slopes and ridges formed in colluvium, residuum, and glacial till and have mixed mineralogy. Areas of rock outcrop and rubble land are on ridges and peaks above the timberline. Most of the soils are skeletal and medium textured to coarse textured.

The main soils and their series:

- Cryalfs (Cloud Peak and Worock series)
- Cryepts (Whitore and Tropal series)
- Cryolls (Libeg and Hanson series)
- Ustalfs (Mocmont and Yreka series)
- Ustepts (Whitecow and Winkler series)
- Xerepts (Sprollow and Packerjohn series)

Biological Resources

This area supports coniferous forests. Forests of ponderosa pine, lodgepole pine, Douglas-fir, subalpine fir, and spruce are common. Alpine grasses, forbs, and shrubs and scattered stands of subalpine fir, spruce, and whitebark pine occur at high elevations. Major wildlife species include elk, mule deer, white-tailed deer, moose, grizzly bear, black bear, mountain lion, bobcat, lynx, bighorn sheep, mountain goat, coyote, gray wolf, mountain grouse, and numerous songbirds.

Land Use

More than three-fourths of this area is federally owned and administered by the U.S. Department of Agriculture, Forest Service. Large commercial timber companies own most of the private land. All the forested areas are used for wildlife habitat, recreation, watershed, and timber production (fig. 43B-2). Meadows on the upper mountain slopes and crests above the timberline provide summer grazing for livestock and big game animals. Less than 1 percent of the MLRA is cropland.

The major soil resource concerns are water erosion, soil productivity, and surface compaction. Water resource concerns include degradation of water quality. Plant resource concerns are plant productivity, health, and vigor; noxious and invasive plants; and the hazard of wildfires. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on forestland generally include forest stand improvement, erosion control, and firebreaks. Control of noxious and invasive plants is needed.

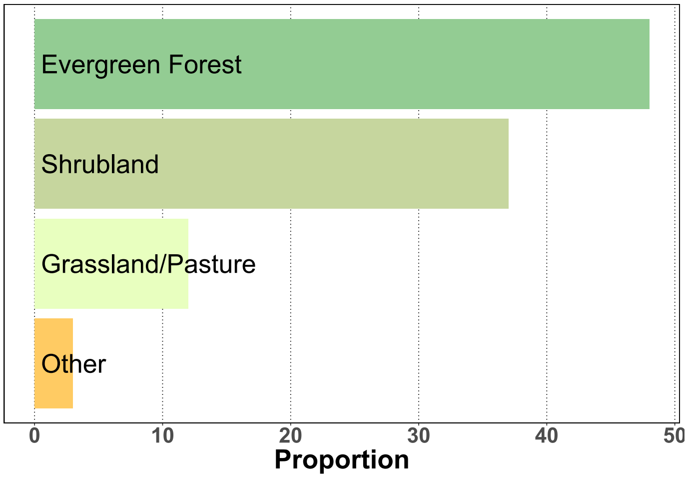

Figure 43B-2: Relative proportions (percentages) of land use in MLRA 43B.

43C—Blue and Seven Devils Mountains

This MLRA (fig. 43C-1) is characterized by thrust- and block-faulted mountains and deep canyons. It is in Oregon (88 percent), Idaho (7 percent), and Washington (5 percent). It makes up about 12,928 square miles (33,482 square kilometers). The area is bordered by MLRA 9 (Palouse and Nez Perce Prairies) to the north; MLRA 10 (Central Rocky and Blue Mountain Foothills) to the south and west; and MLRA 43B (Central Rocky Mountains) to the east.

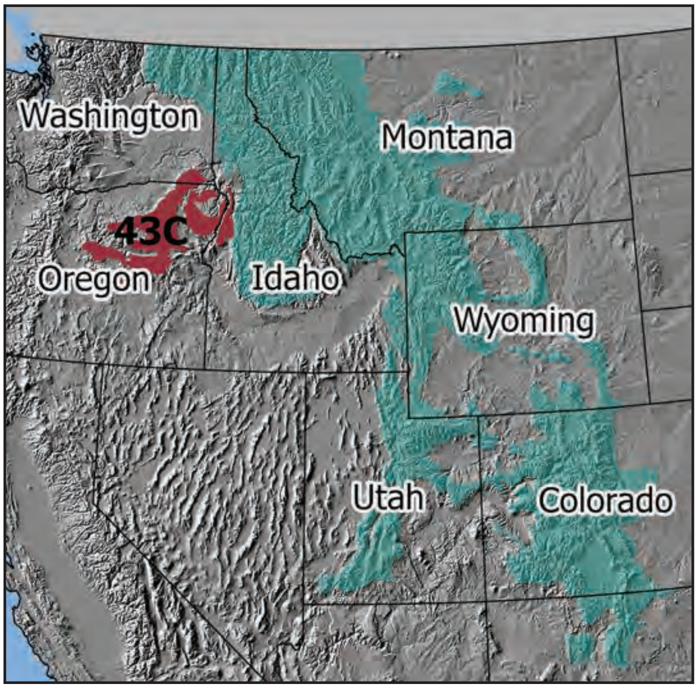

Figure 43C-1: Location of MLRA 43C, which covers 3,348,200 hectares (8,273,600 acres), within Region E.

Physiography

Most of this area is in the Blue Mountain section of the Columbia Plateaus province of the Intermontane Plateaus. The western end in Oregon and the northern end in Washington and Idaho are in the Walla Walla Plateau section of the same province and division. The southernmost part in Oregon extends into the Harney section and the southern part in Idaho extends into the Payette section of the same province and division. The middle part of the area in Idaho is in the Northern Rocky Mountains province of the Rocky Mountain System. The Snake River and the Central Rocky and Blue Mountain Foothills separate the Idaho and Oregon parts of this MLRA. The central and eastern parts of the area have the steepest mountain slopes, and the western and northern parts have more gently rolling mountains. The highest peaks have been sculpted by alpine glaciation, leaving steep slopes and sharp crests. Most of the area is cut by narrow valleys with steep gradients. Some of the larger rivers draining the mountains have wide valley floors. Lakes are common, especially in glaciated areas. Elevation is mainly 1,500 to 7,900 feet (470 to 2,410 meters) but is more than 9,800 feet (2,990 meters) at the top of Mount Sacajawea and the Matterhorn.

This area has the headwaters of the John Day, Grande Ronde, and Umatilla Rivers. The Salmon River crosses the part in Idaho just upstream from its confluence with the Snake River.

Geology

This area consists of a complex collection of bedrock types that have been faulted and uplifted. These bedrock types include sedimentary, metasedimentary, and volcanic rocks. They range from Mesozoic limestones to Cenozoic volcanics. The rocks consist of limestone, serpentine, greenstone (metamorphic lava), schist, granite, andesite, and basalt. The Wallowa and Seven Devils Mountains are made up dominantly of greenstone (metamorphosed lava) with some peaks and ridges of limestone. The Wallowa Mountains and the northern end of the Elkhorn Mountains have a core of granite. The Strawberry Mountains are dominantly andesite. The northern one-third of the Blue Mountains has Columbia River Basalt. The lower elevations include Columbia River Basalt and the Clarno and John Day Formations. Pleistocene glaciation has sculpted the higher peaks and filled many of the valleys with glacial till and outwash.

Climate

The average annual precipitation in most of this area is 12 to 43 inches (300 to 1,088 millimeters), but it can be as much as 76 inches (1,940 millimeters) in the mountains. Summers are dry, except for occasional high-intensity convective thunderstorms, especially at the higher elevations. Most of the precipitation, in the form of snow, occurs during fall, winter, and spring.

The average annual temperature generally is 41 to 51 degrees F (4.8 to 10.5 degrees C), decreasing with elevation. It can be as high as 61 degrees F (16.4 degrees C) in some of the deeper canyons. The freeze-free period averages 113 days and ranges from 40 to 185 days. The shortest freeze-free periods occur in the mountains, and the longest occur in some of the deeper canyons. Freezing temperatures occur every month of the year in the mountains, and some of the highest peaks have a continuous cover of snow and ice.

Water

The moderate precipitation and many perennial streams and lakes provide ample surface water. Streams and reservoirs supply water to the adjoining MLRAs for irrigation and other uses. Springs in the valleys provide water for domestic use and livestock. The surface water is of very good quality. Adequate waterflow and water quality are needed year-round for local fish populations and for anadromous fish migration and spawning.

Ground water occurs in two aquifers in this MLRA. One is in the basin fill and alluvial aquifer occurring in most stream and river valleys throughout the area. Water from this aquifer is moderately hard. It is generally of very good quality and used for domestic supply, livestock, and some irrigation. The second aquifer is the basalt flows from the Columbia River and Idaho batholiths. Interbedded layers of sediments and pyroclastics between the basalt flows and joints, bedding planes, and rubble zones within the basalt itself contain water. The ground water in the basalt is moderately hard. It is generally of very good quality and used for domestic supply, livestock, and irrigation. The supplies of ground water are minimal and mostly untapped in the steep mountains.

Soils

The dominant soil orders in this area include Andisols, Inceptisols, and Mollisols. The soils have a frigid or cryic temperature regime and a xeric or udic moisture regime. Most of the soils have a component of volcanic ash from Mount Mazama (present-day Crater Lake) in south-central Oregon. The soils are shallow to very deep, are very poorly drained to well drained, and include most of the soil texture classes.

The main soils and their series:

- Argixerolls that formed in volcanic ash, colluvium, slope alluvium, and residuum in canyons and on basalt plateaus, hills, and mountain slopes (Klickson and Larabee series)
- Dystrocryepts that formed in volcanic ash, loess, and colluvium over residuum on mountain slopes (Angelbasin and Prouty series)
- Haplocryepts that formed in volcanic ash, colluvium, and slide deposits on mountain slopes and landslides (Bordengulch and Vandamine series)
- Haploxerolls that formed in loess, colluvium, and volcanic ash on uplands (Umatilla series)
- Humicryepts that formed in volcanic ash, colluvium, and slope alluvium over residuum on mountain slopes (Rockcreekbutte series)

Palexerolls that formed in volcanic ash, colluvium, and slope alluvium over residuum on hills (Hankins series)
Udivitrands that formed in volcanic ash, colluvium, slope alluvium, and residuum on mountain slopes and plateaus and in canyons (Gutridge and Limberjim series)
Vitricryands that formed in volcanic ash, colluvium, alluvium, till, and residuum on mountain slopes, moraines, and cirque basins (Angelpeak and Bucketlake series)
Vitrixerands that formed in volcanic ash, loess, and colluvium on basalt plateaus and mountain slopes (Tolo series)

Biological Resources

This area has a highly diverse biological population. The distribution of vegetation is related to climate, especially effective precipitation and aspect. At the lower elevations, which are the driest and warmest, the south aspects are typified by an overstory of western juniper and a sagebrush-bunchgrass plant community in the understory. The north and east aspects at these lower elevations support ponderosa pine with an understory of either bunchgrasses or pinegrass. At the slightly higher elevations, precipitation increases and the vegetation is dominated by an overstory of Douglas-fir with an understory of either snowberry or ninebark. At the high elevations, subalpine fir, Engelmann spruce, and whitebark pine grow. Lodgepole pine and western larch are seral species, especially where grand fir is the potential overstory species. The understory in the cooler, moister areas is typically clintonia and big huckleberry. Grasses, forbs, and sedges dominate the high alpine meadows.

Major wildlife species include elk, mule deer, black bear, mountain lion, bobcat, bighorn sheep, mountain goat, coyote, grouse, and songbirds. Streams provide habitat for several species of trout. Some of the major streams provide valuable spawning grounds for salmon and steelhead.

Land Use

This MLRA is used primarily for timber production, livestock grazing, wildlife habitat, recreation, and watershed (fig. 43C-2). Only a very small area in the valleys is cropland, most of which is irrigated. A large percentage of the area is federally owned and administered by the U.S. Department of Agriculture, Forest Service.

The major soil resource concerns are erosion, surface compaction, and sedimentation of streams. The quality of surface water resources also is a major concern.

Conservation practices on forestland generally include forest site preparation, forest stand improvement, and forest trails and landings. These practices help to control surface compaction, the erosion caused by concentrated flow, and sediment delivery to streams. Prescribed grazing is an important conservation practice in areas that are used for livestock grazing.

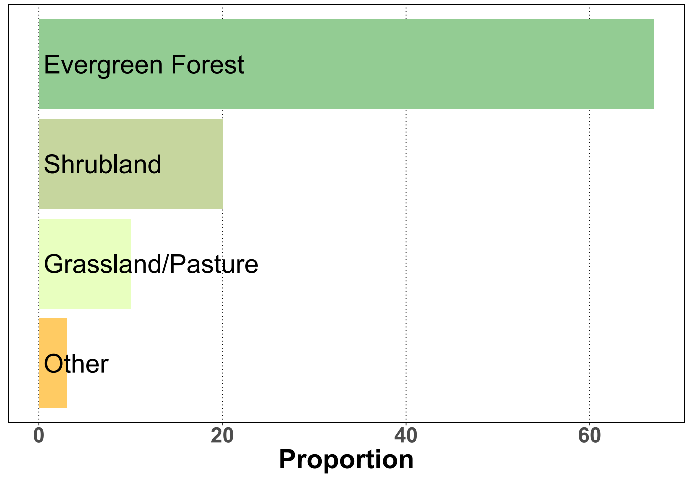

Figure 43C-2: Relative proportions (percentages) of land use in MLRA 43C.

Conservation practices generally include cover crops, conservation crop rotation, crop residue management, waste utilization, nutrient management, pest management, filter strips, grassed waterways, and irrigation water management. These practices are used to control erosion and preserve water quality.

Conservation practices on pasture and hayland generally include prescribed grazing, forage harvest management, nutrient management, waste utilization, and filter strips. These practices protect water quality and aquatic habitat for fish and wildlife by reducing the movement of nutrients and pesticides to surface water and ground water.

44A—Northern Rocky Mountain Valleys

This MLRA (fig. 44A-1) is in Montana (73 percent), Idaho (22 percent), and Washington (5 percent). It makes up about 6,029 square miles (15,614 square kilometers). It is an area of deeply dissected mountain valleys. MLRA 44A is bordered by MLRA 43A (Northern Rocky Mountains) to the north, east, and west and by MLRA 43B (Central Rocky Mountains) to the south.

Physiography

This area is in the Northern Rocky Mountains province of the Rocky Mountain System. The deep valleys are typically bordered by mountains trending north to south. In the valleys, nearly level, broad flood plains are bordered by gently sloping to strongly sloping terraces and alluvial fans. In many areas, the valleys have been modified somewhat by glaciation. In the northern part of the area, glacial debris dams created lakes in the valleys for a period of time in the past. In these areas, lacustrine sediments cover much of the valley floors. Elevation ranges from 1,740 feet (530 meters) to as much as 7,060 feet (2,150 meters).

Figure 44A-1: Location of MLRA 44A, which covers 1,561,400 hectares (3,858,200 acres), within Region E.

Numerous rivers run through the different mountain valleys in this MLRA. The Spokane River connects Spokane, Washington, and Coeur d'Alene, Idaho. The Kootenai, Bitterroot, Clark's Fork, and Flathead Rivers are in the larger valleys in Montana.

Geology

The mountains bordering the valleys in this MLRA are uplifted fault blocks that have been recently glaciated. Streams eroding the mountains have created alluvial fans at the edges of the valleys and have deposited silt, sand, and gravel as alluvial valley fill throughout the area. Modern streams have reworked the valley fill deposits, creating terraces and flood plains at the lower elevations in the valleys. Glacial lake deposits occur in some of the valleys in the northwestern part of the MLRA.

Climate

The average annual precipitation is 14 to 32 inches (357 to 821 millimeters) in most of this area, but it is about 10 inches (260 millimeters) in parts of Montana and is as much as 57 inches (1,440 millimeters) in northern Idaho. Precipitation is fairly evenly distributed throughout fall, winter, and spring but is low in summer. Rainfall occurs during high-intensity convective thunderstorms in spring and fall. Most of the precipitation in winter is snow. The average annual temperature is 35 to 47 degrees F (1.5 to 8.6 degrees C). The freeze-free period averages 125 days and ranges from 75 to 175 days in much of the area. It is 80 days or less at the highest elevations and 130 days or more at the lowest.

Water

Precipitation is adequate for some dryfarming at the higher elevations and throughout the part of this MLRA in northern Idaho. Perennial streams flowing into the area from surrounding mountains are the principal water sources. The amount of water usually is adequate but depends on snow accumulation in the mountains. This water is of good quality, and its use is not limited.

Ground water of very good quality is abundant in the deeper, unconsolidated alluvial valley fill. Some of this water is used for irrigation. The calcium-bicarbonate type of water is hard or very hard. The ground water in the glacial lake deposits in the valleys in the northwestern part of the MLRA is very similar in quality to the ground water in the alluvial valley fill.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Mollisols. The soils in the area dominantly have a frigid or cryic temperature regime, an ustic or xeric moisture regime, and mixed mineralogy. They generally are very deep, well drained, and loamy-skeletal or clayey-skeletal.

The main soils and their series:

- Argixerolls that formed in alluvium and colluvium on alluvial fans and stream terraces (Minesinger series)
- Glossocryalfs that formed in till and volcanic ash in glaciated valleys (Jimlake series)
- Haploxerepts that formed in till and colluvium with loess and ash on moraines and escarpments (Treble series)
- Haploxerolls that formed in alluvium, colluvium, and till on stream terraces, alluvial fans, and moraines (Bigarm and Niarada series)
- Haplustepts that formed in alluvium, outwash, and colluvium on stream terraces, outwash terraces, lake terraces, alluvial fans, and escarpments (Kalispell and Perma series)
- Haplustolls that formed in alluvium, outwash, and colluvium on outwash fans, alluvial fans, stream terraces, drainageways, and escarpments (Chereete and Totelake series)

Biological Resources

This area supports conifer forests and grassland vegetation. Bluebunch wheatgrass, rough fescue, Idaho fescue, and bearded wheatgrass are the major species on grassland in the valleys and foothills. Douglas-fir, ponderosa pine, grand fir, western redcedar, western hemlock, pinegrass, common snowberry, mallow ninebark, and white spirea are the major forest species.

Major wildlife species include elk, mule deer, white-tailed deer, antelope, coyote, bobcat, badger, beaver, mink, otter, muskrat, cottontail, ground squirrel, pheasant, gray partridge, sharp-tailed grouse, sage grouse, blue grouse, spruce grouse, and ruffed grouse. Fish species include rainbow, brown, and brook trout.

Land Use

More than one-half of this MLRA is in farms and ranches (fig. 44A-2). As much as one-third of the land in some valleys is irrigated. Potatoes, sugar beets, and peas are important cash crops, but a larger acreage is used for hay, grain, or pasture for livestock feed. Where precipitation is adequate, dry-farmed wheat is grown. About one-half of the MLRA is rangeland with native grasses and shrubs. Beef cattle and sheep are the principal kinds of livestock, but dairying is an important enterprise near the larger towns. Much of the part of this MLRA in northern Idaho is forested. Elsewhere, many steep and stony soils are forested. These forests are of value to the lumber industry and also are grazed.

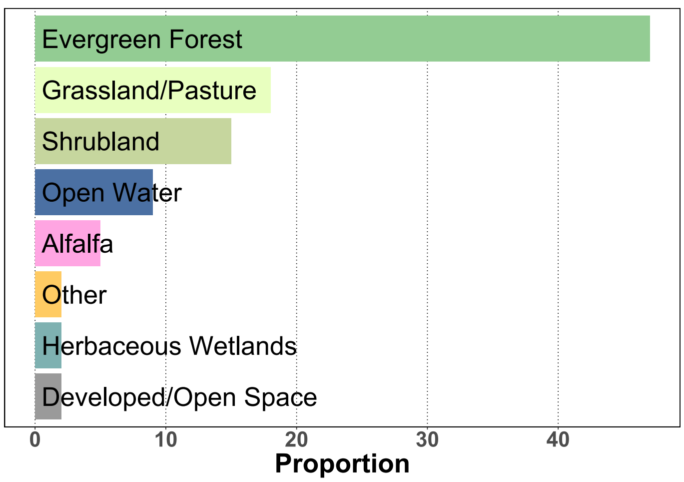

Figure 44A-2: Relative proportions (percentages) of land use in MLRA 44A.

The major soil resource concerns are wind and water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Because of freezing and thawing, the soils are susceptible to erosion. Water resource concerns include failure to meet plant needs because of the inefficient use of water on irrigated cropland. They also include excessive amounts of pesticides, nutrients, and organic material in surface water and ground water. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor and noxious and invasive plants. Animal resource concerns are inadequate food, cover, and shelter.

The most important conservation practices on rangeland are prescribed grazing, fencing, and development of watering facilities. Establishment of food plots and rangeland improvement practices benefit wildlife. Establishment of early- and late-season pastures supplements forage production and keeps livestock off rangeland during critical growth periods.

Conservation practices on cropland generally include crop residue management, minimum tillage, cover crops, nutrient management, and pest management. Practices on irrigated cropland include irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as sprinklers. Noxious and invasive plants can be controlled by pest management and prescribed grazing.

44B—Central Rocky Mountain Valleys

This MLRA (fig. 44B-1) is an area of deeply dissected mountain valleys. It is almost entirely surrounded MLRA 43B (Central Rocky Mountains), except for a small area to the east where it is bordered by MLRA 46 (Northern and Central Rocky Mountain Foothills). MLRA 44B is entirely in Montana. It makes up about 5,954 square miles (15,421 square kilometers).

Figure 44B-1: Location of MLRA 44B, which covers 1,542,100 hectares (3,810,600 acres), within Region E.

Physiography

This area is in the Northern Rocky Mountains province of the Rocky Mountain System. The deep valleys are typically bordered by mountains trending north to south. In the valleys, nearly level, broad flood plains are bordered by gently sloping to strongly sloping terraces and alluvial fans. In many areas, the valleys have been modified somewhat by glaciation. Elevation ranges from 3,650 feet (1,110 meters) to as much as 9,670 feet (2,950 meters).

Numerous rivers run through the different mountain valleys in this MLRA. The Upper Yellowstone River flows from Yellowstone Lake in the southeastern part. The Big Hole and Beaverhead Rivers join the Jefferson River. The headwaters of the Missouri River at Three Forks, Montana, occur in this MLRA. The Madison, Jefferson, and Gallatin Rivers join in this area to form the Missouri River, the largest tributary to the Mississippi River.

Geology

The mountains bordering the valleys in this MLRA are uplifted fault blocks that have been recently glaciated. Streams eroding the mountains have created alluvial fans at the edges of valleys and deposited silt, sand, and gravel as alluvial valley fill throughout the area. Modern streams have reworked the valley fill deposits, creating terraces and flood plains at the lower elevations in valleys.

Climate

The average annual precipitation is 11 to 19 inches (272 to 472 millimeters) in most of this area, but it is as little as 9 inches (220 millimeters) in some parts and as much as 37 inches (940 millimeters) at the higher elevations. Precipitation is fairly evenly distributed throughout fall, winter, and spring but is low in summer. Rainfall occurs during high-intensity, convective thunderstorms in spring and fall. Most of the precipitation in winter is snow.

The average annual temperature is 32 to 46 degrees F (0.3 degree to 8 degrees C). The freeze-free period averages 105 days and ranges from 60 to 150 days in much of the area. It is 80 days or less at the highest elevations and 130 days or more at the lowest.

Water

Precipitation is adequate for some dryfarming at the higher elevations. Perennial streams flowing into the area from surrounding mountains are the principal water sources. The amount of water usually is adequate but depends on snow accumulation in the mountains. This water is of good quality, and its use is not limited.

Ground water of very good quality is abundant in the deeper, unconsolidated alluvial valley fill. Some of this water is used for irrigation. The water is a calcium-bicarbonate type and hard or very hard.

The carbonate rocks in the Madison Group are considered an aquifer on the eastern margins of this area. The use of this bedrock aquifer is limited, however, because deep wells are required to reach it. Beneath the valley floors, the water quality in the Madison Group is marginal for most uses. The water has very high levels of sulfate. This calcium-sulfate type of water is very hard. Near the recharge zones in the mountains, water quality is significantly better.

Soils

The dominant soil orders in this MLRA are Inceptisols and Mollisols. The soils in the area dominantly have a frigid or cryic temperature regime, an ustic moisture regime, and mixed mineralogy. They generally are very deep, well drained, and loamy or loamy-skeletal.

The main soils and their series:

- Argicryolls that formed in alluvium, slope alluvium, colluvium, and slide deposits on stream terraces, alluvial fans, fan remnants, and landslides (Philipsburg series)
- Argiustolls that formed in residuum on hills and plains (Nuley series); that formed in alluvium on alluvial fans, terraces, and hills (Varney series)
- Calciustepts that formed in alluvium, colluvium, and eolian sediments on alluvial fans, stream terraces, plains, and hills (Brocko, Crago, Kalsted, Musselshell, and Scravo series)
- Calciustolls that formed in alluvium on alluvial fans, terraces, and hills (Trimad series)
- Haplocryolls that formed in alluvium, colluvium, outwash, and till on alluvial fans, outwash plains, stream terraces, fan remnants, and moraines (Bearmouth and Wisdom series)

Biological Resources

This area supports conifer forests and grassland vegetation. Bluebunch wheatgrass, rough fescue, Idaho fescue, and bearded wheatgrass are the major species on grassland in the valleys and foothills. Douglas-fir, ponderosa pine, grand fir, western redcedar, western hemlock, pinegrass, common snowberry, mallow ninebark, and white spirea are the major forest species.

Major wildlife species include elk, mule deer, white-tailed deer, antelope, coyote, bobcat, badger, beaver, mink, otter, muskrat, cottontail, ground squirrel, pheasant, gray partridge, sharp-tailed grouse, sage grouse, blue grouse, spruce grouse, and ruffed grouse. Fish species include rainbow, brown, and brook trout.

Land Use

More than one-half of this MLRA is in farms and ranches (fig. 44B-2). As much as one-third of the land in some valleys is irrigated. Potatoes, sugar beets, and peas are important cash crops, but a larger acreage is used for hay, grain, or pasture for livestock feed. Where precipitation is adequate, dry-farmed wheat is grown. About one-half of the area is rangeland with native grasses and shrubs. Beef cattle and sheep are the principal kinds of livestock, but dairying is an important enterprise near the larger towns. Many steep and stony soils are

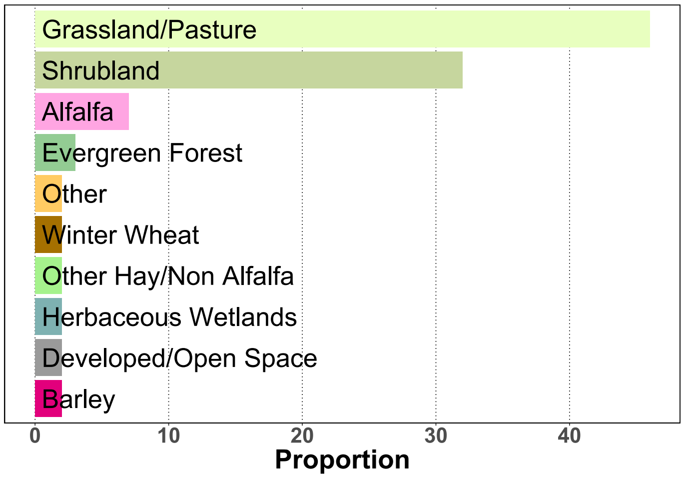

Figure 44B-2: Relative proportions (percentages) of land use in MLRA 44B.

forested. These forests are of value to the lumber industry and also are grazed.

The major soil resource concerns are wind and water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Because of freezing and thawing, the soils are susceptible to erosion. Water resource concerns include failure to meet plant needs because of the inefficient use of water on irrigated cropland. They also include excessive amounts of pesticides, nutrients, and organic material in surface water and ground water. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor and noxious and invasive plants. Animal resource concerns are inadequate food, cover, and shelter.

The most important conservation practices on rangeland are prescribed grazing, fencing, and development of watering facilities. Establishment of food plots and rangeland improvement practices benefit wildlife. Establishment of early- and late-season pastures supplements forage production and keeps livestock off rangeland during critical growth periods.

Conservation practices on cropland generally include crop residue management, minimum tillage, cover crops, nutrient management, and pest management. The practices on irrigated cropland include irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as sprinklers. Noxious and invasive plants can be controlled by pest management and prescribed grazing.

46—Northern and Central Rocky Mountain Foothills

This area (fig. 46-1) is in Montana (65 percent), Wyoming (31 percent), Utah (3 percent), and Colorado (1 percent). It makes up about 18,788 square miles (48,660 square kilometers). It is characterized by Tertiary to Upper Cretaceous sedimentary

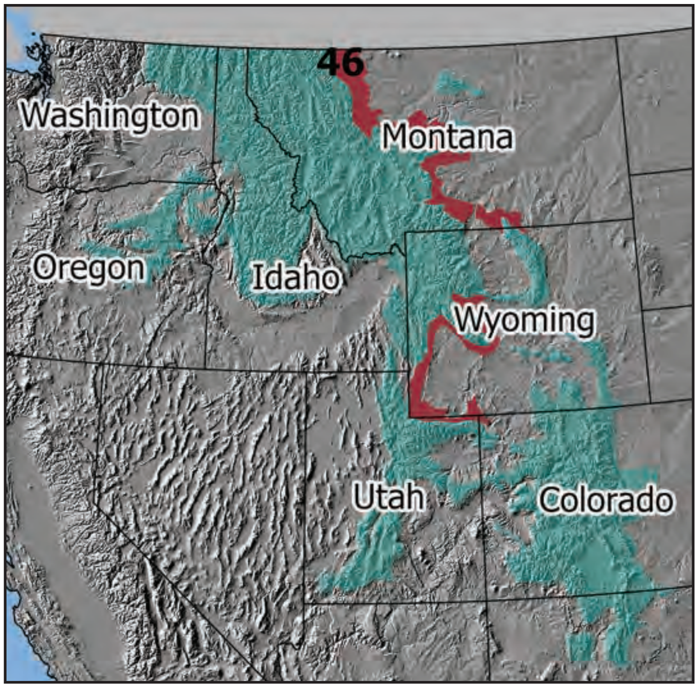

Figure 46-1: Location of MLRA 46, which covers 4,866,000 hectares (12,024,200 acres), within Region E.

rock in Wyoming and Upper Cretaceous to Jurassic sedimentary rock in Montana. The northern part of the MLRA is on the east side of the Rocky Mountains and is bordered by MLRA 52 (Brown Glaciated Plains) to the north and east; MLRA 58A (Northern Rolling High Plains, Northern Part) to the east; MLRA 43B (Central Rocky Mountains) to the south and west; and MLRA 32 (Northern Intermountain Desertic Basins) to the south. The southern part of the MLRA is bordered by MLRA 43B (Central Rocky Mountains) to the north; MLRAs 13 (Eastern Idaho Plateaus) and 47 (Wasatch and Uinta Mountains) to the west; MLRA 32 to the east; and MLRA 34A (Cool Central Desertic Basins and Plateaus) to the south.

Physiography

In Montana, the northern quarter of this MLRA is in the Missouri Plateau, glaciated, section of the Great Plains province of the Interior Plains. The rest is in the Missouri Plateau, unglaciated, section of the same province and division. These two sections have similar landforms. The glaciated parts in the north are on the extreme western edge of the southern extent of continental glaciation, so few glacial landforms and minor glacial deposits occur in the area. The foothills east of the Northern Rocky Mountains are on an old plateau of uplifted marine sediments. The rugged hills and low mountains are cut by many narrow valleys that have steep gradients. Broad flood plains and fans border a few of the major rivers. In Montana, elevation ranges from mostly 3,800 to 5,900 feet (1,100 to 1,800 meters) in the northern part of the area, increasing gradually to mostly 5,900 to 7,870 feet (1,800 or 2,400 meters) in the southern part.

In Wyoming, this MLRA is split between the Wyoming Basin and Middle Rocky Mountains provinces, both of the Rocky Mountain System. The Middle Rocky Mountains province has two sections. The first section consists of steep hillslopes and escarpments of uplifted marine and fluvial sediments of the Wyoming and Uinta Mountains, which are joined by the less steep Session Hills. The second section consists of glaciated landforms of the Pinedale and Bull Lake glacial periods of the Wind River Mountains. The Wyoming Basin province consists of uplifted marine and fluvial sediments dominated by hillslope and fan remnant landforms. In Wyoming, elevation ranges from mostly 5,600 to 9,200 feet (1,700 to 2,800 meters).

In Montana, the Missouri River bisects the MLRA. Numerous tributary streams to the Missouri River cross the area. Clark's Fork of the Yellowstone River flows north across the southern part of the area on its way to join the Yellowstone River just outside this MLRA. In Wyoming, the Green River and many tributaries flow south through the MLRA. Tributary rivers include the Hams Fork and New Fork Rivers flowing south and the Blacks Fork River flowing north from the Uinta Mountains. The Bear River flows north from the Uinta Mountains through this MLRA, eventually draining into the Great Salt Lake, and the Wind River flows east through the MLRA, eventually draining into the Yellowstone River from the Wind River Mountains.

Geology

In Montana, almost all of the area is characterized by Upper Cretaceous to Jurassic marine sediments of the Montana and Colorado Groups and the Kootenai Formation. These rocks are primarily sandstones and shales with some layers of chalk and conglomerate. Dinosaur bones have been found in some of the shales. Tertiary continental sediments are in the southern part of the area. These river-laid sediments contain some coal. The Madison Group occurs at the edges of the central and southern parts of the MLRA, where faults have brought older bedrock units to the surface.

In Wyoming, most of the area is characterized by Tertiary to Upper Cretaceous marine and fluvial sediments of the Wasatch and Green River Formations. These rocks are primarily sandstones and shales with some layers of conglomerate, coal, and deposits of trona. Many fossils have been found in the Fossil Butte Member of the Green River Formation. Precambrian granite and metasedimentary rocks occur in the MLRA along the southern and northern edges of the Wind River Mountains.

Climate

The average annual precipitation is 12 to 21 inches (296 to 527 millimeters) in most of this area. It is as high as 43 inches (1,090 millimeters) at the highest elevations and as low as 6 inches (160 millimeters) in some basins. Most of the rainfall occurs during high-intensity, convective thunderstorms. In the northern part of the area, the minimum precipitation occurs in spring. In the southern part, precipitation is lowest in early summer. Winter precipitation occurs as snow. The average annual temperature is 33 to 50 degrees F (0.7 degree to 9.7 degrees C). The town of Cut Bank, Montana, known for having the coldest temperature in the continental United States on many winter days, is in the northern part of the area. The freeze-free period averages 103 days and ranges from 50 to 155 days, decreasing in length with elevation and from south to north.

Water

The amount of precipitation is too low for good crop growth in some parts of this MLRA. In other parts, it is adequate for grain farming and forage production. The major rivers provide most of the water for irrigation, but small streams furnish local supplies. The surface water generally is of good quality and suitable for most uses.

Ground water is abundant in the alluvial fill in some valleys. It is of good quality and suitable for all uses. Mesozoic aquifers, Eagle Sandstone, and the Kootenai Formation occur in this MLRA, but they contain little or no ground water. The Madison Group aquifer occurs in this area. Its water quantity is not limited, but the aquifer requires deep wells and the water quality generally is poor.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a frigid temperature regime, an ustic moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey.

The main soils and their series:

- Argiustolls that formed in slope alluvium or colluvium over residuum on plains, hills, cuestas, and escarpments (Absarokee and Reeder series); that formed in alluvium, outwash, colluvium, and till on alluvial fans, stream terraces, outwash terraces, and moraines (Fairfield and Work series)
- Calciustepts that formed in alluvium, slope alluvium, and colluvium on alluvial fans, fan remnants, stream terraces, hills, and mountain slopes (Crago and Whitecow series)
- Calciustolls that formed in alluvium, slope alluvium, and colluvium on alluvial fans, fan remnants, and stream terraces (Judith, Niart, and Windham series)
- Haplustolls that formed in colluvium or slope alluvium over residuum on hills, plains, and mountains (Castner and Winifred series)
- Ustorthents that formed in colluvium or slope alluvium over residuum on hills, plains, and escarpments (Cabba and Wayden series)

Biological Resources

This area supports grass and shrub vegetation in the valleys and foothills and forest vegetation at the higher elevations. Bluebunch wheatgrass, rough fescue, Idaho fescue, Columbia needlegrass, spike fescue, and western wheatgrass are the major grass species. Mountain big sagebrush, antelope bitterbrush, and serviceberry are the major shrub species. Ponderosa pine, limber pine, Douglas-fir, Rocky Mountain juniper, common snowberry, and skunkbush sumac are the dominant species in forested areas.

Major wildlife species include white-tailed deer, mule deer, pronghorn antelope, coyote, badger, raccoon, fox, skunk, ground squirrel, pocket gopher, cottontail rabbit, ring-necked pheasant, gray partridge, sharp-tailed grouse, and sage grouse.

Land Use

Nearly one-third of this area is federally owned. The rest is in farms and ranches (fig. 46-2). Nearly 70 percent of the area is rangeland with short and mid grasses and shrubs. Many of the valleys are irrigated, but they make up only 1 or 2 percent of the total area. Grain and forage for livestock are the main crops, but potatoes, sugar beets, peas, and other crops are grown in the warmer valleys. About one-fifth of the area, mainly along the northeastern side, is used for dry-farmed wheat. Some of the highest hills are forested.

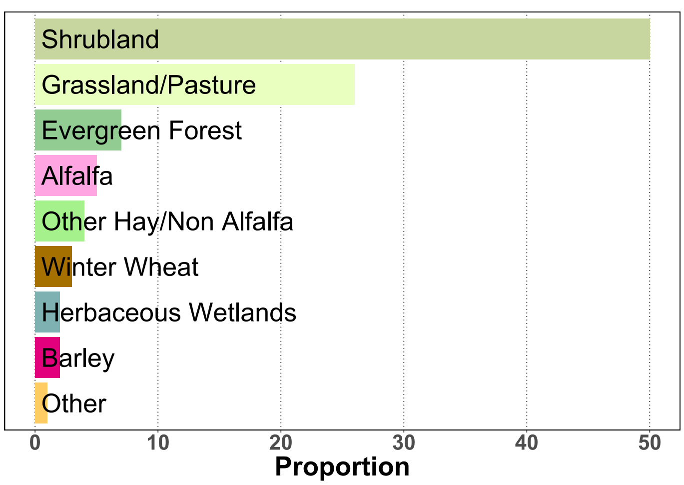

Figure 46-2: Relative proportions (percentages) of land use in MLRA 46.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and control of saline seeps. Water resource concerns include failure to meet plant needs because of the inefficient use of water on irrigated cropland. They also include excessive amounts of pesticides, nutrients, and organic material in surface water and ground water. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor; noxious and invasive plants; and the hazard of wildfires. Animal resource concerns are inadequate food, cover, and shelter.

The most important conservation practices on rangeland are prescribed grazing, fencing, and development of watering facilities. Establishment of food plots and rangeland improvement practices benefit wildlife. Establishment of early- and late-season pastures supplements forage production and keeps livestock off rangeland during critical growth periods.

Conservation practices on cropland generally include crop residue management, minimum tillage, cover crops, stripcropping, nutrient management, soil salinity management, and pest management. The practices on irrigated cropland include irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as sprinklers. Noxious and invasive plants can be controlled by pest management and prescribed grazing.

Conservation practices on forestland include forest stand improvement and firebreaks. These practices reduce the hazard of wildfires and improve forest growth, quality, health, and productivity.

47—Wasatch and Uinta Mountains

This area (fig. 47-1) is primarily characterized by tilted fault-block mountains—the Wasatch Mountains, which trend north and south, and the Uinta Mountains, which trend east and west. It is in Utah (94 percent), Colorado (3 percent), and Idaho (3 percent). It makes up about 20,279 square miles (52,522 square kilometers). This MLRA is bordered by MLRAs 13 (Eastern Idaho Plateaus) and 46 (Northern and Central Rocky Mountain Foothills) to the north; MLRA 28A (Ancient Lake Bonneville) to the west; MLRAs 34B (Warm Central Desertic Basins and Plateaus) and 48A (Southern Rocky Mountains) to the east; and MLRA 35 (Colorado Plateau) to the south.

Physiography

The northern half of this area is in the Middle Rocky Mountains province of the Rocky Mountain System. The southern half is in the High Plateaus of Utah section of the Colorado Plateaus province of the Intermontane Plateaus. Parts of the western edge of this MLRA are in the Great Basin section of the Basin and Range province of the Intermontane Plateaus.

The steeply sloping, precipitous Wasatch Mountains have narrow crests and deep valleys. Active faulting and erosion are a dominant force in controlling the geomorphology of the area. The Uinta Mountains have a broad, gently arching, elongate shape. Structurally, they consist of a broadly folded anticline that has an erosion-resistant quartzite core. Some of the mountain areas above 7,500 feet (2,285 meters) and all of the areas above 10,000 feet (3,050 meters) have been subject to alpine or mountain glaciation. There are arêtes, horns, cirques,

Figure 47-1: Location of MLRA 47, which covers 5,252,200 hectares (12,978,500 acres), within Region E.

all types of moraines, and outwash features. The southern part of the MLRA has rolling mountains and thrust-faulted plateaus. The plateaus are broad, gently sloping surfaces with steep side slopes that have deep canyons cut into them. The Wasatch and Uinta Mountains have elevations of about 4,900 to 13,500 feet (1,495 to 4,115 meters).

The Duchesne River and many other tributaries to the Green River run through the northeastern part of the MLRA. The Sevier River is in the central and southern parts. The headwaters of the Virgin River are in the southern part.

Geology

The mountains in the MLRA are primarily fault blocks that have been tilted up. Alluvial fans at the base of the mountains are recharge zones for the basin fill aquifer and are significant sources of sand and gravel for construction. An ancient shoreline of historic Lake Bonneville is evident on the footslopes along the western edge of the area. Rocks exposed in the mountains are mostly Mesozoic and Paleozoic sediments, but Precambrian rocks are exposed in the Uinta Mountains. The Uinta Mountains are among the few ranges in the United States that are oriented west to east. Younger igneous rocks (ash and lava) are throughout the area. Lava-capped mesas are common in the southern part of the MLRA. The southern Wasatch Mountains consist of Tertiary volcanic rocks occurring as extrusive lava and intrusive crystalline rocks. Eroded volcanic cones are in the southwestern part of the MLRA.

Climate

The average annual precipitation in most of this area is 13 to 36 inches (333 to 906 millimeters). It is 10 to 15 inches (255 to 380 millimeters) in some areas in the southern part of the MLRA and can be as much as 67 inches (1,700 millimeters) at the higher elevations in the northeastern part. In the northern and western parts of the area, peak precipitation occurs in winter. The southern and eastern parts have a greater incidence of high-intensity summer thunderstorms, and therefore a significant amount of the precipitation occurs during summer in these parts. The higher elevations receive significant amounts of snowfall each year. The average annual temperature is 25 to 60 degrees F (-3.7 to 15.6 degrees C). The freeze-free period averages 138 days and ranges from 35 to 240 days, generally decreasing in length with elevation.

Water

Streams, lakes, and ground water supply enough water for the grazing and forestry enterprises in most of the area. Reservoirs in the mountains store water for downstream use. The mountain water is of excellent quality. Perennial streams from the Wasatch Mountains in this area provide irrigation and municipal and industrial water for most of the population in Utah. The Green and Sevier Rivers provide irrigation water in areas away from the population centers. Almost 99 percent of the flow within the Sevier River basin in the southern end and middle part of this MLRA is used for irrigation and some public supply. Salinity in irrigation return flows is a hazard for rivers in the southern part of the area.

Ground water is primarily in the unconsolidated deposits of sand and gravel filling the major river valleys in the interior of the area and in similar deposits filling the basins on the western edge. Water from these aquifers is very hard. Low levels of salts occur in the ground water closest to the recharge areas along the base of the mountains, and briny water occurs in the deeper parts of these deposits.

Soils

The dominant soil orders in this MLRA are Aridisols, Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a frigid temperature regime on plateaus and the lower mountain slopes and a cryic temperature regime at the higher elevations. The soils at higher elevations have a udic moisture regime. The soils at the lowest elevations, on south-facing slopes, and in some of the valleys in southern Utah have a mesic temperature regime. The soils in the northern part of the area typically have a xeric moisture regime but grade to ustic in the extreme eastern and southern parts. Mineralogy is typically mixed. The soils are very shallow to very deep, generally well drained, and loamy or loamy-skeletal.

The main soils and their series:

Argicryolls that formed in slope alluvium, colluvium, and residuum on mountain slopes (Dranburn, Senchert, and Skutum series)

Argixerolls that formed in slope alluvium, colluvium, and residuum on mountain slopes, fan remnants, and hills (Fewkes, Horrocks, and Yeates Hollow series)

Calcixerepts that formed in slope alluvium, colluvium, and residuum on foothills, mountain slopes, and valley sides (Richsum and Cutoff series)

Calcixerolls that formed in slope alluvium, colluvium, and residuum on foothills and mountain slopes (Lizzant and Mower series)

Haplocalcids that formed in slope alluvium, colluvium, and residuum on mountain slopes, hills, and fan remnants (Amtoft and Bruman series)

Haploxerolls that formed in slope alluvium, colluvium, and residuum on mountain slopes (Agassiz and St. Marys series)

Haploxerepts that formed in slope alluvium or colluvium over residuum on mountain slopes (Heiners series)

Haplustepts that formed in slope alluvium or colluvium over residuum on structural benches, mountain slopes, escarpments, and hills (Pathead, Podo, and Ruko series)

Palecryolls that formed in slope alluvium, colluvium, or till on mountain slopes and moraines (Baird Hollow and Lucky Star series)

Torriorthents that formed in alluvium and slope alluvium on alluvial fans and valley floors (Tebbs and Codley series)

Biological Resources

This area supports conifer, aspen, grass, mountain shrub, and sagebrush-grass vegetation. The composition of the vegetation varies, mainly depending on elevation and aspect. The zone above an elevation of about 13,000 feet (3,965 meters) supports alpine meadow. Coniferous forests of Engelmann spruce, white fir, subalpine fir, and Rocky Mountain Douglas-fir dominate areas at the mid to high elevations. The most common understory plants in these forests are Oregon grape, myrtle pachistima, and heartleaf arnica. The part of the MLRA in the Uinta Mountains includes significant amounts of lodgepole pine, and the southern part of the Wasatch Mountains includes significant amounts of ponderosa pine. Forests of quaking aspen commonly have an understory that includes blue wildrye, mountain brome, Fendler's meadow-rue, and aspen peavine. Bluebunch wheatgrass, bearded wheatgrass, blue wildrye, mountain brome, and numerous forbs grow in the understory in areas of Gambel oak, curl-leaf and birchleaf mountain mahogany, snowberry, and serviceberry. Big sagebrush and bluebunch wheatgrass are the dominant species in the sagebrush-grass plant communities that are common at the lowest elevations. The abundance of warm-season herbaceous species increases significantly in the southern part of the MLRA.

Major wildlife species include moose, elk, mule deer, coyote, red fox, bobcat, beaver, porcupine, snowshoe hare, jackrabbit, sage grouse, chukar, sharp-tailed grouse, gray partridge, ruffed grouse, and blue grouse. Fish species include rainbow trout, brown trout, brook trout, cutthroat trout, catfish, and sucker.

Land Use

Less than one-third of this area is in farms and ranches (fig. 47-2); the remainder is dominantly federally administered. Grassland, shrubland, and woodland are grazed in summer. Some dense forests are on moist sites. Recreation, grazing, timber management, and mineral development are important land uses. A few valleys are irrigated. Forage for livestock is the main crop.

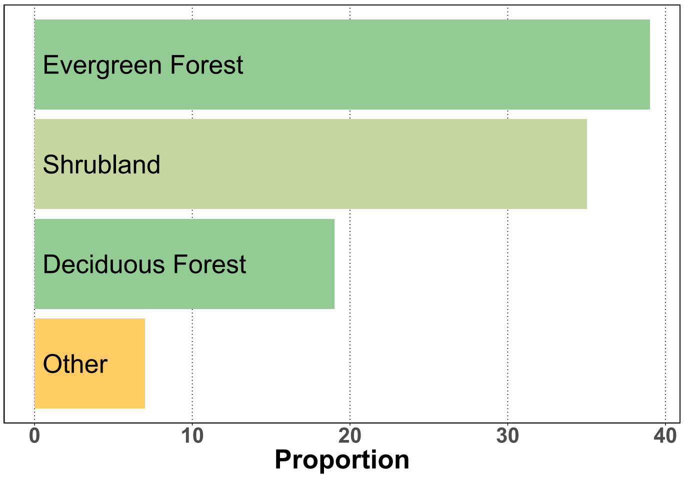

Figure 47-2: Relative proportions (percentages) of land use in MLRA 47.

The major soil resource concerns are wind erosion, water erosion, maintenance of soil productivity, and maintenance of the quality of surface water. Maintaining a vegetative cover, maintaining the content of soil organic matter, and preventing excessive compaction are important. Mass movement of the soils also is a concern. Proper grazing use is a concern on grazing lands. The primary concerns during timber harvesting are controlling erosion along roads and skid trails and minimizing the compaction caused by harvesting equipment.

On rangeland, conservation practices generally include brush management, rangeland seeding, prescribed grazing, fencing, and development of watering facilities. On dry-farmed cropland, they include terraces, sediment-control basins, summer fallow tillage, crop residue management, and pest management. On irrigated cropland and hayland, they include irrigation system improvement, irrigation water management, conservation tillage, crop rotation, crop residue management, forage harvest management, and nutrient management. On irrigated pasture, they include irrigation system improvement, irrigation water management, pasture planting, development of watering facilities, fencing, prescribed grazing, and nutrient management.

48A—Southern Rocky Mountains

This MLRA (fig. 48A-1) is in Colorado (72 percent), New Mexico (15 percent), Utah (7 percent), and Wyoming (6 percent). It makes up about 50,921 square miles (131,884 square kilometers). It is bordered by MLRA 34A (Cool Central Desertic Basins and Plateaus) to the north; MLRAs 34B (Warm Central Desertic Basins and Plateaus) and 36 (Southwestern Plateaus, Mesas, and Foothills) to the west; MLRAs 49 (Southern Rocky Mountain Foothills), 69 (Upper Arkansas Valley Rolling Plains), and 70A (High Plateaus of the Southwestern Great Plains) to the east; and MLRA 42C (Central New Mexico Highlands) to the south.

Figure 48A-1: Location of MLRA 48A, which covers 13,188,400 hectares (32,589,200 acres), within Region E.

Physiography

Most of the MLRA is in the Southern Rocky Mountains province of the Rocky Mountain System. The western extension of the area into Utah is in the Uinta Basin section of the Colorado Plateaus province of the Intermontane Plateaus. Small parts of the southwest corner and some isolated areas farther west are in the Canyon Lands section of the same province and division. The Southern Rocky Mountains consist primarily of two belts of strongly sloping to precipitous mountain ranges trending north to south. Several basins, or parks, are between the belts. Some high mesas and plateaus are included. The ranges include the Sangre de Cristo Mountains, the Laramie Mountains, and the Front Range in the east and the San Juan Mountains and the Sawatch and Park Ranges in the west. The ranges are dissected by many narrow stream valleys having steep gradients. In some areas the upper mountain slopes and broad crests are covered by snowfields and glaciers. High plateaus and steep-walled canyons are fairly common, especially in the west.

Elevation typically ranges from 6,500 to 14,400 feet (1,980 to 4,390 meters). The part of the MLRA in central Colorado includes the highest point in the Rockies, Mount Elbert, which reaches an elevation of 14,433 feet (4,400 meters). More than 50 peaks in the part of the MLRA in Colorado are at an elevation of more than 14,000 feet (4,270 meters). Many small glacial lakes are in the high mountains.

The headwaters of many of the major rivers on the High Plains and the Colorado Plateau are in this area. The Continental (or Great) Divide also is in this area. The North Platte, South Platte, and Arkansas Rivers and the Rio Grande drain toward the Atlantic Ocean, and the Green, Yampa, and Colorado Rivers drain toward the Pacific Ocean.

Geology

The mountains in this area were formed mainly by crustal uplifts during the Late Cretaceous and Early Tertiary Periods. The Rockies on the east side of this area are called the "Front Range" and consist of a fault block that was tilted on edge and uplifted. The block was tilted up on the east edge, so the east side has a steep front and the west side is more gently sloping. The rocks exposed in the mountains are mostly Precambrian igneous and metamorphic rocks, which in many places are flanked by steeply dipping Mesozoic sedimentary rocks. Younger igneous rocks, primarily basalt and andesitic lava flows, tuffs, breccias, and conglomerates, are throughout this area. Representative formations are the Silver Plume and Pikes Peak granites, San Juan volcanics, and Mancos Shale. Many of the highest mountain ranges were reshaped by glaciation during the Pleistocene Epoch. Alluvial fans at the base of the mountains are recharge zones for local basin and valley fill aquifers. They also are important sources of sand and gravel.

Climate

The average annual precipitation ranges from 7 to 73 inches (180 to 1,860 millimeters) but is dominantly 14 to 32 inches (355 to 815 millimeters). Summer rainfall commonly occurs during high-intensity, convective thunderstorms. About half of the annual precipitation occurs as snow in winter; the proportion increases with elevation. In the mountains, deep snowpacks accumulate throughout winter and generally persist into spring or early summer, depending on elevation. Some permanent snowfields and small glaciers are on the highest mountain peaks. In the valleys at the lower elevations, snowfall is lighter and snowpacks can be intermittent.

The average annual temperature is 23 to 55 degrees F (-5.1 to 12.8 degrees C). The freeze-free period averages 115 days and ranges from 35 to 195 days, decreasing in length with elevation. The climate of this area is strongly dependent upon elevation; precipitation is greater and temperatures are cooler at the higher elevations.

Water

Water from streams and lakes in this MLRA is abundant and generally of excellent quality. In some places, mining activities during the late 1800s have contributed to the degraded quality of surface water, mainly because of elevated levels of metals. The lower valleys depend on streamflow from this area for irrigation water. Most of the streamflow is from snowmelt, which typically occurs from March to June, so reservoirs or a source of ground water is needed to supply water for irrigation late in the growing season. This MLRA provides most of the water for the Denver metropolitan area, just to the east.

This area has only two extensive aquifers. One is the unconsolidated to consolidated silt, sand, and gravel of the High Plains and equivalent aquifers in the southern part of Carbon County, Wyoming. The other is the Leadville Limestone aquifer in Colorado. The water from the High Plains aquifer is of good quality, and high-yielding wells are common in areas of this aquifer. The water is used for irrigation, livestock, domestic supply, oil and gas exploration, and mining. It is hard or moderately hard. The Leadville Limestone has salty water at depth. Because of ample supplies of surface water and the lower quality of this ground water, the Leadville Limestone aquifer has not been extensively developed in this area.

Limited quantities of ground water occur in the basin and valley fill sediments in most of the streams and rivers at the lower elevations in this area. These aquifers are directly connected with the streams, so water quality is similar to that of the surface runoff. The water is generally of good quality and suitable for all uses.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Mollisols. The soils in the area dominantly have a cryic or frigid temperature regime and a udic or ustic moisture regime. Mineralogy is typically mixed or smectitic.

The main soils and their series:

Argicryolls that formed in slope alluvium, colluvium, till, or slide deposits on mountain slopes, fan remnants, moraines, and landslides (Clayburn, Cochetopa, Gothic, Quander, and Tellura series)

Dystrocryepts that formed in till, colluvium, slope alluvium, or residuum on mountain slopes or moraines (Catamount, Leighcan, and Fallriver series); that formed in colluvium or slope alluvium over residuum on mountain slopes, in areas of andesite and rhyolite bedrock (Endlich and Whitecross series)

Glossocryalfs that formed in colluvium and slope alluvium on mountain slopes, in areas with granite, gneiss, and schist bedrock (Angostura, Granile, Peeler, and Seitz series)

Haplocryalfs that formed in colluvium, slope alluvium, and residuum on mountain slopes (Agneston, Goosepeak, Needleton, and Snowdon series)

Haplocryolls that formed in colluvium or slope alluvium over residuum on mountain slopes, in areas with granite, gneiss, and schist bedrock (Irigul and Rogert series); that formed in alluvium, slope alluvium, colluvium, and residuum on mountain slopes, alluvial fans, fan remnants, and drainageways (Lamphier and Parachute series)

Haplustolls that formed in slope alluvium or colluvium over residuum on mountain slopes and hills (Cathedral and Ratake series)

Biological Resources

The potential vegetation is grass and sagebrush at the lower elevations, montane and subalpine coniferous forest and some grassland at the mid and high elevations, and alpine tundra on the mountain peaks above the timberline (at an elevation of about 11,500 feet, or 3,505 meters). Some common plants are mountain big sagebrush, western wheatgrass, and needle and thread at the lower elevations; ponderosa pine, Rocky Mountain Douglas-fir, white fir, Arizona fescue, mountain muhly, common snowberry, Parry's oatgrass, and mountain brome at mid elevations; Engelmann spruce, subalpine fir, corkbark fir, lodgepole pine, limber pine, bristlecone pine, grouse whortleberry, elk sedge, and Thurber's fescue at the higher elevations; and kobresia, alpine bluegrass, alpine clover, and golden avens above the timberline.

Wildlife species in the alpine tundra include white-tailed ptarmigan, rosy finch, pika, yellow-bellied marmot, long-tailed weasel, bighorn sheep, and mountain goats. In the slightly lower, montane to subalpine forested sites, typical species include chickaree, Albert's squirrel, golden-mantled ground squirrel, beaver, black bear, elk, mule deer, moose, Steller's jay, golden eagle, blue grouse, black-billed magpie, mountain chickadee, Clark's nutcracker, and common raven. There is considerable overlap of species between the montane and lower shrub-grassland habitats; however, typical species in these lower areas include bobcat, coyote, mountain lion, sage grouse, western rattlesnake, bullsnake, Merriam's turkey, golden eagle, and pinyon jay.

This area has a variety of fish habitats, including streams and rivers, small alpine lakes, and larger lakes and reservoirs. Fish species in streams and lakes at the higher elevations are rainbow, brown, cutthroat, brook, and lake trout; kokanee; and mountain whitefish. These species also occur at the lower elevations, and some waters at the lower elevations also contain northern pike, yellow perch, and a variety of non-game species.

Land Use

Over 70 percent of this MLRA is federally owned. The rest consists of farms, ranches, or other private holdings. Nearly all of the land is in natural vegetation. Grazing, forestry, recreation, and watershed are the main uses (fig. 48A-2). Small areas of hayland and pasture, some of it irrigated, are in some valleys. Local ranchers commonly graze livestock in national forests during summer and move the animals to lower elevations in winter. The large areas of public land provide excellent opportunities for outdoor recreation, particularly hunting, fishing, skiing, camping, hiking, boating, and sightseeing. The spectacular mountain scenery in many parts of this MLRA contributes to the popularity of these activities and attracts tourists from distant regions. Recreation supports a significant tourism industry, upon which many local economies depend. The major soil resource concerns are wind and water erosion and maintenance of soil productivity. Minimizing the sediment that reaches watercourses also is a concern. Proper grazing use is a concern in areas of grazing land. The primary concerns during timber harvesting are controlling erosion on roads and skid trails and minimizing soil compaction caused by harvesting equipment.

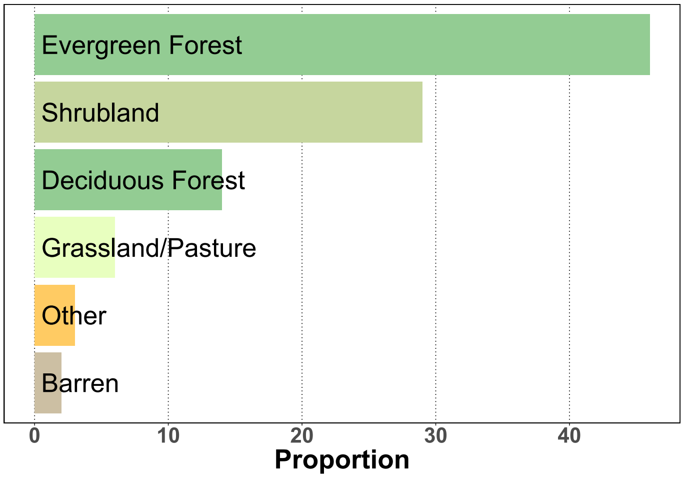

Figure 48A-2: Relative proportions (percentages) of land use in MLRA 48A.

48B—Southern Rocky Mountain Parks and Valleys

This area (fig. 48B-1) consists of nearly level to rolling mountain parks and valleys and is used mostly for grazing cattle and sheep. MLRA 48B is entirely surrounded by MLRA 48A (Southern Rocky Mountains). It is in Colorado (99 percent) and Wyoming (1 percent). It makes up about 2,476 square miles (6,414 square kilometers).

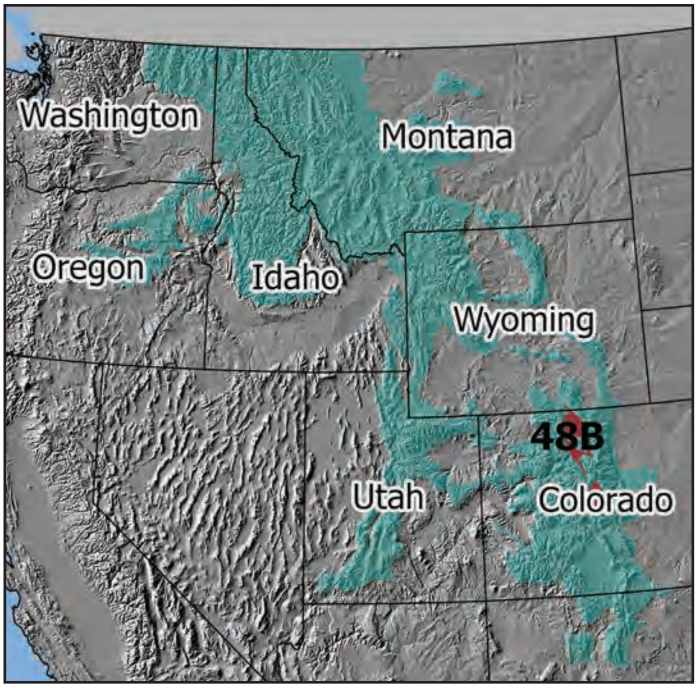

Figure 48B-1: Location of MLRA 48B, which covers 641,400 hectares (1,584,900 acres), within Region E.

Physiography

This area is within the Southern Rocky Mountains province of the Rocky Mountain System. It consists of nearly level to rolling mountain parks and valleys and a few narrow mountain ridges. It occurs as two separate parts in the center of the Southern Rockies. The southern half of the northern part is on the west side of the Continental Divide, and the rest of the MLRA is on the east side of the divide. Elevation ranges from 7,280 to 11,190 feet (2,220 to 3,410 meters).

The North Platte River leaves Colorado and enters Wyoming in the northern half of the northern part of the MLRA (North Park). The Colorado River is in the southern half of the northern part of the MLRA (Middle Park). The South Platte River is in the southern part of the MLRA (South Park).

Geology

The mountain valleys and parks characteristic of this MLRA are surrounded by high mountain peaks of the adjacent MLRA 48A. Steep slopes result in steep-gradient streams that are able to move cobbles and gravel from the mountain slopes down into the valleys. The coarse textured sediments on the surface of this area were deposited by either glacial meltwater or present-day rivers. Buried deep beneath the sediments is a complex of sedimentary and igneous rocks. Residuum from sedimentary rocks is on the steeper slopes that were not covered by alluvium and glacial outwash.

Climate

The average annual precipitation is mainly 13 to 22 inches (318 to 557 millimeters). It is as high as 36 inches (930 millimeters) at the higher elevations that border this MLRA. Precipitation generally increases with elevation. Rainfall comes from high-intensity, convective thunderstorms during the growing season. About half of the annual precipitation falls as snow. Soil moisture is unevenly distributed within short distances because of snowdrifts. The amount of precipitation is highly influenced by rain shadows. The surrounding peaks receive most of the precipitation as storm systems traverse the area. The average annual temperature is 33 to 40 degrees F (0.5 degree to 4.7 degrees C). The freeze-free period averages 90 days and ranges from 70 to 110 days, decreasing in length with elevation.

Water

Perennial streams originating from snowmelt in the adjacent high mountains furnish an abundance of water for irrigation of hay meadows in June and July. In August, the streams are often low in water. Large reservoirs store water for domestic use, power supply, and irrigation outside the area. The surface water from the mountain runoff is of good quality and generally suitable for all uses.

Some ground water is available locally in valley fill deposits under the larger streams and rivers. In the valleys, the ground water and surface water are connected, so the quality of the ground water is almost the same as that of the surface water.

Soils

The dominant soil order is Mollisols. Alfisols are of lesser extent. The soils in the area are very shallow to deep, generally well drained, and loamy or clayey and have mixed or smectitic mineralogy. The soil temperature regime is dominantly cryic; it is frigid in some small areas, primarily on south- or west-facing slopes. The soil moisture regime is mainly ustic, but a marginal aridic regime occurs where the average annual precipitation is less than about 12 inches (305 millimeters). The most extensive great group is Argicryolls.

The main soils and their series:

- Argicryolls that commonly formed in outwash, slope alluvium, colluvium, and till, on outwash terraces, fan remnants, pediments, mountain slopes, and moraines (Gebson, Hodden, Lucky, and Tiagos series)
- Cryaquolls that formed in alluvium on flood plains and drainageways (Blackwell, Dobrow, and Mendenhall series)
- Haplocryalfs that formed in slope alluvium and colluvium on fan remnants and pediments (Gebson and Monahan series)
- Haplocryolls that formed in alluvium, slope alluvium, colluvium, and residuum on hills, fan remnants, mountain slopes, drainageways, and flood plains (Betemer, Lanswick, Rogert, and Temdille series)

Biological Resources

This area supports grass and grass-shrub vegetation. Mountain big sagebrush, Idaho fescue, bluebunch wheatgrass, streambank wheatgrass, and muttongrass are the common plants in North Park and Middle Park. Western wheatgrass, Arizona fescue, mountain muhly, needle and thread, and Parry's oatgrass are common in South Park.

Major wildlife species include black bear, elk, mule deer, antelope, coyote, beaver, snowshoe hare, jackrabbit, and sage grouse. Moose were introduced in North Park and flourished as their range expanded to the south.

Land Use

About one-fourth of this area is Federal land leased to ranchers for grazing by cattle and sheep (fig. 48B-2). The rest consists mainly of privately owned ranches. Irrigated pastures and hayland adjacent to rivers and streams produce most of the forage in the area. The hay consists mainly of grasses and sedges and a small amount of clover. Grazing land is sparsely vegetated with grasses and shrubs and produces a low amount of forage because of inadequate rainfall and low temperatures.

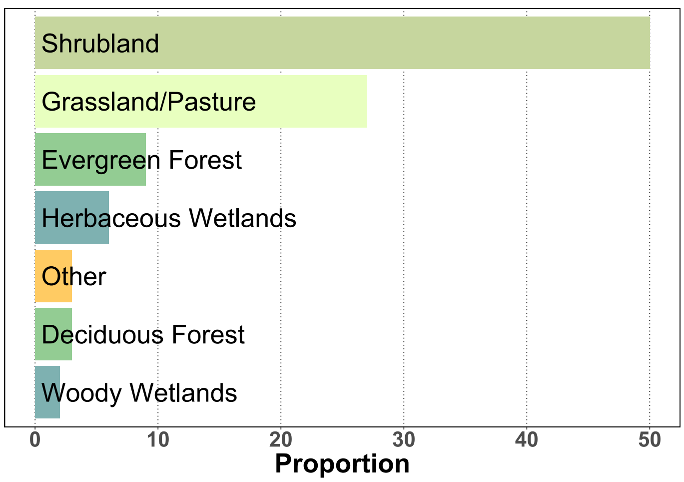

Figure 48B-2: Relative proportions (percentages) of land use in MLRA 48B.

The major soil resource concerns are water erosion, a short growing season, steep slopes, and shallow and rocky soils. Conservation practices on hayland and pasture generally include management of crop residue, nutrients, pesticides, and irrigation water. Forage harvest management is important on the rangeland and pasture in the area.

49—Southern Rocky Mountain Foothills

This MLRA (fig. 49-1) is the foothills along the eastern side of the Southern Rocky Mountains. It is in Colorado (60 percent) and Wyoming (40 percent). It makes up about 7,612 square miles (19,716 square kilometers). The northern part of the MLRA is in Wyoming and bordered by MLRA 58B (Northern Rolling High Plains, Southern Part) to the north; MLRA 34A (Cool Central Desertic Basins and Plateaus) to the west; and MLRA 67A (Central High Plains, Northern Part) to the east. The southern part is in Colorado and bordered by MLRA 48A (Southern Rocky Mountains) to the west; MLRA 67B (Central High Plains, Southern Part) to the east; and MLRA 69 (Upper Arkansas Valley Rolling Plains) to the south.

Figure 49-1: Location of MLRA 49, which covers 1,971,600 hectares (4,871,800 acres), within Region E.

Physiography

Almost half of this area is in the Southern Rocky Mountains and Wyoming Basin provinces of the Rocky Mountain System. The rest is in the Colorado Piedmont, Raton, and High Plains sections of the Great Plains province of the Interior Plains. The northern part of the MLRA consists of the Laramie Mountains. The central and southern parts generally are bordered on the east by the Great Plains and on the west by the Southern Rocky Mountains. Elevation ranges from 5,000 to 8,000 feet (1,525 to 2,440 meters) in most of the MLRA, but small mountains are as high as 10,230 feet (3,120 meters).

The Laramie and North Platte Rivers and their associated tributaries are the principal streams in the Wyoming portion of the MLRA. The Cache La Poudre, Big Thompson, Saint Vrain, South Platte, Arkansas, Saint Charles, Huerfano, and Cucharas Rivers; Clear and Fountain Creeks; and their associated tributaries are the principal streams in the Colorado portion.

Geology

This area has been impacted by the geologic processes of uplift, folding, and faulting and by subsequent erosion and deposition. The Southern Rocky Mountains were uplifted 50 to 70 million years ago during the Laramide uplift. Most of this MLRA is adjacent to this uplift and was also affected. The uplift induced erosion of the relatively soft Late Pennsylvanian to Cretaceous sedimentary rocks from the uplands and dissected the underlying Precambrian crystalline rocks. The relief of the area was reduced by a combination of erosion of uplands and alluvial filling. Approximately 7 million years ago, a large portion of the area was uplifted again to elevations of 14,000 feet (4,270 meters) or more at the core of the Laramide uplift. Since then, precipitation occurring as both rain and snow led to the renewal of erosion and subsequent alluvial fills.

The Wyoming portion of the MLRA, the Laramie Mountains, consists primarily of Precambrian plutonic rocks with Pennsylvanian and Permian sedimentary rocks folded and faulted at the margin of the range. The Colorado portions of the area consist primarily of remnants of the uplifted and folded Pennsylvanian through Cretaceous sedimentary rocks that formed hogbacks, ridges, and hills, the ranges of which trend in a general north-south direction, parallel to the uplifted Southern Rocky Mountains. Tertiary volcanic flows filled valleys in some areas. After extensive erosion, these more resistant volcanic rocks now form prominent mesas, such as North and South Table Mountains near Golden, Colorado. Stream erosion from the eastern front of the Southern Rocky Mountains fostered the creation of a sequence of large alluvial fan remnants, pediments, and terrace deposits in this MLRA.

Climate

The average annual precipitation is 12 to 25 inches (305 to 635 millimeters) in most of this area but ranges to 32 inches (820 millimeters), generally increasing with elevation. Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation occurs as snow. The average annual temperature is 34 to 52 degrees F (0.9 degree to 11.4 degrees C). The freeze-free period averages 120 days and ranges from 75 to 165 days, decreasing in length with elevation and from south to north.

Water

The numerous major streams crossing this area provide some public supply water and irrigation water for narrow belts of cropland in the stream valleys. The only limitation affecting the quality of the surface water is a high sediment load.

Alluvium in the South Platte River and its tributaries provides some water for irrigation, livestock, and domestic use in the northern part of this MLRA. Water from this aquifer is a calcium-sulfate type and hard. Alluvium in the valleys of Fountain Creek and Black Squirrel Creek, in the middle of the MLRA, provides some ground water for agricultural and domestic uses. This water is moderately hard to very hard. Another source of ground water is the Denver Basin aquifer system southeast of Denver. Consolidated sandstone and conglomerate beds in this aquifer provide water that is slightly less hard than the water from the river alluvium.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the Colorado portions of the MLRA dominantly have a mesic or frigid temperature regime. Those in the Wyoming portion have a frigid or cryic temperature regime. Most of the soils in the area have an ustic moisture regime, but those on the higher peaks and on some north aspects have a udic moisture regime. The soils in the area dominantly have smectitic or mixed mineralogy. They are very shallow to very deep and are dominantly well drained. Texture is dominantly loamy in soils that formed in material weathered from igneous and metamorphic rocks and dominantly loamy or clayey in soils that formed in material weathered from sedimentary rocks.

The main soils and their series:

- Argiustolls (Bresser, Boyle, Nunn, and Truckton series)
- Cryorthents (Alflack series)
- Haplocryolls (Hazton and Irson series)
- Haplustalfs (Fort Collins, Kettle, and Sarcillo series)
- Haplustepts (Rombo series)
- Haplustolls (Pring and Stapleton series)
- Paleustolls (Fondis series)
- Ustorthents (Lorencito series)

Biological Resources

This area supports grassland, shrub-grassland, and forestland vegetation. Grassland that supports blue grama, buffalograss, and wheatgrasses is common at the lower elevations. Pinyon pine, juniper, true mountain mahogany, blue grama, needle and thread, and wheatgrasses are common in the southern Colorado portion of the MLRA. Ponderosa pine, Gambel oak, Douglas-fir, white fir, kinnikinnick, Parry's oatgrass, and Arizona fescue are common at the higher elevations and in the Wyoming portion of the MLRA. Cottonwood grows along the major streams.

Major wildlife species include elk, mule deer, antelope, jackrabbit, cottontail, and mourning dove. Waterfowl inhabit areas near perennial streams, lakes, and reservoirs.

Land Use

Nearly 75 percent of this area consists of privately owned farms, ranches, and forestland (fig. 49-2). The rest is mostly Federal land. About 14 percent of the area is forestland. Less than 3 percent is irrigated cropland. The major crops are small grains and hay. The native rangeland is grazed in spring and summer. The forestland is used for the production of firewood and fenceposts.

The major soil resource concerns are water erosion, steep slopes, shallow and rocky soils, and a high shrink-swell potential. Conservation practices on cropland generally include management of crop residue, nutrients, pesticides, and irrigation water. Forage harvest management is important on the rangeland and pasture.

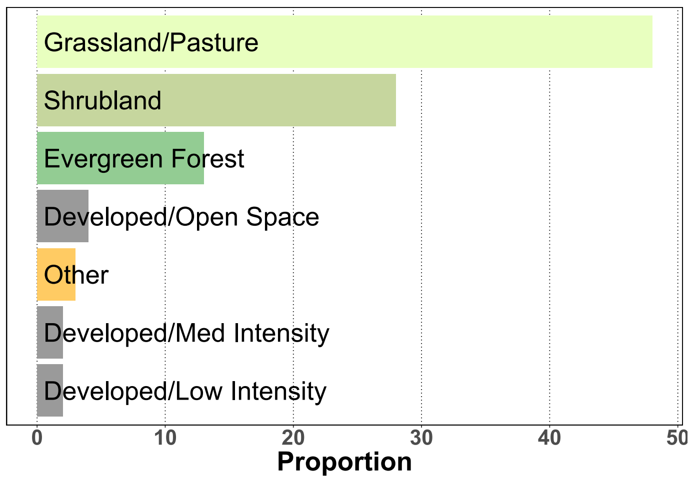

Figure 49-2: Relative proportions (percentages) of land use in MLRA 49.

51—High Intermountain Valleys

This MLRA (fig. 51-1) is an isolated, high mountain valley bounded by the Sangre de Cristo Mountains on the east and the La Garita and San Juan Mountains on the north and west. It is entirely surrounded by MLRA 48A (Southern Rocky Mountains), except for a small section in the south where it is bordered by MLRA 36 (Southwestern Plateaus, Mesas, and Foothills). This area is in Colorado (87 percent) and New Mexico (13 percent). It makes up about 3,769 square miles (9,762 square kilometers). The part of this area in Colorado is known locally as the San Luis Valley.

Physiography

This MLRA is in the Southern Rocky Mountains province of the Rocky Mountain System. Much of the MLRA consists of nearly level to gently sloping areas of old valley fill. Most of the southern end consists of gently sloping to steep hills underlain by volcanic rocks. Elevation commonly ranges from 7,500 feet to 8,200 feet (2,290 to 2,500 meters). Local relief generally is slight, but it is as much as 330 feet (100 meters) in the southern tip of the area.

Figure 51-1: Location of MLRA 51, which covers 976,200 hectares (2,412,300 acres), within Region E.

The headwaters of the Rio Grande are in the mountains west of this area. The Alamosa, Trinchera, Culebra, and Chama Rivers join the Rio Grande in this MLRA.

Geology

Most of this area is covered with old alluvial deposits washed into the valley from the adjacent mountains. Because of a low amount of precipitation, these deposits commonly have not been reworked. The only river that has a well defined flood plain and some terraces is the Rio Grande. The southern end of the area has basalt flows with some associated volcanic cones at the surface. It also has some scattered outcrops of tuff and rhyolite.

Climate

The average annual precipitation is mainly 8 to 13 inches (200 to 334 millimeters) but ranges to 33 inches (840 millimeters) in areas bordering the mountains. It increases with elevation from the town of Center, Colorado, where the lowest precipitation in the area occurs. Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation occurs as snow. The average annual temperature ranges from 36 to 46 degrees F (2.4 to 7.7 degrees C). The freeze-free period averages 120 days and ranges from 100 to 140 days, decreasing in length with elevation.

Water

Most of the MLRA supports only a sparse cover of rangeland plants because of low precipitation; however, rainfall at the higher elevations is adequate for a good cover of grass and shrubs. The Alamosa River and Rio Grande and small reservoirs on intermittent streams flowing into the area from surrounding mountains provide drinking water. The Chama River is an important source of water in the southern part of the area. The content of dissolved salts is low where the surface water exits the mountains, but it increases quickly downstream as salt-laden runoff and irrigation tailwater from the valley floor flow into the rivers. The quality of the surface water is generally acceptable for irrigation and drinking. Acid mine drainage has decreased the pH of some streams draining mined lands in the western part of this MLRA.

Wells that tap ground water in the deep valley fill are important sources of water for irrigation and domestic use. The valley fill aquifer in Colorado is known locally as the San Luis Valley aquifer system. The upper 130 feet of this aquifer contains unconfined ground water. Where clay, fine sand, or volcanic rock layers occur in the alluvium, ground water beneath those layers is confined. The quality of the confined ground water is better than that of the unconfined water. The valley fill aquifer in New Mexico is called the Rio Grande Valley, north, aquifer. Water in both aquifers can be soft or hard. Salinity is a problem in much of the area. The ground water contains much lower levels of total dissolved salts near the recharge areas close to the mountains than in down-gradient areas lower in the valley. Salts are dissolved from soils during periods of natural runoff and irrigation return flows.

Soils

The dominant soil orders are Aridisols and Entisols. The soils in the area dominantly have a frigid temperature regime, an aridic moisture regime, and mixed mineralogy. They generally are deep or very deep and somewhat excessively drained to somewhat poorly drained. Soil texture varies.

The main soils and their series:

- Haplargids that formed in alluvium on alluvial fans, fan remnants, and stream terraces (Graypoint and San Arcacio series)
- Haplocalcids that formed in alluvium and colluvium on alluvial fans, fan remnants, and valley sides (Garita and McGinty series); that formed in residuum on basalt flows and mesas (Travelers series); that formed in alluvium on valley dunes and ridges (Space City series)
- Natrargids that formed in alluvium on flood plains, alluvial fans, and stream terraces (Hooper, Mosca, and San Luis series)
- Psammaquents that formed in alluvium on flood plains, alluvial fans, and stream terraces (Gunbarrel series)

Biological Resources

This area supports desert shrub-grassland vegetation. The common plants are greasewood, rabbitbrush, fourwing saltbush, saltgrass, alkali sacaton, western wheatgrass, sedges, and rushes at the lower elevations and twoneedle pinyon, oneseed juniper, Indian ricegrass, blue grama, needle and thread, western wheatgrass, and muttongrass at the higher elevations. Big sagebrush is common on the east side of the MLRA. Narrowleaf cottonwood is along the major streams. Major wildlife species in this MLRA include elk, mule deer, antelope, jackrabbit, cottontail, pheasant, mourning dove, and waterfowl.

Land Use

More than 75 percent of this area consists of privately owned farms and ranches (fig. 51-2). The rest is mostly Federal land. Desert shrubs and short grasses cover most of the area. About 16 percent of the area is irrigated cropland. The major crops are potatoes, malt barley and other small grains, field peas, cool-season vegetables, and hay. The native rangeland is grazed in summer, but it has a low carrying capacity.

The major soil resource concerns are water erosion, wind erosion, and saline and sodic soils. A high water table also is a concern in some areas. Conservation practices on cropland generally include management of crop residue, nutrients, pesticides, and irrigation water. Forage harvest management is important on the hayland and pasture.

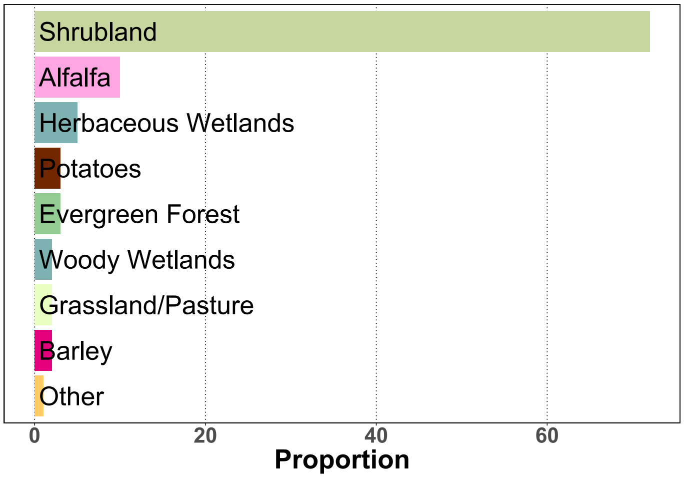

Figure 51-2: Relative proportions (percentages) of land use in MLRA 51.

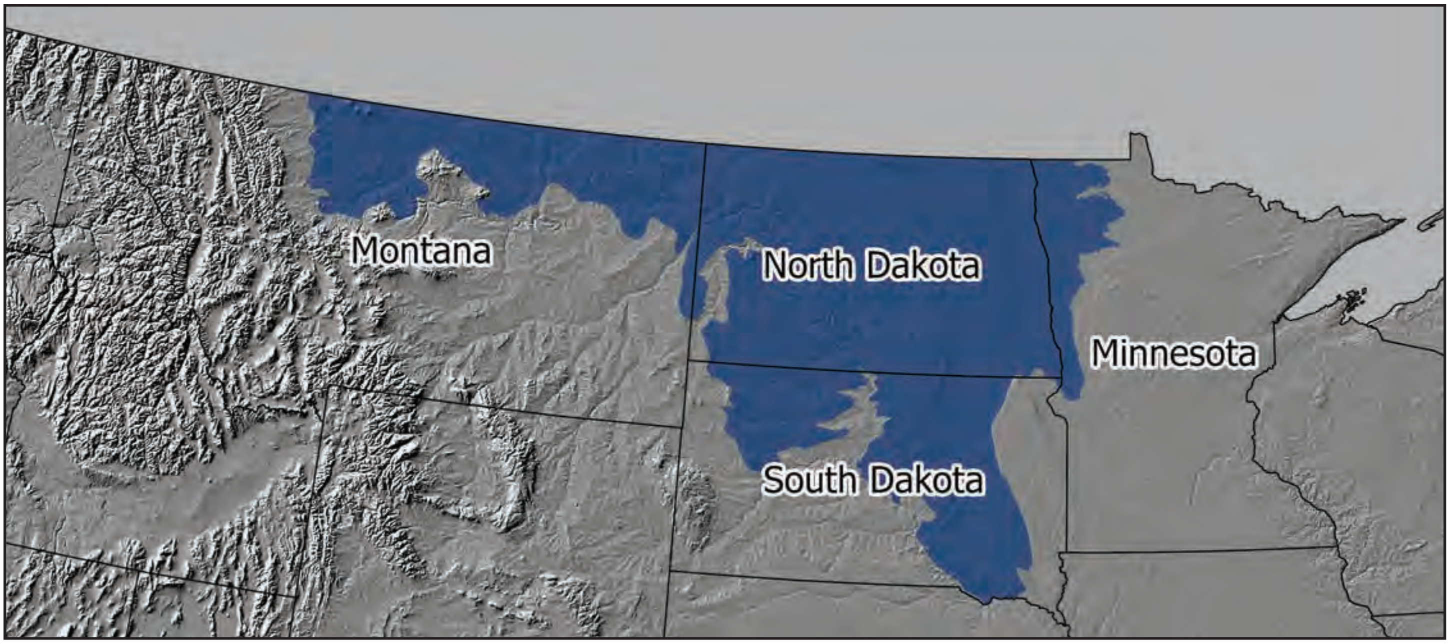

Figure F-1: Location and size of Land Resource Region F, which covers 366,490 square kilometers (141,505 square miles) and stretches along the southern Canadian border from Montana into Minnesota, dipping south into and across South Dakota.

F—Northern Great Plains Spring Wheat Region

Land Resource Region F (fig. F-1) is the mostly glaciated, Mollisol-dominated, cropland region of the northern Great Plains. Within this region, the only MLRA that was not glaciated is MLRA 54 in southwestern North Dakota and northwestern South Dakota. Region F is one of the major cropland regions in the Nation (fig. 8, page 12). Most of this region consists of soft unconsolidated geologic deposits that were laid down as part of the Cretaceous Western Interior Seaway. These deposits are overlain in some areas by Tertiary continental deposits and modified by continental glaciation, including the formation of large glacial lakes. This region contains 11 major land resource areas. The extent of these MLRAs and their range in elevations are shown in table F-1.

The boundary between Regions F and E, to the west (fig. 1, page 5), demarks the physiographic contact between the Great Plains and the Rocky Mountain Foothills. The southern boundary with Region G is the contact between the glacial deposits in Region F and non-glacial Tertiary alluvial and Cretaceous clastic sediments in Region G. This boundary also marks the change from Mollisols, in Region F, to Entisols, Inceptisols, and Vertisols, in Region G (fig. 2, page 6). The boundary between Regions F and M is primarily climatic. Region F is drier, especially along its southern boundary with Region M where the contact follows the ustic boundary. The boundary between Regions F and K, to the east, demarks the change from Mollisols to Alfisols, Spodosols, and Histosols, which reflects the change from cropland on lacustrine sediments of Pleistocene Lake Agassiz (Region F) to forests and wetlands on glacial till overlying crystalline bedrock (Region K).

The climate in Region F is dry and continental, characterized by short, warm summers and long, cold winters. Frequent periods of strong, desiccating winds are an important climatic factor. The region also is subject to periodic intense droughts. The mean annual precipitation in most of the region is 14 to 21 inches (355 to 535 millimeters). About 30 percent of the annual precipitation occurs as snow in winter, and the rest occurs during the growing season. In most of the region, the mean annual air temperature is 39 to 45 degrees F (4 to 7 degrees C) and the freeze-free period ranges from 130 to 170 days, increasing from north to south. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables F-2 and F-3.

Soils in this region are dominantly Mollisols (Ustolls and Aquolls). Ustolls are on uplands, and Aquolls are in low, wet areas and along streams. Aquolls are extensive in the Red River Valley. Some of the Ustolls have a high content of sodium, and some of the Aquolls have a high content of sodium and lime. Other important soils are Orthents on the steeper slopes and Vertisols associated with clayey lacustrine deposits.

Carbonates occur throughout the soils in this region and are especially prominent in the glacial till deposits that overlie calcareous shales in the east (fig. 5, page 9). Restrictive zones occur mainly as paralithic bedrock in North and South Dakota (fig. 9, page 13). Natric horizons are also soil restrictions

Table F-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
52	58,665	22,650	600	1,970	730	2,390	880	2,900	1,090	3,590	1,490	4,890
53A	21,720	8,385	560	1,840	620	2,030	710	2,330	860	2,820	1,010	3,310
53B	49,005	18,920	450	1,470	540	1,780	600	1,970	690	2,270	800	2,640
53C	10,620	4,100	430	1,420	510	1,680	560	1,840	610	2,000	670	2,220
54	75,965	29,330	10	40	580	1,900	710	2,340	860	2,830	1,090	3,590
55A	35,640	13,760	290	950	440	1,460	470	1,560	590	1,930	770	2,520
55B	36,865	14,235	290	970	370	1,230	440	1,460	490	1,610	690	2,270
55C	27,615	10,660	350	1,150	390	1,300	430	1,430	500	1,660	650	2,140
55D	7,925	3,060	360	1,200	390	1,280	390	1,300	430	1,430	520	1,730
56A	30,390	11,735	230	750	240	810	280	920	320	1,070	400	1,310
56B	12,080	4,665	250	820	280	930	330	1,080	350	1,170	410	1,350

Table F-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
52	3.8	39	5.1	41	6.3	43	7.2	45	8	46	85	128	133/135	139	155
53A	3.8	39	4.5	40	5.4	42	6.3	43	7	45	110	125	131/130	134	145
53B	3.6	39	4.1	39	5.2	41	6.3	43	7.2	45	120	126	134/135	142	150
53C	6.7	44	7	45	7.7	46	8.3	47	8.7	48	135	142	149/150	154	170
54	4	39	5.7	42	6.3	43	7.4	45	8.2	47	125	129	132/135	144	155
55A	2.1	36	3	37	4	39	4.5	40	5	41	125	126	130/130	134	145
55B	3.8	39	4.5	40	5.1	41	6.2	43	6.9	45	130	133	141/140	147	155
55C	6.7	44	7.2	45	8.3	47	9.2	48	10	50	140	147	158/155	162	170
55D	5.8	42	6.2	43	6.6	44	6.9	44	7.1	45	140	142	148/145	153	155
56A	3.5	38	4	39	5.2	41	6	43	6.3	43	130	135	146/145	150	155
56B	3.2	38	3.5	38	3.9	39	4.4	40	5.1	41	130	132	134/135	139	145

Table F-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
52	240	10	277	11	311/315	12/12	361	14	500	19
53A	280	11	320	13	335/335	13/13	354	14	380	15
53B	330	13	392	15	457/455	18/18	515	20	550	21
53C	400	16	469	18	500/510	20/20	563	22	620	24
54	340	13	375	15	418/415	16/16	447	18	500	19
55A	360	14	431	17	467/470	18/18	506	20	580	23
55B	420	17	461	18	526/520	21/20	552	22	610	24
55C	500	20	547	22	615/610	24/24	652	26	690	27
55D	540	22	553	22	560/565	22/22	579	23	600	24
56A	500	20	522	21	570/570	22/22	618	24	650	25
56B	540	21	565	22	593/590	23/23	612	24	630	25

throughout the region (fig. 11, page 15). Argillic horizons are common, except in soils on the younger lacustrine, glacial, and fluvial landforms (fig. 12, page 16). The calcareous eastern portion of Region F is an area where soils have some of the highest amounts of organic carbon accumulation in the conterminous United States (fig. 14, page 18).

Land use in this region is mainly grassland or pasture (fig. F-2) but the region also has much agriculture (see fig. 8). Fertile soils and dominantly smooth topography favor agricultural uses, but relatively low amounts of precipitation and a short growing season severely limit the choice of crops that can be grown. The main crops are soybeans and spring wheat, which are dry-farmed. Other spring-planted grains, flax, and alfalfa also are grown. Potatoes, sugar beets, and corn are important crops in the Red River Valley. The native vegetation consists mainly of mixed and tall prairie grasses. The main management concerns in areas of cropland are a reduced nutrient content, increased salinity, and susceptibility to water erosion and wind erosion.

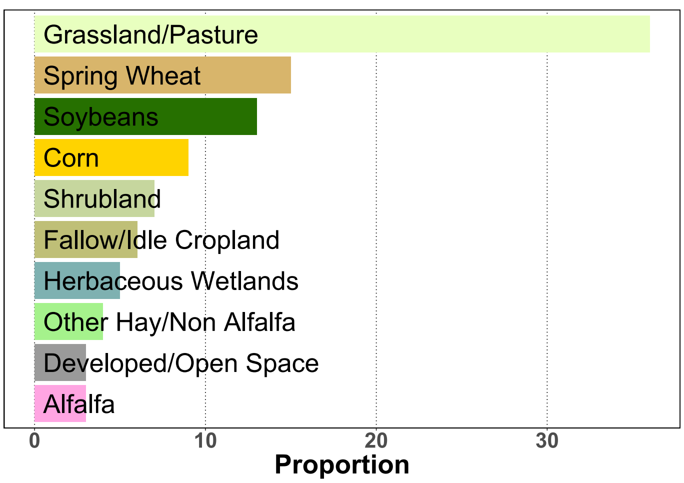

Figure F-2: Relative proportions (percentages) of land uses in Land Resource Region F (National Agricultural Statistics Service, 2018).

52—Brown Glaciated Plains

This area (fig. 52-1) is entirely in north-central Montana and makes up about 22,651 square miles (58,666 square kilometers). MLRA 52 represents the driest and westernmost extent of the Laurentide Ice Sheet. Late Wisconsin-age (approximately 14,000 to 25,000 years ago) till makes up the majority of this MLRA, but Illinoian-age (approximately 120,000 to 150,000 years ago) glacial deposits cover significant portions of the area, particularly in the eastern half. The common landscapes are till plains and lake plains. The dominant landforms include moraines, hillslopes, and till-floored lake plains. Most of MLRA 52 has a semiarid climate, and the basal till is relatively high in soluble sulfate salts and low in calcium carbonates. The western half of the MLRA is dominantly farmland, and dry-

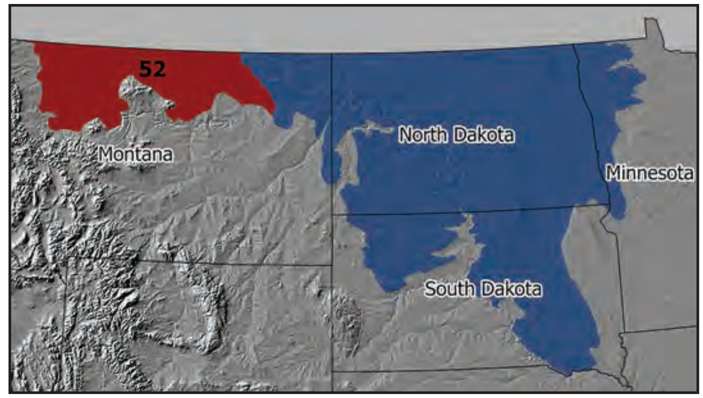

Figure 52-1: Location of MLRA 52, which covers 5,866,600 hectares (14,496,700 acres), within Region F.

farmed winter wheat is the principal crop. The eastern half is principally rangeland managed for beef cattle production.

MLRA 52 is bordered by the Canadian provinces of Alberta and Saskatchewan to the north. Much of the till and glacial lake deposits in the west and southwest are bordered by alluvial fans and igneous and sedimentary residuum of the Rocky Mountain Foothills (in MLRA 46). The southeastern part of the MLRA is largely bordered by the sandstone and shale residuum of the Northern Rolling High Plains (in MLRA 58A). This boundary is typically difficult to determine as till deposits in the transition zone are thin, eroded, and intermixed with residual bedrock. The eastern boundary with the Northern Dark Brown Glaciated Plains (MLRA 53A) is formed by a gradual climatic break where the timing of peak precipitation changes from May and June (in MLRA 52) to June and July (in MLRA 53A). The increase in moisture results in an extended growing season in MLRA 53A.

Physiography

This MLRA is in the Missouri Plateau, glaciated, section of the Great Plains province of the Interior Plains. Elevation generally ranges from 1,970 to 4,600 feet (600 to 1,400 meters), increasing from east to west. The glaciated plain in this area is generally nearly level to gently rolling, but belts of steeper slopes occur on end moraines and adjacent to drainageways. The Milk River has extensive flood plains in the eastern half of the MLRA where it occupies a former channel of the Missouri River, but flood plains along most drainages are narrow and discontinuous. The Teton, Marias, Milk, and Frenchman Rivers occur in this MLRA. A short reach of the Missouri River flows through the southwest and southeast corners of the area.

Geology

The majority of this MLRA consists of a till plain, but sizeable portions of the western half consist of glacial lake plains. Till from continental glaciation is the dominant parent material, but alluvium and bedrock are also common. Till deposits are typically less than 50 feet thick, and in some areas glacially deformed bedrock occurs at or near the soil surface. Underlying sedimentary bedrock largely consisting of Cretaceous shale, sandstone, and mudstone is commonly exposed on hillslopes, particularly along drainageways. The geology of the bedrock frequently influenced the relatively thin overlying till as fine-loamy till is more common in areas underlain by sandstone and mudstone and clayey till is more common in areas underlain by shale. Significant alluvial deposits are along glacial outwash channels and major drainages, including portions of the Missouri, Teton, Marias, Milk, and Frenchman Rivers. Large glacial lakes, particularly in the western half of the MLRA, deposited dominantly clayey and silty lacustrine sediments.

Climate

The average annual precipitation is 10 to 19 inches (249 to 500 millimeters), and 70 to 80 percent of this occurs during the growing season. The majority of precipitation occurs as steady, soaking, frontal system rains in late spring to early summer. Midsummer rainfall comes mainly from isolated convection thunderstorms that typically deliver scattered amounts of rain in intense bursts. These storms may be accompanied by damaging winds and large-diameter hail and result in flash flooding along low-order streams. Winter snowfall ranges from 20 to 60 inches (510 to 1,525 millimeters) with an average of 40 inches (1,015 millimeters) each year. Severe drought occurs on average in 2 out of 10 years. Extreme climatic variations, especially droughts, have the greatest influence on vegetative cover and production.

The average annual temperature is 37 to 46 degrees F (3 to 8 degrees C). The freeze-free period averages 140 days and ranges from 120 to 160 days. In winter, the western half of the MLRA commonly experiences chinook winds, which are strong west to southwest surface winds accompanied by abrupt increases in temperature. The chinook winds are strongest on the western boundary of the MLRA near the Rocky Mountain Foothills and decrease eastward.

Water

Most of the area depends on precipitation for water for both range and crops. The Milk and Teton Rivers provide irrigation water to their flood plains and adjacent areas. In the uplands, water for livestock is stored in small reservoirs or is pumped from deep wells and distributed by pipeline systems. The surface water generally is suitable for most uses, except during periods of low flow when it has increased concentrations of dissolved solids. Several drainages in the area have naturally higher concentrations of salts and therefore are more limiting.

Ground water is principally extracted from deep aquifers in Cretaceous sandstone. Eagle Sandstone under the western half of the MLRA provides soft water, and the Judith River Formation under the eastern half provides hard water. The content of dissolved solids in both aquifers exceeds national drinking water standards. Small, localized aquifers are in several locations where Tertiary and Quaternary alluvial deposits were deposited in former channels of the Missouri River.

Soils

The dominant soil orders in this MLRA are Mollisols, Alfisols, and Inceptisols. The soils in the area dominantly have a frigid temperature regime, an ustic moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained, and loamy or clayey.

The main soils and their series:

- Albaqualfs that formed in alluvium over till on moraines and in closed depressions (Nishon series)
- Argiustolls that formed in till on moraines (Scobey, Joplin, Bearpaw, and Vida series); that formed in alluvium on alluvial fans, stream terraces, swales, and lake plains (Ethridge and Evanston series)
- Haplustalfs that formed in till on moraines (Phillips series)
- Haplustepts that formed in till on moraines and hillslopes (Hillon and Sunburst series)
- Natrustalfs that formed in till on moraines (Elloam and Thoeny series)
- Ustorthents that formed in residuum on hillslopes (Cabbart and Neldore series); that formed in alluvium on lake plains and in drainageways (Kobase and Havre series)

Biological Resources

This area supports natural mixed-grass prairie vegetation characterized by needle and thread and rhizomatous wheatgrass with minor amounts of green needlegrass, blue grama, and prairie Junegrass. Big sagebrush is prominent in the southern portions of the MLRA, where it is considered critical habitat for the greater sage-grouse, a species of concern.

Other major wildlife species in this area are elk, mule deer, white-tailed deer, antelope, coyote, badger, beaver, raccoon, mink, black-tailed prairie dog, Richardson's ground squirrel, jackrabbit, cottontail rabbit, pheasant, Hungarian partridge, sharp-tailed grouse, ducks, geese, swans, pelicans, and shorebirds. Fish species include trout, walleye, northern pike, sauger, channel catfish, and perch.

Land Use

Most of the MLRA is privately owned farms and ranches (fig. 52-2). Level tracts, mostly in the western part of the area, are used as cropland, which makes up almost one-half of the total area. Winter wheat is the major cash crop, but spring wheat, barley, dry peas, and garbanzo beans are also grown. Most of the land in the eastern part of the area, including significant tracts managed by the Bureau of Land Management, is rangeland, but arable gently sloping soils are used for dry-farmed wheat and hay. Below the Fresno Reservoir, the majority of the Milk River flood plain is irrigated for grass and alfalfa

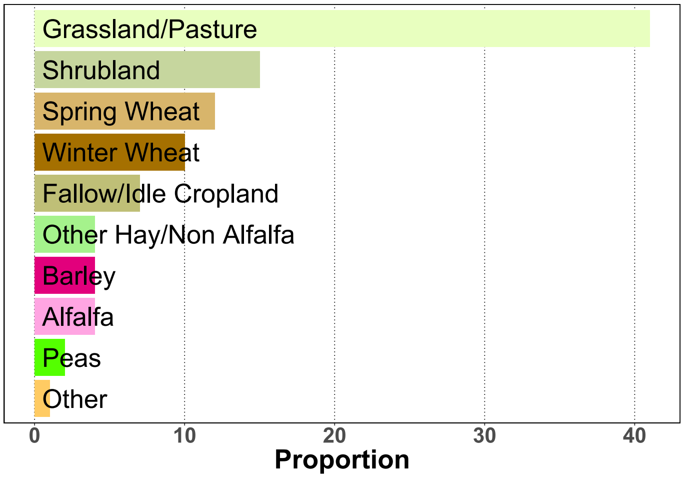

Figure 52-2: Relative proportions (percentages) of land use in MLRA 52.

hay. Small amounts of irrigated silage corn and hay barley are also grown. Narrow, discontinuous strips along the Teton, Marias, and Missouri Rivers are also irrigated. Wooded areas are generally small and occur as narrow bands along streams and rivers or as shelterbelts around farmsteads. Recreational hunting and fishing are also important land uses.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, soil acidification, and control of saline seeps. Water loss from poorly maintained ditches and soil salinization on irrigated land are major water resource concerns. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor; noxious and invasive plants; and occasional wildfires. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on cropland generally include systems of crop residue management (especially no-till or other conservation tillage systems that conserve moisture and contribute to soil quality), cover crops, nutrient management, soil salinity management, and pest management. Conservation practices on irrigated cropland generally include ditch lining, land leveling, land smoothing, main line burial, and installation of gated pipe and sprinklers. Noxious and invasive plants can sometimes be controlled by pest management and prescribed grazing. Firebreaks reduce the hazard of wildfires. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments.

53A—Northern Dark Brown Glaciated Plains

This area (fig. 53A-1) is in northeastern Montana (93 percent) and northwestern North Dakota (7 percent). It makes up about 8,386 square miles (21,719 square kilometers) and represents the driest portion of the Dark Brown Glaciated

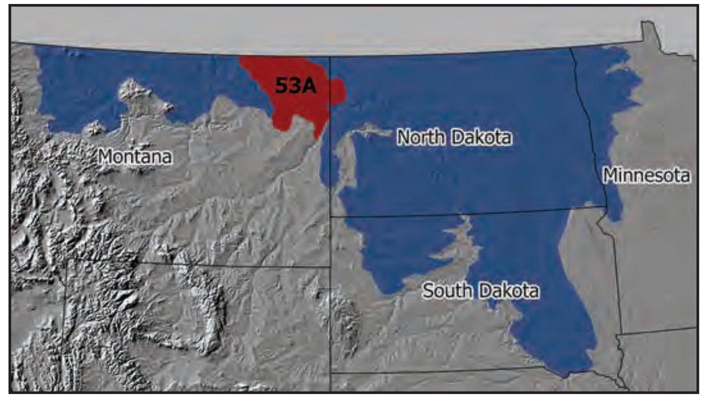

Figure 53A-1: Location of MLRA 53A, which covers 2,171,900 hectares (5,366,900 acres), within Region F.

Plains. The common landscapes are till plains and tablelands. The dominant landforms include moraines, hillslopes, and paleoterraces. Most of MLRA 53A has a semiarid climate. The basal till is relatively low in soluble sulfate salts and high in calcium carbonates.

MLRA 53A is bordered by the Canadian province of Saskatchewan to the north. Its western boundary with MLRA 52 is gradual and occurs where the timing of peak precipitation changes from June and July to May and June. This change results in a shift from a typic ustic to an aridic ustic soil moisture regime. The southern part of MLRA 53A is largely bordered by the sandstone and shale residuum of the Northern Rolling High Plains (in MLRA 58A). This boundary is typically difficult to determine as till deposits in the transition zone are thin, eroded, and intermixed with residual bedrock. The southeastern boundary with the Rolling Soft Shale Plain (MLRA 54) is formed by the Yellowstone River Valley. The eastern boundary with the Central Dark Brown Glaciated Plains (MLRA 53B) is formed by the Missouri Coteau. The coteau, which is a large disintegration moraine with thick till deposits and numerous potholes, represents the maximum extent of the final glacial advance of the Late Wisconsinan age (approximately 14,000 years ago).

Physiography

This MLRA is in the Missouri Plateau, glaciated, section of the Great Plains province of the Interior Plains. Elevation ranges from 1,840 to 3,300 feet (560 to 1,005 meters), increasing gradually from southeast to northwest. The gently undulating to rolling till plains in this area are interrupted by more strongly rolling and steep slopes adjacent to valleys and drainageways.

The Missouri River bisects the southern part of this MLRA, and the Yellowstone River joins the Missouri River just inside the North Dakota border, forming a natural southeastern boundary. The Poplar, Big Muddy, and Little Muddy Rivers, all tributaries of the Missouri River, occur in this MLRA.

Geology

Till from continental glaciation is the dominant parent material, but bedrock is also common. Till deposits mostly consist of fine-loamy, calcareous till from the Late Wisconsinan (approximately 14,000 to 25,000 years ago) Missouri Valley Lobe, but some deposits in the western half of the MLRA are of Illinoian age (approximately120,000 to 150,000 years ago) and from the Wood Mountain Lobe. Till deposits are typically less than 50 feet thick, and glacially deformed bedrock occurs at or near the soil surface in some places. Underlying sedimentary bedrock largely consisting of Tertiary sandstone, siltstone, and shale of the Fort Union Formation is commonly exposed on hillslopes, particularly along drainageways and near former glacial margins. Unglaciated paleoterraces consisting of Tertiary deposits of sands and gravel of the Flaxville formation make up approximately 15 percent of the MLRA and are concentrated in the northwestern corner. Younger alluvial deposits are along the Missouri River and its major tributaries.

Climate

The average annual precipitation is 11 to 15 inches (284 to 376 millimeters). Approximately 80 percent of the annual precipitation occurs during the growing season. June is the wettest month, followed by July and May. The majority of spring precipitation occurs as steady, soaking, frontal system rains in late spring to midsummer. Summer rainfall is mainly from convection thunderstorms that typically deliver scattered amounts of rain in intense bursts. These storms may be accompanied by damaging winds and large-diameter hail and result in flash flooding along low-order streams. Winter snowfall ranges from 20 to 40 inches (510 to 1,015 millimeters) with an average of 30 inches (760 millimeters) each year. Climatic extremes are common, with severe drought and severe wetness each occurring 1 out of 10 years. Extreme climatic variations, especially droughts, have the greatest influence on vegetative cover and production. The average annual temperature is 39 to 45 degrees F (4 to 7 degrees C). The freeze-free period averages 135 days and ranges from 110 to 155 days.

Water

In most years, moisture is inadequate for maximum crop production. In the uplands, water for livestock is stored in small reservoirs or is pumped from deep wells and distributed by pipeline systems. The Missouri River is the only dependable source of water for irrigation. As a result, only a small acreage is irrigated. The Missouri River water is of good quality and suitable for most uses with minimal treatment.

There is a limited supply of ground water in the Tertiary Fort Union Formation. This formation consists of soft, calcareous shales, siltstones, and sandstones. Water from these aquifers is a sodium-sulfate type. It is very hard and high in total dissolved solids.

Soils

The dominant soil orders are Mollisols and Inceptisols. The soils in the area dominantly have a frigid temperature regime, an ustic moisture regime, and mixed mineralogy. They generally are very deep, well drained, and loamy.

The main soils and their series:

- Albaqualfs that formed in alluvium over till on moraines and in closed depressions (Nishon series)
- Argiustolls that formed in till on moraines (Vida, Williams, and Bowbells series); that formed in alluvium or eolian deposits over till on moraines (Dooley series); that formed in alluvium on terraces or in drainageways (Turner and Farnuf series)
- Calciustepts that formed in till on moraines and hillslopes (Zahill series)
- Haplustolls that formed in eolian deposits, alluvium, or glaciofluvial deposits on fans, terraces, dunes, and moraines (Tally series)
- Ustorthents that formed in residuum on hillslopes (Cabba series)

Biological Resources

This area supports natural mixed-grass prairie vegetation characterized by rhizomatous wheatgrasses, needle and thread, western porcupinegrass, green needlegrass, and blue grama. Little bluestem is an important species on the more sloping and shallower soils. Scurfpea, goldenrod, prairie coneflower, and echinacea are commonly interspersed throughout the MLRA. Small wooded areas dominated by green ash, chokecherry, and buffaloberry naturally occur in draws and narrow valleys.

Major wildlife species include elk, mule deer, white-tailed deer, antelope, pheasant, sharp-tailed grouse, Hungarian partridge, Canadian goose, mallard, blue-winged teal, pintail, pelican, and shorebirds. Fish species include walleye, northern pike, sauger, channel catfish, paddlefish, and perch.

Land Use

Most of this area is in farms and ranches (fig. 53A-2). Slightly more than one-half of the area is dry-farmed cropland. Spring wheat is the chief crop, but dry beans and peas, lentils, and flax are grown on some farms. Dryland hay is also grown for winter use by cattle operations. The more sloping soils support native grasses and are used as rangeland. Recreational hunting and fishing are also important land uses.

The major soil resource concerns are wind and water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and control of saline seeps. Water resource concerns are inefficient water use on irrigated cropland and excessive amounts of pesticides, nutrients, and organic material in surface waters.

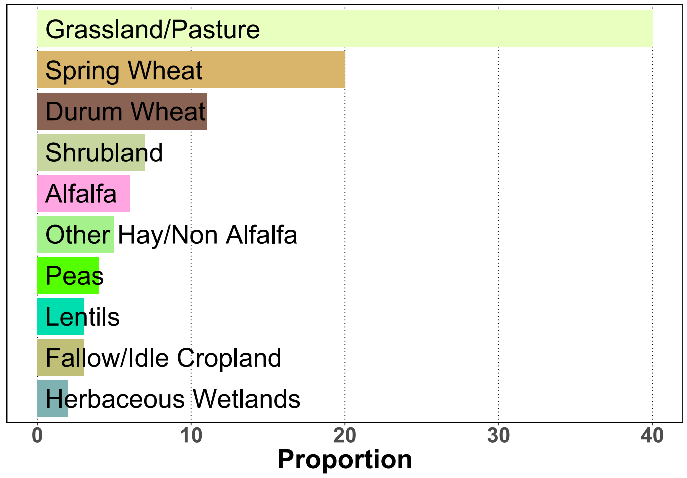

Figure 53A-2: Relative proportions (percentages) of land use in MLRA 53A.

Plant resource concerns are deterioration of plant condition, productivity, health, and vigor and noxious and invasive plants. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on cropland generally include systems of crop residue management (especially no-till or other conservation tillage systems that conserve moisture and contribute to soil quality), cover crops, nutrient management, soil salinity management, and pest management. Conservation practices that improve water use and distribution on irrigated cropland generally include irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as land leveling, land smoothing, water-control structures, and sprinklers. Noxious and invasive plants can sometimes be controlled by pest management and prescribed grazing. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments.

53B—Central Dark Brown Glaciated Plains

MLRA 53B (fig. 53B-1) is in North Dakota (80 percent), South Dakota (18 percent), and Montana (2 percent). It makes up about 18,922 square miles (49,007 square kilometers). This area marks the boundary of the western limits of glaciation in North Dakota and north-central South Dakota. It has a high concentration of wetlands and is interspersed with small glacial kettle lakes. It is nearly without streams and rivers. It is bordered by MLRAs 53B, 55A, and 55B along the boundary of the ustic soil moisture regime, marked by the eastern footslopes of the Missouri Coteau. The moisture regime transitions from ustic (MLRA 53B) to udic (MLRAs 55A and 55B) along this boundary.

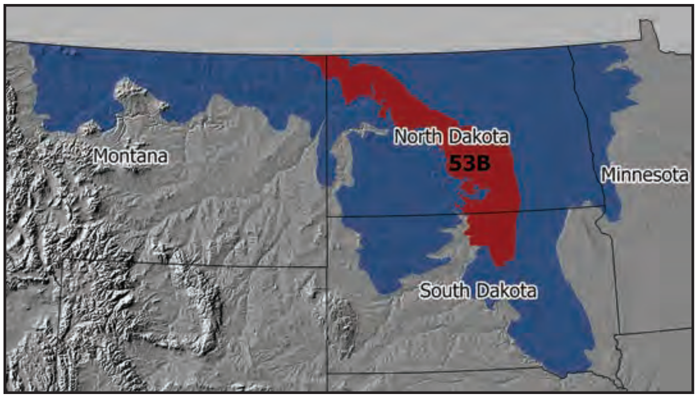

Figure 53B-1: Location of MLRA 53B, which covers 4,900,700 hectares (12,109,800 acres), within Region F.

Physiography

Almost the entire MLRA is in the Missouri Coteau portion of the Missouri Plateau, glaciated, section of the Great Plains province of the Interior Plains. The Missouri Coteau lies west of the Drift Prairie and is separated from the main portion of the Missouri Plateau to the west by the Missouri River. The characteristic pothole topography of the Missouri Coteau resulted from the collapse of glacial sediments that overlay a sheet of ice. The hummocky, undulating rolling hills of the Missouri Coteau dramatically rise 150 to 300 feet above the Drift Prairie. Small portions of the northeastern corner of the MLRA are in the Western Lake section of the Central Lowland province of the Interior Plains.

The nearly level to rolling till plains in this MLRA include kettle holes, kames, moraines, and small glacial lakes. Moderately steep and steep slopes are adjacent to the major stream valleys. Elevation ranges from 1,280 to 2,560 feet (390 to 780 meters), increasing gradually from southeast to northwest. The Missouri River runs parallel to the western boundary along most of this MLRA. The Des Lacs and Upper Souris Rivers just touch the northeast corner of the MLRA.

Geology

This area is dominated by a disintegration moraine of Wisconsin-age till over Tertiary sandstone and shale. It has numerous closed-basin potholes with little integrated drainage. Areas of the stagnant ice moraine have numerous remnant and existing lacustrine sediments, typically occurring as stable and collapsed ice-walled lake plains. Glacial outwash deposits are along the margins of steep moraines leading to large glacial outwash plains. The glacial deposits of the western portion of the MLRA are generally from older glacial advances, are thinner, are more weathered with moderate to gradual sloping till, and have more open drainage. The drainages contribute to the Missouri River watershed. Some outwash materials are associated with the drainages or were deposited when streams were active glacial meltwater channels. Alluvial deposits are extensive along the Missouri, Des Lacs, and Souris Rivers but occur in narrow and discontinuous strips along other streams and rivers. Low terraces are along the major rivers.

Climate

The average annual precipitation is 13 to 21 inches (335 to 541 millimeters). About 75 percent of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation is typically snow. The annual snowfall is 25 to 50 inches (635 to 1,270 millimeters). The average annual temperature is 39 to 45 degrees F (4 to 7 degrees C). The freeze-free period averages 135 days and ranges from 110 to 140 days.

Water

Precipitation is the principal source of moisture for crops. In most years, moisture is inadequate for maximum crop production. The Missouri River is the only dependable source of water of good quality for irrigation and livestock. Thus, only small areas close to the river and to Lake Sakakawea are irrigated. In other areas, ponds are a source of water for livestock. The Missouri River has good quality water, while the quality of other surface water is fair or poor. Limited quantities and high amounts of dissolved solids limit water use. Rural water systems are improving the quality of water available for domestic use. These systems typically obtain their water from the Missouri River and its reservoirs.

There is a limited supply of deep ground water in surficial, unconsolidated aquifers and in the Cenozoic sedimentary bedrock aquifers beneath the till plains. The unconsolidated aquifers consist of alluvial deposits in stream valleys and glacial drift and outwash deposits. Water in the unconsolidated aquifers is generally very hard and high in sodium and sulfate. It is used as drinking water in some rural areas. High salinity levels limit its use for irrigation.

The sedimentary bedrock aquifers make up the Fort Union aquifer system in the northern two-thirds of the MLRA and the Hell Creek-Fox Hills aquifer system in the southern third. Both aquifer systems contain soft water with high levels of sodium and dissolved solids. High salinity levels limit the use of the water for irrigation. Naturally occurring selenium levels in the Fort Union aquifer system are much greater than the recommended levels for drinking water.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a frigid temperature regime; the regime is mesic near the southern border. They have an ustic or aquic moisture regime and mixed or smectitic mineralogy. They generally are very deep, well drained to very poorly drained, and clayey or loamy.

The main soils and their series:

- Argiaquolls that formed in alluvium in depressions on till plains, moraines, and lake plains (Parnell series)
- Argiustolls that formed in till on till plains, moraines, and hills (Williams series); that formed mixed till and alluvium on till plains, moraines, and hills (Bowbells series)
- Calciustolls that formed in till on till plains and moraines (Zahl series)
- Endoaquolls that formed in alluvium in depressions on till plains, moraines, and lake plains (Southam series)
- Haplustolls that formed in alluvium on outwash plains and terraces (Bowdle and Lehr series); that formed in glaciofluvial deposits on outwash plains and terraces (Wabek series); that formed in till on till plains (Max series); that formed in silty drift or loess on uplands (Bryant series)
- Natrustolls that formed in till on till plains and moraines (Niobell and Noonan series)

Biological Resources

Almost all of MLRA 53B is in the Missouri Coteau ecological subsection. A small portion of the northeast corner is in the Glacial Drift Plains ecological subsection. Native vegetation was dominated by tall-grass prairie species. This area supports natural prairie vegetation characterized by western wheatgrass, needle and thread, green needlegrass, and big bluestem. Little bluestem is an important species on the more sloping and shallower soils. Prairie cordgrass, northern reedgrass, and slim sedge are important species on wet soils. Western snowberry, stiff goldenrod, echinacea, and prairie rose are commonly interspersed throughout the area.

Major wildlife species include white-tailed deer, red fox, raccoon, muskrat, mink, jackrabbit, cottontail rabbit, fox squirrel, pheasant, gray partridge, sharp-tailed grouse, mourning dove, geese, and ducks. Fish species include northern pike, walleye, trout, catfish, bass, bluegill, perch, and bullhead.

Land Use

Most of this area is in farms and ranches (fig. 53B-2). Slightly more than one-half of the area is cropland. Crops are grown for sale or livestock feed. The principal crops are wheat, corn, soybeans, alfalfa, and oats. The more sloping soils support native grasses and are used as rangeland. Recreational hunting and fishing are important uses of the many natural wetlands.

The major soil resource concerns are wind and water erosion, maintenance of the content of organic matter and productivity of the soils, soil wetness, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management, especially

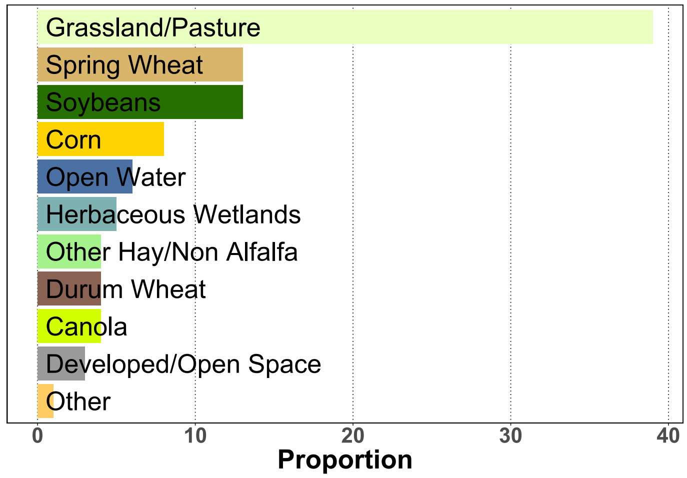

Figure 53B-2: Relative proportions (percentages) of land use in MLRA 53B.

no-till or other conservation tillage systems that conserve moisture and contribute to soil quality. The use of cover crops is also widespread. Other practices include vegetative wind barriers, wind stripcropping, grassed waterways, and nutrient management. Prescribed grazing is the most common conservation practice used to address resource concerns on rangelands in this MLRA.

53C—Southern Dark Brown Glaciated Plains

MLRA 53C (fig. 53C-1) is entirely in South Dakota and makes up about 4,099 square miles (10,618 square kilometers). It marks the boundary of the western limits of glaciation in South Dakota, and a terminal moraine occurs in its southern end. The landscape is broken up by wetlands, and the area is interspersed with small glacial kettle lakes. Hilly topography is the most distinguishing feature of the MLRA. It resulted from the collapse of sediments that overlay a sheet of ice.

MLRA 53C has distinct boundaries to the east, south, and west. To the east and southeast is MLRA 55C (Southern Black Glaciated Plains), also known as James Valley Lowlands, where the topography is a gently undulating ground moraine. The James Lobe of Pleistocene glaciers advanced and retreated through the area of MLRA 55C. To the southwest and west is MLRA 63A (Northern Rolling Pierre Shale Plains) where shales replace glacial till as soil parent material. Much of the western half of MLRA 53C is dissected by streams flowing into the Missouri River to the west. To the north MLRA 53C has a gradual boundary with MLRA 53B (Central Dark Brown Glaciated Plains), which consists of the Missouri Coteau. The undulating, rolling hills rise 390 feet above the James Valley Lowlands in some places. The northern boundary of

Figure 53C-1: Location of MLRA 53C, which covers 1,061,800 hectares (2,623,600 acres), within Region F.

MLRA 53C marks the boundary between frigid and mesic soil temperature regimes.

Physiography

The entire MLRA is in the Missouri Plateau, glaciated, section of the Great Plains province of the Interior Plains. Elevation ranges from 1,150 to 2,230 feet (350 to 680 meters). The nearly level to gently rolling till plains include many areas of potholes. A terminal moraine occurs in the southern end of the MLRA, north and west of Wessington Springs. Local relief is about 390 feet (120 meters) from the top of the moraine to the outwash and till plain to the east. Moderately steep and steep slopes are adjacent to the major valleys.

The area does not have many streams or rivers, nor does it have an integrated drainage system. Rivers or streams drain west, towards the Missouri River. The headwaters of many creeks in central South Dakota occur in this high-lying MLRA.

Geology

This MLRA is covered by glacial till and outwash in areas broken by numerous potholes. Outwash plains occur in the western portion of the MLRA, along the Missouri River or along drainages that empty into the Missouri River. A terminal moraine occurs in the southern end of the area while stagnation moraines are evident in the northern end. Glacial deposits are thin in many places throughout the MLRA. Cretaceous Pierre Shale and Dakota limestone underlie the glacial deposits.

Climate

The average annual precipitation is 16 to 24 inches (404 to 615 millimeters). About 70 percent of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation is typically snow. The annual snowfall is 25 to 45 inches (635 to 1,145 millimeters). The average annual temperature is 44 to 48 degrees F (7 to 9 degrees

C). The freeze-free period averages 140 days and ranges from 120 to 160 days.

Water

Precipitation is the principal source of moisture for crops. In most years moisture is inadequate for maximum crop production. The Missouri River is the only dependable source of water for irrigation, and its water is of good quality. In areas away from the Missouri River, ponds are a source of water for livestock. Surface water quality outside of the Missouri River is fair or poor. Limited quantities and high amounts of dissolved solids limit the use of this water. Rural water systems are improving the quality of water available for domestic use. These systems typically obtain their water from the Missouri River and its reservoirs.

There is a limited supply of ground water in the glacial drift and alluvial aquifers that are near the ground surface. These aquifers consist of unconsolidated sand and gravel. The fresh to saline water is hard and contains calcium, bicarbonate, and sulfate. The aquifers provide water primarily for domestic use and livestock. Many private wells have high levels of nitrate plus nitrite. Most of this contamination occurs where wells are located downslope from septic tank absorption fields, feedlots, barnyards, and fertilizer storage areas.

Soils

The dominant soil order is Mollisols. The soil temperature regime is mesic throughout the MLRA, except at the northern border, where it is frigid. The soils in the area have an ustic soil moisture regime and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and clayey or loamy. Soil parent materials are dominantly fine-loamy to clayey till, glaciofluvial deposits, eolian deposits, alluvium, and, to a lesser extent, loess material.

The main soils and their series:

- Argialbolls that formed in alluvium in depressions (Plankinton and Tetonka series)
- Argiaquolls that formed in alluvium in closed basins (Worthing series); that formed in alluvium in drainageways on till plains (Crossplain series)
- Argiustolls that formed in fine-loamy till on till plains (Glenham, Peno, Prosper, and Raber series); that formed in silty sediments on till plains (Eakin and Highmore series); that formed in silty sediments on till plains (Mobridge and Onita series); that formed in loess on till plains (Agar series)
- Calciustepts that formed in fine-loamy till on moraines (Betts series)
- Calciustolls that formed in fine-loamy till on till plains (Ethan series)
- Haplustolls that formed in fine-loamy till on till plains (Java series); that formed in glaciofluvial deposits on outwash till plains (Oahe series); that formed in alluvium on flood plains (Bon series)
- Natraquolls that formed in alluvium in closed basins (Hoven series); that formed in alluvium on flood plains (Durrstein series)
- Natrustolls that formed in fine-loamy till on till plains (Cavo series); that formed in silty sediments on till plains (DeGrey and Walke series)

Biological Resources

This area supports natural prairie vegetation. Western wheatgrass, big bluestem, needle and thread, and green needlegrass are the dominant species. Little bluestem, sideoats grama, and prairie sandreed are important species on the steeper sites. Western snowberry and prairie rose are commonly interspersed throughout the area

Major wildlife species include mule deer, white-tailed deer, coyote, bobcat, cottontail, sharp-tailed grouse, gray partridge, mourning dove, pheasant, geese, and ducks. Fish species include largemouth bass, bluegill, bullhead, and yellow perch.

Land Use

Most of this area is in farms and ranches, and slightly more than one-half is used for crops grown for sale or livestock feed (fig. 53C-2). Winter wheat is the chief cash crop. Corn, sunflowers, grain sorghum, oats, and alfalfa are also grown on many farms. The more sloping soils support native grasses and are used as rangeland. Recreational hunting and fishing are important land uses for the many natural wetlands.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management, especially no-till or other

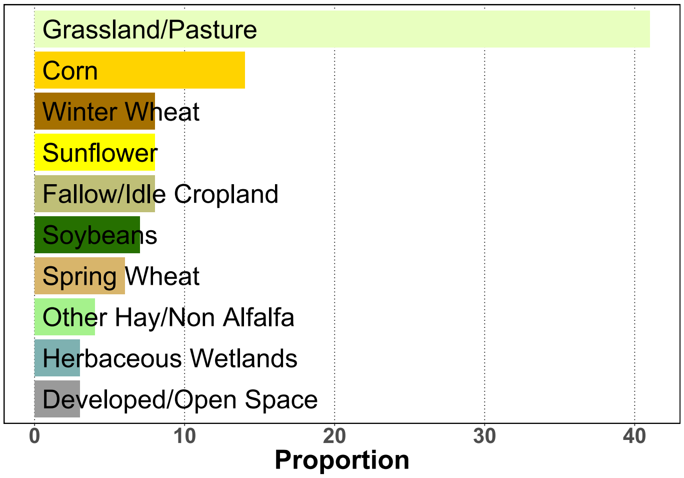

Figure 53C-2: Relative proportions (percentages) of land use in MLRA 53C.

conservation tillage systems that conserve moisture and contribute to soil quality. Other practices include planting cover crops, vegetative wind barriers, wind stripcropping, grassed waterways, and nutrient management.

54—Rolling Soft Shale Plain

MLRA 54 (fig. 54-1) is in North Dakota (64 percent), South Dakota (33 percent), and Montana (3 percent). It makes up about 29,330 square miles (75,965 square kilometers). The landscape is characterized by old, moderately dissected rolling plains.

The MLRA has a visibly distinct boundary along its eastern and northern edges where it transitions to the glaciated Missouri Plateau and remnants of glacial till parent materials remain in the high landscape areas. The Missouri River runs along the north and east sides of the MLRA. The MLRA has a more gradual, but still visibly evident, boundary to the south and west sides, with differences in climate, land use, and soil parent material. Specifically, adjacent MLRAs are drier, have soil parent materials consisting of marine sediments, and are mostly rangeland used for grazing.

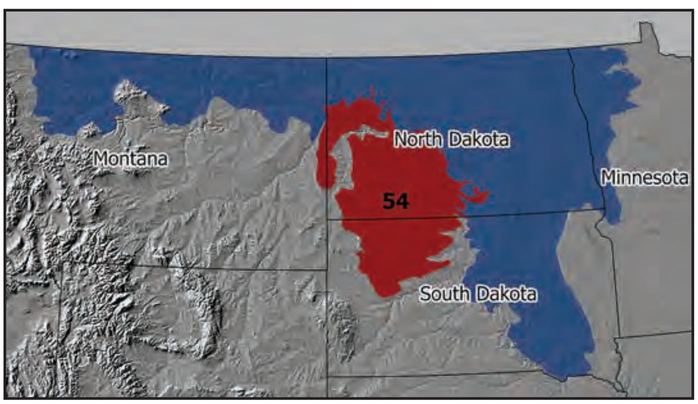

Figure 54-1: Location of MLRA 54, which covers 7,596,500 hectares (18,771,400 acres), within Region F.

Physiography

This area is in the Missouri Plateau, unglaciated, and Missouri Plateau, glaciated, sections of the Great Plains province of the Interior Plains. It is dominantly unglaciated, but the eastern and northern edges were glaciated. The area is on an old, moderately dissected, rolling plain with some local badlands, buttes, and isolated hills. Terraces are adjacent to broad flood plains along most of the major drainages. Elevation is 1,650 feet (505 meters) in the east, gradually decreasing to about 3,600 feet (1,100 meters) in the west. Maximum local relief is about 330 feet (100 meters), but relief is considerably lower in most of the area. The Knife, Heart, Cannonball, and Cedar Rivers, which are major tributaries of the Missouri River in North Dakota, drain this area. In addition, the Grand and Moreau Rivers in South Dakota drain the southern part of the area.

Geology

This area is underlain by soft, calcareous shales, siltstones, and sandstones of the Tertiary Fort Union Formation and the Fox Hills and Hell Creek units. The principal sources of ground water in the area are in these rocks. Impermeable Cretaceous shale underlies these aquifers. The northern and eastern parts of the area have a glacially modified topography and in places are covered by thin layers of glacial drift.

Climate

The average annual precipitation is 13 to 19 inches (340 to 500 millimeters). Most of the rainfall comes from convective thunderstorms during the growing season. About half of the annual precipitation occurs as snow in winter. The average annual temperature is 39 to 47 degrees F (4 to 8.2 degrees C). The freeze-free period averages 150 days and ranges from 125 to 155 days. It is shortest in the southern part of the area and longest in the northern part.

Water

In most years the supply of moisture is inadequate for maximum crop production. Water for irrigation is available in quantity only from the Missouri River and a few of its larger tributaries. The surface water is generally soft and typically a sodium-bicarbonate type. Water for livestock is stored primarily in small reservoirs. Missouri River water is used dominantly as cooling water for thermoelectric power generation.

Small areas of sand and gravel buried beneath valley floors yield moderate quantities of hard water. Ground water from the Tertiary units is generally hard or very hard. Sodium, sulfate, and bicarbonate are the major ions in the ground water. The Fort Union Formation in North Dakota yields soft water, but the water has a high content of selenium. The content of molybdenum is high in the water in the shallow aquifers in South Dakota. High levels of selenium and molybdenum affect the health of humans and livestock. Ground water is scarce or does not occur in areas underlain by shale. Farms, ranches, and small communities use ground water for most purposes, except for irrigation.

Soils

The dominant soil orders in this MLRA are Mollisols and Entisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, generally somewhat excessively drained to moderately well drained, and loamy or clayey.

The main soil series:

Argiustolls that formed in residuum on uplands (Morton, Reeder, and Regent series); that formed in till on till plains and moraines (Williams series)
Calciustolls that formed in residuum and colluvium on uplands (Chama series)
Haplustolls that formed in residuum on uplands (Amor and Vebar series); in alluvium on stream terraces and in upland drainageways (Parshall series)
Natrustolls that formed in residuum and alluvium on uplands and stream terraces and in upland drainageways (Belfield, Daglum, and Rhoades series)
Ustipsamments that formed in residuum and colluvium on uplands (Flasher series)
Ustorthents that formed in residuum and colluvium on uplands (Cabba series)

Biological Resources

This area supports natural prairie vegetation characterized by western wheatgrass, needle and thread, green needlegrass, and blue grama. Little bluestem, prairie sandreed, and sideoats grama are important species on shallow soils. Prairie rose, leadplant, and patches of western snowberry are interspersed throughout the area. Green ash, chokecherry, and buffaloberry occur in draws and narrow valleys.

Major wildlife species in this area include white-tailed deer, mule deer, pronghorn antelope, red fox, coyote, white-tailed jackrabbit, prairie dog, ring-necked pheasant, gray partridge, sharp-tailed grouse, ducks, and geese. Fish species include rainbow trout, walleye, smallmouth bass, bluegill, yellow perch, and northern pike. Fishing is limited mostly to rivers and constructed impoundments.

Land Use

Privately owned farms and ranches make up nearly 90 percent of this area (fig. 54-2). They produce a combination of cash-grain crops and livestock. More than one-half of the area supports native grasses and shrubs that are grazed. About one-third of the area is used for dry-farmed small grains, such as wheat, barley, oats, rye, and flax. Corn for grain and silage, sunflowers, and alfalfa also are important crops. Some small tracts on the bottom land along the Missouri River are irrigated.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and control of saline seeps. Conservation practices on cropland generally include systems of crop residue management and minimum-till and no-till systems that reduce the need for summer fallow tillage. Other practices include cover crops, windbreaks, vegetative wind barriers, stripcropping, nutrient management, and soil salinity management. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments.

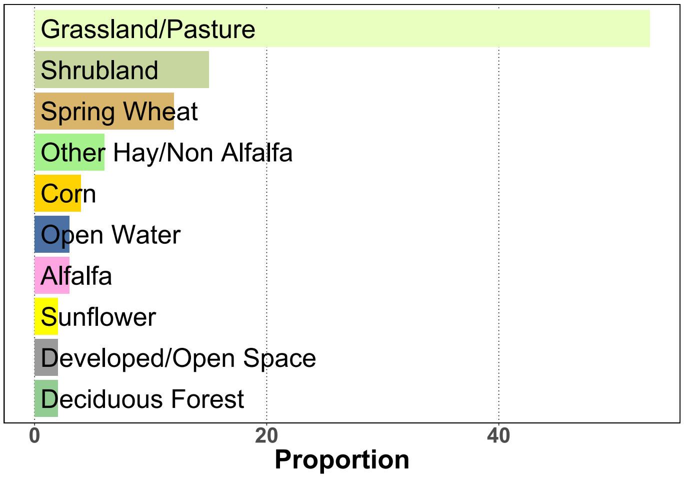

Figure 54-2: Relative proportions (percentages) of land use in MLRA 54.

55A—Northern Black Glaciated Plains

MLRA 55A (fig. 55A-1) is entirely in North Dakota and makes up about 13,761 square miles (35,641 square kilometers). The area is part of the Prairie Pothole Region, where lakes, ponds, and marshes are common on level to rolling topography with many depressions. Natural drainages are mostly ill-defined, but there are some moderately defined drainages. The till plain was formed by the Wisconsin glacier. Low-relief landforms dominate, but there are a few prominent moraines. Much of the MLRA is farmland converted from prairie, but some areas of grassland remain. Agricultural drainage practices have impacted shallow depressions in many areas.

MLRA 55A has distinct boundaries to the east and west. To the east is the Red River Valley (in MLRA 56A), which is characterized by silty and clayey sediments and sandy beach ridges of glacial Lake Agassiz. To the west is the Missouri Coteau (in MLRA 53B), which is an extensive north-south moraine that marks the break to the ustic soil moisture regime.

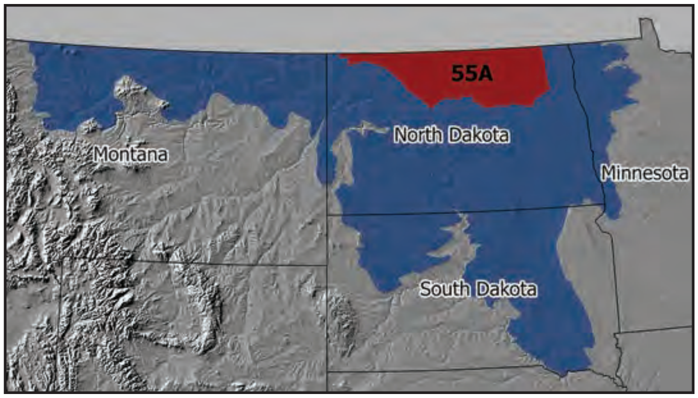

Figure 55A-1: Location of MLRA 55A, which covers 3,564,100 hectares (8,806,900 acres), within Region F.

MLRA 53B has more grassland than MLRA 55A and has upland soils that are lighter in color (dark brown). To the south, MLRA 55A has a less apparent boundary with MLRA 55B. MLRA 55B has a similar till plain but has somewhat warmer mean annual air temperatures and longer freeze-free periods.

Physiography

This area is in the Western Lake section of the Central Lowland province of the Interior Plains. Elevation ranges from 950 to 2,525 feet (290 to 770 meters), generally increasing from east to west. The mostly nearly level to rolling till plains include areas of kettle holes, kames, eskers, and moraines. Some of the depressions contain lakes. The area also has level to moderately sloping glacial lake plains and some steep slopes adjacent to streams. The Turtle Mountain moraine is approximately 1,950 to 2,525 feet (595 to 770 meters) in elevation, rising approximately 500 feet (150 meters) above nearby till and glacial lake plains.

Geology

This MLRA is dominantly glacial till plains with some moraines, glacial lake plains, and glacial outwash plains. It also has eskers, kettle holes, and kames in some areas. The Turtle Mountains are remnants of a glacial moraine, which also has collapsed glacial lake and outwash plains at high elevations. There are two large glaciolacustrine areas in the MLRA—the Lake Souris plain in the western part and the Devils Lake Basin in the southeastern part. Each of these commonly has glacial till within a depth of 6 feet. Some areas of the till plain are mantled with wind-deposited materials, which are moderately coarse textured or sandy. Shale beds underlie the till. The shale is generally very deep (20 to more than 100 feet); however, in the eastern part of the MLRA (particularly in the Pembina Gorge area) it is at a depth of 1 to 5 feet. Alluvial deposits are extensive along the Souris River but occur in narrow and discontinuous strips along other streams and rivers. Low terraces are along the major rivers.

Climate

The average annual precipitation is 14 to 23 inches (364 to 576 millimeters). About 75 percent of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation is typically snow. The average annual snowfall is 25 to 50 inches (635 to 1,270 millimeters). Strong winds commonly deposit the snow unevenly across the landscape. The average annual temperature is 36 to 41 degrees F (2 to 5 degrees C). The freeze-free period averages about 125 days and ranges from 110 to 150 days.

Water

Precipitation is the principal source of moisture for crops, but in some years it is inadequate for maximum crop production. The few perennial streams in the area are widely spaced and are little used for irrigation. For irrigation, ground water is primarily drawn from major aquifers within the glacial drift; however, flood irrigation is used on one large area of hayland adjacent to the Souris River. Water for livestock generally is from shallow wells, is stored in ponds and small reservoirs on individual farms and ranches, or is obtained from rural water pipeline systems. In some areas, it is obtained from natural springs. There are several reservoirs on the Souris and Des Lacs Rivers. The surface water is of good quality but at times is limited in quantity in most of the area.

Ground water is plentiful in unconsolidated sand and gravel deposits in glacial drift, but the water is very hard and generally has a mixture of calcium bicarbonate and sodium bicarbonate or chloride. The MLRA has deep, sedimentary bedrock aquifers, but they are of poor quality for irrigation, livestock, or human consumption. Shallow ground water is used for drinking water in some rural areas where pipeline systems are not available.

Soils

The dominant soil order in this MLRA is Mollisols. Vertisols, although less extensive, are also significant. The soils in the area have a frigid temperature regime, an aquic or udic moisture regime, and mixed or smectitic mineralogy. They generally are very deep and somewhat excessively drained to very poorly drained. Soil parent materials are dominantly loamy till with smaller amounts of sandy to clayey glaciolacustrine sediments but also include glaciofluvial and eolian deposits and alluvium. In addition, a few areas of organic materials (calcareous fens) occur in the Turtle Mountains and along old oxbows of the Souris River.

The main soil series:

- Arvilla series—Hapludolls that formed in sand and gravel deposits on outwash plains
- Barnes series—Hapludolls that formed in loamy till on till plains and moraines
- Bearden series—Calciaquolls that formed in silty sediments on lake plains
- Buse series—Calciudolls that formed in loamy till on till plains and moraines
- Hamerly series—Calciaquolls that formed in loamy till on ground moraines
- Hegne series—Calciaquerts that formed in clayey sediments on lake plains
- Parnell series—Argiaquolls that formed in local alluvium in depressions on till plains and moraines
- Souris series—Hapludolls that formed in loamy till on ground moraines
- Tonka series—Argialbolls that formed in local alluvium in depressions on till plains
- Vallers series—Calciaquolls that formed in loamy till on till plains

Biological Resources

Native vegetation is characterized by western wheatgrass, green needlegrass, needle and thread, and blue grama. Little bluestem is an important species on the more sloping and shallower soils as well as on highly calcareous, somewhat poorly drained soils. Prairie cordgrass, northern reedgrass, big bluestem, and slough sedge are important species on wet soils. Western snowberry, leadplant, and prairie rose are common shrub species interspersed throughout the area. A small part of the area supports forest vegetation characterized by bur oak with an understory of chokecherry and other shrubs or by aspen with an understory of beaked hazelnut. Sprengel's sedge is common in the herbaceous layer.

Major wildlife species include white-tailed deer, moose, coyote, red fox, badger, beaver, raccoon, skunk, muskrat, mink, white-tailed jackrabbit, cottontail rabbit, fox squirrel, sharp-tailed grouse, gray partridge, mourning dove, wild turkey, ducks, geese, various species of grassland birds, shore birds, and amphibians. Snowshoe hares inhabit the Turtle Mountains, and ruffed grouse are important in the Turtle Mountains and Pembina Gorge areas. The MLRA provides important feeding and resting areas for migrating waterfowl. Many Canada geese and several species of ducks also nest in the area. Dominant fish species are northern pike, walleye, yellow perch, and bullhead, but crappie, bluegill, and trout are important in some lakes. White bass is a significant species in Devils Lake.

Land Use

Most of this MLRA is in farms and ranches (fig. 55A-2). Crops are grown for sale or livestock feed. Dryland farming dominates, but some areas are irrigated. The principal crops are alfalfa, barley, canola, corn (for grain or silage), soybeans, and spring wheat, but dry edible beans and peas, durum, oats, safflower, sunflowers, flax, and rye are also grown. Potatoes are grown in a few areas where the soils are stone-free. Where not drained, areas with a concentration of wetlands are commonly used as habitat for waterfowl and other wildlife. Steep, shallow, or sandy soils are commonly used as native range. Less than one-tenth of the area is forested. Other wooded areas occur as narrow bands along streams and rivers, as field windbreaks, and as shelterbelts around farmsteads. Recreational hunting is an important land use throughout the area, and recreational fishing is important on reservoirs and natural lakes.

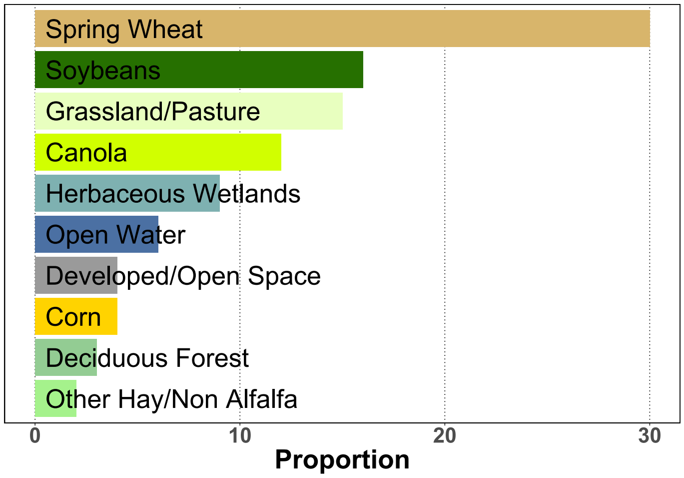

Figure 55A-2: Relative proportions (percentages) of land use in MLRA 55A.

The major soil resource concerns are wind erosion, water erosion, maintenance of the organic matter content and productivity of the soils, management of soil moisture, aggregate stability, management of soil wetness and soil salinity, and water quality. Conservation practices on cropland generally include systems of crop residue management (especially no-till or other conservation tillage systems that conserve soil moisture and contribute to soil quality), nutrient management, and pest management. Other practices include grassed waterways, filter strips, wetland conservation and restoration, seeding of salt-tolerant grass on saline soils, and subsurface water management.

55B—Central Black Glaciated Plains

MLRA 55B (fig. 55B-1) is mostly in North Dakota (88 percent) but it extends into South Dakota (12 percent) on the till plains between the Lake Dakota Plain and the prominent Missouri Coteau on the west and the Prairie Coteau on the east. It makes up about 14,234 square miles (36,867 square kilometers). The area is part of the Prairie Pothole Region, where lakes, ponds, and marshes are common on level to rolling topography with many depressions. Natural drainages are mostly ill-defined. The till plain was formed by the Wisconsin glacier. Low-relief landforms are dominant. Much of the MLRA is farmland converted from prairie, but some areas of grassland remain. Agricultural drainage practices have impacted shallow depressions in many areas.

MLRA 55B has distinct boundaries to the east, west, and south. To the east is the Red River Valley (in MLRA 56A), which is characterized by silty and clayey sediments and sandy beach ridges of glacial Lake Agassiz. To the west is the Missouri Coteau (in MLRA 53B), which is an extensive north-south moraine that marks the break to the ustic soil moisture regime. MLRA 53B has more grassland than MLRA 55B and has upland soils that are lighter in color (dark brown). To the south is the Lake Dakota Plain (in MLRA 55D), which is characterized by sandy to clayey sediments and by silty and clayey alluvium on flood plains of the James River and its tributaries. To the north, the boundary with MLRA 55A is less apparent. MLRA 55A has a till plain similar to that of MLRA 55B as well as somewhat cooler mean annual air temperatures and shorter freeze-free periods.

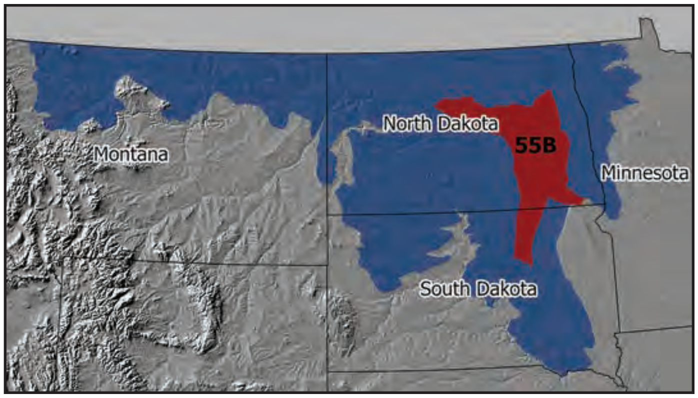

Figure 55B-1: Location of MLRA 55B, which covers 3,686,700 hectares (9,109,900 acres), within Region F.

Physiography

Almost all of the MLRA is in the Western Lake section of the Central Lowland province of the Interior Plains. Elevation ranges from 985 to 2,135 feet (300 to 650 meters), generally increasing from east to west. The area is characterized by mostly nearly level to rolling till plains with many depressions. Most drainage channels in the uplands are poorly defined; however, some moderately defined channels are associated with the James River and Sheyenne River systems. Some depressions contain lakes. Steep slopes adjacent to rivers and perennial streams and glacial lake plains break up the dominant landscape.

Geology

This MLRA is dominantly glacial till plains with some glacial lake plains and glacial outwash plains. It has eskers and kettle holes in some areas. Some areas of the till plain are mantled with wind-deposited materials, which are moderately coarse textured or sandy. Shale beds underlie the till. The shale is generally very deep (20 to more than 100 feet); however, along breaks to river valleys, it is at a depth of 1 to 5 feet in places. Alluvial deposits and low terraces are common along the James and Sheyenne Rivers but also occur in narrow and discontinuous strips along other streams.

Climate

The average annual precipitation is 17 to 24 inches (424 to 602 millimeters). About 75 percent of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation is typically snow. The average annual snowfall is 25 to 50 inches (635 to 1,270 millimeters). Strong winds commonly deposit the snow unevenly across the landscape. The average annual temperature is 39 to 45 degrees F (4 to 7 degrees C). The freeze-free period averages about 135 days and ranges from 120 to 150 days.

Water

Precipitation is the principal source of moisture for crops, but in some years it is inadequate for maximum crop production. Perennial streams in the area are widely spaced and little used for irrigation. Where irrigation is used, the water is primarily drawn from major aquifers within the glacial drift. Water for livestock typically is from shallow wells, is stored in ponds and small reservoirs on individual farms and ranches, or is obtained from rural water pipeline systems. In some areas, it is obtained from natural springs. There are large reservoirs on the James and Sheyenne Rivers. The surface water is of good quality but may be limited in quantity in most of the area.

Ground water is plentiful in unconsolidated sand and gravel deposits in glacial drift. This water is typically fresh or saline and hard or very hard. The freshwater is high in calcium, bicarbonate, and sulfate. The saline water is high in sodium and sulfate. The high salinity in some aquifers limits the use of the water for irrigation, but the aquifers provide water for livestock. Shallow ground water is used for drinking water in some rural areas where pipeline systems are not available. A sedimentary bedrock aquifer in the Dakota sandstone is about 1,000 feet (305 meters) beneath the land surface. It has large quantities of slightly saline or moderately saline artesian water. In addition, the sedimentary bedrock of the Hell Creek and Fox Hills Formations is under the glacial deposits in the northwest corner of the MLRA. This aquifer system contains soft water with high levels of sodium and dissolved solids. High salinity levels limit the use of this water for irrigation.

Soils

The dominant soil order is Mollisols. Vertisols, though less extensive, are also significant. The soils in the area have a frigid temperature regime, an aquic or udic moisture regime, and mixed or smectitic mineralogy. They generally are very deep and somewhat excessively drained to very poorly drained. The parent materials are dominantly loamy till with smaller amounts of sandy to clayey glaciolacustrine sediments. Glaciofluvial and eolian deposits and alluvium also occur.

The main soil series:

- Arvilla series—Hapludolls that formed in sand and gravel deposits on outwash plains
- Barnes series—Hapludolls that formed in loamy till on till plains and moraines
- Bearden series—Calciaquolls that formed in silty sediments on lake plains
- Buse series—Calciudolls that formed in loamy till on till plains and moraines
- Cavour series—Natrudolls that formed in loamy till on ground moraines
- Emrick series—Hapludolls that formed in loamy till on till plains and moraines

Fargo series—Epiaquerts that formed in clayey sediments on lake plains
Forman series—Argiudolls that formed in loamy till on till plains
Hecla series—Hapludolls that formed in sandy sediments on lake plains
Heimdal series—Hapludolls that formed in loamy till on till plains and moraines

Biological Resources

Native vegetation is characterized by western wheatgrass, green needlegrass, needle and thread, and blue grama. Little bluestem and sideoats grama are important species on the more sloping and shallower soils. Little bluestem also is an important species on highly calcareous, somewhat poorly drained soils. Prairie cordgrass, northern reedgrass, big bluestem, and slough sedge are important species on wet soils. Western snowberry, leadplant, and prairie rose are common shrub species interspersed throughout the area.

Major wildlife species include white-tailed deer, coyote, red fox, badger, beaver, raccoon, skunk, muskrat, mink, white-tailed jackrabbit, cottontail rabbit, pheasant, sharp-tailed grouse, gray partridge, mourning dove, wild turkey, ducks, geese, and various species of grassland birds, shore birds, and amphibians. The MLRA provides important feeding and resting areas for migrating waterfowl. Dominant fish species are northern pike, walleye, yellow perch, and bullhead, but crappie, bluegill, and smallmouth bass are important in some lakes.

Land Use

Most of the MLRA is in farms and ranches (fig. 55B-2). Crops are grown for sale or livestock feed. Dryland farming dominates, but some areas are irrigated. The principal crops are alfalfa, barley, canola, corn (for grain or silage), soybeans, and spring wheat, but dry edible beans and peas, oats, sunflowers, flax, winter wheat, and rye are also grown. Potatoes are grown in a few areas where the soils are stone-free. Where not drained, areas with a concentration of wetlands are commonly used as habitat for waterfowl and other wildlife. Steep, shallow, or sandy soils are commonly used as native range. Wooded areas occur as narrow bands along streams and rivers, as field windbreaks, and as shelterbelts around farmsteads. Recreational hunting is an important land use throughout the area, and recreational fishing is important on reservoirs and natural lakes.

The major soil resource concerns are wind erosion, water erosion, maintenance of the organic matter content and productivity of the soils, aggregate stability, and management of soil moisture, soil wetness, and soil salinity. Water quality also is a resource concern. Conservation practices on cropland generally include systems of crop residue management (especially no-till or other conservation tillage systems that conserve soil moisture and contribute to soil quality), nutrient management, and pest management. Other practices include grassed waterways, filter strips, wetland conservation and restoration, seeding of salt-tolerant grass on saline soils, and subsurface water management.

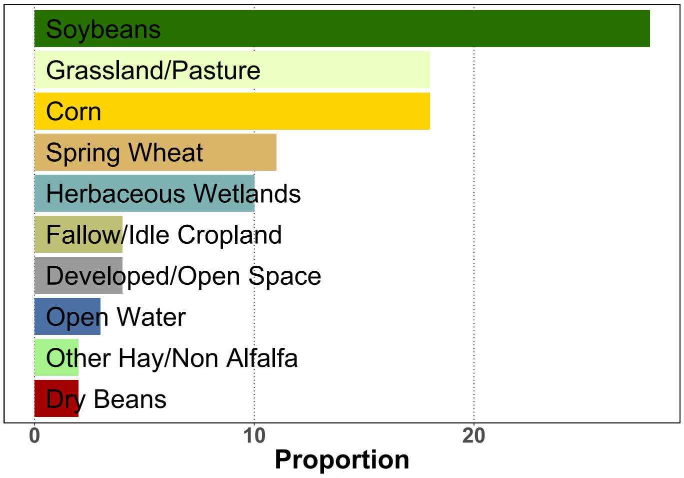

Figure 55B-2: Relative proportions (percentages) of land use in MLRA 55B.

55C—Southern Black Glaciated Plains

MLRA 55C (fig. 55C-1) is entirely in South Dakota and makes up about 10,662 square miles (27,615 square kilometers). This area is part of the glacial till plain region. It has level to rolling topography with many depressions and ill-defined drainages and is used to produce livestock and cash and grain crops.

The Coteau des Prairies is located along the northeastern boundary of MLRA 55C and is one of the more prominent landforms in North America. This high area split the last continental ice sheet of the James Lobe to the west. To the east of MLRA 55C is a till plain that has characteristics very similar to the Southern Black Glaciated Plains but is dominated by drift-covered moraines and breaks from the ustic soil moisture regime to the udic. The loess uplands represent the southern boundary of MLRA 55C and consist of the Missouri River and

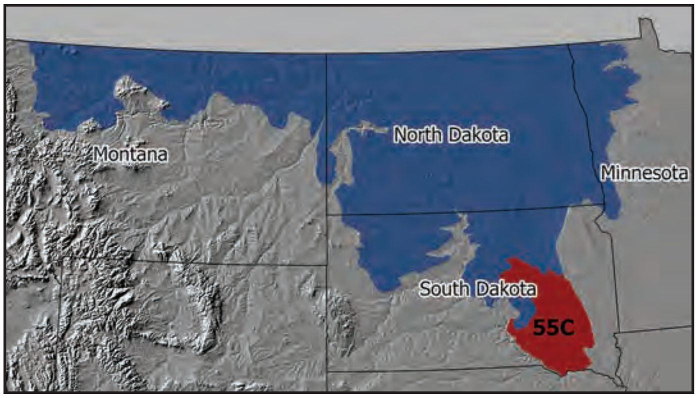

Figure 55C-1: Location of MLRA 55C, which covers 2,761,500 hectares (6,823,700 acres), within Region F.

wind-deposited silty material. Southwest of the MLRA is an area underlain by the Cretaceous Pierre Shale. The smectitic clays shrink when dry and swell when wet, causing significant limitations for structural foundations. The MLRA boundary to the west is defined by a terminal moraine with moderately steep to steep slopes where Cretaceous Pierre Shale lies beneath the glacial deposits. The boundary to the north is characterized by glacial lacustrine deposits of glacial Lake Dakota and a break to the frigid soil temperature regime.

Physiography

Three-fourths of this MLRA is in the Western Lake section of the Central Lowland province of the Interior Plains. The southwest quarter is in the Missouri Plateau, glaciated, section of the Great Plains province of the Interior Plains. Elevation ranges from 1,310 to 1,970 feet (400 to 600 meters). The Missouri River runs along the southwest edge of this MLRA, and the James River flows north to south down the center of the MLRA.

Geology

Most of the area consists of nearly level to undulating till plains with potholes and moraines. Steep slopes are adjacent to the major streams. Minor moraines are in scattered areas throughout the MLRA, and stagnation moraines are dominant in the southwestern part. Small areas of outwash are adjacent to the minor moraines.

The James River is an underfit stream. Its valley was carved by floodwaters draining glacial Lake Dakota and is filled with glacial outwash and alluvial deposits. The Missouri River flows in a trench cut by glacial meltwater in adjacent MLRA 63B. A high terrace scarp separates the valley floor along the Missouri and James Rivers from the surrounding land. The transitional area between the uplands and the valley floors of the two rivers is deeply eroded. This area along the Missouri River is called "The Breaks."

Climate

The average annual precipitation is 20 to 27 inches (509 to 687 millimeters). About 70 percent of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation is typically snow. The annual snowfall is 23 to 46 inches (585 to 1,170 millimeters). The average annual temperature is 44 to 50 degrees F (7 to 10 degrees C). The freeze-free period averages 165 days and ranges from 140 to 190 days.

Water

In most years precipitation is inadequate for maximum crop production. Perennial streams are few and widely spaced and are little used for irrigation. Water for livestock is stored in ponds and small reservoirs on individual farms and ranches. The surface water is of fair or poor quality. Limited quantities and high amounts of dissolved solids limit the use of the water. Missouri River water is of good quality. It meets national drinking water standards. Water from reservoirs on the Missouri River is used for irrigation on the adjacent upland soils.

The area has a limited supply of ground water in the shallow, unconsolidated sand and gravel deposits that make up the glacial drift and alluvial aquifers. A significant glacial outwash deposit is beneath the flood plain along the lower reaches of the James River in the southern part of the MLRA. A significant acreage is irrigated by this local aquifer. The fresh or saline water is hard and a calcium-bicarbonate-sulfate type. The ground water is used primarily for domestic supply, livestock, and irrigation. The level of total dissolved solids typically exceeds the recommended levels for drinking water. Many private wells have high levels of nitrate plus nitrite. Most of this contamination occurs where wells are located downslope from septic tank absorption fields, feedlots, barnyards, and fertilizer storage areas.

A confining layer of shale beneath the glacial deposits overlies two sedimentary bedrock aquifers in this MLRA—the Niobrara-Codell and Dakota-Newcastle. These aquifers are at a depth of about 1,100 feet (335 meters). The shale lying directly beneath the glacial deposits is not an aquifer. The sedimentary bedrock aquifers yield large quantities of slightly saline or moderately saline artesian water. The water is very hard and typically a sodium-sulfate type. The Niobrara-Codell aquifer provides water for domestic uses and livestock, but the level of total dissolved solids is too high for the water to be used for irrigation. Water from the Dakota-Newcastle aquifer is used only for livestock.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic temperature regime, an ustic moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and clayey or loamy. Soil parent materials are dominantly fine-loamy to clayey till, glaciofluvial deposits, eolian deposits, alluvium, and, to a lesser extent, loess.

The main soils and their series:

- Argialbolls that formed in alluvium in depressions (Tetonka series)
- Argiaquolls that formed in alluvium in closed basins (Worthing series); that formed in alluvium in drainageways on till plains (Crossplain series)
- Argiustolls that formed in fine-loamy till uplands on till plains (Beadle, Houdek, and Prosper series); that formed in silty sediments on till plains (Eakin and Highmore series); that formed in silty sediments on till plains (Onita series)
- Calciustepts that formed in fine-loamy till on moraines (Betts series)
- Calciustolls that formed in fine-loamy till on till plains (Ethan series)

Haplustolls that formed in fine-loamy till on till plains (Bonilla, Clarno, and Hand series); that formed in glaciofluvial deposits on outwash till plains (Delmont, Enet, and Talmo series); that formed in sandy eolian material (Elsmere and Forestburg series); that formed in coarse-loamy eolian on till plains (Carthage series); that formed in alluvium on flood plains (Bon series)
Natraquolls that formed in alluvium in closed basins (Hoven series)
Natrustolls that formed in fine-loamy till on till plains (Dudley, Jerauld, and Stickney series)

Biological Resources

Ecological subsections in MLRA 55C include the Southern Missouri Coteau, the Southern Missouri Coteau Slope, and the James River Lowland. This area supports natural prairie vegetation characterized by western wheatgrass, green needlegrass, needle and thread, and porcupinegrass. Big bluestem is an important species on soils that receive beneficial overflow or are subirrigated. Prairie cordgrass, reed canarygrass, and western wheatgrass are dominant on the poorly drained soils.

Major wildlife species include mule deer, white-tailed deer, fox, beaver, raccoon, opossum, muskrat, mink, cottontail, tree squirrel, pheasant, partridge, bobwhite quail, mourning dove, geese, and ducks. Fish species include bluegill, bass, carp, shad, channel catfish, black bullhead, crappie, walleye, and northern pike.

Land Use

Nearly all this area is in farms and ranches (fig. 55C-2). Slightly more than one-half of the area is dry-farmed cropland. Corn, soybeans, small grains, and alfalfa are the principal crops. Grain sorghum also is grown. About one-third of the area is used as native range or tame pasture.

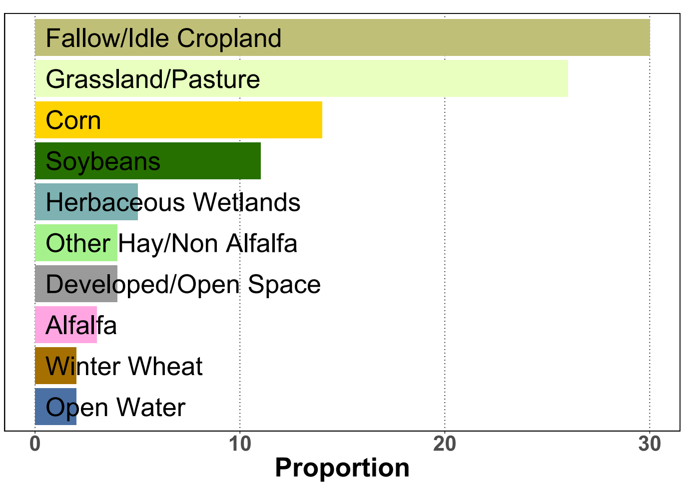

Figure 55C-2: Relative proportions (percentages) of land use in MLRA 55C.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management and no-till systems that conserve moisture and improve soil quality. Other practices include vegetative wind barriers, stripcropping, grassed waterways, and nutrient management.

55D—Glacial Lake Dakota

MLRA 55D (fig. 55D-1) is in South Dakota (92 percent) and southeastern North Dakota (8 percent). It makes up about 3,059 square miles (7,923 square kilometers). This area, which is part of the glacial till plain region, consists of a large, glacial lake plain that was drained by the James River, which flows southward through the area. The MLRA is dominantly farmland converted from prairie, but some areas of grassland remain. Agricultural drainage practices have impacted shallow depressions in many areas.

Figure 55D-1: Location of MLRA 55D, which covers 792,300 hectares (1,957,700 acres), within Region F.

MLRA 55D has distinct boundaries. Till plains are on all sides. MLRA 55B borders the area largely to the north and is also between the Lake Dakota Plain and two prominent coteaus—the Missouri Coteau on the west and the Prairie Coteau on the east. To the south is MLRA 55C (Southern Black Glaciated Plains), which has a mesic soil temperature regime.

Physiography

This area is in the Central Lowland province of the Interior Plains. Elevation ranges from 1,250 to 1,330 feet (380 to 405 meters), generally increasing from south to north. The area is characterized by mostly level to moderately sloping lake plains with many depressions and drainages. Much of the area has integrated drainage; drainage channels are poorly to moderately defined.

Geology

The glaciolacustrine sediments of the Lake Dakota Plain range from sandy to clayey and are commonly stratified. Some areas of the lake plain are mantled with wind-deposited materials, which are moderately coarse textured or sandy. Alluvial deposits and low terraces are common along the James River and its major tributaries but also occur in narrow and discontinuous strips along other streams.

Climate

The average annual precipitation is 22 to 23 inches (549 to 594 millimeters). About 75 percent of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation is typically snow. The average annual snowfall is 25 to 50 inches (635 to 1,270 millimeters). Strong winds commonly deposit the snow unevenly across the landscape. The average annual temperature is 43 to 45 degrees F (6 to 7 degrees C). The freeze-free period averages about 135 days and ranges from 120 to 150 days.

Water

Precipitation is the principal source of moisture for crops but in some years is inadequate for maximum crop production. Perennial streams in the area are widely spaced and little used for irrigation. Where irrigation is used, the water is primarily drawn from major aquifers within the underlying glacial drift. Water for livestock typically is from shallow wells, is stored in ponds and small reservoirs on individual farms and ranches, or is obtained from rural water pipeline systems. There are large reservoirs on the James River. The surface water is of good quality but at times is limited in quantity in most of the area.

Ground water is plentiful in unconsolidated sand and gravel deposits in the underlying glacial drift. This water is typically fresh or saline and hard or very hard. The freshwater is high in calcium, bicarbonate, and sulfate. The saline water is high in sodium and sulfate. The high salinity in some aquifers limits the use of the water for irrigation, but the aquifers provide water for livestock. Shallow ground water is used for drinking water in some rural areas where pipeline systems are not available. Two sedimentary bedrock aquifers, the Niobrara-Codell and Dakota-Newcastle, are about 1,100 feet (335 meters) beneath the land surface. Water from the Niobrara-Codell aquifer is used for domestic purposes and livestock, but the level of dissolved solids is too high for the water to be used for irrigation. Water from the Dakota-Newcastle aquifer is used only for livestock.

Soils

The dominant soil order in this MLRA is Mollisols. Vertisols, although less extensive, are also significant. The soils in the area have a frigid temperature regime, an aquic or udic moisture regime, and mixed or smectitic mineralogy. They generally are very deep and well drained to very poorly drained. Soil parent materials are dominantly loamy till with smaller amounts of sandy to clayey glaciolacustrine sediments. Eolian deposits and alluvium also occur.

The main soil series:

- Bearden series—Calciaquolls that formed in silty sediments on lake plains
- Beotia series—Hapludolls that formed in silty sediments on lake plains
- Great Bend series—Hapludolls that formed in silty sediments on lake plains
- Harmony series—Argiudolls that formed in silty and clayey sediments on lake plains
- Hecla series—Hapludolls that formed in sandy sediments on lake plains
- Lamoure series—Endoaquolls that formed in silty alluvium on flood plains
- Ludden series—Endoaquerts that formed in clayey alluvium on flood plains
- Nahon series—Natrudolls that formed in silty and clayey sediments on lake plains
- Tonka series—Argialbolls that formed in alluvium over silty sediments in depressions on lake plains
- Winship series—Argiudolls that formed in silty alluvium in shallow depressions and drainageways

Biological Resources

Native vegetation is characterized by western wheatgrass, green needlegrass, needle and thread, and blue grama. Little bluestem is also common on highly calcareous, upland soils. Prairie cordgrass, northern reedgrass, big bluestem, and slough sedge are important species on wet soils. Western snowberry, leadplant, and prairie rose are common shrub species interspersed throughout the area.

Major wildlife species in the MLRA include white-tailed deer, coyote, red fox, badger, beaver, raccoon, skunk, muskrat, mink, white-tailed jackrabbit, cottontail rabbit, pheasant, gray partridge, mourning dove, wild turkey, ducks, geese, various species of grassland birds, shore birds, and amphibians. The MLRA provides important feeding and resting areas for migrating waterfowl. Dominant fish species are northern pike and walleye.

Land Use

Most of this area is in farms and ranches (fig. 55D-2). Dryland farming dominates, but some areas are irrigated. Corn and soybeans are the main crops, but feed grains and hay crops are also widely grown. Where not drained, areas with a concentration of wetlands are commonly used as habitat for waterfowl and other wildlife. Wooded areas occur as narrow bands along streams and rivers, as field windbreaks, and as shelterbelts around farmsteads. Recreational hunting is an important land use throughout the MLRA.

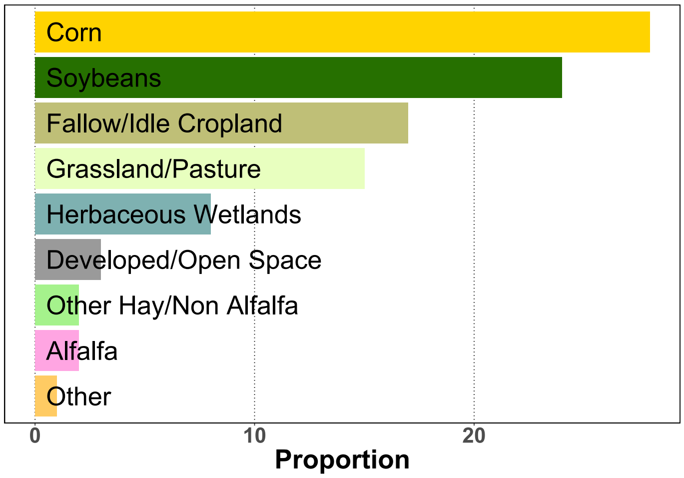

Figure 55D-2: Relative proportions (percentages) of land use in MLRA 55D.

The major soil resource concerns are wind erosion, water erosion, maintenance of the organic matter content and productivity of the soils, management of soil moisture, aggregate stability, and management of soil wetness and soil salinity. Water quality is also a resource concern. Conservation practices on cropland generally include systems of crop residue management (especially no-till or other conservation tillage systems that conserve soil moisture and contribute to soil quality), nutrient management, and pest management. Other practices include grassed waterways, filter strips, wetland conservation and restoration, seeding of salt-tolerant grass on saline soils, and subsurface water management.

56A—Glacial Lake Agassiz, Red River Valley

This area (fig. 56A-1) is primarily in North Dakota (60 percent) and Minnesota (40 percent), but a small portion (61 square miles, or 158 square kilometers) is in South Dakota. The area makes up about 11,735 square miles (30,392 square kilometers). MLRA 56A is part of the Red River Valley of the North, which formed as glacial Lake Agassiz receded and drained mainly to the south through the glacial River Warren, the current basin of the Minnesota River. Most of the area is clayey glaciolacustrine sediments with associated deltas, beaches, and eolian dunes.

The area is bordered by till plains on the south (MLRA 102A), west (MLRAs 55A and 55B), and much of the east (MLRAs 57 and 102A) and by Canada to the north. The boundary on the northeast (MLRA 56B) is less apparent as the adjoining area is also in the Agassiz basin. However, due to climatic differences, albeit subtle, there are differences in soil genesis and land use.

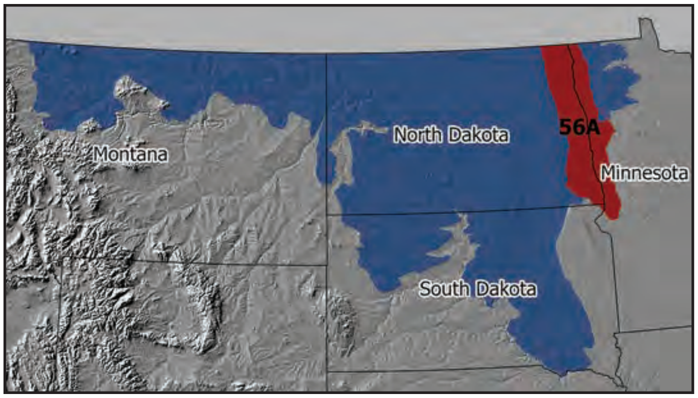

Figure 56A-1: Location of MLRA 56A, which covers 3,039,200 hectares (7,510,100 acres), within Region F.

Physiography

This area is in the Western Lake section of the Central Lowland province of the Interior Plains. It is on a nearly level glacial lake plain bordered on the east by outwash plains, gravelly beaches, and dunes and on the west by beaches and a till plain. Elevation is generally 1,000 feet (305 meters), but it gradually decreases to 650 feet (200 meters) to the north.

The Red River bisects this MLRA. It forms where the Otter Tail and Bois de Sioux Rivers meet at Wahpeton, North Dakota. The Sheyenne River is the largest tributary to the Red River in the part of the MLRA in North Dakota, and the Red Lake River is the largest tributary in the part in Minnesota.

Geology

This area is a portion of the bed of glacial Lake Agassiz. It is a glacial lake plain with remnants of gravelly beaches marking its eastern and western borders. Due to the erosion resistance of the gravel, the beaches appear as ridges in an otherwise flat landscape. Some dunes have formed in areas near the beaches where sand has been deposited.

Climate

The average annual precipitation is 20 to 25 inches (504 to 639 millimeters). About 70 percent of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation, typically 25 to 50 inches (630 to 1,270 millimeters) of snow, accounts for about 15 percent of the annual precipitation. The average annual temperature is 38 to 43 degrees F (3 to 6 degrees C), decreasing from south to north. The freeze-free period averages 145 days and ranges from 125 to 170 days. It is shortest in the northern part of the area and longest in the southern part.

Water

In years of normal precipitation, moisture is sufficient for the crops commonly grown in the area, but some areas are irrigated.

Surface water is more abundant in Minnesota than in North Dakota. The surface water is used primarily for municipal, commercial, and industrial supplies, but some is used for irrigation. Water from the Red River and its tributaries in North Dakota is generally suitable for drinking. Most of the tributaries on the North Dakota side of the Red River are saline. The water in the Wild Rice and Goose Rivers, for example, exceeds the drinking water standard for sulfate. Late winter and early spring flooding along the Red River is a constant hazard. In the southern part of the MLRA, thaws occur earlier in spring while the river's outlet in Canada is still frozen. The flat slope of the Red River adds to the flooding hazard. In most areas drainage systems are needed so that farming operations can begin when temperatures are favorable.

Ground water is not used to a great extent in this MLRA because of the relative abundance of better quality surface water. Almost all of the rural domestic water used in the MLRA, however, is ground water. The city of Fargo pumps public water from a buried glacial deposit of sand and gravel. The surficial and buried glacial outwash deposits are the primary aquifers in this area. Ground water from these aquifers is hard or very hard, and much of the ground water in the area exceeds the secondary national drinking water standard for total dissolved solids. The water in the Cretaceous sedimentary bedrock aquifers that lie beneath the glacial deposits and in the Precambrian crystalline igneous and metamorphic rocks that lie beneath the sedimentary rocks is unsuitable for most uses, except for livestock watering. The latter aquifer has low-yield wells.

Soils

The dominant soil orders in this MLRA are Mollisols and Vertisols. The soils in the area dominantly have a frigid temperature regime, an aquic or udic moisture regime, and mixed or smectitic mineralogy. They are very deep, somewhat poorly drained to very poorly drained, and loamy or clayey.

The main soils and their series:

- Calciaquerts that formed in clayey glaciolacustrine sediments on lake plains (Hegne series)
- Calciaquolls that formed in loamy glaciolacustrine sediments on lake plains (Bearden, Colvin, Glyndon, Grimstad, Ulen, and Wheatville series); that formed in till on till plains (Hamerly, Vallers, Roliss, and Kratka series)
- Epiaquerts that formed in clayey glaciolacustrine sediments on lake plains (Fargo and Northcote series)
- Epiaquolls that formed in clayey or loamy glaciolacustrine sediments on lake plains (Perella and Tiffany series)
- Hapludolls that formed in glaciolacustrine sediments on lake plains (Embden, Gardena, and Overly series)

Biological Resources

This area supports natural prairie vegetation characterized by big bluestem, switchgrass, Indiangrass, and little bluestem. Bur oak, American basswood, American elm, eastern cottonwood, green ash, and willows grow in drainageways. Shrubs include American plum, common chokecherry, and western snowberry.

Major wildlife species include white-tailed deer, red fox, raccoon, muskrat, mink, jackrabbit, cottontail, tree squirrel, pheasant, gray partridge, sharp-tailed grouse, mourning dove, geese, and ducks. Fish species include perch, bullhead, northern pike, walleye, and catfish.

Land Use

Nearly all of this area is in farms and ranches (fig. 56A-2). More than three-fourths of the area is dry-farmed cropland. Important cash crops are spring wheat, soybeans, potatoes, sugar beets, corn, oil-producing crops, and edible beans. Less than one-tenth of the area is forested.

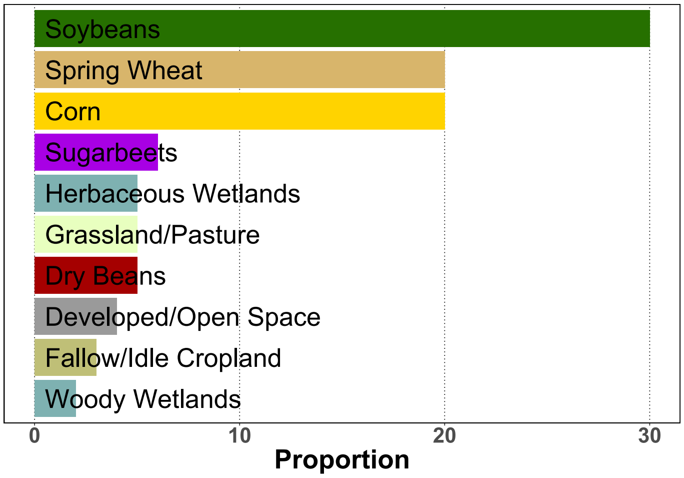

Figure 56A-2: Relative proportions (percentages) of land use in MLRA 56A.

The major soil resource concerns are wind erosion, deposition of sediment by floodwater, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, salinity in selected areas, surface compaction, and aggregate stability. The efficient use of water is a major concern on irrigated land. Conservation practices on cropland generally include crop residue management, conservation tillage systems, conservation cropping systems, field windbreaks, herbaceous wind barriers, filter strips, cover crops, nutrient management, and pest management.

56B—Glacial Lake Agassiz, Tallgrass Aspen Parklands

MLRA 56B (fig. 56B-1) is part of the glacial Lake Agassiz basin, which formed as the lake receded. Most of the area is glaciolacustrine sediments overlying till. This MLRA is

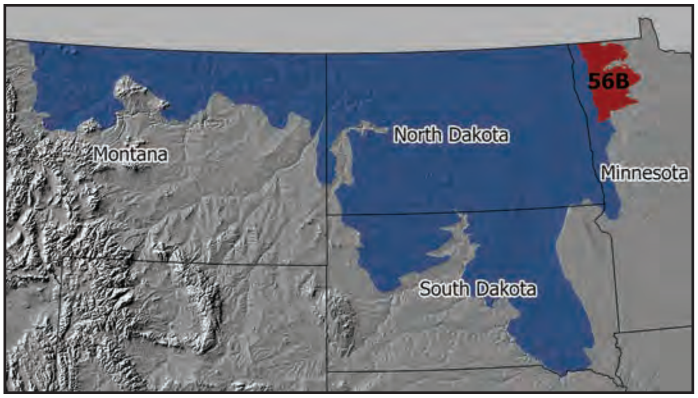

Figure 56B-1: Location of MLRA 56B, which covers 1,207,900 hectares (2,984,700 acres), within Region F.

entirely in Minnesota and makes up about 4,664 square miles (12,079 square kilometers). It is bordered by beaches and a lake plain on the west (MLRA 56A), by a till plain on the south (MLRA 102A), and by a lake plain and till plain on the east (MLRA 88).

Physiography

This area is in the Western Lake section of the Central Lowland province of the Interior Plains. Elevation is generally 1,100 feet (305 meters), but it gradually decreases to 950 feet (290 meters) to the west.

Geology

This area, a portion of the bed of glacial Lake Agassiz, is a glacial lake plain with remnants of gravelly beaches marking its western border. The surface is covered mostly by silty and clayey lacustrine sediments and lake-modified glacial till.

Climate

The average annual precipitation is 21 to 25 inches (542 to 629 millimeters). About 70 percent of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation, typically 25 to 50 inches (630 to 1,270 millimeters) of snow, accounts for about 15 percent of the annual precipitation. The average annual temperature is 38 to 41 degrees F (3 to 5 degrees C), decreasing from south to north. The freeze-free period averages 145 days and ranges from 125 to 170 days. It is shortest in the northern part of the area and longest in the southern part.

Water

In years of normal precipitation, moisture is sufficient for the crops commonly grown in the area. This area has abundant supplies of both surface and ground water that meet all of the current needs of the area. The surface water generally is of good quality, and its use is not limited.

Abundant supplies of good-quality ground water are in both surficial and buried drift aquifers throughout this area. Water from these aquifers is hard and a calcium-magnesium-bicarbonate type. Nitrate concentrations can approach the harmful limit in the surficial drift aquifer. Glacial till generally caps the buried drift aquifer, which is thus more protected from contamination by surface activities than the surficial drift aquifer. The deeper aquifer, however, has very high levels of iron.

Soils

The dominant soil orders in this MLRA are Mollisols, Entisols, Inceptisols, and Histosols. The soils in the area dominantly have a frigid temperature regime, an aquic or udic moisture regime, and mixed or smectitic mineralogy. They are very deep and somewhat poorly drained to very poorly drained.

The main soils and their series:

Calciaquolls that formed in glaciolacustrine sediments on till-floored lake plains (Grimstad and Strathcona series); that formed in glaciolacustrine sediments on lake plains (Glyndon and Borup series)

Haplosaprists that formed in organic material over glaciolacustrine sediments on lake plains (Berner, Cathro, Dora, and Markey series)

Humaquepts that formed in loamy till on till plains (Hamre and Haug series)

Udipsamments that formed in glaciolacustrine sediments on lake plains (Poppleton and Redby series)

Biological Resources

This area supports natural prairie vegetation characterized by big bluestem, switchgrass, Indiangrass, and little bluestem. Aspen is the most common tree species both in pure stands and in mixed stands with birch, maple, oak, white spruce, and red pine. Shrubs include American plum, common chokecherry, and western snowberry. Major wildlife species include white-tailed deer, red fox, raccoon, muskrat, mink, cottontail, tree squirrel, gray partridge, sharp-tailed grouse, mourning dove, geese, and ducks.

Land Use

About 75 percent of this area is forested (fig. 56B-2), dominantly by the aspen cover type. Hardwood and softwood species are harvested mostly for pulp. Most of the cropland is in the western part of the MLRA. The main crops are alfalfa,

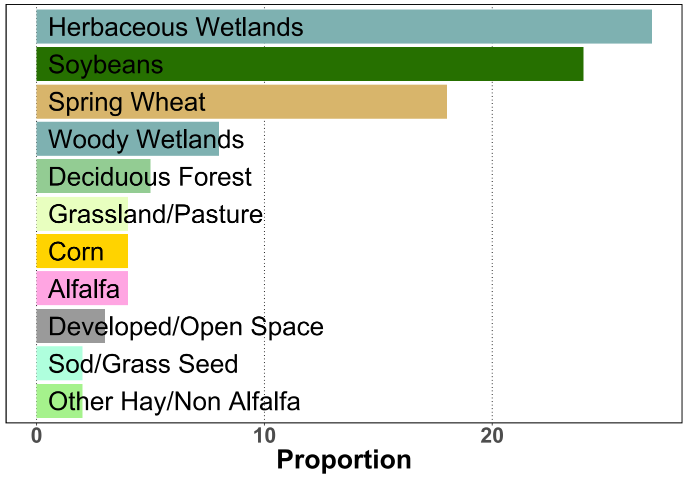

Figure 56B-2: Relative proportions (percentages) of land use in MLRA 56B.

barley, oats, sunflowers, and wheat. A short growing season, excessive rainfall, and poor drainage can reduce yields in some years. Specialty crops, including bluegrass seed, foundation seed potatoes, and wild rice, are grown in some areas. Livestock operations are scattered throughout the MLRA. Many lakes provide opportunities for recreation.

The major resource concerns are excessive soil wetness, the short growing season, and surface compaction. Some sandy areas are subject to wind erosion. The important conservation practices on cropland include selection of crops that are tolerant of wetness and a short growing season. They also include timely tillage, which improves yields. Cover crops and minimum tillage can help to overcome the effects of strong winds on sandy soils. Timely harvesting of trees can minimize compaction when the soils are wet and can enhance the regeneration of tree species.

G—Western Great Plains Range and Irrigated Region

Land Resource Region G (fig. G-1) is the westernmost, highest, and driest section of the Great Plains that abuts the Rocky Mountains and Basin and Range to the west. With the exception of irrigated agricultural land in eastern Colorado, the region is dominantly grasslands and shrublands. Geologically, Region G is largely an elevated piedmont plain of Paleogene and Neogene sediments emanating from the uplift of the Rocky Mountains and other highlands to its west. The plain is dissected by numerous rivers and includes low-relief areas of exhumed Paleozoic and Cretaceous bedrock. Quaternary eolian deposits, most notably the Nebraska Sand Hills, and Quaternary alluvium associated with numerous rivers flowing eastward also occur throughout Region G. This region contains 18 major land resource areas. The extent of these MLRAs and their range in elevations are shown in table G-1.

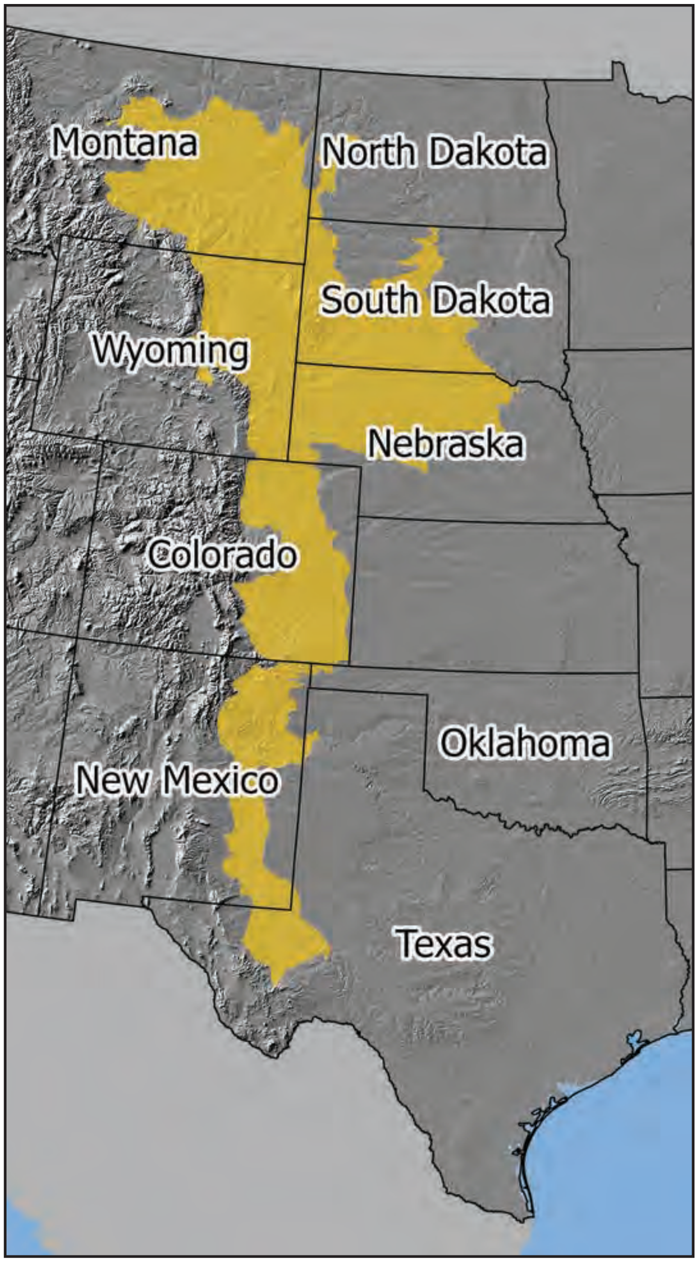

Figure G-1: Location and size of Land Resource Region G, which covers 212,900 square miles (551,405 square kilometers) and extends from near the border with Mexico to near the border with Canada.

The boundaries separating Region G from Regions E and D to the west are sharp physiographic contacts with mountains (fig. 1, page 5). The contact between Regions G and F is also sharp and delineates the non-glaciated rangeland on Entisols, Vertisols, and Inceptisols in Region G from the glaciated cropland on Mollisols in Region F. To the east, the boundary between Regions G and H roughly reflects the change from rangeland to cropland. To the south, the boundary between Regions G and I is the contact between the Aridisols that formed on alluvium of the Pecos River valley (Region G) and the Mollisols that formed on limestone (Region I).

The climate throughout the long expanse of Region G from west Texas to northern Montana is relatively uniform in precipitation. This semiarid climate results in soils with ustic aridic and aridic ustic moisture regimes. Temperatures, however, are much warmer in the south than in the north. As a result, soil temperature regimes are thermic in the south, mesic in the middle of the region, and frigid in the north. The average annual precipitation is 14 to 23 inches (350 to 585 millimeters) in most of the region. Most of the precipitation comes from spring thunderstorms and winter snowfalls. The average annual temperature ranges from 43 to 61 degrees F (6 to 16 degrees C) in most of the region. The freeze-free period ranges from 120 to 215 days, increasing in length from north to south. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables G-2 and G-3.

The numerous soil types in Region G reflect the variety of bioclimatic and parent material changes. In the south, the region is dominated by Aridisols of the Chihuahuan Desert with narrow zones of Entisols on flood plains and as eolian deposits (fig. 2, page 6). Northward into northeast New Mexico and eastern Colorado, the extent of Mollisols and some Alfisols increases as areas of shortgrass steppes increase. Farther north into Nebraska, Wyoming, and Montana, Entisols become prominent, such as the Psamments in the Nebraska Sand Hills. Vertisols are common on clayey badlands. Inceptisols occur across large areas of eastern Montana (fig. 2). Soils commonly have carbonates in this dryland region, especially where limestone is the parent material (fig. 5, page 9). Restrictive zones in soils occur mainly as paralithic bedrock in the northern portion of Region G (fig. 9, page 13). They also include petrocalcic horizons in the south and natric horizons in the north (fig. 11, page 15). Argillic horizons reflect older geomorphic

Table G-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
58A	110,120	42,515	570	1,880	750	2,470	920	3,040	1,190	3,910	1,920	6,290
58B	49,885	19,250	970	3,200	1,200	3,930	1,420	4,660	1,690	5,540	2,370	7,770
58C	5,955	2,300	560	1,830	640	2,110	760	2,500	870	2,860	1,040	3,440
58D	6,920	2,675	810	2,680	880	2,890	940	3,100	1,040	3,420	1,260	4,130
60A	26,475	10,220	580	1,900	810	2,650	980	3,220	1,240	4,080	1,520	5,000
60B	9,245	3,570	770	2,540	850	2,810	980	3,240	1,120	3,690	1,300	4,270
61	5,110	1,970	940	3,090	1,080	3,540	1,250	4,100	1,490	4,890	1,960	6,430
62	7,560	2,920	1,020	3,360	1,320	4,320	1,610	5,300	1,950	6,410	2,190	7,200
63A	26,255	10,135	430	1,410	510	1,670	610	2,000	740	2,430	920	3,020
63B	11,355	4,385	300	985	430	1,420	530	1,760	630	2,080	770	2,540
64	30,475	11,765	630	2,070	780	2,560	1,160	3,800	1,490	4,910	1,870	6,130
65	53,420	20,625	560	1,840	690	2,270	950	3,130	1,180	3,880	1,340	4,400
66	14,720	5,685	410	1,360	560	1,850	700	2,290	870	2,850	1,020	3,340
67A	25,505	9,850	990	3,270	1,210	3,970	1,470	4,830	1,810	5,960	2,270	7,470
67B	50,935	19,665	1,030	3,380	1,250	4,100	1,440	4,750	1,660	5,440	2,090	6,880
69	30,800	11,890	1,060	3,490	1,230	4,050	1,460	4,790	1,760	5,780	2,200	7,220
70A	24,120	9,315	1,150	3,790	1,420	4,660	1,810	5,940	2,070	6,800	2,710	8,880
70B	62,585	24,165	690	2,280	810	2,660	1,090	3,600	1,410	4,640	2,110	6,950

Table G-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
58A	4.9	41	6.7	44	7.5	46	8.2	47	9.7	49	105	130	136/135	145	165
58B	3.8	39	7.1	45	7.5	46	8	46	8.8	48	100	126	131/130	138	150
58C	5.4	42	5.8	42	6.3	43	6.6	44	6.9	44	125	128	130/130	134	150
58D	6.3	43	6.6	44	6.8	44	7.2	45	7.8	46	125	129	132/130	134	145
60A	6.5	44	7.2	45	8.4	47	9	48	9.6	49	125	131	143/140	149	155
60B	6.5	44	7	45	7.3	45	7.9	46	8.4	47	120	129	134/135	141	150
61	4.6	40	6.3	43	7.4	45	8.7	48	9.5	49	105	121	132/135	147	155
62	3.2	38	4.3	40	6.2	43	7.6	46	8.9	48	80	96	120/120	136	145
63A	6.4	44	7.3	45	8.4	47	8.9	48	9.3	49	130	144	151/150	154	160
63B	6.9	44	8.3	47	9	48	9.4	49	9.8	50	135	148	154/155	161	165
64	6.8	44	7.5	46	8.7	48	9.1	48	9.7	49	120	127	142/140	149	160
65	7.9	46	8.5	47	9	48	9.3	49	10	50	135	140	144/145	154	165
66	8.4	47	8.7	48	9	48	9.3	49	9.7	49	140	142	152/150	159	165
67A	6.2	43	7.7	46	8.6	47	9.3	49	9.9	50	125	131	135/135	147	160
67B	7.5	46	9	48	9.8	50	11.9	54	12.8	55	130	143	154/155	165	180
69	8.6	48	10.4	51	11.3	52	11.9	53	12.3	54	140	158	162/160	168	175
70A	6.9	44	9.3	49	10.6	51	12.5	54	15	59	135	147	157/160	178	210
70B	9.9	50	13.8	57	16.3	61	18.5	65	19.2	66	155	192	212/215	239	255

Table G-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
58A	270	11	309	12	346/350	14/14	386	15	580	23
58B	230	9	305	12	340/345	13/14	395	16	680	27
58C	340	14	357	14	368/375	14/15	399	16	450	17
58D	340	14	369	15	382/380	15/15	394	15	420	16
60A	330	13	373	15	426/420	17/17	453	18	540	21
60B	300	12	317	12	350/350	14/14	384	15	460	18
61	370	15	420	17	465/475	18/19	540	21	640	25
62	410	16	481	19	560/570	22/22	673	26	820	32
63A	400	16	438	17	458/465	18/18	499	20	530	21
63B	480	19	509	20	562/565	22/22	628	25	690	27
64	330	13	383	15	451/440	18/17	495	19	530	21
65	390	15	454	18	541/540	21/21	633	25	690	27
66	490	19	516	20	593/585	23/23	646	25	700	27
67A	330	13	361	14	407/405	16/16	442	17	500	19
67B	320	13	354	14	398/395	16/16	431	17	510	20
69	280	11	312	12	359/360	14/14	402	16	520	20
70A	370	15	411	16	427/435	17/17	463	18	570	22
70B	260	10	312	12	349/360	14/14	419	16	500	20

surfaces. The amount of organic carbon is notably lower in the soils of Region G than in the Mollisols of land resource regions to its east (fig. 14, page 18).

Land use in Region G is dominantly grassland and shrubland used for grazing by cattle and some sheep (fig. G-2; and fig. 8, page 12). Dry-farmed winter wheat and other small grains are grown either for cash or feed. Irrigated crops are grown along many of the major streams. These crops primarily include corn, alfalfa, forage crops, and sugar beets. The native vegetation consists mainly of short prairie grasses, but some large areas support mid and tall prairie grasses. Ponderosa pine and pinyon-juniper forests occur at the higher elevations. The major soil resource concerns in this region are overgrazing and wind and water erosion where ground cover has deteriorated. The invasion of undesirable plant species is a concern on rangeland. Wind and water erosion, maintenance of the content of soil organic matter, and soil moisture management are major resource concerns on cropland. The quality of surface water also is a concern. Sediment, nutrients, pesticides, and organic material are the major nonpoint sources of the pollution of surface water and ground water. Control of saline seeps on rangeland and salt management on irrigated land are needed in some areas.

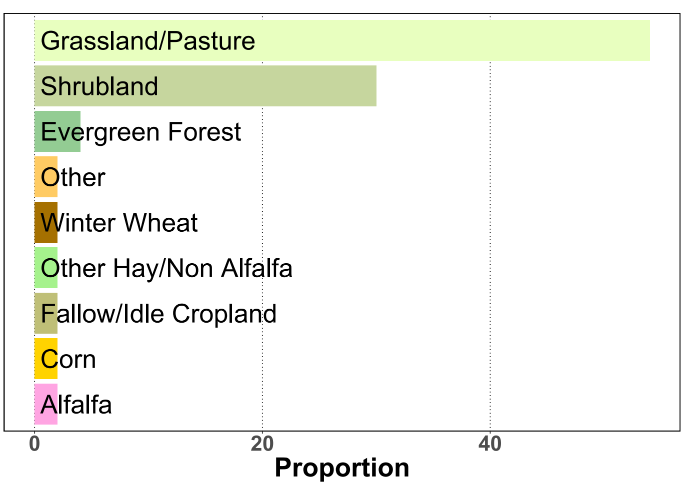

Figure G-2: Relative proportions (percentages) of land uses in Land Resource Region G (National Agricultural Statistics Service, 2018).

58A—Northern Rolling High Plains, Northern Part

This MLRA (fig. 58A-1) is an area of old plateaus and terraces that have been eroded. It is in Montana (99 percent) and Wyoming (1 percent). It makes up about 42,517 square miles (110,118 square kilometers).

MLRA 58A has an apparent boundary with MLRA 53C (Southern Dark Brown Glaciated Plains) to the north, where glacial till ends near the Missouri River. It is bordered to the west by MLRA 46 (Northern and Central Rocky Mountain Foothills). It is bordered to the south by MLRA 58B (Northern Rolling High Plains, Southern Part). This boundary is less apparent and is based on the mesic-frigid soil temperature regime. To the east, MLRA 58A borders MLRA

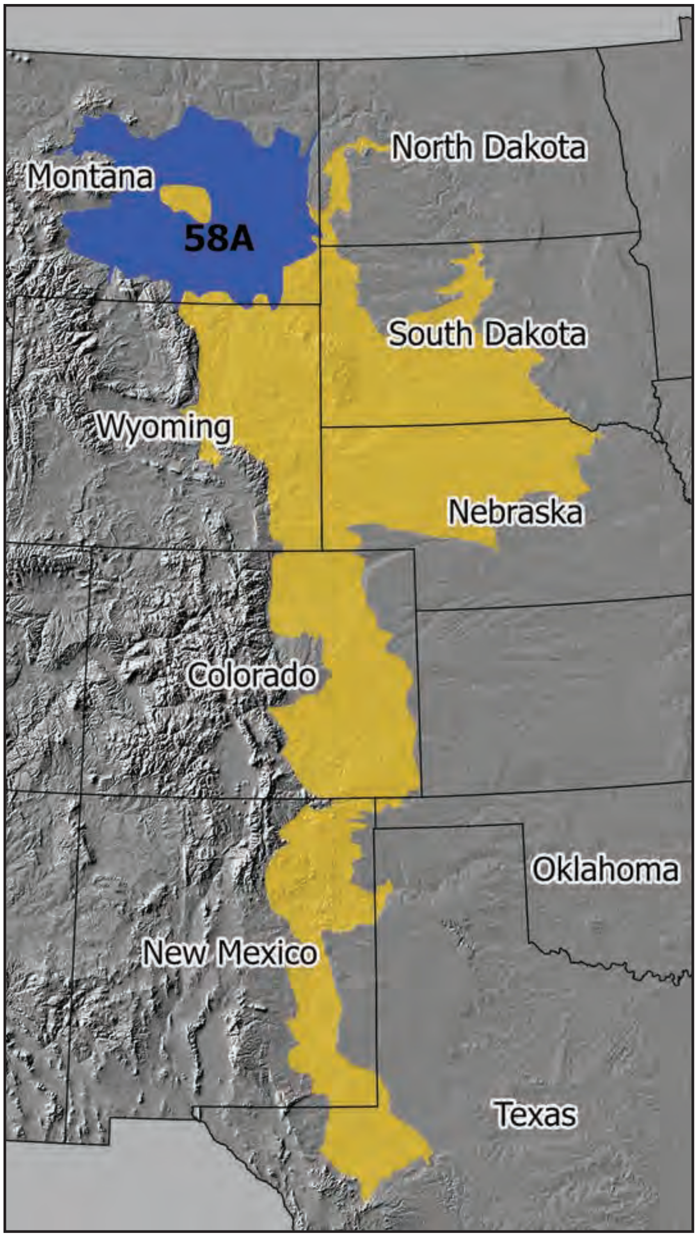

Figure 58A-1: Location of MLRA 58A, which covers 11,011,800 hectares (27,210,800 acres), within Region G.

54 (Rolling Soft Shale Plain), which has a different soil moisture regime.

Physiography

This area is in the Missouri Plateau, unglaciated, section of the Great Plains province of the Interior Plains. Slopes generally are gently rolling to steep, and wide belts of steeply sloping badlands border a few of the larger river valleys. Local relief is mainly 10 to 100 feet (3 to 30 meters). In some areas flat-topped, steep-sided buttes rise sharply above the general level of the plains. Elevation generally ranges from 1,880 to 6,290 feet (570 to 1,920 meters), increasing from east to west and from north to south. In a few mountains, it is as high as 6,900 feet (2,105 meters).

The Missouri and Yellowstone Rivers run through this area. There are no dams for more than 800 miles along the Yellowstone River, one of the longest free-flowing rivers in the United States.

Geology

Underlying the eastern one-third to one-half of this area are Paleogene and Neogene continental shales, siltstones, and sandstones. These stream deposits are part of the Fort Union Formation. This formation also contains coalbeds. Marine and continental sediments of the Cretaceous Montana Group underlie the rest of the MLRA, generally at the higher elevations. The Montana Group includes the Bearpaw shale; the Judith River sandstone, siltstone, and shale; the Claggett Shale; the Eagle Sandstone; and the Telegraph Creek sandy shale. A group of younger Cretaceous sediments occurs between the higher elevation Montana Group sediments and the lower elevation Tertiary sediments. These younger deposits include the St. Mary River mudstone, the volcaniclastics of the Livingston Group, and the Hell Creek sandstone and shale. There are many dinosaur fossils digs in this MLRA.

Climate

The average annual precipitation is 10 to 14 inches (254 to 356 millimeters) in most of this area but is as much as 30 inches (760 millimeters) in the mountains. It fluctuates widely from year to year. Most of the rainfall occurs during frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August, and some rain falls in autumn. Precipitation in winter occurs as snow. The average annual temperature is 41 to 49 degrees F (5 to 10 degrees C). The freeze-free period averages 155 days and ranges from 105 to 165 days, decreasing in length with elevation.

Water

The surface water generally is suitable for all uses, but adequate supplies away from the Missouri and Yellowstone Rivers are scarce. The low and erratic precipitation is the principal source of water for agriculture. Water stored in small reservoirs is used for livestock, but supplies are inadequate for significant irrigation. Irrigation water is available from the Missouri and Yellowstone Rivers and one or two of the larger tributaries of these rivers.

Ground water is scarce in most of this area, but local sand and gravel deposits and coalbeds in the Cenozoic Fort Union Formation yield small to moderate amounts. Small amounts of ground water are available in the alluvial and terrace deposits along the Missouri and Yellowstone Rivers. The ground water is a sodium-bicarbonate or sulfate type and generally is hard or very hard.

Saline seeps are a concern in the areas of cropland. Management practices promote infiltration of precipitation into shallow aquifers. As the shallow water table rises to the ground surface, evaporation of the water leaves concentrations of salts behind.

Soils

The dominant soil orders in this MLRA are Entisols and Inceptisols. The soils in the area dominantly have a frigid temperature regime, an ustic moisture regime, and mixed or smectitic mineralogy. They generally are shallow to very deep, well drained, and clayey or loamy.

The main soils and their series:

- Calciustepts that formed in alluvium, colluvium, and residuum on fans, hills, and plains (Cambeth series)
- Haplustepts that formed in alluvium, eolian deposits, and residuum on terraces, fans, and hills (Busby, Cherry, Delpoint, Lonna, and Yamacall series)
- Haplustolls that formed in alluvium and glaciofluvial deposits on fans and terraces and in drainageways (Shambo series)
- Natrustalfs that formed in alluvium and glaciofluvial deposits on fans and terraces and in drainageways (Gerdrum series)
- Ustifluvents that formed in alluvium on fans, terraces, and flood plains (Havre series)
- Ustorthents that formed in residuum on hills and ridges (Bainville, Cabba, Cabbart, Neldore, and Yawdim series); that formed in alluvium on fans and terraces (Lambert series)

Biological Resources

This area supports grassland vegetation. Western wheatgrass, bluebunch wheatgrass, green needlegrass, and needle and thread are the dominant species. In the eastern part of the area, little bluestem replaces bluebunch wheatgrass as the dominant species. Cheatgrass and Japanese brome are extensive non-native species.

Major wildlife species include mule deer, white-tailed deer, antelope, coyote, fox, badger, beaver, raccoon, jackrabbit, cottontail, muskrat, mink, ground squirrel, pheasant, sharp-tailed grouse, Hungarian partridge, sage grouse, geese, and ducks.

Land Use

More than one-half of this area consists of privately owned ranches generally dominated by livestock production (fig. 58A-2). Incidental cash or feed grains and irrigated cropland are concentrated along the major streams. Some areas in the southern part of the MLRA consist of forestland in Tribal, national forest, or private holdings. More than three-fourths of the MLRA supports native grasses, shrubs, and limited timber and is grazed by cattle and sheep. The rest is used mainly for dry-farmed wheat. Sugar beets, alfalfa and other hay crops, and corn for silage are important crops on the irrigated land. Some of the land is used as tame pasture. Open woodland is on the upper slopes and the tops of some of the higher buttes and mountains.

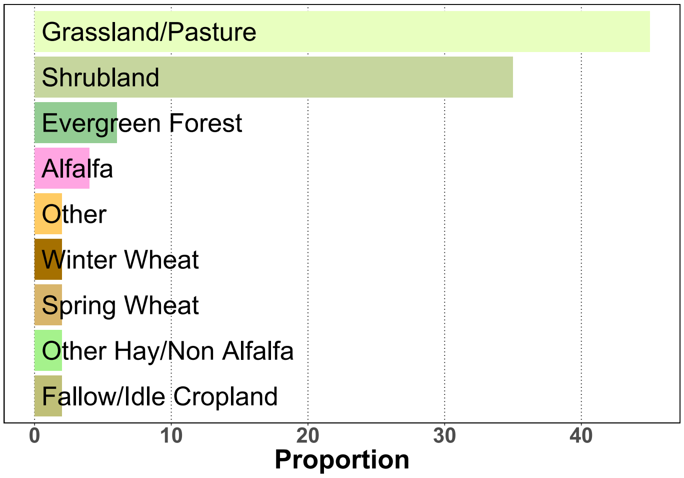

Figure 58A-2: Relative proportions (percentages) of land use in MLRA 58A.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and the control of saline seeps. Water resource concerns are inefficient water use on irrigated cropland and excessive amounts of pesticides, nutrients, and organic material in surface water and ground water. Plant resource concerns are deterioration of plant condition, productivity, health, and vigor; noxious and invasive plants; and the hazard of wildfires. Animal resource concerns are inadequate food, cover, and shelter.

Conservation practices on cropland generally include crop residue management (especially minimum tillage), cover crops, stripcropping, nutrient management, soil salinity management, and pest management. Practices that improve water use and distribution on irrigated cropland are irrigation water management, irrigation water delivery systems, and on-farm irrigation practices, such as land leveling, land smoothing, water-control structures, and sprinklers. Noxious and invasive plants can be controlled by pest management and prescribed grazing.

The most important conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early- and late-season pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. Forest stand improvement and firebreaks reduce the hazard of wildfires and improve forest growth, quality, health, and productivity.

58B—Northern Rolling High Plains, Southern Part

This MLRA (fig. 58B-1) covers most of the Powder River Basin. This basin contains the largest deposits of coal in the United States, as well as important oil, gas, and uranium deposits. This area is in Wyoming (95 percent) and Montana (5 percent). It makes up about 19,250 square miles (49,857 square kilometers).

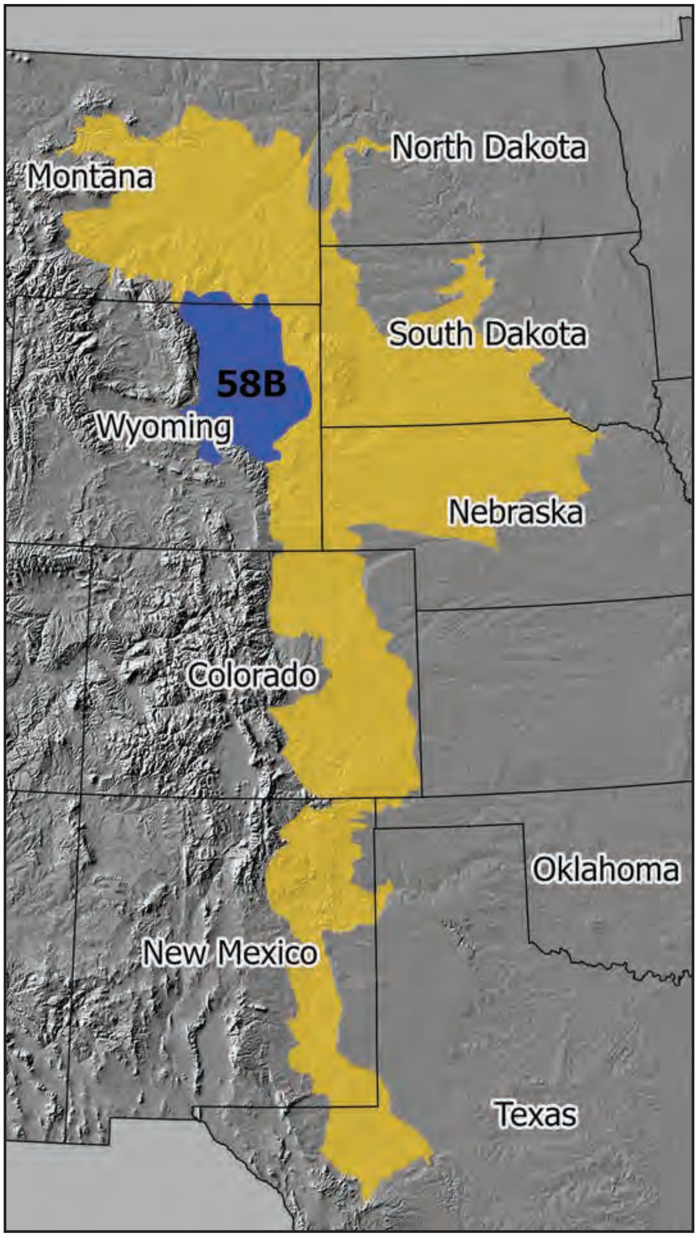

Figure 58B-1: Location of MLRA 58B, which covers 4,985,700 hectares (12,319,900 acres), within Region G.

MLRA 58B has a generally gradual boundary with MLRA 58A (Northern Rolling High Plains, Northern Part) to the north, which is based on the boundary between the mesic and frigid soil temperature regimes. It is bordered to the west by MLRAs 43B (Central Rocky Mountains) and 34A (Cool Central Desertic Basins and Plateaus). It is bordered to the south by MLRAs 49 (Southern Rocky Mountain Foothills), 67A (Central High Plains, Northern Part), and 64 (Mixed Sandy and Silty Tableland and Badlands). It is bordered to the east dominantly by MLRA 60A (Pierre Shale Plains) and to a small extent by MLRA 60B (Pierre Shale Plains, Northern Part). The boundaries between the MLRAs to the west, south, and east are generally abrupt, due to significant changes in climate, land use, and soil parent material.

Physiography

This area is in the Missouri Plateau, unglaciated, section of the Great Plains province of the Interior Plains. It is an area of old plateaus and terraces that have been deeply eroded. Elevation generally ranges from 2,950 to 5,900 feet (900 to 1,800 meters), increasing gradually from north to south. A few buttes are as high as 6,890 feet (2,100 meters). Typically, local relief is about 150 to 250 feet (45 to 75 meters). Slopes generally are gently rolling to steep, and wide belts of steeply sloping badlands border a few of the larger river valleys. Terraces are common along most of the major river systems in the area. In places flat-topped, steep-sided buttes rise sharply above the general level of the plains.

The North Platte River runs through the southern part of this MLRA. The upper reaches of the Powder, Tongue, Belle Fourche, and Cheyenne Rivers drain the northern half.

Geology

The middle third of this area is underlain by Tertiary continental sediments consisting of shale, siltstone, and sandstone from the Wasatch and Fort Union Formations. Cretaceous marine and continental sediments underlie the northwestern third and southeastern third. These older units also consist of interbedded layers of shale, siltstone, and sandstone. This MLRA is an important mining (coal and uranium) and petroleum district.

Climate

The average annual precipitation is 9 to 27 inches (230 to 680 millimeters) in most of this area. It fluctuates widely from year to year. The higher precipitation occurs at the higher elevations. Most of the rainfall occurs during frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August, and some rain falls in autumn. Precipitation in winter occurs as snow. The average annual temperature is 39 to 48 degrees F (4 to 9 degrees C). The freeze-free period averages 130 days and ranges from 100 to 150 days.

Water

The surface water generally is suitable for all uses, but adequate supplies away from the North Platte, Powder, and Tongue Rivers are scarce. The low and erratic precipitation is the principal source of water for agriculture. Water stored in small reservoirs is used for livestock, but supplies are inadequate for significant irrigation. Narrow strips of land along the perennial streams are irrigated with water from the North Platte, Powder, and Tongue Rivers and some of the larger tributaries of these rivers.

The Structural Basin aquifer underlies almost all of this area. This is the most extensively used aquifer in Wyoming. It consists of lenticular beds of sandstone, coal, and shale. The ground water is confined, so flowing wells are common. This water is unsuitable for drinking. It is used for livestock and some irrigation. The ground water is a sodium-bicarbonate or sulfate type and is soft or moderately hard.

Small amounts of ground water are available in the alluvial and terrace deposits along the North Platte, Powder, and Tongue Rivers. This water is a sodium-bicarbonate or sulfate type and is generally hard or very hard. The level of total dissolved solids typically exceeds drinking water standards. The ground water in Wyoming has naturally high levels of fluoride, iron, manganese, selenium, and radionuclides.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The soils in the area dominantly have a mesic temperature regime, an aridic moisture regime that borders on ustic, and mixed or smectitic mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey. Mollisols and Alfisols occur in areas that have an ustic soil moisture regime that borders on aridic.

The main soils and their series:

Haplargids that formed in alluvium (Cambria, Forkwood, and Ulm series); that formed in mixtures of alluvium, eolian sediments, and residuum (Bowbac, Cushman, and Hiland series)

Torriorthents that formed in alluvium on alluvial fan remnants, fan piedmonts, stream terraces, hills, and plateaus (Kishona series); that formed in residuum or colluvium on hills (Samday, Shingle, Tassel, and Theedle series)

Biological Resources

This area supports grassland vegetation. Rhizomatous wheatgrasses, green needlegrass, needle and thread, and blue grama are the dominant species on deep soils. Rhizomatous wheatgrasses, bluebunch wheatgrass, Indian ricegrass, and needle and thread are the major species on shallow soils on hills and ridges. Basin wildrye, green needlegrass, rhizomatous wheatgrasses, and shrubs are dominant on bottom land and along streams. Big sagebrush is the dominant shrub.

Major wildlife species include elk, deer, antelope, coyote, beaver, muskrat, jackrabbit, cottontail rabbit, sage grouse, and turkey. Fish species include rainbow trout, brown trout, brook trout, and cutthroat trout.

Land Use

More than 90 percent of this area supports native grasses and shrubs grazed by cattle and sheep (fig. 58B-2). About 4 percent is dry-farmed in a wheat-summer fallow rotation. The dry-farmed areas are mainly on gently sloping, deep soils. Narrow strips of land along the Tongue, Powder, and Platte Rivers and some of their tributaries are irrigated. Alfalfa, other hay crops, and feed grains are the principal crops. Some tracts are used as tame pasture. Open stands of ponderosa pine are on the higher buttes and steep slopes that receive higher amounts of precipitation.

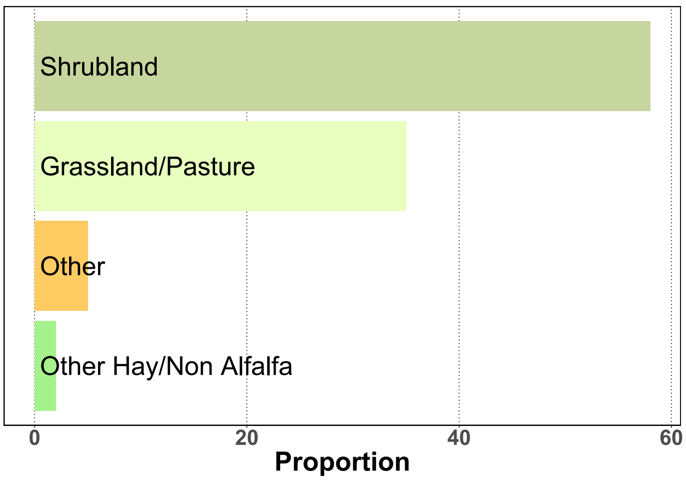

Figure 58B-2: Relative proportions (percentages) of land use in MLRA 58B.

The major resource concerns are soil quality and the quantity and quality of water. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early- and late-season pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. Conservation practices on cropland generally include those that minimize wind erosion and maximize the amount of soil moisture available for crops.

58C—Northern Rolling High Plains, Northeastern Part

MLRA 58C (fig. 58C-1) is known as the Little Missouri Badlands. The landscape is characterized by sparsely vegetated, steeply sloping, dissected badlands along the Little Missouri River and its tributaries. It includes rolling hills and old plateaus and terraces. Moderately steep and steep slopes are along the river and its tributaries. It is in North Dakota (96 percent) and Montana (4 percent). It makes up about 2,299 square miles (5,953 square kilometers).

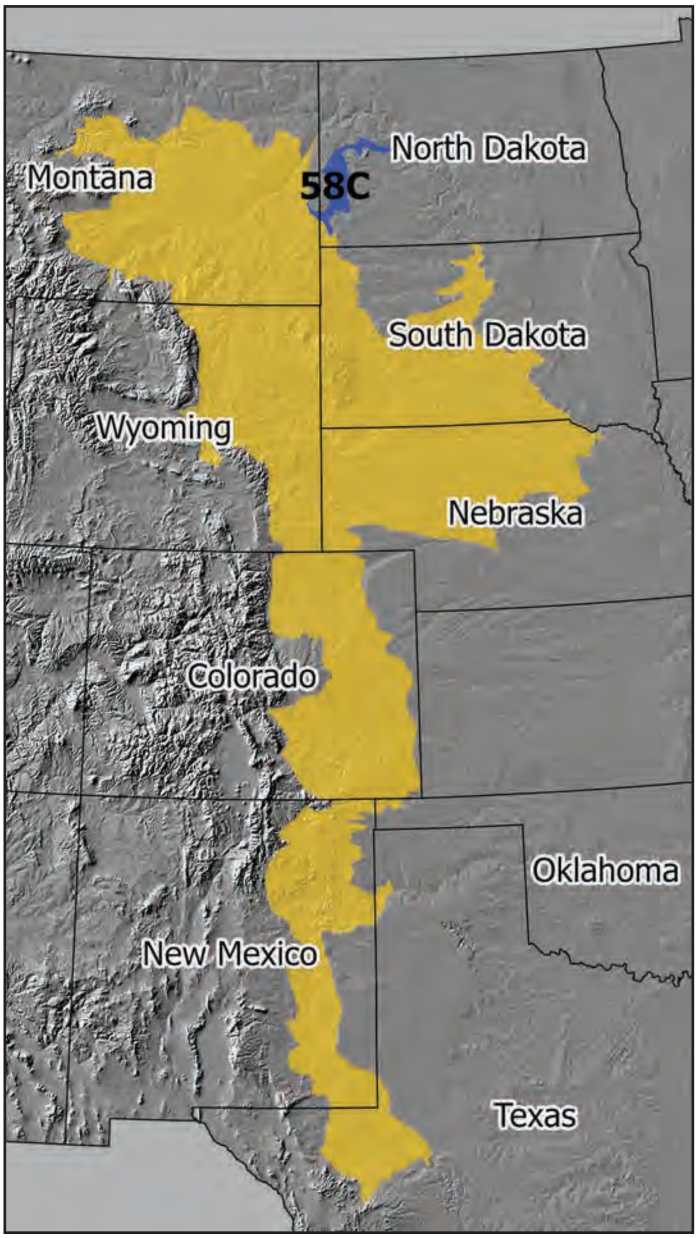

Figure 58C-1: Location of MLRA 58C, which covers 595,300 hectares (1,471,000 acres), within Region G.

MLRA 58C is surrounded on three sides by MLRA 54 (Rolling Soft Shale Plain). The boundaries between MLRA 58C and adjacent MLRAs 54 and 58C are abrupt and unmistakable and based on topography and land use. The rolling plains of MLRAs 54 and 58D change abruptly to the steep badlands of MLRA 58C.

Physiography

Most of this area is in the Missouri Plateau, unglaciated, section of the Great Plains province of the Interior Plains. The northeastern part is in the Missouri Plateau, glaciated, section of the same province and division. The MLRA has some glacially modified topography, but it is very similar to the unglaciated parts. The area formed when the Little Missouri River was diverted along a shorter, steeper course by Pleistocene glaciers. The river’s gradient increased after the eastward diversion, and as a result the river began rapidly downcutting into the soft, calcareous sedimentary shale, siltstone, and sandstone of the Fort Union and Hell Creek Formations. The rapid downcutting eroded and carved the badlands. This cycle of erosion and deposition continues today.

Elevation is generally about 1,830 to 3,440 feet (560 to 1,040 meters). The area includes some isolated mountains, such as the Killdeer Mountains. The Little Missouri River, which flows through the entire MLRA, empties into Lake Sakakawea. The lake was formed by Garrison Dam on the Missouri River, in the northeast corner of the area.

Geology

Tertiary marine sediments, shale, siltstone, and sandstone occur in most of this area. The White River Group probably represents isolated remnants of the old plateau surface at the higher elevations. The Sentinel Butte Formation occurs in most of the eastern half of this MLRA, and successively older sediments occur to the west (Bullion Creek Formation) and south (Slope and Ludlow Formations) at the lower elevations. The Cretaceous Hell Creek Formation may be exposed in the southern tip of the MLRA, along the Little Missouri River. The northeastern part of the area, at the lower end of the Little Missouri River, has a glacially modified topography and thin layers of glacial drift cover the marine sediments. Deposits of river sand and gravel occur on the valley floors of the larger streams and on the valley floor and terraces along the Little Missouri River.

Climate

The average annual precipitation is 14 to 17 inches (340 to 450 millimeters). Most of the rainfall comes from frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August, and some rain falls in autumn. More than half of the precipitation falls during the growing season. Precipitation in winter occurs as snow. The average annual temperature is 42 to 44 degrees F (5 to 7 degrees C). The freeze-free period averages 130 days and ranges from 125 to 150 days.

Microclimates inherent to the badlands of the area influence both the variety and abundance of vegetation. South- and west-facing exposures are dry, hot, and sparsely vegetated. More humid and cooler north- and east-facing exposures are favorable for abundant forage and woody vegetation.

Water

Most of the surface water is used in the generation of electric power as Lake Sakakawea drains through Garrison Dam. In most years, the supply of moisture is inadequate for maximum crop production. The Little Missouri River and Lake Sakakawea are the principal sources of surface water in the area. This water is of good quality and is used for what little irrigation is applied to the flood plains and terraces along the Little Missouri River. Some livestock water is stored in ponds.

Farms and ranches obtain their drinking water and some of their livestock water from the Fort Union aquifer. The water in this aquifer is soft, but a high level of total dissolved solids and salinity limit its use for irrigation. It also contains naturally high levels of selenium. Ground water is scarce or does not occur in areas underlain by shale.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a frigid temperature regime, an ustic moisture regime that borders on aridic, and mixed mineralogy. They are shallow to very deep, generally well drained, and loamy.

The main soils and their series:

Haplustepts that formed in colluvium on uplands (Arikara series); that formed in alluvium on alluvial fans, stream terraces, and flood plains (Lonna series)

Haplustolls that formed in alluvium on flood plains, stream terraces, and alluvial fans (Kremlin series)

Ustifluvents that formed in alluvium on flood plains, stream terraces, and alluvial fans (Havre series)

Ustipsamments that formed in residuum on hills (Fleak series)

Ustorthents that formed in residuum on hills and plains (Cabbart series); that formed in alluvium on alluvial fans and in swales (Patent series)

Biological Resources

This area supports natural prairie vegetation characterized by western wheatgrass, needle and thread, green needlegrass, blue grama, and threadleaf sedge. Little bluestem and sideoats grama are important species on sloping, shallow soils. Big bluestem and sideoats grama, along with scattered green ash, chokecherry, and western snowberry, are important species in swales. North-facing slopes support Rocky Mountain juniper, green ash, and chokecherry and an understory of little bluestem, porcupinegrass, and needle and thread.

Major wildlife species include mule deer, white-tailed deer, antelope, coyote, prairie dog, jackrabbit, reptiles, amphibians, sharp-tailed grouse, hawks, turkeys, and various species of grassland birds.

Land Use

Grazing and recreation are the dominant land uses (fig. 58C-2). About four-fifths of the area is rangeland used for ranching. The principal livestock enterprise consists of cow-calf operations. The principal dry-farmed crops are small grains, such as wheat, barley, and oats. Alfalfa, flax, forage crops, and corn for silage are grown on irrigated land along the major streams.

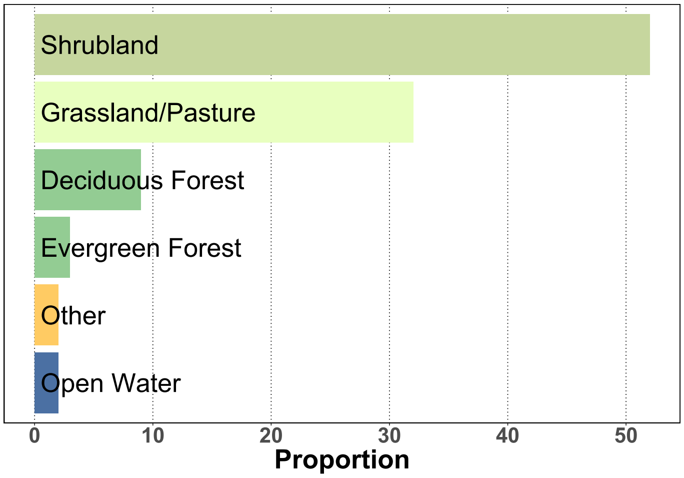

Figure 58C-2: Relative proportions (percentages) of land use in MLRA 58C.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and conservation of soil moisture. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early- and late-season pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. Conservation practices on cropland generally include crop residue management; conservation tillage systems, such as no-till; conservation cropping systems that eliminate the need for fallowing; nutrient management; and pest management.

58D—Northern Rolling High Plains, Eastern Part

MLRA 58D (fig. 58D-1) is dominantly rangeland on sedimentary bedrock. It has some sandy areas and a few steep areas with forests. It is primarily in northwestern South Dakota (67 percent), with smaller areas in southeastern Montana (20 percent) and extreme southwestern North Dakota (13 percent). It makes up about 2,673 square miles (6,922 square kilometers).

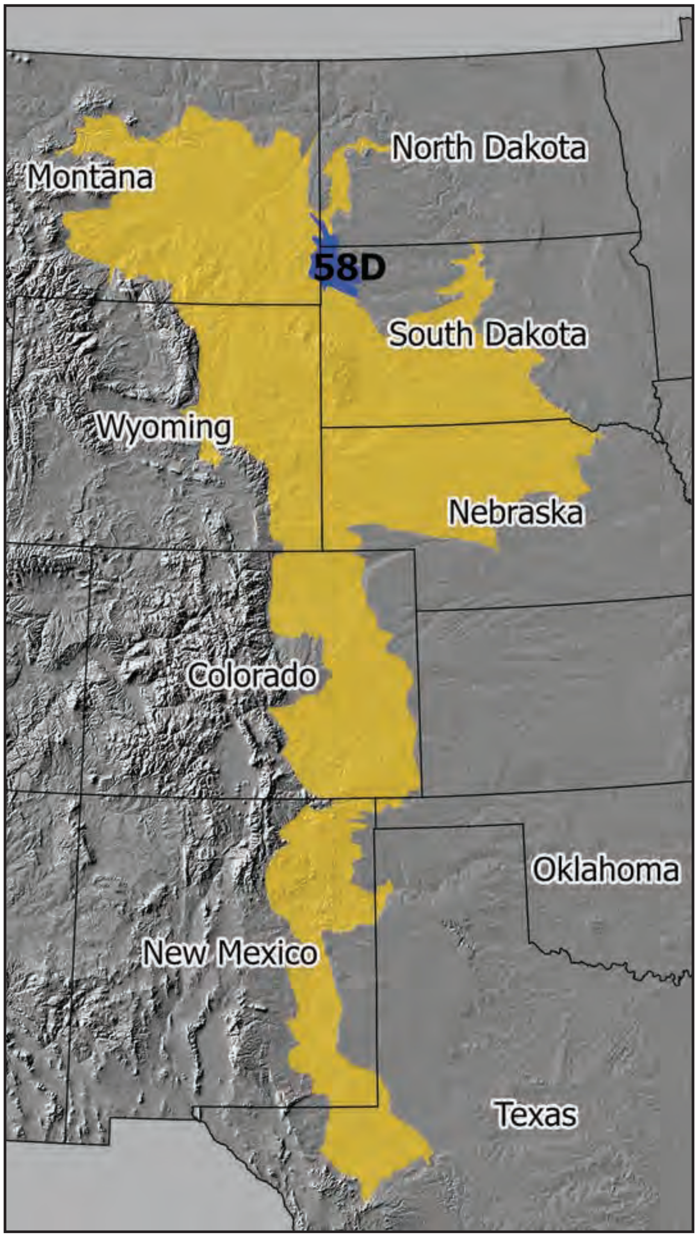

Figure 58D-1: Location of MLRA 58D, which covers 692,200 hectares (1,710,400 acres), within Region G.

MLRA 58D has a generally gradual boundary with MLRAs 60B, 58A, 58C, and 54. It has a generally abrupt boundary with MLRA 60A. MLRA 60B has less rainfall than MLRA 58D and has dominantly clayey shale bedrock as soil parent material. MLRA 58A has less rainfall than MLRA 58D and different geology. MLRA 58C has generally steeper topography and significantly more areas of badlands than MLRA 58D. MLRA 54 has more rainfall than MLRA 58D and somewhat different geology. It also has more areas of farming. MLRA 60A is warmer than MLRA 58D and has dominantly clayey shale bedrock as soil parent material.

Physiography

This area is in the Missouri Plateau, unglaciated, section of the Great Plains province of the Interior Plains. Elevation ranges from 2,300 to 4,000 feet (700 to 1,220 meters), increasing gradually from east to west. Harding Peak, the highest point in the MLRA, reaches an elevation of 4,019 feet (1,225 meters). Slopes generally are gently rolling to steep. Local relief is mainly 80 to 330 feet (25 to 100 meters). In places flat-topped, steep-sided buttes rise sharply above the general level of the plains. The Little Missouri River and the headwaters of the major tributaries that eventually form the Grand and Moreau Rivers in South Dakota are in this area.

Geology

Cretaceous marine and continental sediments of shale, siltstone, and sandstone occur in the majority of this MLRA. The continental and marine Hell Creek Formation occurs in approximately 85 percent of the MLRA, and the Fox Hills Sandstone forms the southern boundary of the MLRA. Tertiary deposits also occur in scattered areas throughout the MLRA. These deposits are made up of the Paleocene Ludlow and Tongue River Formations, the Oligocene White River Group, and the Miocene Arikaree Group. These resistant Paleocene, Oligocene, and Miocene beds lie above the Cretaceous beds. Ponderosa pine growing on these Tertiary beds further distinguishes them from the other formations in the MLRA. Quaternary river sand and gravel deposits occur on the valley floors and on the terraces along the larger rivers in the area. A large Quaternary eolian deposit occurs directly south of the town of Buffalo, North Dakota.

Climate

The average annual precipitation is 114 to 17 inches (340 to 450 millimeters) in most of this area. It fluctuates widely from year to year. Most of the rainfall occurs during frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August. Precipitation in winter occurs as snow. The average annual temperature is 43 to 46 degrees F (6 to 8 degrees C). The freeze-free period averages 130 days and ranges from 125 to 145 days.

Water

The low and erratic precipitation is the principal source of water for agriculture. Most of the surface water in this MLRA is of good quality and used for limited irrigation on the flood plains and terraces along the major streams. Water for livestock is stored in small ponds or dugouts.

Some wells in the Fort Union-Fox Hills-Hell Creek aquifer provide water for domestic use and livestock. High levels of total dissolved solids and salinity limit the use of this ground water for irrigation. Naturally high levels of selenium and molybdenum occur in the water from the Fort Union sediments. These elements can cause health problems for livestock.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a frigid temperature regime, an ustic moisture regime that borders on aridic, and mixed mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey.

The main soils and their series:

- Argiustolls that formed in alluvium or fluvial deposits on fans, terraces, and till plains (Assinniboine series); that formed in mixed alluvium and colluvium on fans, terraces, and till plains (Eapa series); that formed in residuum on hills and ridges (Marmarth series)
- Haplustepts that formed in alluvium or eolian sediments over residuum on hills and ridges (Twilight series)
- Haplustolls that formed in residuum on hills and ridges (Rhame series)
- Natrustalfs that formed in residuum on hills and ridges (Bullock and Parchin series); that formed in alluvium or fluvial deposits on fans, terraces, and till plains (Absher and Gerdrum series)
- Torriorthents that formed in residuum on hills and plains (Blackhall series)
- Ustorthents that formed in residuum on hills and plains (Cabbart and Delridge series)

Biological Resources

The native vegetation consists primarily of grasses and forbs. Some trees and shrubs are along streams. The area supports mixed prairie vegetation characterized by western wheatgrass, green needlegrass, blue grama, and buffalograss. Threadleaf sedge, buffalograss, blue grama, and some little bluestem grow on shallow soils. Needle and thread and prairie sandreed grow on sandy soils. Big bluestem grows along streams, especially where the soil has an effective water table. The most common forbs are purple coneflower, prairie coneflower, American vetch, dotted gayfeather, Missouri goldenrod, breadroot scurfpea, silverleaf scurfpea, scarlet globemallow, heath aster, desert biscuitroot, and cudweed sagewort.

Shrubs such as buffaloberry, silver sagebrush, western snowberry, and chokecherry are common. Big sagebrush grows in the driest areas of the western part of the MLRA. Boxelder, green ash, and plains cottonwood are the principal trees along streams and drainageways. Ponderosa pine forests occur on the upper slopes and on the top of some of the higher buttes in Custer National Forest. These forests stand out from the normal native grass vegetation in the northwestern part of the MLRA. Silver sagebrush and big sagebrush grow on clayey soils in the western part of the MLRA.

Major wildlife species include mule deer, white-tailed deer, antelope, coyote, fox, bobcat, rattlesnake, badger, raccoon, porcupine, beaver, skunk, mink, jackrabbit, prairie dog, golden eagle, ferruginous hawks, pheasant, sharp-tailed grouse, sage grouse, gray partridge, magpie, and lark bunting.

Land Use

More than four-fifths of this area is in private ranches. The dominant land uses are rangeland and hayland (fig. 58D-2). Less than 5 percent of the area is federally owned. Most of the area supports native grasses and shrubs grazed by cattle and sheep. Gently sloping, deep and moderately deep soils, which make up 10 to 15 percent of the area, are used for dry-farmed wheat or alfalfa. Some tracts are used as tame pasture. Open woodland is on the upper slopes and the top of some of the higher buttes.

The major soil resource concerns are wind erosion and soil quality on cropland, especially where wheat-fallow is the principal crop rotation. Surface water quality also is a resource concern. Wind erosion and soil quality are resource concerns on continuously overgrazed rangeland.

The most important conservation practices for rangeland are prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early- and late-season

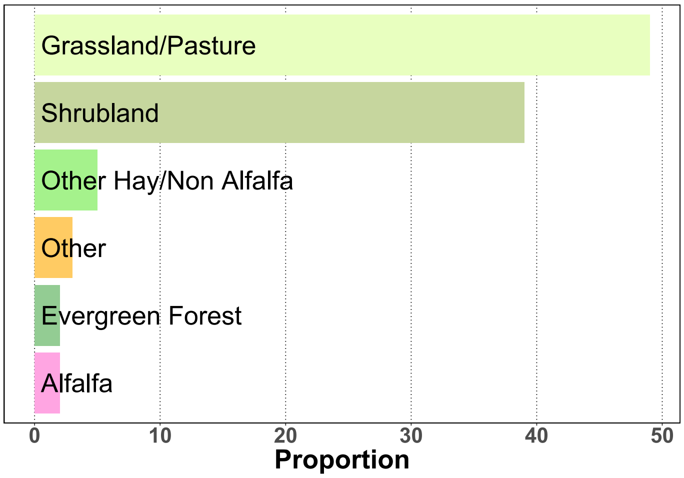

Figure 58D-2: Relative proportions (percentages) of land use in MLRA 58D.

pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. Important conservation practices for cropland are no-till and other conservation tillage systems, contour farming, and crop residue management.

60A—Pierre Shale Plains

MLRA 60A (fig. 60A-1) is dominantly rangeland on clayey shale bedrock. A high percentage of its soils are fine or very fine. The area is typically not very steep but it has a few buttes and steep valleys. It is in South Dakota (70 percent), Wyoming (20 percent), Nebraska (8 percent), and Montana (2 percent). It makes up about 10,222 square miles (26,475 square kilometers).

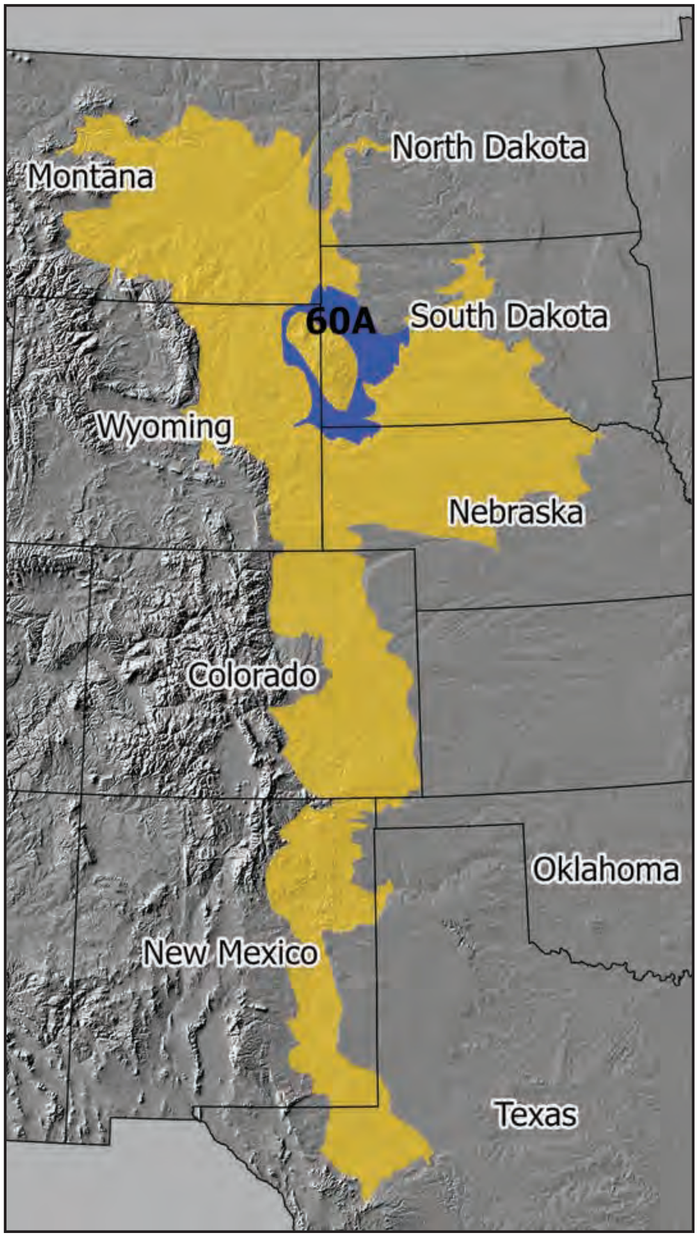

Figure 60A-1: Location of MLRA 60A, which covers 2,647,500 hectares (6,542,100 acres), within Region G.

MLRA 60A has a generally abrupt boundary with MLRAs 58D, 64, 58B, and 61. It has a generally gradual boundary with MLRAs 54, 63A, and 60B. MLRA 58D has cooler temperatures than MLRA 60A and typically has more sandstone bedrock. MLRA 54 has more rainfall and less clayey shale parent material than MLRA 60A and more areas of farming. MLRA 63A has more rainfall and more areas of farming. MLRA 64 has badlands and sandstone tablelands. It has more areas of farming in the tablelands than MLRA 60A. MLRA 58B has less rainfall and less clayey shale parent material. MLRA 60B is cooler than MLRA 60A. MLRA 61, which consists of the Dakota Hogback and the Red Valley between the Hogback and the Black Hills, is generally moister and cooler than MLRA 60A. Much of the Hogback is forested.

Physiography

This area is in the Missouri Plateau, unglaciated, section of the Great Plains province of the Interior Plains. It is an area of old plateaus and terraces that have been deeply eroded. Elevation is generally 2,650 to 4,080 feet (810 to 1,2400 meters) on uplands, but it ranges to 5,000 feet (1,520 meters). The shale plains have long, smooth slopes and generally are gently sloping to strongly sloping. Slopes are moderately steep or steep along drainages and streams. Extensive terraces occur along many of the major streams draining the Black Hills. The Cheyenne and Belle Fourche Rivers occur in this MLRA.

Geology

Cretaceous Pierre Shale underlies almost all of this area. It is a marine sediment with layers of volcanic ash that has been altered to smectitic clay. This clay shrinks as it dries and swells as it gets wet, causing significant problems for road and structural foundations. Cretaceous shale of the Belle Fourche, Mowry, and Skull Creek Formations is adjacent to the Dakota Hogback. These formations, along with Newcastle Sandstone, make up the Graneros Group. Tertiary river gravel, deposited by streams carrying erosional debris from the Black Hills following their uplift, caps the ridges separating the streams draining the Black Hills.

Climate

The average annual precipitation is 13 to 21 inches (330 to 540 millimeters). Most of the rainfall occurs during frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August. Precipitation in winter occurs mainly as snow, which usually is accompanied by high winds that cause much drifting. The average annual temperature is 43 to 49 degrees F (6 to 10 degrees C). The freeze-free period averages about 140 days and ranges from 125 to 155 days.

Water

Because of the limited amount of precipitation, the production of dry-farmed crops is marginal. Most of the soils are moist or wet early in spring and are deficient in moisture during much of the growing season. In irrigated areas along the Belle Fourche River in the northern part of the MLRA and the Cheyenne River in the southern part, surface water is drawn from the Belle Fourche and Angostura Reservoirs, respectively. Some areas along Rapid Creek are irrigated. Water for livestock comes mainly from runoff that flows into dams. Surface runoff from the forested Black Hills is of good quality. Stream runoff seeps into the cavernous Pahasapa Limestone within the Black Hills. Springs occur at the edges of the Black Hills when this water discharges at the surface. This water is of excellent quality and used for public supply.

Because the Pierre Shale underlies almost all of the MLRA, ground water is scarce. A few areas have shallow water wells for domestic use, but the water is of marginal quality for drinking. Some shallow wells also draw domestic water from alluvial sand and gravel under the larger stream valleys. This water is of significantly better quality than the shallow ground water in the Pierre Shale.

Soils

The dominant soil orders are Entisols, Alfisols, Vertisols, and Inceptisols. Mollisols are of lesser extent. The soils in the area dominantly have a mesic temperature regime, an ustic moisture regime, and smectitic or mixed mineralogy. They are shallow to very deep, generally well drained, and clayey.

The main soils and their series:

- Argiustolls on old alluvial terraces along many of the streams that drain the Black Hills (Nunn and Satanta series)
- Haplustalfs that formed in alluvium and residuum on hills, alluvial fans, and fan remnants (Leiter series)
- Haplustepts that formed in residuum and alluvium on stream terraces and uplands (Bufton series); that formed in alluvium and residuum on hills, alluvial fans, and fan remnants (Echeta and Cromack series)
- Haplusterts that formed in residuum and local alluvium on plains and hills (Pierre, Kyle, and Swanboy series)
- Paleustalfs that formed in alluvium on alluvial fans (Jaywest series)
- Ustorthents that formed in residuum and local alluvium on plains and hills (Fairburn, Grummit, Lismas, and Samsil series)

Biological Resources

The native vegetation in this MLRA consists primarily of grasses and forbs. Some trees and shrubs grow along streams. The area supports mixed natural prairie vegetation characterized by grasses such as western wheatgrass, green needlegrass, blue grama, and buffalograss. Little bluestem, buffalograss, and sideoats grama grow on the shallow soils. Big bluestem grows along streams, especially where the soils have an effective water table. The most common forbs are purple coneflower, prairie coneflower, American vetch, dotted gayfeather, Missouri goldenrod, breadroot scurfpea, silverleaf scurfpea, scarlet globemallow, heath aster, desert biscuitroot, and cudweed sagewort. Shrubs include sand sagebrush on sandy soils and silver sagebrush, western snowberry, and leadplant on clayey soils in the western part of the MLRA. Big sagebrush grows in the driest part of the MLRA, in southwestern Fall River County, South Dakota, and areas extending into Wyoming. Boxelder, green ash, and plains cottonwood are the principal trees along streams and drainageways. Eastern redcedar occurs in scattered areas throughout the uplands, especially along the Cheyenne River. Bur oak and ponderosa pine are common in areas of the acid shale of the Graneros Group.

Major wildlife species include mule deer, white-tailed deer, antelope, coyote, bobcat, badger, beaver, raccoon, skunk, muskrat, mink, jackrabbit, cottontail, prairie dog, turkey, pheasant, sharp-tailed grouse, Hungarian partridge, sage grouse, mourning dove, mallard, long-billed curlew, killdeer, yellow-headed blackbird, and red-winged blackbird. Fish species include walleye, channel catfish, white bass, largemouth black bass, bluegill, and northern pike.

Land Use

The dominant land uses are rangeland and hayland (fig. 60A-2). Practically all of this area is in farms and ranches. Most of it supports native grasses and is grazed by livestock. Approximately 10 percent of the area is used for small grain, some of which is used for livestock feed. Some small areas of nearly level to moderately sloping soils are used for winter wheat or feed crops for livestock.

The major resource concerns are wind erosion and soil quality on cropland (especially where wheat-fallow is the

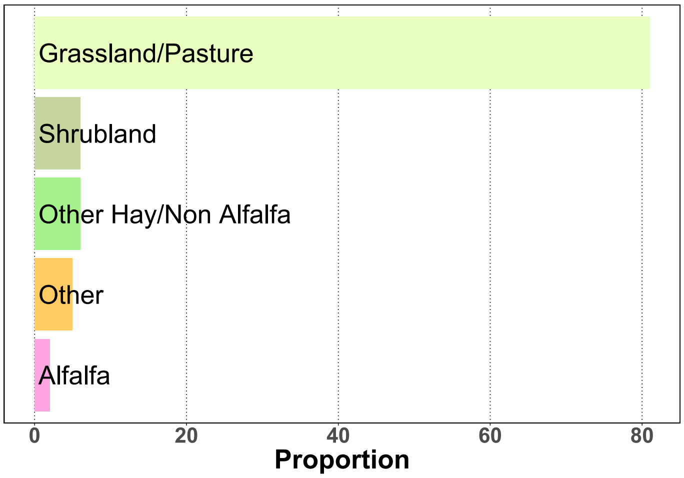

Figure 60A-2: Relative proportions (percentages) of land use in MLRA 60A.

principal crop rotation) and on continuously overgrazed rangeland, and surface water quality. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. The establishment of early- and late-season pastures supplements forage production and keeps livestock off the rangeland during critical growth periods. Conservation practices on cropland generally include no-till and other kinds of conservation tillage, contour farming, and crop residue management.

60B—Pierre Shale Plains, Northern Part

MLRA 60B (fig. 60B-1) occurs in the uplands between most of the major rivers in southeastern Montana (94 percent) and northeastern Wyoming (6 percent). A very small part is in North Dakota. The MLRA consists of about 3,570 square miles (9,246 square kilometers). It is an area of old plateaus and terraces that have been deeply eroded.

MLRA 60B is comprised of two geographically separate delineations. A northern unit that is dominated by the Bearpaw Shale is in the northern part of Rosebud County in southeastern Montana. This delineation is surrounded on all sides by MLRA 58A, which has significantly different geology: marine shale rather than continentally deposited sandstones, siltstones, and shales. A second delineation is in the southeastern corner of Montana, mostly in Carter County, with small areas in extreme northeastern Wyoming. This delineation is dominated by another marine shale, the Pierre Shale. The northwestern boundary of MLRA 60B with MLRA 58A is distinct and based on geology like MLRA 58A. The southern boundaries with MLRAs 60A and 58A are based on the boundary between the frigid and mesic soil temperature regimes. The northeastern boundary with MLRA 58D is gradual and also defined by the distinct lithology of the Pierre Shale as well as a slightly wetter climate.

Physiography

This area is in the Missouri Plateau, unglaciated, section of the Great Plains province of the Interior Plains. The elevation ranges from 2,540 to 4,270 feet (770 to 1,300 meters) on uplands. The shale plains have long, smooth, gentle to strong slopes. Slopes along drainageways and streams are moderately steep or steep.

Geology

The MLRA is defined by exposures of Late Cretaceous marine shales and transitional deposits that formed as the Cretaceous Seaway fluctuated in depth and extent across the interior of the continent. The transitional deposits include beach sandstones, limestone in shallow water deposits, and calcareous shales. Where the sea was deepest, shale deposits are thousands of feet in thickness—the Pierre Shale. At the margins of the seaway and in adjacent basins, the shale is split and intermixed with beach sandstones and other lithic material. Each change in lithology or basin often results in a name change. A mix or section of lithologies may be of such extent that it was mapped as a separate geologic unit. Geologic uplift brought the shales to the surface. The variation in lithology caused the topographic variance in this area.

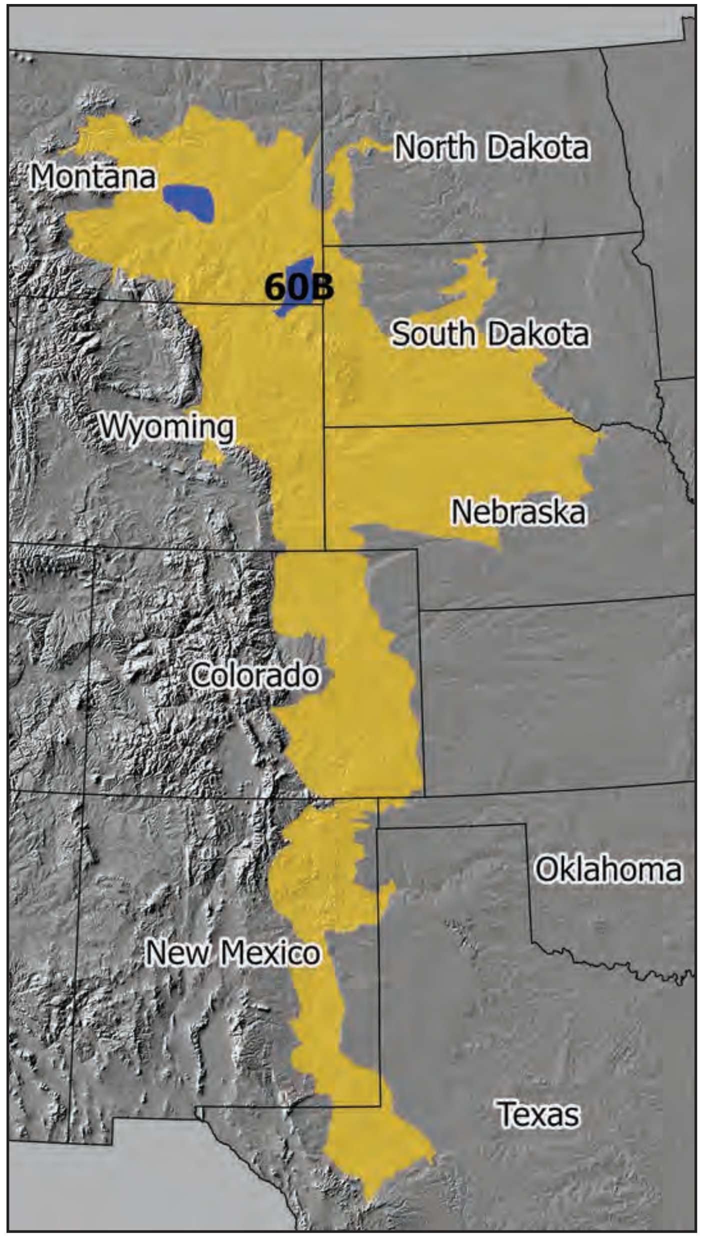

Figure 60B-1: Location of MLRA 60B, which covers 924,600 hectares (2,284,800 acres), within Region G.

Climate

The average annual precipitation in this area is 12 to 18 inches (300 to 460 millimeters). Most of the annual precipitation comes from high-intensity, convective thunderstorms during the growing season. Precipitation in winter occurs mainly as snow, which usually is accompanied by high winds that cause much drifting. The average annual temperature is 43 to 47 degrees F (6 to 8 degrees C). The freeze-free period averages 135 days and ranges from 120 to 150 days.

Water

Because of the limited amount of precipitation, the production of dry-farmed crops is marginal. Most of the soils are moist or wet early in spring and are deficient in moisture during much of the growing season. The quality of the surface water is good, but the quantity typically is inadequate. There is some limited irrigation along the larger streams on the edges of this area. Water for livestock comes mainly from runoff that flows into dams.

Ground water is scarce in most of the area, but local deposits of sand and gravel in the Fox Hills Sandstone and Hell Creek Formation yield small to moderate amounts of domestic and livestock water. This ground water is a sodium-bicarbonate or sulfate type and generally is hard or very hard. The level of total dissolved solids exceeds drinking water standards. The water from alluvial deposits in areas of flood plains and terraces is of much better quality than the water in the bedrock aquifers. Shallow wells provide a limited amount of water for irrigation, domestic use, and livestock.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Vertisols. The soils in the area dominantly have a frigid soil temperature regime, an ustic soil moisture regime, and smectitic mineralogy. They are shallow to very deep, generally well drained, and clayey.

The main soils and their series:

- Natrustalfs that formed in alluvium and glaciofluvial deposits on alluvial fans, stream terraces, and plains (Absher and Gerdrum series)
- Haplusterts that formed in alluvium and residuum on alluvial fans, stream terraces, and plains (Bascovy and Bickerdyke series); that formed in alluvium and lacustrine deposits on alluvial fans, stream terraces, and lake plains (Marias and Marvan series)
- Ustorthents that formed in mixed residuum, alluvium, and colluvium on hills and plains (Neldore, Orinoco, and Yawdim series); that formed in alluvium, lacustrine deposits, and glaciofluvial deposits on alluvial fans, stream terraces, and plains (Vanda series)

Biological Resources

This area supports mixed natural prairie vegetation characterized by western wheatgrass, green needlegrass, and blue grama. Little bluestem and sideoats grama grow on shallow soils. Some areas in the southern part of the MLRA support pine forests. Oak species grow in some protected draws.

Major wildlife species in this area include mule deer, white-tailed deer, antelope, coyote, fox, bobcat, rattlesnake, badger, raccoon, porcupine, beaver, skunk, mink, jackrabbit, prairie dog, golden eagle, ferruginous hawks, pheasant, sharp-tailed grouse, sage grouse, gray partridge, magpie, and lark bunting.

Land Use

Practically all of the MLRA is in farms or ranches (fig. 60B-2). Most of it is rangeland grazed by livestock. Some small areas of nearly level to moderately sloping soils are used for winter wheat or for livestock feed crops.

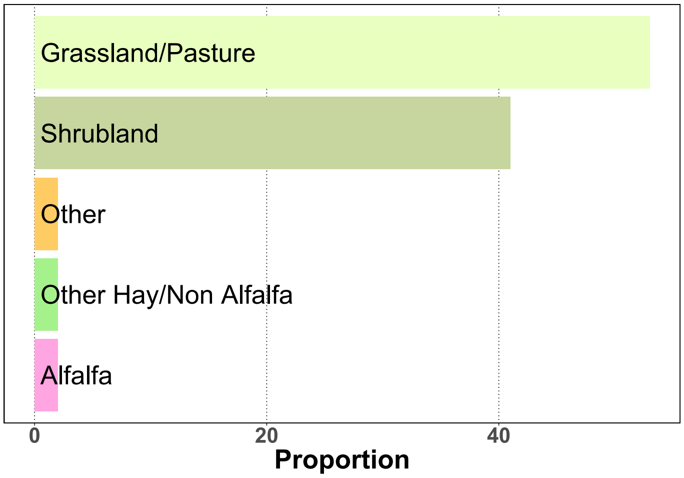

Figure 60B-2: Relative proportions (percentages) of land use in MLRA 60B.

61—Black Hills Foot Slopes

MLRA 61 (fig. 61-1) consists of the Dakota Hogback and Red Valley. The Dakota Hogback part is typically very steep and forested. The Red Valley part is typically much more level and has soils that developed from silty shale and alluvium from the Black Hills. This MLRA is in Wyoming (57 percent) and South Dakota (43 percent). It makes up about 1,972 square miles (5,108 square kilometers).

MLRA 61 has a generally abrupt boundary with MLRAs 60A and 62. MLRA 60A is warmer than MLRA 61 and has less rainfall. It has dominantly clayey and very clayey soils. MLRA 62 consists of the Black Hills. It has mountainous topography and is mostly forested, and much of the bedrock in the area is lithic. It is generally cooler than MLRA 61 and receives more rainfall.

Physiography

This area is in the Black Hills section of the Great Plains province of the Interior Plains. It is an area of steeply dipping

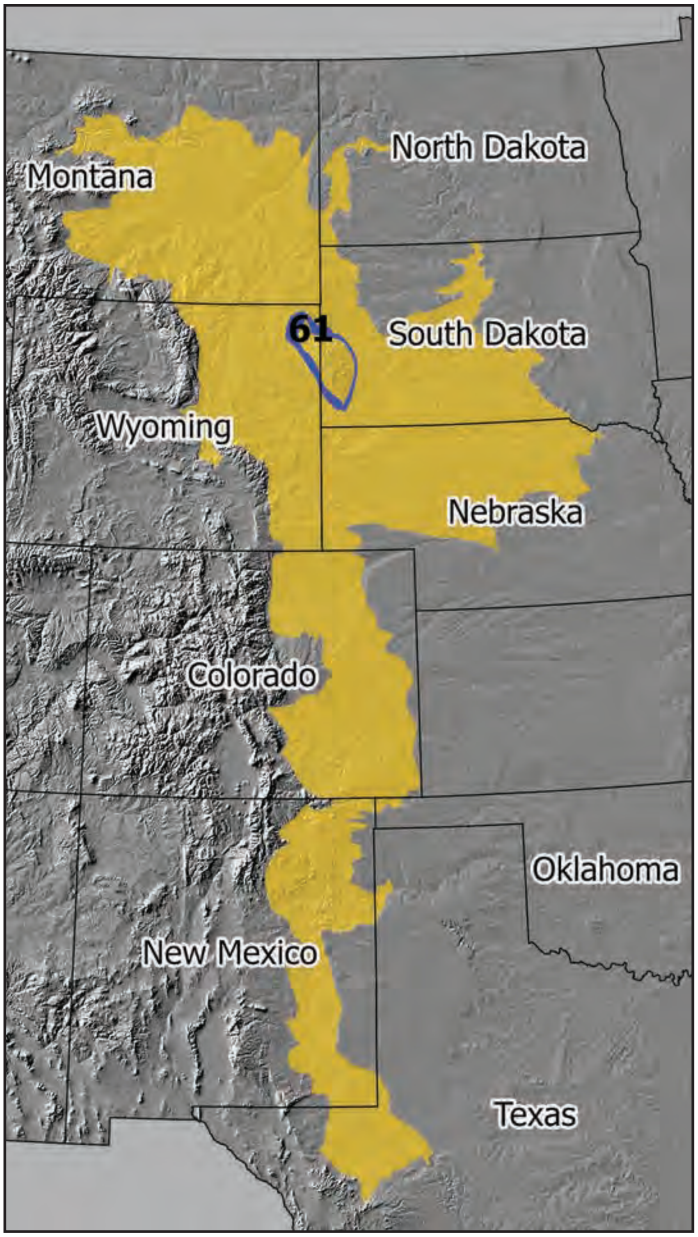

Figure 61-1: Location of MLRA 61, which covers 510,800 hectares (1,262,200 acres), within Region G.

rocks that circle the maturely dissected domed mountains of the Black Hills. As the mountains were uplifted, older sediments were tipped up, so that they now dip away from the core of the mountains. Elevation is mainly 2,950 to 3,940 feet (900 to 1,200 meters) but ranges to 6,430 feet (1,960 meters). The area is generally hilly but is nearly level to moderately sloping where shale red beds occur in the middle of the MLRA. Slopes are steep along both edges of the area where there are more erosion-resistant rocks.

The Belle Fourche River is the only river flowing through this MLRA, but many creeks draining the Black Hills cross the area. The creeks are the headwaters of the Cheyenne River, one of the major rivers in western South Dakota. The drainage pattern in the area is well defined.

Geology

This area consists of marine sediments older than the Cretaceous Pierre Shale on the high plains that surround it. The older rocks were brought closer to the surface during the uplift that formed the Black Hills. The Lower Cretaceous Fall River and Lakota (Inyan Kara Group) sandstones occur on the outside boundary of the area and are referred to as the Dakota Hogback. Permian limestone and shale of the Minnekahta Limestone form the inside boundary and occur in the mountains of the Black Hills (MLRA 62). The Triassic red beds of the Spearfish shale form a low valley, the “red valley.” Native Americans called these red beds the “Great Race Track.” The red beds have gypsum and anhydrous layers. Ground water seepage can dissolve these layers, creating sinkholes on the surface.

Climate

The average annual precipitation 15 to 25 inches (370 to 640 millimeters). Most of the rainfall occurs during frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August. The average snowfall in winter is 24 to 39 inches (60 to 100 centimeters), increasing with elevation. The average annual temperature is 40 to 49 degrees F (5 to 9 degrees C). The freeze-free period averages 135 days and ranges from 105 to 155 days.

Water

Flowing streams, shallow wells, and springs provide almost all of the domestic and public water. The surface water is of good quality during high runoff periods. At low flows, however, much of the surface water does not meet drinking water standards because of pollution and high levels of total dissolved solids. Much of the water used in this area is for public supply for the numerous cities and towns built on the level ground forming the core of the area. Crop production in the area is marginal because of the limited amount of precipitation. There is some limited irrigation along the major streams that have headwaters in the Black Hills and cross the area. Most of the soils suitable for cultivation are dry during much of the growing season. Ground water is scarce because of the underlying shale. Many cities obtain public supply water from large springs in the Pahasapa Limestone on the inside edge of this area.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Mollisols. The soils in the area dominantly have a frigid or mesic temperature regime, an aridic or ustic moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, generally well drained, and loamy.

The main soils and their series:

- Argiustolls that formed in silty sediments on stream terraces and uplands (Boneek and Vale series); that formed in eolian and alluvial deposits on stream terraces and uplands (Satanta and Nunn series)
- Hapludalfs that formed in residuum on hills and valley walls (Lakoa series)
- Haplustalfs that formed in residuum on hills and valley walls (Larkson series)
- Haplustolls that formed in silty sediments on valley floors (Tilford series)
- Torriorthents that formed in residuum on hills and foothills (Canyon, Crownest, Gaynor, Shingle, and Tassel series); that formed in residuum in basins (Enning, Fairburn, and Mittenbutte series)
- Ustorthents that formed in residuum on uplands (Butche and Spearfish series); that formed in alluvium and colluvium on stream terraces and uplands (Nevee and Gypnevee series)

Biological Resources

This area supports open grassland, forest, and savanna vegetation. The grassland is characterized by native grasses such as little and big bluestem, prairie Junegrass, Indian ricegrass, sand dropseed, green needlegrass, western wheatgrass, and needle and thread. The most common forbs are white beartongue, ballhead gilia, white milkwort, dotted gayfeather, rush skeletonplant, purple coneflower, prairie coneflower, and trailing fleabane. The most common shrubs are silver sagebrush, rubber rabbitbrush, and broom snakeweed. Ponderosa pine grows in scattered stands of open forest. Bur oak grows throughout the MLRA and in some areas occurs as nearly pure stands. Quaking aspen and eastern hophornbeam are throughout the forested areas. Green ash, boxelder, and American elm along with big bluestem grow in scattered areas along stream bottoms. Major wildlife species include elk, mule deer, white-tailed deer, antelope, coyote, fox, bobcat, mountain lion, wild turkey, sage grouse, ruffed grouse, and sharp-tailed grouse.

Land Use

Most of the MLRA is privately owned land in farms and ranches (fig. 61-2). The native grasses are used mainly for grazing by livestock. Some of the less sloping areas are used for alfalfa and small grain for livestock feed. Ponderosa pine grows in some areas adjacent to the Black Hills. Urban expansion is a growing concern.

The major resource concerns are wind and water erosion, water quality, and urban expansion. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. The establishment of food plots and range improvement practices benefit wildlife. Conservation practices on cropland generally include contour farming, crop rotations that include grasses and legumes, and crop residue management. The Grassland Reserve Program is an increasingly important tool for limiting urban expansion. Forest stand improvement and firebreaks reduce the hazard of wildfires and improve forest growth, quality, health, and productivity.

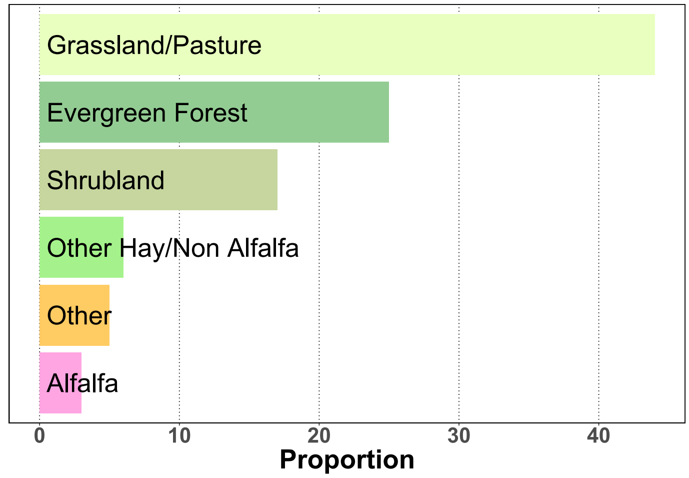

Figure 61-2: Relative proportions (percentages) of land use in MLRA 61.

62—Black Hills

MLRA 62 (fig. 62-1) is mountainous and forested. This area is in South Dakota (74 percent) and Wyoming (26 percent). It makes up about 2,918 square miles (7,558 square kilometers).

MLRA 62 has a generally abrupt boundary with MLRA 61, which surrounds it. MLRA 61 has mostly lower elevations, is warmer, and receives less rainfall. It also has less forested land. The bedrock in MLRA 61 is generally not as hard as that in MLRA 62.

Physiography

This area forms the core of the Black Hills section of the Great Plains province of the Interior Plains. It is an area of maturely dissected domed mountains. Elevation is mainly 3,600 to 6,565 feet (1,100 to 2,000 meters). It is 7,242 feet (2,208 meters) on Harney Peak, the highest point in the United States east of the Rocky Mountains. Slopes range from moderately sloping on some of the high plateaus to very steep along drainageways and on peaks and ridges. Narrow valleys generally are gently sloping to strongly sloping. Streams that drain the MLRA include Box Elder, Castle, French, Rapid, Spearfish, and Spring Creeks.

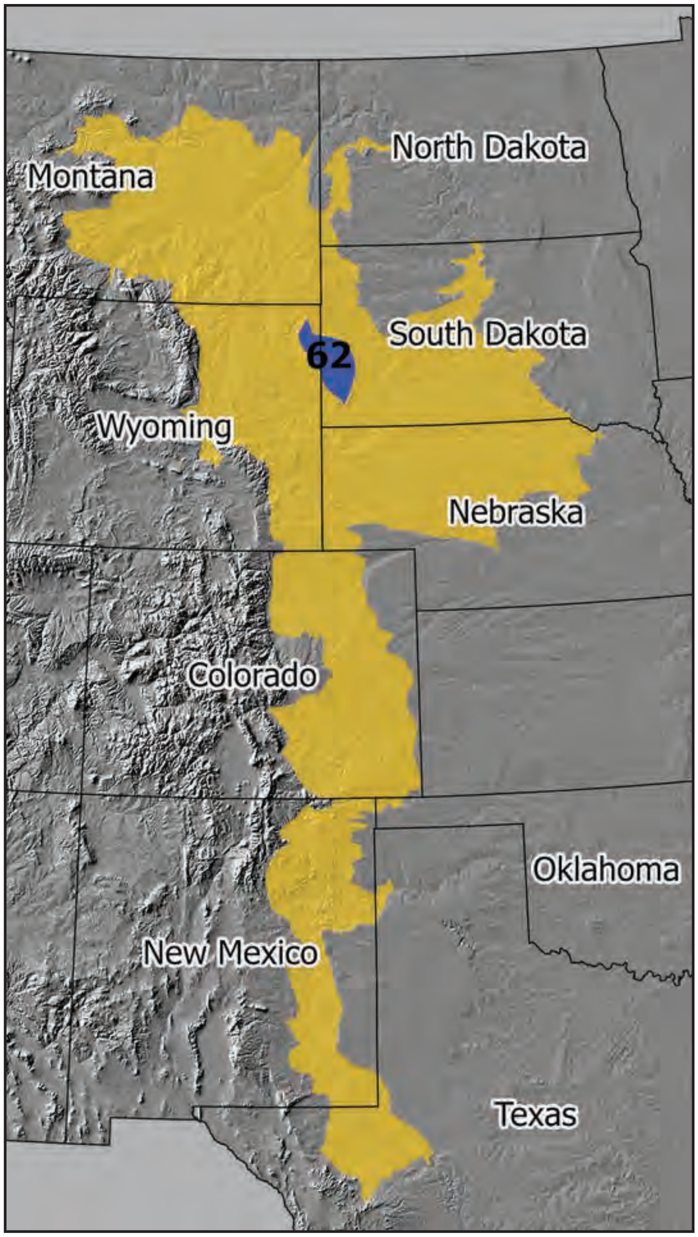

Figure 62-1: Location of MLRA 62, which covers 755,800 hectares (1,867,500 acres), within Region G.

Geology

The core of the Black Hills is a plutonic mass of granite with steeply dipping metamorphic rocks, primarily slate and schist, directly surrounding it. A plateau of Mississippian limestone surrounds the igneous and metamorphic rock core—the Pahasapa (Madison) Limestone. This limestone is broken around the outer edges of the uplifted area. The Permian Minnekahta Limestone forms the outermost boundary of the area. Many other tilted sandstone, shale, and limestone units are exposed like a bathtub ring inside the steeply dipping Pahasapa Limestone. These older units are also exposed on the valley walls along the major drainages that cut through the rock layers.

There are two unique geologic features in the Black Hills. One is the loss of water in the creeks that flow across the cavernous Pahasapa Limestone ringing the Black Hills. This water is discharged to the surface again in major springs that occur at the margins of the Black Hills. The other feature consists of a series of Tertiary igneous intrusives, aligned east to west across the northern third of the Black Hills. Gold deposits formed in the country rock adjacent to these igneous rocks.

Climate

The average annual precipitation is 16 to 32 inches (410 to 820 millimeters), increasing with elevation and decreasing from west to east and north to south. Most of the rainfall occurs during frontal storms early in the growing season, in May and June. Some high-intensity, convective thunderstorms occur in July and August. Precipitation in winter occurs mostly as snow. Annual snowfall ranges from about 60 inches (150 centimeters) at the lower elevations to as much as 140 inches (355 centimeters) at the higher elevations. The average annual temperature is 38 to 48 degrees F (3 to 9 degrees C). The freeze-free period averages 120 days and ranges from 80 to 145 days. It is shortest at the higher elevations and in the northwestern part of the area.

Water

In most years soil moisture is adequate for normal plant growth. Precipitation, perennial streams, springs, and shallow wells provide adequate water for domestic use. The surface water is plentiful and of good quality. Most public supply water for towns in the Black Hills comes from streams. Small hydroelectric plants are along Spearfish Creek.

Most of the granitic and metamorphic rocks in this area are not principal aquifers. Some of the purest water in South Dakota, however, comes from springs in the granite rocks around Mount Rushmore National Monument. The metamorphic rocks have joints and bedding and cleavage planes that allow for transmission of water at the lower elevations. These rocks commonly are the source of the domestic water supply in the Black Hills. The water from the metamorphic rocks is much more mineralized than the water in the granite. The Pahasapa (Madison) Limestone and younger sandstone and limestone sediments are the primary aquifers in the MLRA. The ground water is plentiful and is used primarily for irrigation and livestock. It has high levels of total dissolved solids and is mostly a sodium-sulfate type.

Soils

The dominant soil orders in this MLRA are Alfisols and Mollisols. The soils in the area dominantly have a frigid or cryic temperature regime, a udic or ustic moisture regime, and mixed, micaceous, or smectitic mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey. Soil parent material consists of metamorphic, igneous, and sedimentary bedrock. Most of the sedimentary bedrock formations are older than the metamorphic and igneous formations, but some are younger. Rock outcrop is common throughout the area.

The main soils and their series:
- Haplocryalfs that formed in residuum on mountains (Stovho and Trebor series)
- Hapludalfs that formed in residuum on mountains (Buska, Citadel, Pactola, Vanocker, and Virkula series)
- Haplustalfs that formed in colluvium or alluvium on fans, hills, and mountains (Mocmont series)
- Haplustolls that formed in alluvium on fan aprons and piedmonts (Cordeston series); that formed in residuum on mesas and hills (Paunsaugunt series)
- Ustorthents that formed in residuum on mountains (Sawdust series)

Biological Resources

This area supports open to dense forest vegetation. Ponderosa pine is the dominant species. Black Hills spruce grows at the higher elevations and along the major drainageways. Paper birch and quaking aspen are on sites that have been burned by wildfire or cleared by logging. Junegrass, fuzzyspike wildrye, green muhly, prairie dropseed, roughleaf ricegrass, green needlegrass, poverty oatgrass, Richardson's needlegrass, and Canada wildrye are the most common native grasses under open forest stands. The most common native forbs and shrubs are spreading dogbane, Indianhemp, low larkspur, prairie star, Richardson's alumroot, sulfur paintbrush, bearberry, common juniper, grouseberry, redosier dogwood, poison ivy, Saskatoon serviceberry, red raspberry, chokecherry, creeping blackberry, wild spirea, and western red currant.

Major wildlife species include elk, mule deer, white-tailed deer, coyote, red fox, gray fox, bobcat, mountain lion, raccoon, porcupine, skunk, beaver, red squirrel, northern flying squirrel, mink, bald eagle, golden eagle, red-tailed hawk, turkey, ruffed grouse, and sharp-tailed grouse.

Land Use

The forestland in this area is used mainly for timber production, recreation, and grazing (fig. 62-2). About half of the area is in Black Hills National Forest. The Black Hills area, an important tourist attraction, is used for logging, mining, recreation, and hunting. Some areas, especially in the northern part of the Black Hills, are mined for gold and other minerals. The many streams are popular destinations for trout fishermen. Small farms and ranches, rural homes, and summer homes on small acreages are scattered throughout the area. Small ranches and farms depend on Black Hills National Forest for summer grazing.

The major resource concerns are soil erosion and surface compaction caused by logging, mining, wildfires, grazing, and urban expansion. The quality of ground water and surface water is another concern, especially in the northern part of the Black Hills, because of contamination from mine waste and septic systems in areas of rural development and urban expansion.

The major erosion-control practices are critical area planting and proper tree harvesting on disturbed or burned sites and proper grazing management. Conservation practices on rangeland generally include prescribed grazing, fencing, and water developments. Forest stand improvement and firebreaks reduce the hazard of wildfires and improve forest growth, quality, health, and productivity.

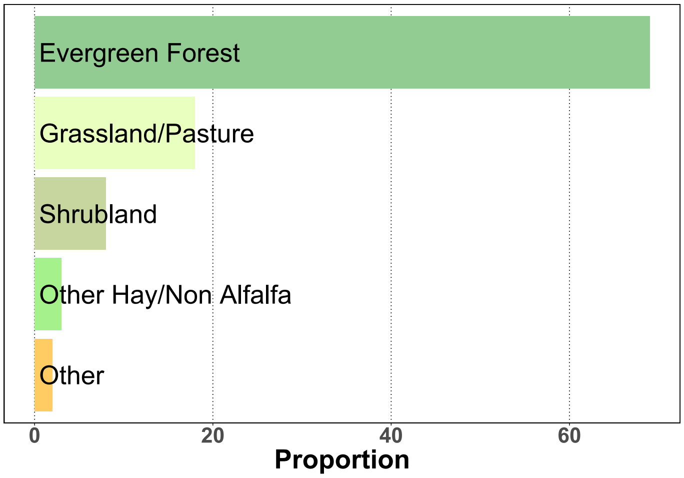

Figure 62-2: Relative proportions (percentages) of land use in MLRA 62.

63A—Northern Rolling Pierre Shale Plains

This MLRA (fig. 63A-1) is characterized by soils with a high clay content and high shrink-swell potential on a landscape that transitions from steep, dissected river breaks along major rivers to rolling upland plains. It is primarily in South Dakota, but a very small part is in North Dakota (less than 1 percent). The area makes up 10,136 square miles (26,253 square kilometers).

MLRA 63A has a gradual boundary with MLRAs to the south and west and a distinct boundary with MLRAs to the north and east. The Missouri River breaks create a distinct boundary to the east where MLRA 63A meets MLRAs 53B (Central Dark Brown Glaciated Plains) and 53C (Southern Dark Brown Glaciated Plains). Unlike MLRA 63A, MLRAs 53B and 53C were glaciated. A change in geology from shale to sandstone and siltstone characterizes the boundary between MLRA 63A and MLRAs 54 (Rolling Soft Shale Plain) and 64 (Mixed Sandy and Silty Tableland and Badlands). In addition, MLRA 64 is in the aridic ustic soil moisture regime, whereas MLRA 63A is in the typic ustic soil moisture regime. The boundary between MLRAs 63A and 60A (Pierre Shale Plains) is gradual and less apparent and is based on the boundary between the typic ustic and aridic ustic soil moisture regimes. The boundary between MLRAs 63A and 63B (Southern Rolling

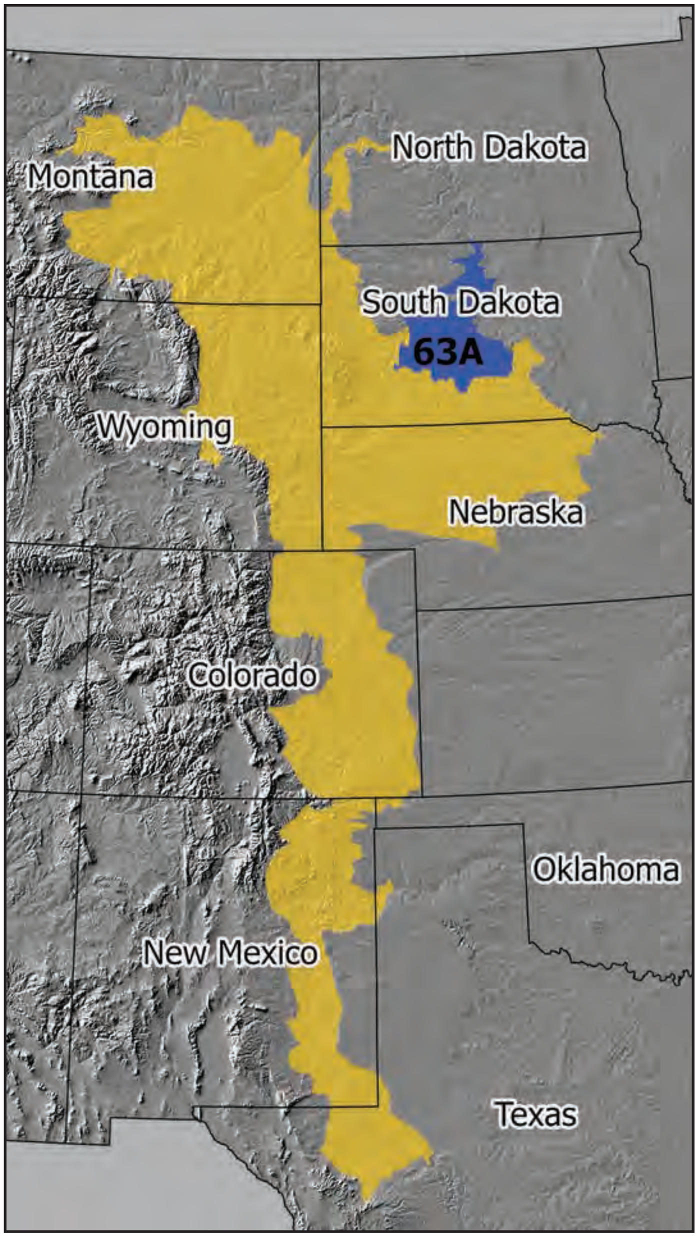

Figure 63A-1: Location of MLRA 63A, which covers 2,625,300 hectares (6,487,200 acres), within Region G.

Pierre Shale Plains) is gradual and less apparent, marking a transition to a slightly wetter and warmer area that has more trees and shrubs in draws (MLRA 63B).

Physiography

This area is primarily in the Missouri Plateau, unglaciated, section of the Great Plains province of the Interior Plains. It consists of old plateaus and terraces that have been deeply eroded. Parts of the eastern edge of this area are in the Missouri Plateau, glaciated, section. Isolated remnants of glacial till are in the glaciated section. Glacial erratics have been found as far west as the center of this area. Elevation ranges from 1,300 to 1,640 feet (395 to 500 meters) on the bottom land along the Missouri River to 1,640 to 2,950 feet (500 to 900 meters) on the shale plain uplands. Areas that are cropped are mainly at elevations of about 1,640 to 2,620 feet (500 to 800 meters). These areas are nearly level to rolling and have long, smooth slopes and a well defined dendritic drainage system. River and creek valleys have smooth floors and steep walls.

The Missouri River is mostly inside this MLRA along its eastern edge. All five of the major rivers draining western South Dakota cross this area. From north to south, they are the Grand, Moreau, Cheyenne, Bad, and White Rivers. With the exception of the White River, the confluence of these rivers with the Missouri River occurs in this area. Three of the four lakes created by main-stem dams on the Missouri River—Lake Oahe, Lake Sharpe, and Lake Francis Case—are in this area.

Geology

Cretaceous Pierre Shale underlies almost all of this MLRA. It is a marine sediment with layers of volcanic ash that have been altered to smectitic clays. These clays shrink as they dry and swell as they get wet, causing significant hazards for road and structural foundations. Fox Hills Sandstone occurs at the higher elevations in the northern and western parts of the area. Tertiary and Quaternary river deposits, remnants of erosion from the Black Hills following their uplift, cap isolated highs in this area. Deposits of alluvial sand and gravel occur on the valley floors adjacent to the major streams.

Climate

The average annual precipitation is 16 to 21 inches (400 to 530 millimeters). Most of the precipitation falls during the growing season as frontal storms in spring and as high-intensity, convective thunderstorms in summer. Precipitation in winter occurs mostly as snow. The annual snowfall is typically 20 to 48 inches (50 to 120 centimeters). The average annual temperature is 44 to 49 degrees F (6 to 9 degrees C). The freeze-free period averages 150 days and ranges from 130 to 160 days.

Water

In most years precipitation is inadequate for maximum plant growth. Some land along the Missouri River and on the flood plains along its major tributaries is irrigated. The surface water is generally of good quality. It is a sodium-bicarbonate type and soft.

This area has few shallow water developments. Most of the water for livestock comes from surface runoff that flows into dams or from deep artesian flows from wells finished in Dakota sandstone. Because of high amounts of dissolved solids, mostly sodium, chloride, and sulfate, the well water is slightly saline or moderately saline. It is very hard and suitable only for watering livestock. High levels of selenium and molybdenum in the runoff from the shale plains may cause some health problems for livestock. Rural water systems are improving the quality of the water available for domestic use. The Missouri River is the source of water for these systems.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, Mollisols, and Vertisols. The soils in this area dominantly have a mesic temperature regime, an ustic moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep and loamy or clayey.

The main soils and their series:

- Calciustepts (Lakoma series) or Haplustepts (Chantier and Dupree series) that formed in residuum on upland plains and hills
- Epiaquerts that are poorly drained and formed in upland depressions (Kolls series)
- Haplusterts that formed in clayey sediments weathered from clayey shale on uplands, fans, or terraces (Millboro, Bullcreek, and Promise series)
- Haplusterts that formed in residuum on upland plains, hills, and river breaks (Opal series)
- Ustifluvents (Wendte series) and Argiustolls (Kirley series) that formed in alluvium on flood plains and stream terraces
- Ustorthents that formed in clayey shale residuum on uplands, hills, ridges, and river breaks (Okaton and Sansarc series)

Biological Resources

The vegetation is a transition between tall prairie grasses and mixed prairie grasses. Green needlegrass, western wheatgrass, needle and thread, porcupinegrass, little bluestem, and big bluestem are the major species. Bluestems, buffalograss, sedges, and sideoats grama are dominant on the shallower soils. Bur oak, buffaloberry, and prairie rose are common along the major streams. Prairie cottonwood and a variety of willow species are common on the flood plains along the major streams. Major wildlife species include mule deer, white-tailed deer, antelope, turkey, pheasant, sharp-tailed grouse, and prairie chicken.

Land Use

Most of this area is in farms or ranches (fig. 63A-2). Urban expansion is limited. The area is used mainly for livestock production and cash-grain farming. Alfalfa, sorghum, and hay are the principal crops grown for livestock feed. Winter wheat is the main cash crop; spring wheat and sunflowers are grown to a lesser extent. Dryfarming on soils that are not suited to cultivation is destroying the native grassland.

The major soil resource concerns are wind and water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need

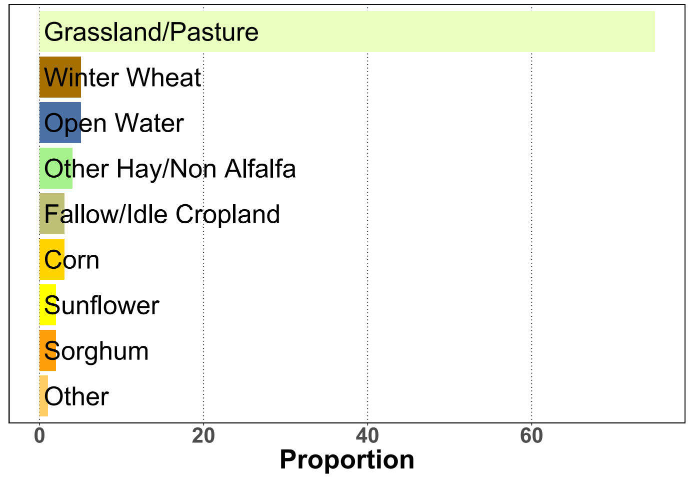

Figure 63A-2: Relative proportions (percentages) of land use in MLRA 63A.

for summer fallow tillage), cover crops, windbreaks, vegetative wind barriers, stripcropping, and nutrient management.

The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Cool-season tame pastures are established to supplement forage production. Haying commonly provides feed during winter.

63B—Southern Rolling Pierre Shale Plains

This MLRA (fig. 63B-1) is characterized by soils with a high clay content and high shrink-swell potential on a landscape that transitions from steep, dissected river breaks along the major rivers to rolling upland plains. It is primarily in South Dakota (82 percent) but also is in Nebraska (18 percent). This area makes up about 4,385 square miles (11,357 square kilometers).

MLRA 63B has a gradual boundary with MLRAs to the north and west and a distinct boundary with MLRAs to the south and east. The Missouri River breaks create a distinct boundary to the east where MLRA 63B meets MLRAs 53C (Southern Dark Brown Glaciated Plains) and 55C (Southern Black Glaciated Plains). Unlike MLRA 63B, MLRAs 55C and 53C were glaciated. A distinct change in geology from shale to sandstone and siltstone characterizes the boundary with MLRAs 64 (Mixed Sandy and Silty Tableland and Badlands) and 66 (Dakota-Nebraska Eroded Tableland). In addition, MLRA 64 is in the aridic ustic soil moisture regime while MLRA 63B is in the typic ustic soil moisture regime. The Niobrara River valley creates a distinct boundary between MLRAs 63B and 66 in north-central Nebraska even though the different geologies intermingle along the river in places. The boundary is gradual and less apparent where MLRA 63B transitions to MLRA 63A (Northern Rolling Pierre Shale Plains). MLRA 63A is slightly drier and cooler and has fewer trees and shrubs in draws.

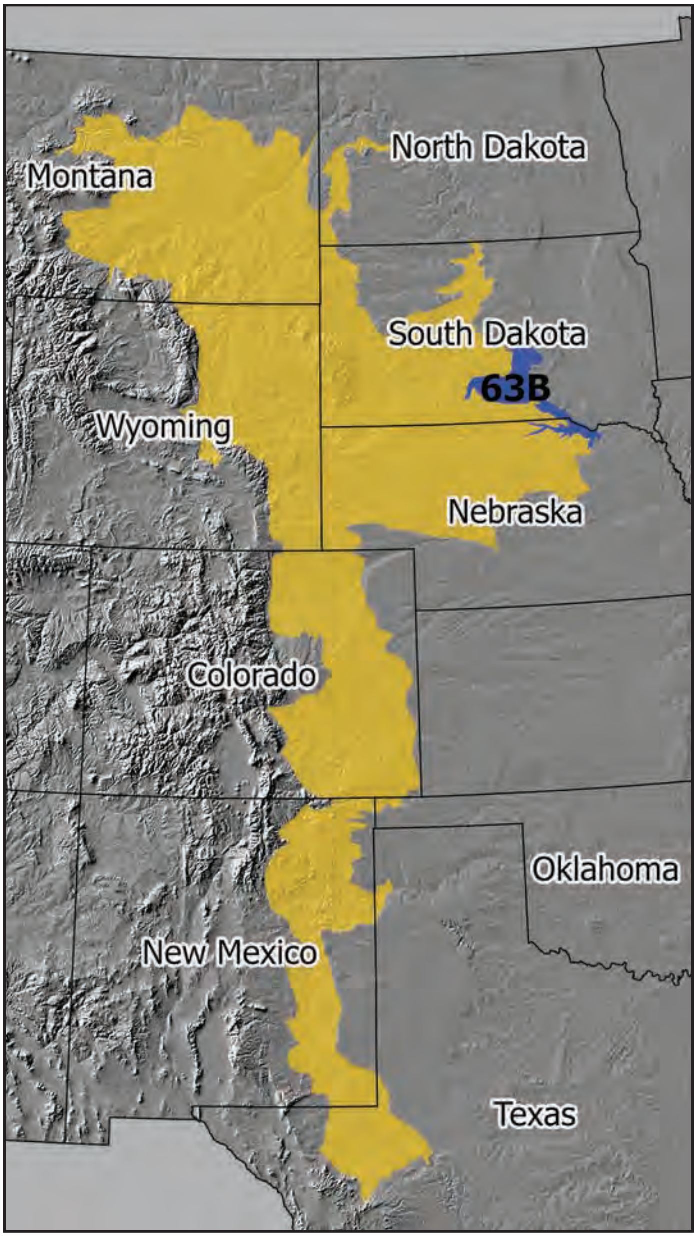

Figure 63B-1: Location of MLRA 63B, which covers 1,135,700 hectares (2,806,200 acres), within Region G.

Physiography

This area is mainly in three different sections of the Great Plains province of the Interior Plains. Most of the area is in the Missouri Plateau, unglaciated, section. This part of the MLRA is an area of old plateaus and terraces that have been deeply eroded. It is nearly level to rolling and has long, smooth slopes and a well defined dendritic drainage system. River and creek valleys have smooth floors and steep walls. The northeast corner of the MLRA, east of the Missouri River, is in the Missouri Plateau, glaciated, section, and the southwest tip is in the High Plains section. The glaciated section is very similar to the unglaciated section. Some of the higher areas have deposits of glacial drift. The topography of the High Plains section is typified by nearly level and broad intervalley remnants of smooth fluvial plains. The southeast tip of the MLRA is in the Dissected Till Plains section of the Central Lowland province of the Interior Plains. The topography is very similar to that of the Missouri Plateau, glaciated, section, but the original surface is a till plain rather than an old plateau.

Elevation ranges from 1,310 to 1,640 feet (400 to 500 meters) on the bottom land along the Missouri River and from 1,310 to 2,540 feet (400 to 770 meters) on the shale plain uplands. Areas that are cropped are mainly at an elevation of about 1,640 feet (500 meters).

The Missouri River and the breaks along it are in this MLRA. The river runs through the north part of the MLRA and then along the eastern edge. The confluence of the White and Missouri Rivers is in this area. The lower reach of the Niobrara River, in Nebraska, also is in this area. Lake Francis Case, Fort Randall Dam, and Lewis and Clark Lake are in this MLRA. Lewis and Clark Lake formed behind Gavins Point Dam, which is outside this MLRA, in an area near Yankton, South Dakota. Gavins Point Dam is the last and farthest downstream of the five main-stem dams on the Missouri River.

Geology

Cretaceous Pierre Shale underlies most of this area. It is a marine sediment with layers of volcanic ash that have been altered to smectitic clays. These clays shrink as they dry and swell as they become wet, causing significant hazards for road and structural foundations. The younger Niobrara Chalk is in the southern part of this area. Some glacial drift remnants are in the northeast corner of the area, east of the Missouri River. Alluvial sand and gravel underlie the valley floors along the major streams.

Climate

The average annual precipitation is 119 to 27 inches (480 to 690 millimeters). Most of the precipitation falls during the growing season as frontal storms in spring and as high-intensity, convective thunderstorms in summer. Precipitation in winter occurs mostly as snow. The annual snowfall is typically 16 to 46 inches (40 to 115 centimeters). The average annual temperature is 44 to 50 degrees F (7 to 10 degrees C). The freeze-free period averages 155 days and ranges from 135 to 165 days.

Water

In most years precipitation is inadequate for maximum plant growth. Some irrigated land is along the Missouri River and on the flood plain along the White River. The water in the Missouri River generally is of good quality. It is a sodium-bicarbonate type and soft. High loads of suspended sediments cause water-quality problems in the White River and in some of the smaller tributaries to the Missouri River.

There are few shallow water developments in this area, and most of the water for livestock comes from surface runoff that flows into dams or from deep artesian flows from wells finished in Dakota sandstone. Because of high amounts of dissolved solids, mostly sodium, chloride, and sulfate, the well water is slightly saline or moderately saline. It is very hard and suitable only for watering livestock. Rural water systems are improving the quality of water available for domestic use. The Missouri River is the source of water for these systems.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly have a mesic temperature regime, an ustic moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey.

The main soils and their series:

- Argiustolls that formed in loess or other silty sediments on uplands and stream terraces (Bazile and Reliance series)
- Calciustepts that formed in residuum on uplands (Lakoma series)
- Epiaquerts that are poorly drained and formed in upland depressions (Kolls series)
- Haplustepts that formed in residuum on uplands (Labu series)
- Haplusterts that formed in clayey sediments weathered from clayey shale on uplands (Millboro and Promise series)
- Ustorthents that formed in clayey shale residuum on uplands and river breaks (Okaton and Sansarc series)

Biological Resources

The vegetation is a transition between tall prairie grasses and mixed prairie grasses. Green needlegrass, porcupinegrass, and big bluestem are the major species. Little bluestem, buffalograss, sideoats grama, and sedges are dominant on the shallow soils. Buffaloberry, skunkbush sumac, and prairie rose are common on steep slopes along the major streams. Prairie cottonwood and a variety of willow species are common on flood plains along the major streams. Green ash, boxelder, chokecherry, bur oak, and buffaloberry occur in draws and narrow valleys. Major wildlife species include mule deer, coyote, bobcat, sharp-tailed grouse, magpie, mallard, gadwall, pintail, and blue-winged teal.

Land Use

Most of this area is in ranches or farms (fig. 63B-2). About three-fifths of the area is rangeland that is grazed primarily by livestock, and a little more than one-fourth is cropland. The major enterprise is cash-grain farming. Winter wheat and corn

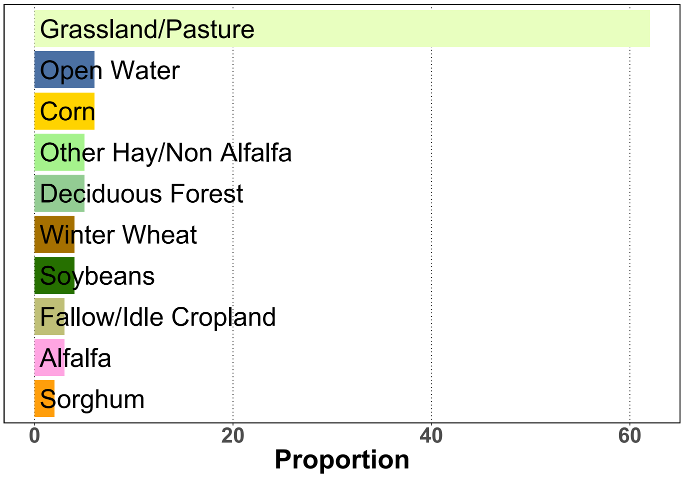

Figure 63B-2: Relative proportions (percentages) of land use in MLRA 63B.

are the main crops, with sunflowers, soybeans, and spring wheat grown to a lesser extent. In other parts of the area, the crops are grown mainly as feed and forage for livestock. Irrigated corn is grown where the supply of water is adequate and the soils are suitable.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for summer fallow tillage), cover crops, windbreaks, vegetative wind barriers, stripcropping, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Establishing cool-season, tame pastures helps to supplement forage production. Haying commonly provides supplemental feed during winter. Forest stand improvement and firebreaks reduce the hazard of wildfires on forestland and improve forest growth, quality, health, and productivity.

64—Mixed Sandy and Silty Tableland and Badlands

MLRA 64 (fig. 64-1) consists of the Badlands in its northeast part and tablelands with sandstone and siltstone bedrock in the other parts. The tablelands include the Pine Ridge escarpment. The Badlands and the Pine Ridge escarpment have many areas with steep topography while the rest of the tablelands are generally more level. Farming is common on the east side. This MLRA is in South Dakota (42 percent), Nebraska (41 percent), and Wyoming (17 percent). It makes up about 11,766 square miles (30,473 square kilometers).

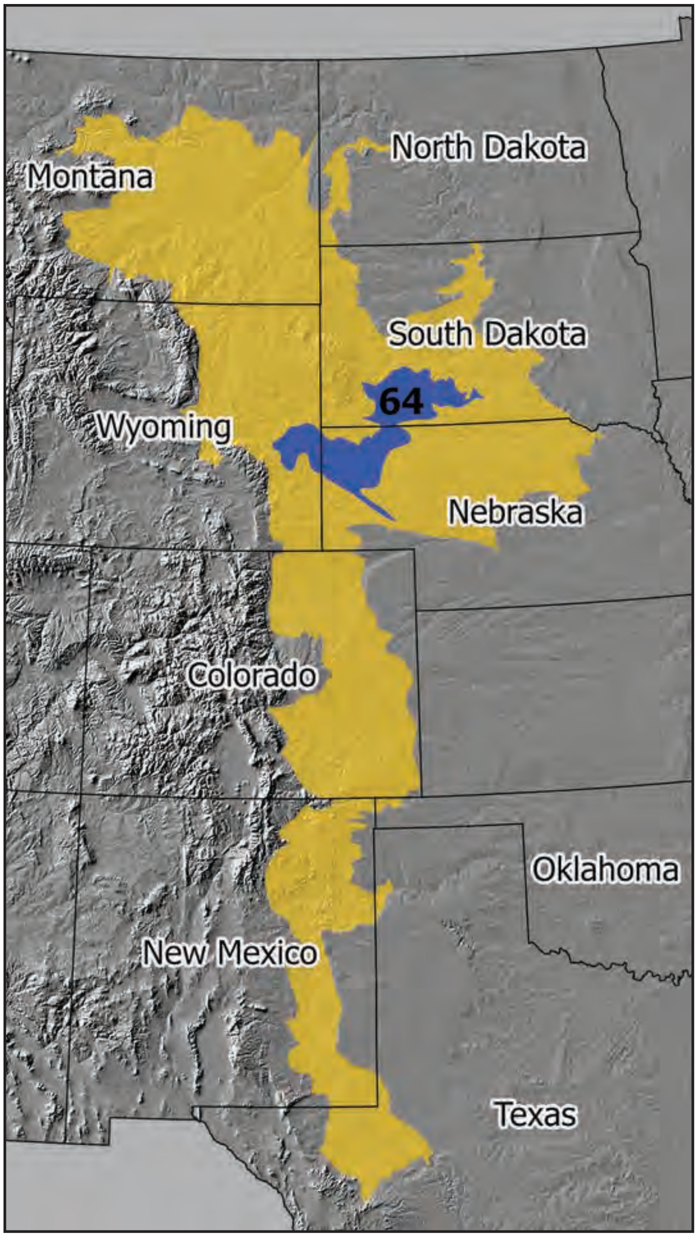

Figure 64-1: Location of MLRA 64, which covers 3,047,300 hectares (7,530,000 acres), within Region G.

MLRA 64 has a generally abrupt boundary with MLRAs 60A, 63A, and 65. MLRA 60A borders the Badlands but is typically not as steep. It has mostly clayey shale bedrock. MLRA 63A also has mostly clayey shale bedrock. It is typically not as steep as the Badlands, receives more rainfall, and is commonly used for farming. MLRA 66 has more limestone and shaly chalk bedrock than MLRA 64. It receives more rainfall and is commonly used for farming. MLRA 65, which consists of the Sand Hills, has commonly dune-shaped topography. It receives more rainfall than MLRA 64 and is used for rangeland and hayland.

Physiography

The northern half of this MLRA is in the Missouri Plateau, unglaciated, section of the Great Plains province of the Interior Plains. This part of the MLRA is an area of old plateaus and terraces that have been deeply eroded. The southern half of the MLRA is in the High Plains section of the same province and division. The topography in this part of the MLRA is typified by nearly level and broad intervalley remnants of smooth fluvial plains. The Pine Ridge escarpment separates the two areas. The area north of the escarpment is strongly sloping but becomes less sloping as distance from the escarpment increases. Local relief is generally less than 30 feet (9 meters). In the Pine Ridge and Badlands regions, however, relief is 100 to 300 feet (30 to 90 meters), and the bottom land along the Niobrara River is 100 to 200 feet (30 to 60 meters) below the surrounding hills and escarpments. Elevation ranges from 2,950 to 3,940 feet (900 to 1,200 meters), increasing gradually from east to west. It is highest on a nearly level to gently sloping tableland south of the narrow, steep-walled valleys near Pine Ridge. The Badlands consist of eroded walls and escarpments, small grass-covered tablelands and mesas, and basins that have scattered eroded buttes. Slopes range from nearly level to very steep. Many streams and gullies cut the Badlands.

The headwaters of the White and Niobrara Rivers are in the part of this MLRA in northwestern Nebraska. The White River is the main drainage through Badlands National Park. Tributaries to the White River carved the Badlands in the northwest corner of the MLRA.

Geology

Tertiary continental sediments consisting of sandstone, siltstone, and claystone underlie most of this area. Locally, these units are called the Ogallala Group and Arikaree Group. Many of the bedrock units in the southern third of the area are covered by loess. Sand, silt, and clay alluvium is under the valley floors of the major drainages. The Pine Ridge escarpment marks the northern extent of the Ogallala aquifer. This is the most extensive and heavily used aquifer on the high plains between the Rocky Mountains and the Mississippi River. The Badlands consist of stream-laid layers of silt, clay, and sand mixed with layers of volcanic ash. They are internationally famous for their Oligocene fossil assemblages.

Climate

The average annual precipitation is 13 to 21 inches (330 to 530 millimeters). Most of the rainfall occurs during frontal storms in spring and early summer. Some high-intensity, convective thunderstorms occur in late summer. Precipitation in winter occurs as snow. Much of this area receives about 35 inches (90 centimeters) of snow annually, but the snow seldom covers the ground for more than a week at a time. The average annual temperature is 44 to 49 degrees F (7 to 10 degrees C).

The freeze-free period averages about 140 days and ranges from 120 to 160 days.

Water

Most of the area depends on the rather low and erratic precipitation for water. Some surface water for irrigation is obtained from the Niobrara and White Rivers in Nebraska. This water is of good quality. It contains less total dissolved solids than the local ground water. It is a sodium-bicarbonate type and hard or very hard.

Ground water is scarce and of poor quality in most of the area. Locally, mainly south of Pine Ridge and in Nebraska, underground sand and gravel in the Ogallala and Arikaree Formations yield moderate to large quantities of good-quality water. This water is the least mineralized ground water in South Dakota but is still hard or very hard. Selenium concentrations from the underlying Pierre Shale can exceed the drinking water standards. Water for all uses is pumped from the Arikaree Formation in Nebraska. This water is less mineralized than that in South Dakota and not as hard. It is a sodium-bicarbonate type and does not contain selenium.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a mesic temperature regime, an ustic or aridic moisture regime, and mixed mineralogy. They are shallow to very deep, generally well drained or somewhat excessively drained, and loamy or sandy.

The main soils and their series:

- Argiustolls that formed in loess and residuum on uplands (Alliance, Hemingford, and Rosebud series)
- Haplustepts that formed in sodium-rich alluvial deposits and residuum in the Badlands (Cedarpass series)
- Haplustolls that formed in residuum on uplands (Busher, Oglala, and Ponderosa series); that formed in alluvium and eolian deposits on alluvial fans, stream terraces, and hills (Jayem and Vetal series)
- Ustifluvents that formed in sodium-rich alluvial deposits and residuum in the Badlands (Interior series)
- Ustipsamments that formed in sandy eolian sediments on dunes (Dankworth series)
- Ustorthents that formed in residuum on uplands (Fairburn and Mittenbutte series)

Biological Resources

This area supports a mixture of short, mid, and tall grasses. Blue grama, western wheatgrass, threadleaf sedge, sideoats grama, little bluestem, prairie sandreed, switchgrass, sand bluestem, and needle and thread are the major species. On Pine Ridge, these plants grow in association with ponderosa pine, eastern redcedar, western snowberry, skunkbush sumac, common chokecherry, and rose. This area has numerous woody draws, which support such species as green ash, boxelder, hackberry, chokecherry, bur oak, buffaloberry, and green muhly. The eroded walls and escarpments of the Badlands are devoid of vegetation.

Major wildlife species include mule deer, white-tailed deer, pronghorn antelope, coyote, beaver, raccoon, skunk, turkey, opossum, muskrat, mink, jackrabbit, cottontail, weasel, prairie dog, prairie grouse, mourning dove, meadowlark, and lark bunting.

Land Use

Most of the MLRA is in ranches or farms (fig. 64-2). More than three-fifths of the area is rangeland that is grazed primarily by livestock. Scenic Pine Ridge has grassed areas and pine trees of commercial value. About 20 percent of the area is cropland. South of Pine Ridge, the major enterprise is cash-grain farming and the main crop is winter wheat. In other parts of the area, the crops are grown mainly as feed and forage for livestock. Irrigated corn and sugar beets are grown where the supply of water is adequate and the soils are suitable.

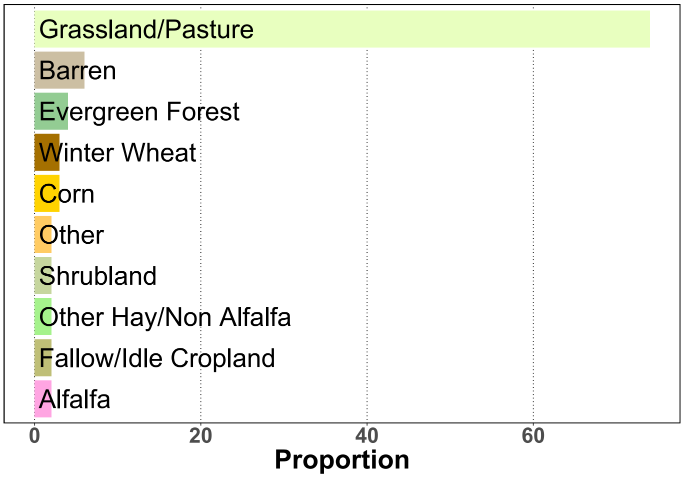

Figure 64-2: Relative proportions (percentages) of land use in MLRA 64.

The main resource concerns are wind and water erosion and the quality of surface water. Wind erosion and water erosion are hazards on cropland and hayland and in areas of pasture and rangeland where the plant cover is depleted by overgrazing. Additional soil resource concerns are maintenance of the content of soil organic matter and tilth and soil moisture management.

Important conservation practices for cropland are cropping systems that include high-residue crops, systems of crop residue management (such as no-till and mulch-till), level terraces, contour farming, contour stripcropping, irrigation water management, and nutrient management. The most important conservation practice for rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Establishing cool-season, tame pastures helps to supplement forage production. Haying commonly provides supplemental feed during winter. Forest stand improvement and firebreaks reduce the hazard of wildfires on forestland and improve forest growth, quality, health, and productivity.

65—Nebraska Sand Hills

MLRA 65 (fig. 65-1) is clearly defined by the 8,000-year-old landscape of sandhills. Its dominant landforms are dunes, sand sheets, and interdunes. It is the largest sand dune area in the Western Hemisphere and is one of the largest grass-stabilized dune regions in the world. The soils are principally derived from deep eolian sand. This area is in Nebraska (98 percent) and South Dakota (2 percent). It makes up about 20,625 square miles (53,420 square kilometers).

MLRA 65 is bordered by the dominantly drier tablelands of MLRA 64 (to the west), by the tablelands of MLRAs 64 and 66 (to the north), by the moister uplands of MLRA 102C (to the east), and by the tablelands, rolling plains, and loess hills of MLRAs 71, 72, and 73 (to the south).

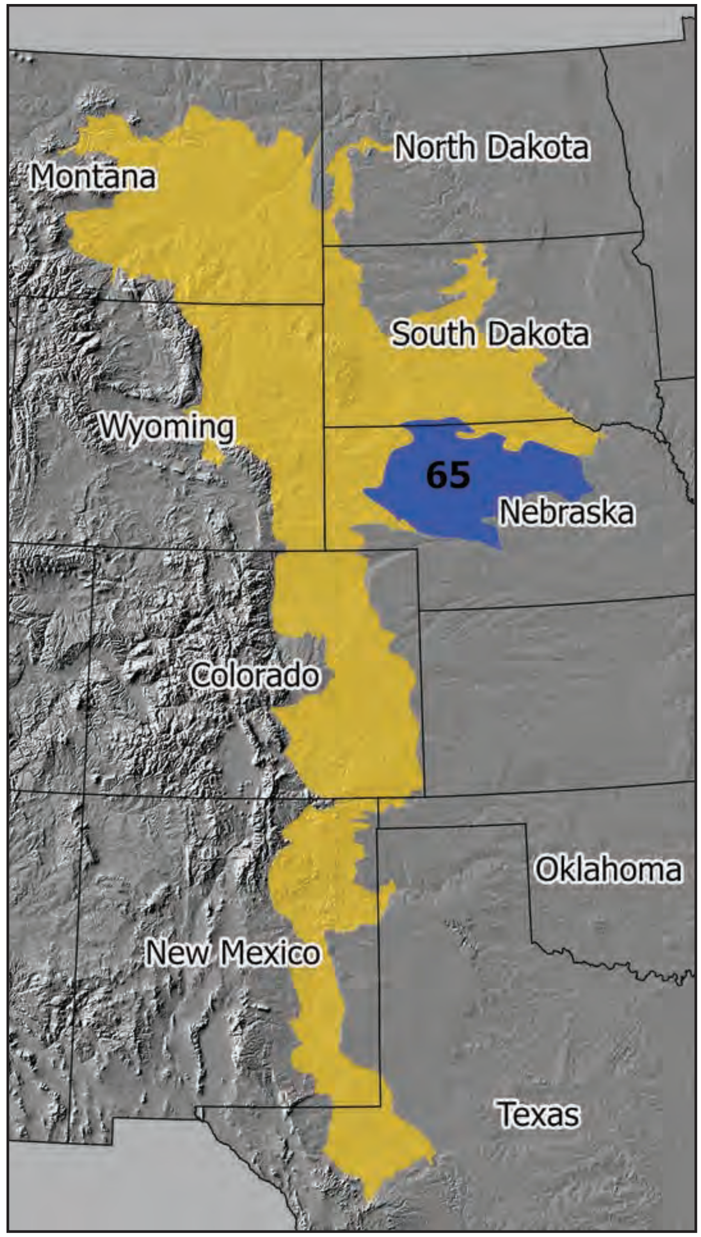

Figure 65-1: Location of MLRA 65, which covers 5,342,000 hectares (13,200,400 acres), within Region G.

Physiography

This area is in the High Plains section of the Great Plains province of the Interior Plains. Elevation ranges from 1,840 to 4,400 feet (560 to 1,340 meters), increasing gradually from east to west. Most of the area occurs as rolling to steep, irregular sand dunes stabilized by grasses and as narrow, elongated, nearly level to gently sloping valleys between the sand dunes. The height of the dunes ranges from 10 to 400 feet (3 to 120 meters). The dunes and narrow valleys commonly extend for several miles in a northwest-southeast direction. Many small depressions are in scattered areas. The MLRA has few streams but many small permanent and intermittent lakes.

The Niobrara River is near the northern boundary of the MLRA. The North Platte River runs along the southwest edge of the area. The North and Middle Loup Rivers and the Calamus, Snake, and Dismal Rivers are in the central and eastern parts of the area.

Geology

This area consists of Quaternary sand dunes. The sands are derived from the underlying Tertiary Ogallala and Arikaree Groups. These units formed when rivers deposited sediments that originated as erosional detritus following the uplift of the Rocky Mountains to the west. The Ogallala aquifer underlies the MLRA. It is the most extensive and heavily used aquifer on the high plains between the Rocky Mountains and the Mississippi River.

Climate

The average annual precipitation is 15 to 27 inches (390 to 690 millimeters). About three-fourths of the precipitation falls from midspring to midautumn. The rainfall occurs during frontal storms in spring and early summer and high-intensity, convective thunderstorms in late summer. Precipitation in winter occurs as snow. The average annual temperature is 46 to 50 degrees F (8 to 10 degrees C). The freeze-free period averages 145 days and ranges from 135 to 165 days.

Water

Precipitation is the source of water for range vegetation. The many small lakes and ponds and a few streams provide water for livestock, some irrigation, and domestic use. The surface water is of excellent quality and is suitable for all uses.

The Sand Hills are a primary recharge area for the Ogallala aquifer. Ground water from the Ogallala aquifer is abundant and of good quality. It is a calcium-bicarbonate type and very hard. Because of the abundance of surface water available for livestock and domestic use, the ground water is used primarily for irrigation in the flatter areas.

Soils

The dominant soil orders in this MLRA are Entisols and Mollisols. The soils in the area dominantly have a mesic temperature regime, an ustic or aridic moisture regime, and mixed mineralogy. They generally are very deep, excessively drained to somewhat poorly drained, and sandy.

The main soils and their series:

Haplustolls that formed in sandy eolian material in areas between dunes and on stream terraces (Dailey and Dunday series); that formed in a mixture of sandy eolian material and sandy alluvial material in swales and on stream terraces (Elsmere series)

Ustipsamments that formed in sandy eolian material on dunes (Valentine series); that formed in a mixture of sandy eolian material and sandy alluvial material on hummocks and terraces (Ipage series); that formed in a mixture of sandy eolian material and sandy alluvial material in swales (Els series)

Biological Resources

This area supports mid and tall grasses. Little bluestem, sand bluestem, prairie sandreed, switchgrass, Indiangrass, sand lovegrass, and needle and thread are the major species on uplands. Big bluestem, switchgrass, Indiangrass, prairie cordgrass, and various sedges and rushes grow on soils that have a high water table.

Major wildlife species include white-tailed deer, mule deer, pronghorn antelope, black-tailed jackrabbit, coyote, upland sandpiper, western meadowlark, sharp-tailed grouse, and greater prairie chicken. Fish species include sunfish, drum, minnow, catfish, perch, bluegill, and carp.

Land Use

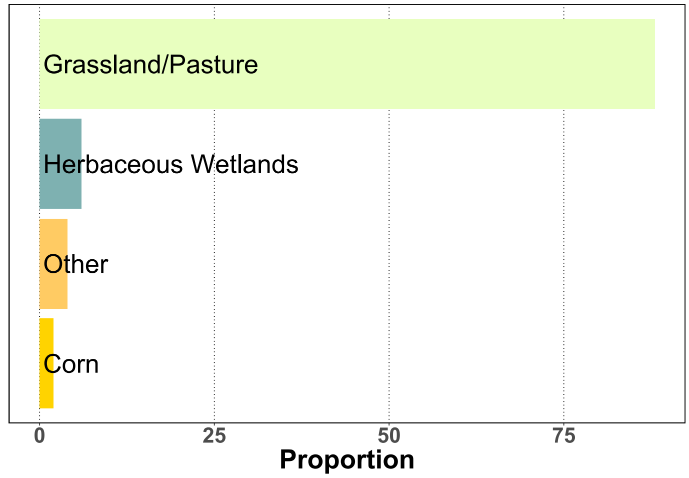

Figure 65-2: Relative proportions (percentages) of land use in MLRA 65.

More than nine-tenths of this area is in large ranches, most of which support native grasses grazed by livestock (fig. 65-2). Tracts along streams and in subirrigated valleys are used mainly for hay. The rolling hills and dry valleys are grazed. Use of sprinkler irrigation has increased in recent years. Corn is the principal irrigated crop.

The major soil resource concern on rangeland is wind erosion where the plant cover has been depleted by overgrazing. The major soil resource concerns on cropland are wind erosion, maintenance of the content of soil organic matter and tilth, and soil moisture management.

Conservation practices on rangeland generally include proper range management and improvement practices, such as proper grazing use, deferment or rest periods, planned grazing systems, range seeding or interseeding, and weed control. The important conservation practices on cropland are cropping systems that include high-residue crops, systems of crop residue management (such as no-till and mulch-till), irrigation water management, and nutrient management.

66—Dakota-Nebraska Eroded Tableland

This MLRA (fig. 66-1) is characterized by loamy and sandy soils that formed from residuum, alluvial sediments, or eolian sediments weathered from the sandstone of the Valentine or Ash Hollow Formations in the Ogallala Group. The landscape is an undulating to rolling tableland with steeper, dissected areas along the bigger rivers and creeks. This MLRA is in Nebraska (56 percent) and South Dakota (44 percent). It makes up about 5,684 square miles (14,722 square kilometers).

MLRA 66 has a gradual boundary to the west and a distinct boundary to the north, east, and south. The change in geology from sandstone to shale and the Niobrara River valley create a distinct boundary between MLRAs 66 and 63B (Southern Rolling Pierre Shale Plains), although the geologies intermingle along the river. The boundary between MLRAs 66 and 65 (Nebraska Sand Hills) is distinct as the landscape changes to the Sand Hills. The boundary between MLRAs 66 and 102C (Loess Uplands) is distinct as geology changes from sandstone to silty loess. The boundary between MLRAs 66 and 64 (Mixed Sandy

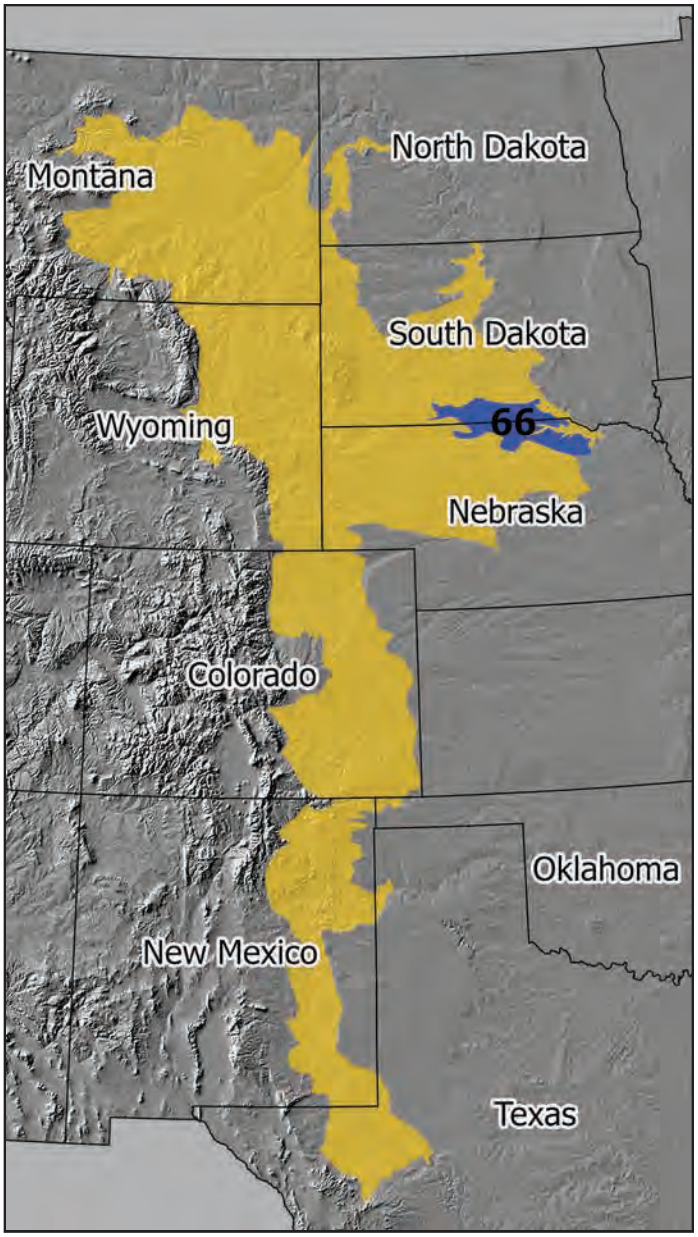

Figure 66-1: Location of MLRA 66, which covers 1,472,200 hectares (3,637,800 acres), within Region G.

and Silty Tableland and Badlands) is gradual and less apparent as the soil moisture regime transitions from typic ustic to aridic ustic.

Physiography

The northern half of this MLRA is in the Missouri Plateau, unglaciated, section of the Great Plains province of the Interior Plains. The southern half is in the High Plains section of the same division and province. This MLRA is part of the fluvial plain that built up to the east as the Rocky Mountains eroded. Broad intervalley remnants of that smooth fluvial plain dominate the area. Some terraces and river breaks and local badlands are along the major drainages. Elevation ranges from 1,360 to 3,340 feet (410 to 1,020 meters). The higher parts of the tableland are nearly level to moderately sloping. Steeper areas are on the sides of ridges and drainages. Stream valleys are well defined, except in some undulating areas where sandy eolian material mantles the bedrock. The Keya Paha, Elkhorn, and Niobrara Rivers flow through this area.

Geology

The Cretaceous Niobrara Formation underlies most of this area. It is made up of layers of marine sediments, mostly shaly chalk and limestone. Some eolian deposits are on the surface in the western and southern parts of the area. Alluvial sand and gravel underlie the valley floors along the major streams.

Climate

The average annual precipitation is 19 to 27 inches (490 to 700 millimeters). Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Precipitation in winter occurs mainly as snow. The annual snowfall ranges from about 24 to 40 inches (610 to 1,015 millimeters). Summers are hot, and winters are cold. The average annual temperature is 47 to 49 degrees F (8 to 10 degrees C). The freeze-free period averages 150 days and ranges from 140 to 165 days.

Water

Because of the limited amount of precipitation, farming is difficult and maximum crop production is not expected in most years. Most of the soils are deficient in moisture during much of the latter part of the growing season. The surface water is of good quality. It is a calcium-magnesium-bicarbonate type and very hard. The Niobrara River, the only perennial stream in the area, provides water for irrigation, livestock, domestic uses, and public supply.

Throughout most of the area, shallow water is available in quantities sufficient for livestock and domestic uses. Most of the shallow water is from sand and gravel deposits in drainages. The Niobrara Formation supplies ground water for irrigation, livestock, and domestic uses. This unit typically is considered an aquifer only where solution channels and fractures have opened the rock. The ground water is a calcium-bicarbonate type and very hard.

Soils

The dominant soil orders in this MLRA are Entisols and Mollisols. The soils in this area dominantly have a mesic temperature regime, an ustic or aridic moisture regime, and mixed mineralogy. They are generally very deep, well drained to excessively drained, and loamy or sandy.

The main soils and their series:

- Argiustolls that formed in loamy sediments over alluvium on uplands (Jansen series)
- Haplustolls that formed in eolian sediments (Anselmo and Dunday series) and loamy over sandy sediments (Meadin, O'Neill, and Pivot series) on stream terraces, on uplands, and in valleys
- Ustipsamments that formed in sandy eolian material on dunes (Valentine series)

Biological Resources

This area supports mixed prairie vegetation. Little bluestem, prairie sandreed, green needlegrass, and needle and thread are the dominant species. Sideoats grama and plains muhly are important species on shallow soils. Leadplant and prairie rose grow on the sides of draws. Hackberry and green ash grow in draws in some areas. Major wildlife species include mule deer, white-tailed deer, coyote, beaver, raccoon, opossum, muskrat, mink, tree squirrel, prairie dog, turkey, pheasant, prairie grouse, meadowlark, lark bunting, bobwhite quail, and mourning dove.

Land Use

Most of this area supports native grasses and is grazed by cattle (fig. 66-2). Some of the smoother areas are used for crops, mainly corn and soybeans, forage and grain sorghum, and alfalfa for livestock feed. Winter wheat is grown as a cash crop in a few areas.

The major soil resource concerns on cropland and hayland are wind and water erosion, maintenance of the content of soil organic matter and tilth, and soil moisture management. The major soil resource concerns on pasture and rangeland are wind and water erosion where the plant cover has been depleted by overgrazing. The quality of surface water is also a major resource concern.

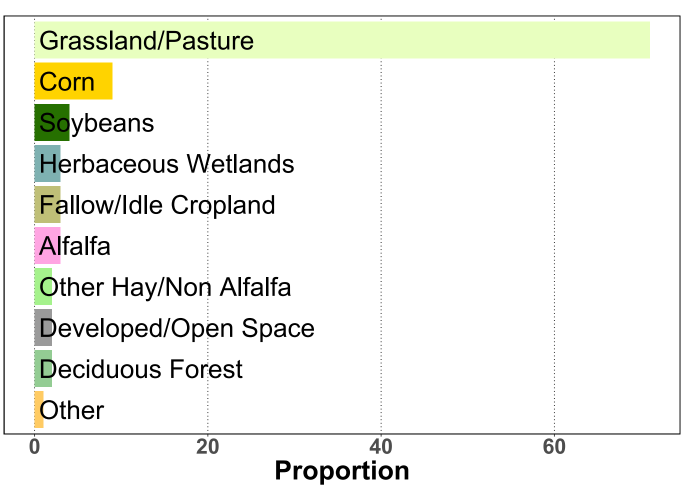

Figure 66-2: Relative proportions (percentages) of land use in MLRA 66.

The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Establishing cool-season, tame pastures helps to supplement forage production. The most important conservation practices on cropland are cropping systems that include high-residue crops, systems of crop residue management (such as no-till and mulch-till), level terraces, contour farming, contour stripcropping, irrigation water management, and nutrient management.

67A—Central High Plains, Northern Part

This MLRA (fig. 67A-1) is defined by a semiarid climate with cool temperatures and a short growing season. It is on dissected high plains and siltstone breaks of southeastern Wyoming and western Nebraska. A large extent is influenced by siltstone residuum, although the MLRA also has areas of eolian deposits and alluvium throughout. This MLRA is in Wyoming (58 percent), Nebraska (38 percent), and Colorado (4 percent). It makes up about 9,848 square miles (25,505 square kilometers).

The northern boundary of MLRA 67A is very distinct and marked by the North Platte River. The river separates MLRA 76A from both the silty tablelands and badlands of MLRA 64 and the sandhills of MLRA 65. The western boundary is also very distinct, located where the high plains meet the foothills (in MLRA 49) of the Southern Rocky Mountains. The southern boundary is very distinct, located where the calcareous siltstone escarpments drop off to MLRA 67B. The eastern boundary is very gradual. It is not apparent on the ground and largely based on increases in mean annual precipitation eastward into MLRA 72.

Physiography

This MLRA occurs primarily in the High Plains section of the Great Plains province of the Interior Plains. The higher parts of the tableland are nearly level to moderately sloping, but areas are steeper on the sides of ridges and drainageways. Drainages are well defined, except in some undulating areas where sandy eolian material mantles the bedrock. In most of the MLRA, elevation ranges from 3,270 to 5,960 feet (990 to 1,810 meters). In some areas, it is as high as 7,400 feet (2,255 meters). Parts of the North Platte and Laramie Rivers are in this MLRA.

Geology

This MLRA is dominated by residual geologic materials. Large areas of eolian and alluvial deposits, however, occur in some parts. Sandstone and conglomerate are the dominant rock types. The Tertiary White River and the Upper Miocene and

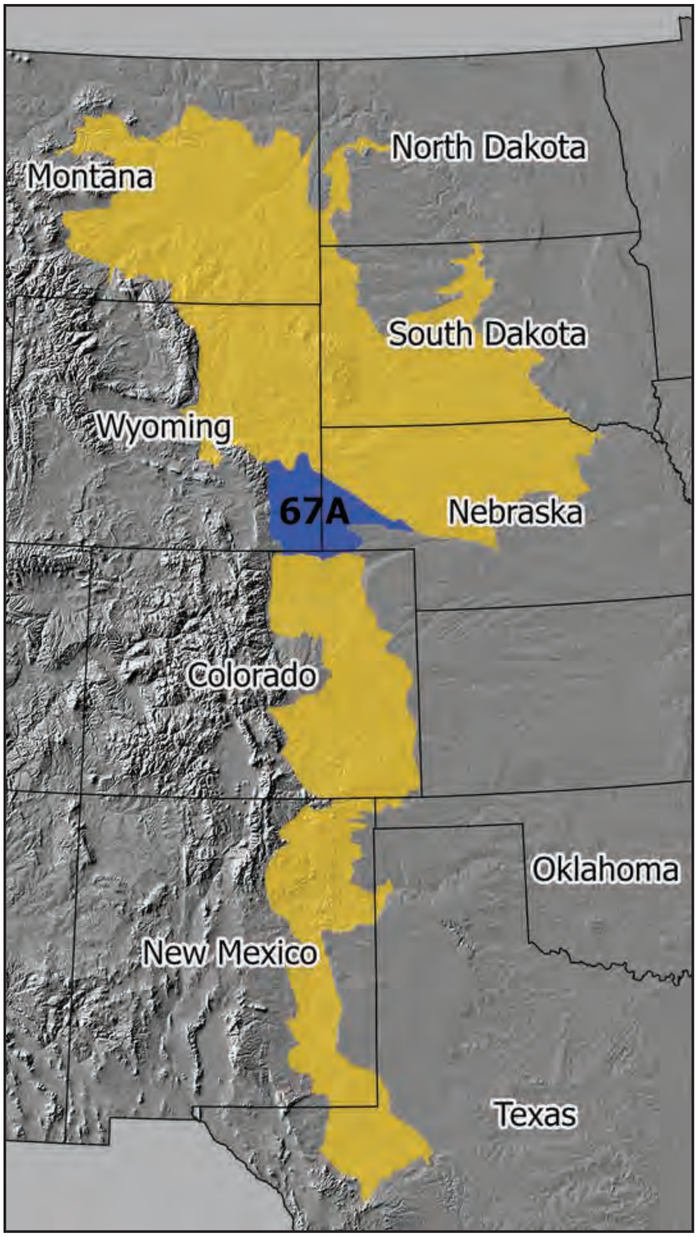

Figure 67A-1: Location of MLRA 67A, which covers 2,550,500 hectares (6,302,500 acres), within Region G.

Lower Miocene rock formations are dominant in the MLRA. The Cretaceous Lance Formation occurs as small areas in the western part the MLRA. Quaternary alluvial and eolian deposits and gravel pediments occur in some areas.

Climate

The average annual precipitation ranges from 13 to 19 inches (330 to 500 millimeters). Much of the precipitation occurs as rain during convective thunderstorms in the period April through July. The driest period is usually November through February. The average annual temperature ranges from 43 to 50 degrees F (6 to 10 degrees C). The freeze-free period averages 135 days and ranges from 125 to 160 days.

Water

The low and erratic precipitation provides water for range vegetation and dryfarming. Irrigation water is obtained mostly from reservoirs on the North Platte River and its tributaries. The surface water is of good quality and has few limitations affecting its use.

This area includes all four of the principal aquifer types in Wyoming. Most of the ground water is pumped from the alluvial aquifer along the North Platte River and its tributaries and from the High Plains (Ogallala) aquifer. These unconsolidated and consolidated sand and gravel aquifers yield adequate quantities of ground water for livestock and domestic use, some irrigation, and other uses. Water from the alluvial aquifer is the hardest water in Wyoming. Wells in the High Plains aquifer provide high yields of water. The water from both aquifers is hard. Where shale bedrock is near the surface, ground water is scarce and commonly of poor quality. The structural basin and sandstone and carbonate bedrock aquifers also occur in this MLRA but are not used because of the readily available water in the shallow aquifers.

Soils

The most extensive and representative great groups in this MLRA include Argiustolls, Haplargids, Haplustolls, and Torriorthents. The dominant soil orders are Mollisols and Entisols. The soils in the area dominantly have a mesic temperature regime, an ustic moisture regime, and mixed mineralogy. They are shallow to very deep, generally well drained, and sandy or loamy. Most of the soils are calcareous.

The main soils and their series:

- Argiustolls that formed in alluvium along the major rivers (Ascalon and Altvan series)
- Haplargids that formed in alluvium, eolian sediments, or residuum derived from sedimentary rocks on hills, pediments, and ridges (Bowbac series); that formed in residuum and colluvium on hills and ridges (Worf series)
- Haplustolls that formed in residuum derived from sandstone on ridges and hillslopes (Treon series); that formed in sandy alluvium and eolian deposits on alluvial fans, stream terraces, and hillslopes (Vetal series)
- Torriorthents that formed in alluvium and eolian sediments on ridges, hillslopes, and benches (Keeline and Turnercrest series); that formed in residuum on hills and ridges (Tassel series)

Biological Resources

This area supports cool- and warm-season grassland vegetation. Rhizomatous wheatgrasses, needle and thread, and blue grama are the dominant species on deep soils.

Rhizomatous wheatgrasses, little bluestem, bluebunch wheatgrass, Indian ricegrass, and needle and thread are the major species on shallow soils on hills and ridges. Sandy soils have a plant community that includes prairie sandreed, sand bluestem, and sagebrush. A few areas of shallow soils on steep escarpments have a plant community that includes Rocky Mountain juniper or ponderosa pine, or both. Basin wildrye, green needlegrass, big bluestem, rhizomatous wheatgrasses, and shrubs are dominant on the bottom land along streams and rivers.

Major wildlife species include deer, antelope, coyote, beaver, muskrat, jackrabbit, cottontail rabbit, geese, ducks, and turkeys. Fish species include walleye, bass, catfish, and rainbow trout.

Land Use

Most of this area is grazed by cattle (fig. 67A-2). The rangeland is primarily warm- and cool-season prairie, but areas of shallow or sandy soils support shrubs. About 30 percent of the area is cropland. The main irrigated crops are corn, alfalfa, beans, and sugar beets. The main nonirrigated crop is winter wheat. The irrigated crops are grown where irrigation water is available from rivers or ground water sources. Nonirrigated small grain crops are grown in areas with level to moderately sloping soils that can store an adequate amount of soil moisture and receive an adequate amount of precipitation.

The major resource concerns are wind erosion and the quality of water in streams, rivers, and aquifers. The quantity of water for irrigating crops is a concern in some areas. The important conservation practices on cropland are those that reduce the hazard of wind erosion, improve the efficiency of irrigation water use, and protect ground water from contamination by leached nutrients and pesticides. The important conservation practices on rangeland are those that improve the health of the soil and plant communities and improve the distribution of livestock.

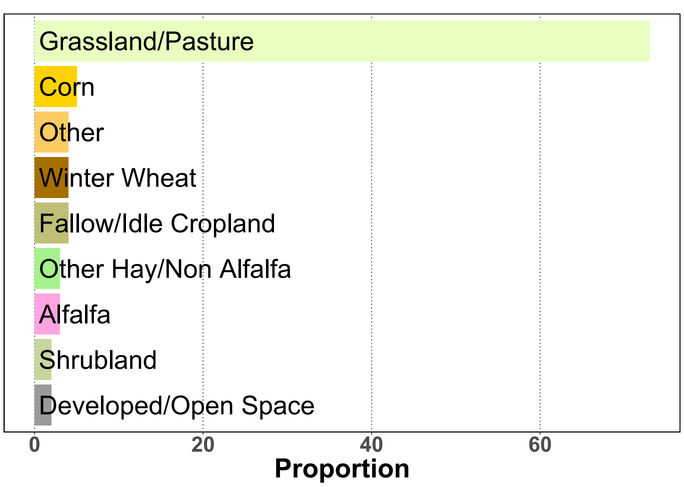

Figure 67A-2: Relative proportions (percentages) of land use in MLRA 67A.

67B—Central High Plains, Southern Part

MLRA 67B (fig. 67B-1) is defined by a semiarid climate on the dissected high plains of eastern Colorado. A large extent is influenced by eolian sand, although the MLRA also has areas of alluvium, loess, and sedimentary residuum of shale or sandstone throughout. Gas and oil fields are scattered throughout the MLRA, but the greatest concentration of these fields is in the Denver Basin area. The MLRA is entirely in Colorado and makes up about 19,665 square miles (50,933 square kilometers).

The northern boundary of MLRA 67B is very distinct and identifiable by the calcareous siltstone escarpments that lead

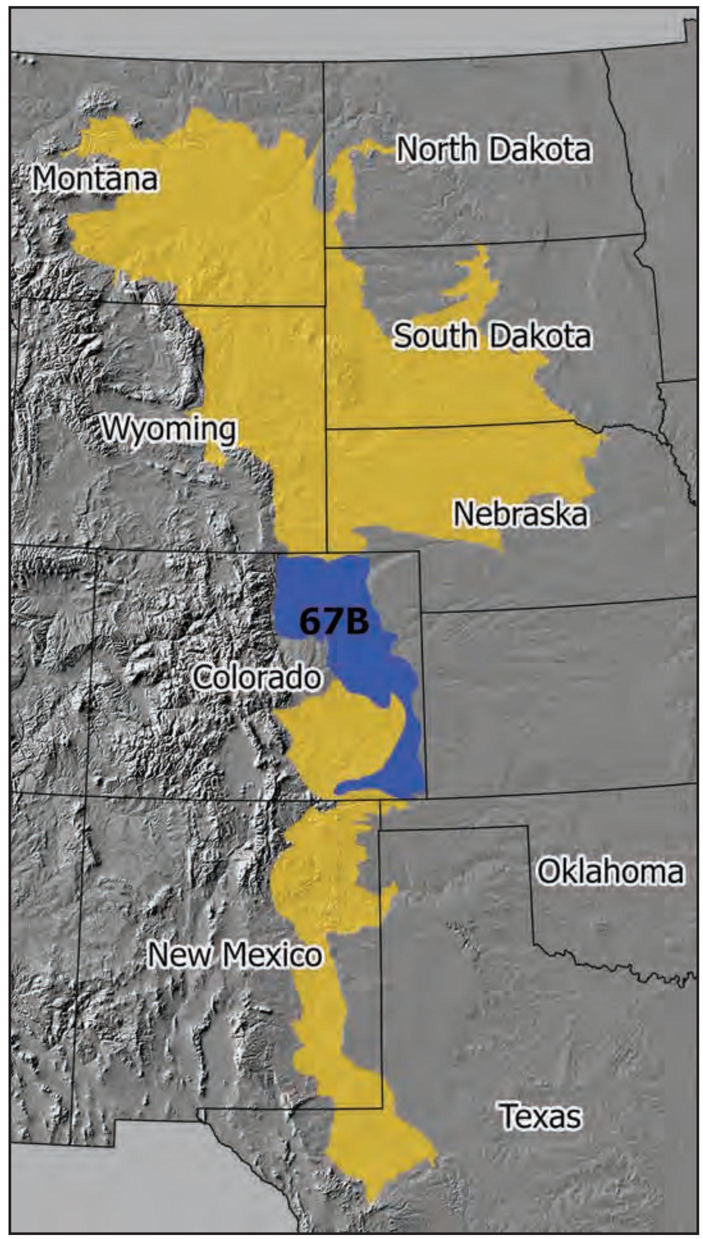

Figure 67B-1: Location of MLRA 67B, which covers 5,093,300 hectares (12,585,700 acres), within Region G.

into MLRA 67A. The western boundary is also very distinct, located where the high plains meet the foothills (in MLRA 49) of the Southern Rocky Mountains. The southern and southwestern boundary is distinct and identifiable by the much drier climate of MLRA 69, where dryland farming is very minimal or nonexistent. The eastern boundary is very gradual. It is not apparent on the ground and largely based on increases in mean annual precipitation eastward into MLRA 72.

Physiography

Most of this area is in the Colorado Piedmont section of the Great Plains province of the Interior Plains. The rest is in the Raton section of the same province and division. This MLRA is on an elevated, smooth to slightly irregular plain consisting of sediments deposited by rivers that drained the young and actively eroding Rocky Mountains. This old plain is now a dissected peneplain with a few dissected, lava-capped plateaus and buttes. Elevation ranges from 3,380 to 6,880 feet (1,030 to 2,090 meters), increasing gradually from east to west. In many areas the undulating to rolling shale plain is mantled by loess or windblown sand, alluvium, and outwash. Wide bands of steep slopes border several of the larger tributaries of the South Platte and Arkansas Rivers. Local relief is mostly less than 80 feet (25 meters) but is as much as 165 feet (50 meters) in some of the rough, broken areas. The South Platte and Arkansas Rivers bisect this MLRA as they flow east into Nebraska and Kansas.

Geology

Cretaceous and Quaternary sediments cover approximately equal surface areas in this MLRA. Rolling sandy plains and dune areas are throughout the MLRA. Eolian and alluvial deposits cover large areas of the South Platte River drainage. Cretaceous Pierre Shale is at the surface in much of the area north of the Arkansas River. The older Niobrara Chalk is exposed closer to the river, and the even older Dakota sandstone is exposed south of the river. Some scattered outcrops of Jurassic and Triassic sandstone, shale, and siltstone also are south of the Arkansas River. These units are commonly reddish. About half of the area is covered by river-laid continental sediments consisting of loose to well cemented sand and gravel with some silts and clays. Much of the Quaternary alluvium has been reworked into dunes and loess caps by the wind. The Tertiary Ogallala Formation occurs at the far eastern edges of this MLRA. Quaternary and more recent sand and gravel deposits cover the shale and chalk in the river valleys.

Climate

The average annual precipitation is 13 to 20 inches (320 to 510 millimeters), increasing from west to east. The amount of precipitation fluctuates widely from year to year. Rainfall occurs during frontal storms in spring and early summer and high-intensity, convective thunderstorms in late summer. The maximum precipitation occurs from midspring through late autumn. Precipitation in winter occurs as snow. The average annual temperature is 46 to 55 degrees F (7 to 13 degrees C). The freeze-free period averages 155 days and ranges from 130 to 180 days.

Water

Water for range vegetation and dryfarming is provided by the low and erratic precipitation. Irrigation water is obtained mostly from reservoirs on the South Platte River and its tributaries in the northern part of the MLRA and from the Arkansas River and its tributaries in the southern part. In the western part of the MLRA, the surface water is of good quality and has few limitations affecting its use. As more agricultural drainage is returned to the rivers, the level of total dissolved solids and sediment causes some water-quality problems in the eastern part of the area.

The ground water used in the northern part of this area is pumped from the alluvial aquifer along the South Platte River and its tributaries. This unconsolidated and consolidated sand and gravel aquifer yields large quantities of ground water for irrigation, for some public supply, and for livestock and domestic use. Water from the alluvial aquifer is a calcium-sulfate type and very hard. Water quality is best along the edges of valleys where there is recharge from adjacent aquifers. The water degrades downstream because of the addition of salts from irrigation return flows and seepage from leaky ditches, reservoirs, and the river itself.

In the southern part of this area, a 1-to-5-mile-wide band of alluvial deposits along the Arkansas River provides water for livestock, public supply, and domestic uses and for local irrigation. The salt content increases downstream to the point that the water can be used only to irrigate salt-tolerant crops. The high amounts of dissolved solids, especially sulfate, limit use of the water for drinking. This water is very hard.

The deeper consolidated sand and gravel deposits in the Denver Basin aquifer provide water for livestock, some domestic use, and limited local irrigation. This aquifer underlies the northwestern part of the area. The water is soft and generally contains sodium bicarbonate and sulfate ions.

The High Plains aquifer occurs in the eastern part of this MLRA. It provides water for irrigation, livestock, public supply, and domestic uses. Wells provide water that is very low in total dissolved solids north of the Arkansas River. The water is a calcium-bicarbonate type and moderately hard or hard. South of the Arkansas River, the median level of total dissolved solids doubles and the water becomes more of a sodium-sulfate type. Naturally occurring levels of fluoride, sulfate, and total dissolved solids in this part of the High Plains aquifer commonly exceed the national drinking water standards. Where shale bedrock is near the surface, ground water is scarce and commonly of poor quality.

Soils

The dominant soil orders in this MLRA are Mollisols, Alfisols, Aridisols, and Entisols. The soils in the area dominantly have a mesic temperature regime, an ustic or aridic moisture regime, and mixed, carbonatic, or smectitic mineralogy. They are very shallow to very deep, generally well drained, and loamy or clayey.

The main soils and their series:
- Argiustolls that formed in alluvium along the major rivers (Ascalon, Altvan, and Nunn series)
- Haplargids that formed in eolian sediments on hills and plains (Olney series)
- Haplustalfs that formed in loamy sediments on hills and plains (Baca series); that formed in eolian sediments on hills and plains (Vona and Wiley series)
- Torriorthents that formed in alluvium and eolian sediments on alluvial fans, flood plains, and footslopes (Thedalund and Rocky Ford series); that formed in residuum and eolian sediments on hills, cuestas, and mesas (Minnequa, Penrose, and Travessilla series)
- Ustorthents that formed in loess on hills and plains (Colby and Otero series)

Biological Resources

Most of this area supports short prairie grasses. Needle and thread, prairie Junegrass, blue grama, galleta, cholla, threeawn, ring muhly, and alkali sacaton are the major species. Cottonwood is common along the major streams. Stony and rocky soils support a mixed stand of pinyon and juniper with understory species similar to those in nearby openings and grasslands. Sand sage is the potential natural vegetation on rolling plains with grass-stabilized sand dunes and sheets.

Major wildlife species include mule deer, antelope, jackrabbit, cottontail, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. Fish species include walleye, catfish, and crappie.

Land Use

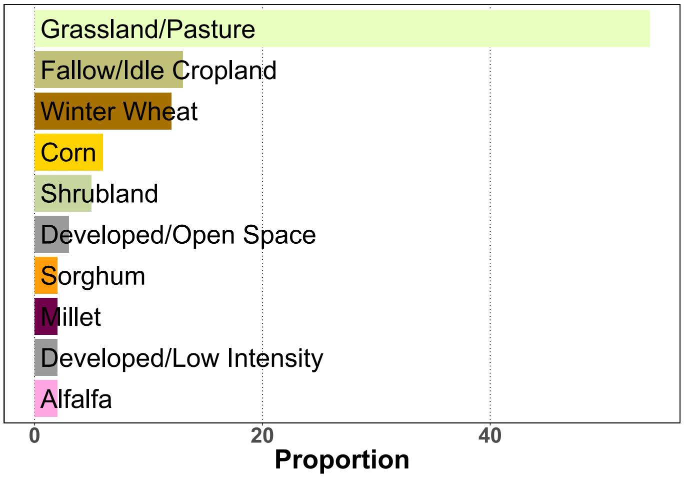

Figure 67B-2: Relative proportions (percentages) of land use in MLRA 67B.

Nearly all of this area is in farms or ranches (fig. 67B-2). About two-thirds of the area supports native short grasses used for grazing. Flood plains and terraces along the Platte and Arkansas Rivers, which make up about one-fifth of the area, are irrigated. Corn, sugar beets, grain sorghum, melons, seed crops, alfalfa, small grains, onions, and other vegetables are the chief crops. Soils that are frequently flooded and soils that are strongly affected by salts generally are used for grazing. About one-tenth of the area is dry-farmed. Winter wheat, dry beans, and grain sorghum are the main crops.

A major soil resource concern is the loss of prime farmland and cropland of statewide importance through conversion to urban use. Additional concerns are wind erosion, water erosion, surface compaction caused by tillage practices, increased salinization of cropland caused by irrigation water management practices, and overall degradation of soil quality.

Conservation practices on cropland generally include irrigation water management, conservation tillage, crop rotations, crop residue management, pest management, and nutrient management. The most important conservation practice on rangeland is prescribed grazing.

69—Upper Arkansas Valley Rolling Plains

This MLRA (fig. 69-1) is defined by a dry climate. More than three-fourths of the area supports native short grasses and is used for grazing. This area is entirely in Colorado and makes up about 11,892 square miles (30,800 square kilometers).

The western boundary of MLRA 69 is distinct, located where the plains meet the foothills (in MLRA 49) of the Southern Rocky Mountains. The northern, southern, and eastern boundaries are gradual boundaries that are not apparent on the ground and largely based on increases in mean annual precipitation in bordering MLRAs.

Physiography

The northern two-thirds of this area is in the Colorado Piedmont section of the Great Plains province of the Interior Plains. The rest is in the Raton section of the same province and division. This MLRA is an elevated plain consisting of sediments deposited by rivers that drained the young and actively eroding Rocky Mountains. This old plain is now a dissected peneplain with dissected, lava-capped plateaus in the southern part of the MLRA. Elevation ranges from 3,500 to 7,220 feet (1,067 to 2,200 meters), increasing gradually from east to west. South of Pueblo a strong upward fold extends southeast, bringing the Dakota sandstone to the surface. On the northern side of this fold, the Niobrara Limestone comes to the surface. East of Pueblo are considerable areas where the surface

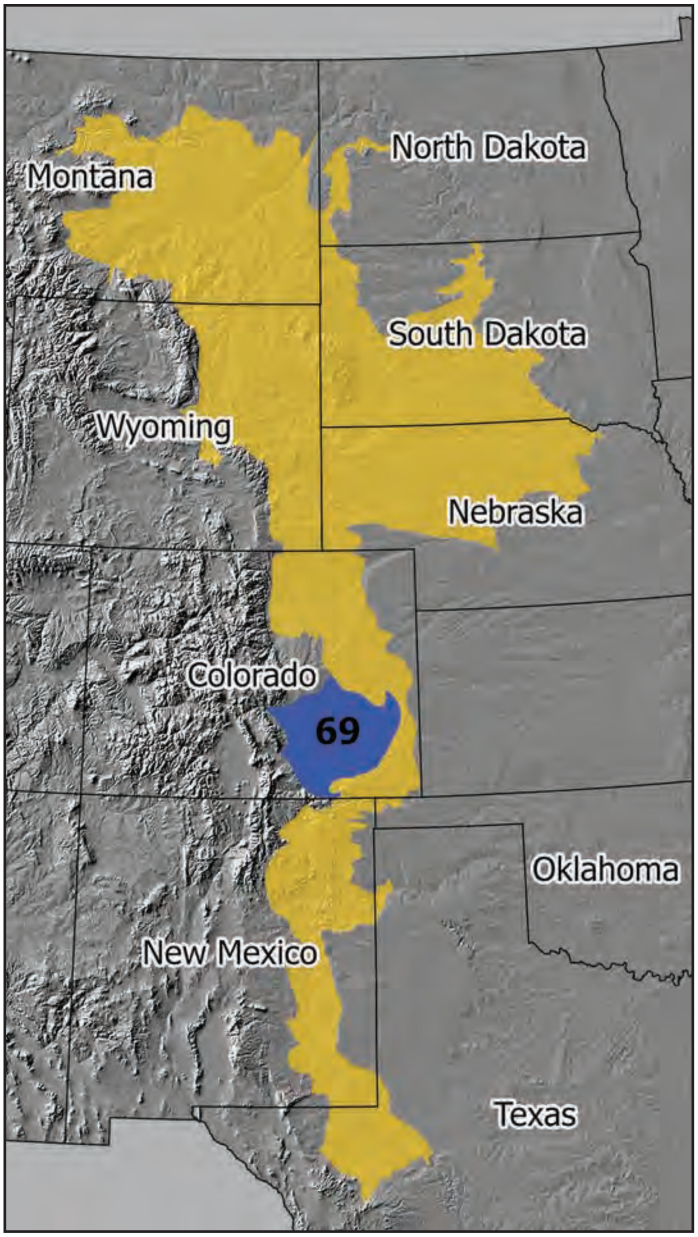

Figure 69-1: Location of MLRA 69, which covers 3,080,000 hectares (7,610,900 acres), within Region G.

formation is the soft Pierre Shale worn down to low relief. The Arkansas River bisects this MLRA as it flows east into Kansas.

Geology

This MLRA is dissected by the Arkansas River, which runs east and west. North of the Arkansas River the Cretaceous Pierre Shale and the older Niobrara Formation (shale and limestone) are partially covered by younger Quaternary eolian deposits and older alluvium sand and gravel deposits. The Arkansas River Valley has alluvium with older sand and gravel deposits on higher terraces. Pockets of the Pierre Shale occur south of the Arkansas River, and the southwestern part of the MLRA consists mostly of the Niobrara Formation. Cretaceous shale and limestone also occur with the Dakota sandstone. In addition, some scattered outcrops of Jurassic and Triassic sandstone, shale, and siltstone are south of the Arkansas River. These units commonly are reddish.

Climate

The average annual precipitation is 11 to 20 inches (280 to 520 millimeters), increasing from west to east. The amount of precipitation fluctuates widely from year to year. Rainfall occurs during frontal storms in spring and early summer and during high-intensity, convective thunderstorms in late summer. The peak period of precipitation is from March through May. Precipitation in winter occurs as snow. The average annual temperature is 48 to 54 degrees F (9 to 12 degrees C). The number of frost-free days averages 160 and ranges from 140 to 175.

Water

The low and erratic precipitation is the source of water for range vegetation. The Arkansas River and its larger tributaries provide water for irrigation and public supply in their valleys. Several reservoirs on tributaries to the Arkansas River provide water for irrigation and public supply.

This MLRA has two major aquifer systems: the Arkansas River Basin alluvium system and the Dakota-Cheyenne sedimentary aquifer. A band of alluvial deposits 1 to 5 miles wide along the Arkansas River provides water for public supply and irrigation. The water in the lower Arkansas River Basin aquifer is a sodium-calcium-sulfate-bicarbonate type and of fair to good quality. The Dakota-Cheyenne sedimentary aquifer is an assemblage of shales, mudstones, sandstones, and limestones. The quality of its water is generally good.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The soils in the area have a mesic temperature regime, an aridic moisture regime bordering on ustic, and mixed, carbonatic, or smectitic mineralogy. They are very shallow to very deep and generally well drained.

The main soils and their series:

Calciargids that formed in old alluvium or eolian sands on interfluves, hillslopes, or stabilized sand sheets (Fort and Vonid series)

Haplargids that formed in alluvium or eolian sands on fan remnants, terraces, hillslopes, interfluves, or stabilized sand sheets (Manzanola and Olney series)

Haplocalcids that formed in loess or loess over slope alluvium and residuum from limestone and shale on interfluves, ridges, or pediments (Manvel and Minnequa series)

Torrifluvents that formed in recent alluvium on flood plains and flood-plain steps (Bankard and Glenberg series)
Torriorthents that formed in slope alluvium over residuum from limestone or sandstone (Penrose and Travessilla series)

Biological Resources

This area supports short prairie grasses. Blue grama, galleta, sideoats grama, ring muhly, and alkali sacaton are the major species. Walkingstick cactus and fourwing saltbush are common shrubs. Cottonwood is common along the major streams. Sand sage is the potential natural vegetation on stabilized sand sheets and dunes. Soils that are shallow to bedrock support a mixed stand of pinyon and juniper.

Major wildlife species include mule deer, pronghorn, jackrabbit, cottontail, turkey, scaled quail, bobwhite quail, and mourning dove. Grassland songbirds in the area include Cassin's sparrow, western meadowlark, and McCown's longspur. Fish species include catfish, flathead chub, sand shiner, and central stoneroller.

Land Use

Nearly all of this area is in farms or ranches (fig. 69-2). More than three-fourths of the area supports native short grasses and is used for grazing. Flood plains and terraces along the Arkansas River, which make up about one-tenth of the area, are irrigated. Alfalfa, melons, onions, green chiles, and other vegetables are the chief crops.

The major soil resource concerns are wind erosion, water erosion, increased salinization of cropland because of inefficient water management practices, surface compaction resulting from tillage practices, and overall degradation of soil quality. Conservation practices on cropland generally include irrigation water management, conservation tillage, crop rotations, crop residue management, pest management, and nutrient management. An important conservation practice on rangeland is prescribed grazing.

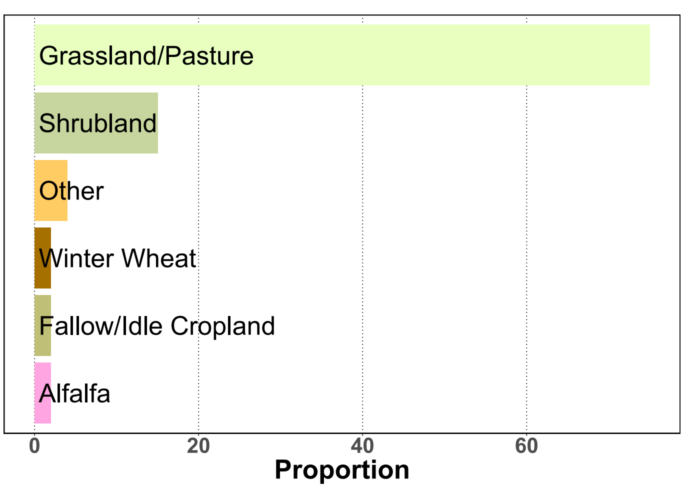

Figure 69-2: Relative proportions (percentages) of land use in MLRA 69.

70A—High Plateaus of the Southwestern Great Plains

This area (fig. 70A-1) is in New Mexico (90 percent), Oklahoma (4 percent), and Colorado (6 percent). It makes up about 9,313 square miles (24,121 square kilometers). MLRA 70A is a high-elevation subdivision of the Great Plains physiographic province. The region is characterized by the

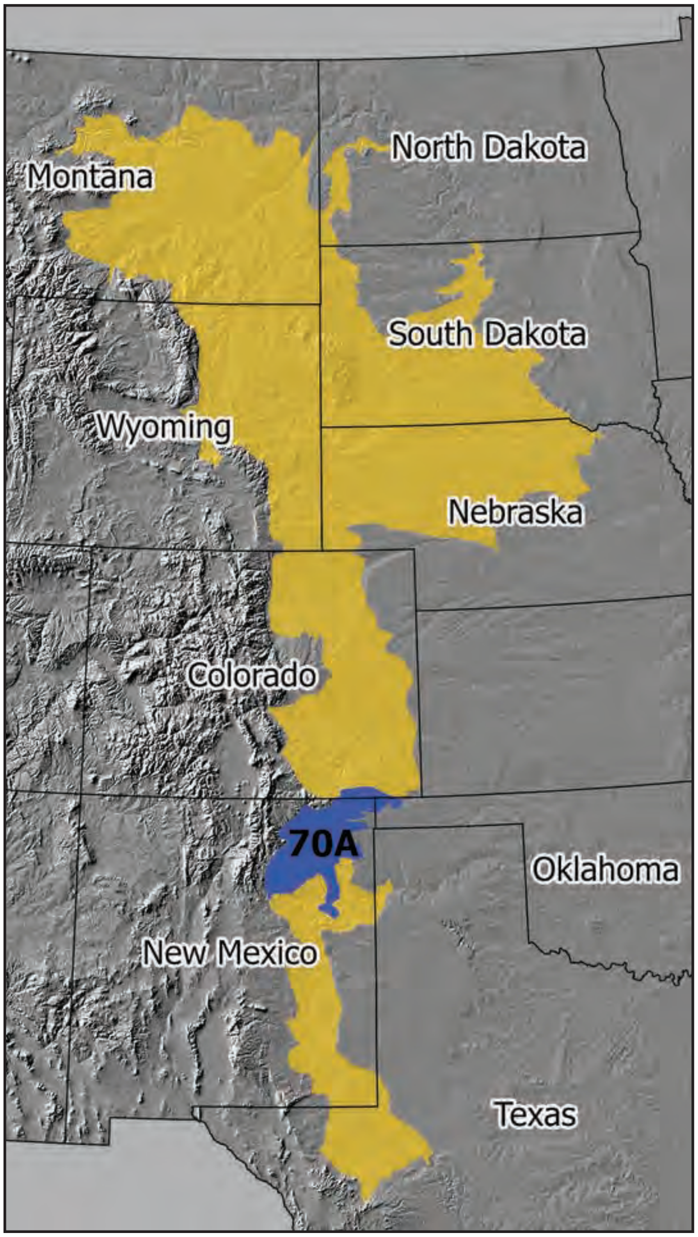

Figure 70A-1: Location of MLRA 70A, which covers 2,412,100 hectares (5,960,300 acres), within Region G.

Canadian River and its tributaries, which cut through the Raton and Las Vegas Basins down into the Tucumcari Basin (Gutentag et al., 1984).

The area encompasses a large part of northeastern New Mexico east of the Rocky Mountains but also includes small portions of southeastern Colorado and the western panhandle area of Oklahoma. It is unique from much of the Great Plains in that it consists primarily of elevated plateau landscapes constructed from sedimentary or volcanic geologies. These western Great Plains, braced against the Rocky Mountains, were influenced by proximity to a turbulent tectonic history that resulted in topographic relief more rugged than that of plains to the east.

Boundary Concepts

MLRA 70A shares a boundary with eight other MLRAs. In clockwise order from the north, they are: 69, 67B, 77A, 77B, 70B, 42C, and 48A.

MLRAs 69 (Upper Arkansas Valley Rolling Plains) and 67B (Central High Plains, Southern Part) share the northern boundary of MLRA 70A and are similarly part of the Great Plains region. They are lower in elevation than MLRA 70A and, as the result of a stronger rain-shadow position, generally receive 10 to 20 percent less annual precipitation. They are separated from the higher and moister plateaus of MLRA 70A to the south by an extensive volcanic plateau spanning about 90 miles from the foothills of the Rocky Mountains to the Southern Great Plains of Kansas and Oklahoma. The boundary between MLRA 70A and MLRAs 69 and 67B is defined where the volcanic plateaus transition into the high plains of the Arkansas River watershed to the north. This distinct boundary occurs below the steep, rocky soils of the escarpments (littered with volcanic colluvium and slope alluvium) that bank this volcanic plateau to deeper and gentler slopes of the plains, where soils have few to no volcanic materials.

In a few isolated parts of the northeast corner of MLRA 70A there is a very subtle boundary on plateau bedrock terrain. Here, MLRA 70A is separated from MLRAs 69 and 67B at the watershed divide between the Dry Cimarron and Purgatory River systems. This MLRA break is based on subtle, geographic and elevation-driven climatic partitioning that begins on plateau surfaces at about the watershed divide. On the Dry Cimarron side, mostly in New Mexico, most precipitation falls in May through September; north of the divide, more towards Colorado, the bulk of annual precipitation falls in April through early August. Based in part on this difference, an offset in vegetative community patterns is detectable between the two regions, and increasingly so with distance.

MLRAs 77A and 77B (Southern High Plains) border MLRA 70A to the east. They are both located on Tertiary Ogallala alluvium with a characteristic thick petrocalcic caprock. This material is commonly mantled by an eolian deposit of well sorted materials. The Ogallala Formation in MLRAs 77A and 77B is thick and tends to bear good aquifers, therefore irrigated crops are common in these areas. In contrast, MLRA 70A has areas of Ogallala deposits that consist of thin, isolated bodies of the Tertiary sediments that overlie Cretaceous or younger plateau rocks. As a result, the sediments of MLRA 70A do not bear a substantial aquifer.

Elevations are significantly higher in MLRA 70A than in MLRAs 77A and 77B and, as a result, soil temperatures in MLRA 70A are more representative of cooler mesic climates. Despite the higher elevations, MLRA 70A is drier because it has less frequent access to Gulf moisture, especially during the growing season. In addition, the Ogallala units of MLRA 70A are highly intermingled with other geologies, most notably volcanic features such as basalt plateaus and cones, which are at depths that regularly influence physical soil properties.

MLRA 70B (Pecos and Canadian River Basins) borders MLRA 70A to the south and southeast where erosion has carved escarpments into older bedrock layers. These escarpments lead to narrow canyons that eventually open into the broader, lower elevation valleys of MLRA 70B. The boundary is associated with an abrupt elevational drop, characterized by a large escarpment, from the high plateaus that formed in Cretaceous rocks to the lower elevation and warmer Triassic and Jurassic basins of the Pecos and Canadian River valleys.

Both MLRAs 70A and 70B contain steep escarpment complexes with soils commonly shallow to Mesozoic bedrock. However, escarpments in MLRA 70A are capped by Cretaceous-age Dakota sandstone whereas those in MLRA 70B are not and are disconnected from those that do. Directly below these escarpment complexes, MLRA 70B landscapes begin at the alluvial valley-fill interface that drains into the Canadian and Pecos Rivers. This interface includes fan aprons or smaller bajadas and stream terraces as well as flood plains on valley bottoms. However, in some areas within the extent of MLRA 70A, tectonics internal to the Canadian Plateaus unit have formed sections of elevated plateau whose escarpments along the fault line descend to lowered portions of the same plateau and no MLRA boundary has been crossed.

MLRA 42C (Central New Mexico Highlands) meets the southwestern corner of MLRA 70A. Plateau rims above the Gallinas River clearly mark this transition. The strongest difference between MLRAs 42C and 70A is in the physiographic origin of their landscapes. MLRA 42C has landscapes more characteristic of the Basin and Range province: alternating horst and graben structures typical of fault-block terrain. In contrast, MLRA 70A has a broad, elevated plateau that grades gently to the east and southeast into the Great Plains province. At the boundary, MLRA 42C soils are distinguishable by their soil parent materials, derived from sandstones and limestones of mostly Permian-age sedimentary rocks (with some Triassic and younger rock in isolated areas). In contrast, MLRA 70A soils formed in mostly shale alluvium from Cretaceous and younger parent materials.

Climatic differences between MLRAs 42C and 70A are subtle but important. Rainfall patterns, especially during spring and summer, differ primarily due to the moisture-laden air derived from the Gulf of Mexico. This Gulf moisture effect, increasing from west to east, contributes to spring and summer precipitation in both MLRAs but is more pronounced in MLRA 70A. Soils in MLRA 70A receive more annual precipitation, especially during the growing season, creating a primarily aridic ustic soil moisture regime, unlike the dominantly ustic aridic soil moisture regime of MLRA 42C. This slight difference results in a greater extent of Mollisols in MLRA 70A, especially in upland positions.

MLRA 48A (Southern Rocky Mountains) is in the Rocky Mountains physiographic province and borders MLRA 70A to the west. It includes the rugged mountainous terrain and erosional foothills descending to the Great Plains. The most obvious features of the boundary between the Great Plains and the Rocky Mountains provinces are the Dakota hogbacks (upturned anticlinal strata that occur along the eastern margin of the foothills). These hogbacks commonly form strike valleys on the Rocky Mountains side (MLRA 48A) and grade steeply on the Great Plains side to meet the gently sloping and planar plateaus of MLRA 70A. The hogback features are along the eastern front of the Rocky Mountains, originating at a point just south of Las Vegas, New Mexico, and appear regularly along the mountain border through North America into Canada. They mark the transition from historically forest plant communities to historically grassland plant communities.

In some locations, volcanic plateaus blur the boundary between MLRAs 70A and 48A since they stretch across the plains from low to high elevations in one unbroken landform. MLRA 70A plateaus are characteristically smooth on the treads and have historic grassland plant communities that grade to grassland savanna near their margins (escarpments, canyons, or drainages). Such volcanic landscapes are usually identified by their continuous, planar slopes that gently descend from west to east, but can also appear as isolated sky islands where drainages have carved them from the main plateau body. Landforms in MLRA 48A are commonly in contrast to these plateaus in their highly dissected and commonly tilted tectonic forms, with narrow and linear summit treads and no volcanic fragments in their soils. In addition, these landforms have not historically supported grassland or savanna plant communities. Where volcanic plateaus of MLRA 70A abut steep, erosional foothill landforms at the front of the Rocky Mountains, they may have similar bedrock below the basalt cap and their escarpments, free of any volcanic materials, and may be grouped under the slope concepts of MLRA 48A. Good examples of high-elevation volcanic plateaus in MLRA 70A include Rayado Mesa west of Springer, New Mexico, and Raton and Johnson Mesas at the New Mexico-Colorado border.

Physiography

This MLRA is in the Great Plains province of the Appalachian Highlands. Subdivisions of this province include the Canadian Plateaus, the Mesozoic Canyons and Breaks, the High Plains, and the Volcanic Plateaus. None of these are a single, contiguous resource unit; rather, they are spatially enmeshed into a landscape mosaic separated by their distinctive physiographic features.

The Canadian Plateaus subdivision is defined where soils are derived from Cretaceous-age plateau bedrock. The Canadian River valley, dissecting the plateaus from the northwest to the southeast, is the base level towards which much of the plateau drains and thus erodes. As plateaus grade towards the Canadian River, the elevation drops from above 7,500 feet to below 5,000 feet over a distance of 30 to 40 miles. The Canadian Plateaus, comprised of planar but mostly tilted strata of sedimentary rocks, also dip slightly from west to east due to uplift from faulting concentrated in western parts of the area.

The Mesozoic Canyons and Breaks subdivision occurs at the margins of the Canadian Plateaus where subtle drainageways of the plateau tread converge to carve deeper stream channels approaching the plateau rim. This area has shallow soils overlying the caprock of the sandstone rim as well as the narrow alluvium-filled canyon bottoms.

The High Plains formed in materials from piedmont surfaces occurring as remnants from outwash events during mountain-building phases of the ancestral Rocky Mountains. The unconsolidated sediment surfaces have endured several periods of climatic fluctuation, which included dry periods when carbonates accumulated in the soil and periods when large quantities of fine sediments became airborne and then were deposited as eolian surface layers.

The Volcanic Plateaus subdivision occurs where active volcanism, in the form of shield volcanoes and cinder cones, produced basalt flows ranging from a few to tens of miles. Many of these basalt plateaus are inverted landscapes that formed when lava flowed into low areas along the landscape, such as stream valleys. Over time, the entire landscape around these basalt-filled valleys eroded away. Consequently, the formerly low positions are preserved as elevated lineaments. Volcanic features create striking boundaries with contrasting adjacent landscapes, but in some places basalts overlie older plateau bedrock. In this volcanic subdivision of MLRA 70A, soils along transition zones to other subdivisions retain their characteristics by having a majority of their parent material derived from volcanic materials.

Geology

The erosional gradient of the Canadian Plateaus subdivision slopes downward from the foothills of the Rocky Mountains to the valley of the Canadian River. Along this gradient, from west to east, the exposed strata of the Canadian Plateaus bedrock generally reveal progressively older geologies. In the west, the younger rocks, such as the Late Cretaceous shales and limestones, remain intact, a testament to their distance from the Canadian River valley. Soils in this area formed in alluvium derived from some fraction of the more erodible and mobile shale parent materials and tend to have a fine family texture class. The shales are of marine origin, and the clay fraction is rich in 1:1 phyllosilicate minerals, which can be a source of soluble salts. To the east, the Dakota sandstone serves as a caprock that forms the plateau rim.

The Mesozoic Canyons and Breaks subdivision, which begins at the plateau rims, is supported by sandstone of the Dakota Formation. This formation commonly forms a steep escarpment with a cliff that sheds some talus or bouldery materials to the slopes below. Lower on the landscape, soils are derived from Jurassic rocks, which are dominantly sandstones but include Late Jurassic rocks associated with the Morrison Formation, characterized by interbedded mudstones, siltstones, and sandstones. Below this, a layer of the Entrada Sandstone, formed from a series of cross-bedded eolian deposits, overlies the lowest (and oldest) geologic expression of the Canadian Plateaus, which is exposed in limited locations. This Late Triassic deposit emerges at the bottom, supplying mostly red sedimentary layers of shale and soft sandstone to the colluvial aprons and eventually the valley bottoms below.

The High Plains subdivision is represented by thin bodies of the Ogallala Formation overlying the Canadian Plateaus bedrock. They are composed of unconsolidated deposits of poorly sorted clay, silt, sand, and gravel. The upper parts of the deposits are commonly cemented by calcium carbonates derived from petrocalcic layers of paleosols formed during the Late Tertiary and Early Quaternary. Overlying this in some areas, and typically exposed at the surface, are loess deposits composed of silt and some very fine sand and clays.

The volcanic structures of the Volcanic Plateaus subdivision are the most northeastern expressions of the Jemez Lineament, a southwest-northeast-trending zone of Tertiary and younger volcanism that stretches from the Mogollon Rim in Arizona. These volcanoes are characterized by many individual volcanic centers, which began erupting over 8 million years ago; the most recent eruption was around 60,000 years ago (Kudo, 1976). The volcanic rock from the eruptions is dominantly alkali basalts, but andesites and dacites are also prevalent. Only small amounts of ash contribute to the soils of this area, whereas the dark-colored basalts, which are less weatherable and rarely mobile, compose the residual portion of soil parent materials.

Climate

The soil climate regimes for this MLRA are primarily mesic and aridic ustic; some smaller areas at the higher elevations and on the more northerly aspects have frigid and ustic conditions. The entire MLRA has similar seasonal patterns of rainfall, with highest amounts in May through August and lowest amounts in November through February, but minor variations occur on an east-west elevational gradient. A slight surge in late spring moisture is more pronounced at the higher latitudes and provides a modest advantage to cool-season grasses in northern parts of the MLRA. There are two overlapping precipitation patterns from west to east. As elevation increases westward, a corresponding precipitation increase is caused by orographic forcing, the rising and cooling of warm air due to the physical barrier of the Rocky Mountains. In contrast, there is a general gain in precipitation eastward with increasing proximity to moist air flow from the Gulf of Mexico. The net effect of these two patterns is a relatively homogeneous distribution of rainfall. The average annual precipitation is 15 to 22 inches (374 to 564 millimeters). The average annual temperature is 44 to 59 degrees F (7 to 15 degrees C).

Water

One of the key concepts of this MLRA is the lack of ground water for irrigation. Water is scarce throughout the area because of the low and erratic precipitation and the few perennial streams. Most of the surface water used in this area is from smaller streams and rivers whose flow is often impaired by multiple diversions and withdrawal from local water tables. The surface water is of good quality because only a small amount of agricultural return is diverted back to the channels. Alluvial deposits within the Raton Basin and Las Vegas Valley are thin but can have limited aquifers. The plateau bedrock can also store ground water, but in much smaller quantities and with lower quality than alluvial deposits (Kilmer, 1987). Small amounts of ground water are in fractures and joints in the shale and sandstone bedrock and can vary in quality based on the formation. Unconsolidated piedmont deposits in the High Plains contain limited aquifers with good water quality, but these are also thin and have insufficient volumes to sustain a long-term aquifer.

Playas are common across MLRA 70A atop treads of plateaus and plains, ranging in scale from small, isolated depressions to larger lake-type features. These localized depressions serve to recharge the local water table as well as provide upland sources of water to wildlife. In some places they collect water regularly and in others rarely. They are islands of enhanced moisture and can be important during periods of drier weather, serving as refuges for important plant and wildlife species.

Soils

The dominant soil orders are Mollisols, Entisols, Alfisols, and Inceptisols. The soils in the area formed in materials derived from eolian deposits; alluvium from Cretaceous, Jurassic, and Triassic sedimentary rocks; and Tertiary-age materials from both volcanic and alluvial piedmont surfaces. Most of the parent materials lend finer textures to the soils, but soils with coarser textures are on the lee side of major drainages and river valleys. Secondary carbonates are common but not prevalent as they are derived from sources that are not contemporary, such as degrading paleosols within Tertiary-age piedmonts or bedrock of limestone and calcareous shale. Hydric soils are along riparian zones in active flood plains, below seeps, in playa bottoms, or in some drainageway bottoms. Generally, the MLRA is within the mesic soil temperature regime and the aridic ustic soil moisture regime; however, typic ustic (warm frigid) areas occur at high elevations, such as atop volcanic mountains, and aridic ustic (warm mesic) areas occur at lower elevations to the east.

Relative ages of volcanic events can be determined by soil properties. Through time, rugged lava surfaces, still visible on the younger flows, become smoothed from erosion (or topographic collapse) and filled or buried by eolian deposition. On gently sloping basalt plateaus, deeper, well developed soils formed where eolian deposits accumulated. Alternatively, shallower soils formed closer to plateau margins where erosion rates countered the deposition.

Common soil series:

Bernal series—Shallow Argiustolls that formed from sandstone on plateaus
Capulin series—Argiustolls that formed in loess, alluvium, and residuum from basalt on volcanic plateaus
Carnero series—Argiustolls that formed in loess and alluvium over sandstone on plateaus
Colmor series—Haplustolls that formed in upland alluvium from mostly shale on plateaus
Fallsam series—Argiustolls that formed in basalt fragments on younger or steeper volcanic flows
Gruver series—Paleustolls that formed in calcareous eolian sediments on piedmonts
LaBrier series—Argiustolls that formed in fine textured alluvial sediments in drainageways
Philmont series—Argiustolls that formed from fine textured alluvial and eolian upland sediments on plateaus
Sombordoro series—Haplustalfs that formed in skeletal materials derived from sandstone plateau bedrock
Torreon series—Argiustolls that formed in loess, alluvium, and residuum from basalt on volcanic plateaus
Tricon series—Paleustolls with petrocalcic horizons that formed in alluvium and eolian sediments on piedmonts
Valmora series—Epiaquolls that formed in fine textured alluvium and eolian materials in playa bottoms

Biological Resources

Vegetatively, the area can be described as mid and short grass prairie with mostly herbaceous grasslands that have scattered communities of shrubs and woody species. The woody species generally occur on shallow soils near plateau breaks and on escarpments. A mix of cool- and warm-season grasses, such as blue grama, buffalograss, ring muhly, and sand dropseed, is common throughout the MLRA, but warm-season varieties are usually dominant. Cool-season grasses, such as western wheatgrass, bottlebrush squirreltail, and New Mexico feathergrass, are more common at the higher elevations, where winter precipitation is greater.

Wildlife species in the area are adapted to both the Great Plains and the foothills of the Rocky Mountains. In winter, elk and pronghorn graze where forage is available, especially on south-facing slopes. Mule and white-tailed deer inhabit areas with abundant browse. Large predators include black bear, mountain lion, bobcat, coyote, and red and gray foxes. Raptors include the red-tailed hawk, northern harrier, American kestrel, and great horned owl. Black-tailed prairie dogs churn up the soil in some areas, providing habitat for reptiles and the burrowing owl.

Land Use

A history of season-long grazing management coupled with several historic droughts (1890s, 1930s, 1950s, and 2000s) has reduced range health, species diversity, and forage production in many areas (USDI-USGS, 2013). As a result, much of this MLRA has been de-stocked.

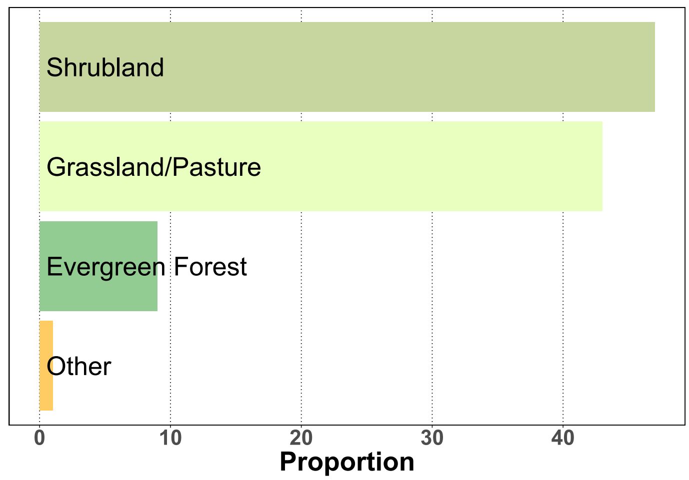

Figure 70A-2: Relative proportions (percentages) of land use in MLRA 70A.

Because the area was the western epicenter of the Dust Bowl in the early 1930s, a significant acreage in the central portion of the MLRA was designated as National Grassland. Plant species diversity is still relatively low: blue grama is the most abundant species in many areas.

The majority of the MLRA is still rangeland, used predominantly as forage production for livestock grazing (fig. 70A-2). Less than 1 percent of the area is cropland or pasture. Irrigated hay, pasture, and small grains are grown in minor tracts where irrigation water is provided by the Dry Cimarron, Canadian, and Mora Rivers and other smaller streams and rivers originating from the Rocky Mountains.

70B—Pecos and Canadian River Basins

This area (fig. 70B-1) occurs in New Mexico (64 percent) and Texas (36 percent). It makes up about 24,163 square miles (62,582 square kilometers). This MLRA represents the

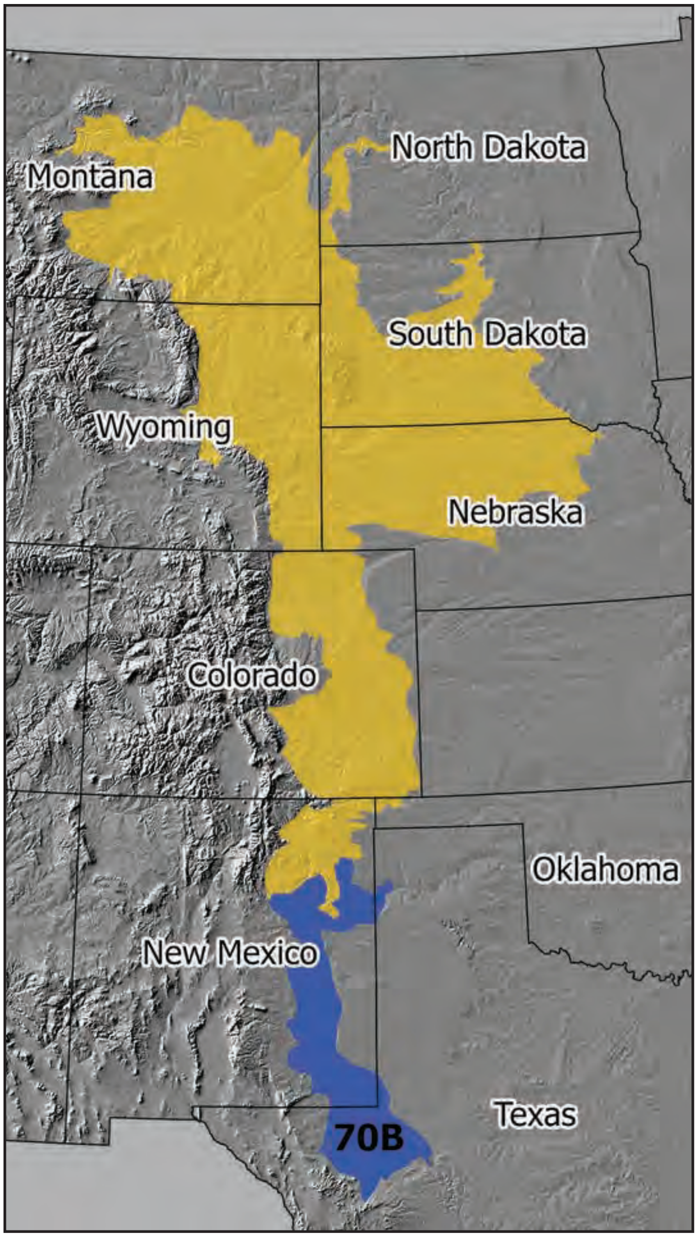

Figure 70B-1: Location of MLRA 70B, which covers 6,258,200 hectares (15,464,400 acres), within Region G.

southern terminus of Land Resource Region G, the Western Great Plains. The entirety of the MLRA is within two primary river basins carved out of the Great Plains by the Canadian and Pecos Rivers—the Tucumcari Basin and the Pecos River Basin. This MLRA constitutes the transition from the Basin and Range province of the west to the Southern High Plains, with its Ogallala aquifer-bearing deposits, to the east. Most of the MLRA is rangeland punctuated by extensive areas of petroleum extraction in the southern and eastern parts of the Pecos Basin. In smaller areas along waterways, water diverted from the main river or shallow water tables are used to irrigate bottom-land fields.

This MLRA shares a boundary with MLRAs 70A, 42A, 42C, 77B, 77C, 77D, 77E, 81A, 81B, and 81C. Some boundaries are obvious, such as where the caprock of the Southern High Plains forms a distinct edge to the eastern margin of the basins, but in many places boundaries are subtle. As a guiding principle, all the landforms in MLRA 70B are a result of basin-carving processes specific to the Pecos and Canadian Rivers and therefore post-date the basin formation.

Boundary Concepts

MLRA 70A (High Plateaus of the Southwestern Great Plains) borders MLRA 70B on the south and east, serving as its watershed via river valleys that eventually open into the Tucumcari Basin of the Canadian River. It is situated on higher elevation plateaus and has cooler, mesic soil temperatures, as opposed to the thermic soil temperatures of MLRA 70B. In general, the northernmost boundary of MLRA 70B originates at the base of the extensive escarpment to the higher plateaus of MLRA 70A, which is capped by Dakota sandstone. Due to faulting within the Canadian Plateaus, some escarpments descend to landscapes still atop the plateau and, as a result, all escarpment landforms descending from MLRA 70A plateaus are included in that MLRA. Plateau escarpments within the river basins of MLRA 70B do not ascend to Dakota sandstone, and the few islands that do remain are islands of MLRA 70A.

Below the escarpments of the Canadian Plateaus, all inset alluvial valleys draining directly into the Canadian or Pecos basins are in MLRA 70B. Valleys draining into other basins are outside of this MLRA. Many of these inset valleys are not well delineated by the MLRA boundary, which is at a scale of 1:1 million.

There are no volcanic features within MLRA 70B; however, a few volcanic plateaus of MLRA 70A share boundaries with MLRA 70B in isolated areas. In contrast to MLRA 70B, MLRA 70A has plateaus and escarpments capped by volcanic basalt flows.

MLRA 42A (Trans-Pecos Mountains, Plateaus, and Basins) occurs in the arid areas to the southwest of the Pecos Basin. It characterizes the southern portion of southwestern States where the annual balance for available soil moisture has deficits far below zero. The boundary of this MLRA occurs at the base of the mountain slope below the Trans-Pecos Mountains and where shallow Permian bedrock plateaus of the Trans-Pecos highlands transition to deep alluvial plains of piedmonts descending eastward into the Pecos River Valley.

MLRA 70B shares its western boundary with MLRA 42C (Central New Mexico Highlands). MLRA 42C is an elevated part of the Basin and Range province located between the Rio Grande Rift Valley and the Pecos River Basin. It is composed of large blocks of continent that are faulted upwards relative to the surrounding terrain, resulting in mountains, plateaus, and plains that drain into the Pecos River Basin in eastern watersheds. MLRA 70B contains all the landforms defined by: 1) any Pecos

Basin valley-border sediments (alluvial structures associated with Pecos River deposits); 2) all landforms and their materials ascending to escarpments that terminate the piedmont slopes of Buchanan and Guadalupe Mesas; 3) the landform contact zones where Permian limestone contiguous with structurally elevated fault-block plateaus (MLRA 42C) meets Triassic-age bedrock (typically red sandstones or mudstones) within the Pecos Basin (MLRA 70B); and 4) areas along the margin of the Sacramento and Guadalupe Mountains where bedrock-controlled soils of Permian-age limestones (MLRA 42C) transition to the deeper alluvial piedmont soils (MLRA 70B).

The boundary with MLRA 42C in the northwest part of MLRA 70B along the Pecos River, where it transitions from a mountain valley stream system to a river basin, is characterized by a landscape shift from the elevated plateaus and plains of MLRA 42C to the basins of MLRA 70B. MLRA 42C is on the more tectonically elevated landscapes that have exposed older Permian limestone while MLRA 70B is on landscapes with materials from younger geologic formations, primarily from Triassic red beds of sandstones and mudstones. The exception is the redbed shale and evaporite (gypsum) of the late-Permian Artesia Group where they occur on basin surfaces in MLRA 70B.

Piedmont features of MLRA 42C occur on surfaces above and outside of the Pecos River Basin and therefore predate the basin's formation. In the time since the basin formed, there have also been piedmont surfaces deposited entirely within the basin. Although these two piedmonts share some similarities, such as secondary carbonates and even petrocalcic layers, only the deposits contained within the basin are in MLRA 70B. At the boundary for the piedmont surfaces of Buchanan and Guadalupe Mesas in MLRA 42C, where a slope inflection marks steeper slopes of the basin margin, MLRA 70B is distinguishable by several characteristic features: presence of shallow soils over sedimentary bedrock with parent materials highly influenced by the bedrock properties, soil hues typically redder than 7.5YR, fragments dominated by sedimentary rock, and historical presence of oneseed juniper.

MLRAs 77B, 77C, 77D, and 77E (Southern High Plains) occur on the piedmont surfaces that formed in Tertiary-age Ogallala sediments or in Early Quaternary sediments that overlie the Ogallala Formation. The landscapes are extensive plains with low relief, commonly dotted with playas. In most locations, the boundary separating the Southern High Plains from the basins of MLRA 70B is distinct and obvious. Where High Plains surfaces have the iconic caprock (horizon several meters thick) exposed at the surface near the edge of the escarpment, the MLRA boundary is just below the exposed caprock. The boundary is less obvious in a few locations where drainageways cut into Ogallala materials, exposing older bedrock, and where sand sheets bury the distinctive caprock formation. In these areas, if the Ogallala Formation is observable, then the area is considered part of the Southern High Plains.

MLRAs 81A, 81B, and 81C have soils associated with limestone bedrock of the Edwards Plateau. MLRA 70B does not have soils that formed in materials derived from Cretaceous-age limestone bedrock.

Geology and Physiography

Prior to the existence of the present-day Canadian and Pecos Rivers, Tertiary-age alluvial piedmonts extended uninterrupted from the Southern Rocky Mountains and central New Mexico mountain chains southeastward across the New Mexico-Texas border. These piedmonts, known collectively as the Southern High Plains, form a gently sloping, semi-continuous plain for hundreds of miles, descending at about 10 to 20 feet per mile (Bachman, 1976; Reeves, 1972). The alluvium overlies an unconformity of sedimentary plateau rocks, ranging in age from Cretaceous to Permian. The Canadian and Pecos Rivers dissected these plains into two large basins. This MLRA can be divided into the following subdivisions: Basin Alluvium, Mesozoic Bedrock, Sand Sheets, and Permian Redbeds.

Basin Alluvium.—This subdivision has three types of sediment-deposited landforms characterized by deeper soils: piedmont remnants, alluvial aprons, and riverine valley deposits. These surfaces may contain playas in places but do not include surfaces covered by eolian sand sheets.

Following the formation of the river basins, there were several stages of basin floor development corresponding to aggradation of alluvial surfaces. During these stages (commonly wetter periods or glacial maxima, when huge layers of ice over the Rocky Mountains formed, melted, and reformed multiple times during the Pleistocene Epoch) sediment from mountain watersheds was transported and deposited onto early versions of basin floors as extensive piedmonts, now referred to as the Quaternary-age Gatuna surface. Subsequent downcutting by the river systems isolated these surfaces which became stabilized, allowing soils with paleosols to develop. Through time and variable climates, the paleosols formed extensive carbonate deposits that are still present today and commonly form a petrocalcic layer known as the Mescalero caliche (Bachman, 1976). In many places, remnants of this surface occur as isolated bodies atop mesas or on broad plateau benches supported at various elevations by lithologic structures.

Extensive coalesced alluvial fan aprons abut the Sacramento and Guadalupe Mountains as well as smaller areas of isolated alluvial fans at the base of plateau escarpments. These fans are often covered by wind-deposited sand sheets. They are either bordered by a bedrock-controlled surface or descend to a riverine valley deposit, such as an alluvial terrace. Riverine valley deposits include the channel, flood-plain, and terrace complexes paralleling major axial streams or river systems throughout the MLRA, namely along the Pecos and Canadian Rivers.

Mesozoic Bedrock.—This subdivision is characterized by shallower soils that formed over Mesozoic-age bedrock. Both major basins of MLRA 70B were formed by downcutting into layers of bedrock and sediments at steep gradients by the erosion and scouring of rivers. Where significant deposition has not covered these erosional surfaces, there are thinner soils that contact Triassic or Jurassic bedrock. Such landforms are present throughout the MLRA and form structural benches of various sizes and their steeper-sloped escarpments that ascend or descend to other landform features.

Sand Sheets.—On the east side of the river basins, adjacent to the margin of the High Plains, sand sheets have accumulated due to prevailing westerlies. The sands are presumably sourced from piedmont (Ogallala) materials eroding west, towards the axial drainage, and returning east again, transported by wind (Hall and Goble, 2006). Sand sheets may cover older landform features such as piedmont surfaces or erosional Mesozoic bedrock. Areas where the sands have accumulated enough to affect the hydropedology, and therefore the plant community dynamics, are part of the Sand Sheets.

Permian Redbeds.—This subdivision consists of soils that formed in or over materials from Permian-age shales of Artesia Group geology, sandstones, and anhydrites in a noncontiguous area, mostly between the towns of Santa Rosa and Artesia, New Mexico. These soils formed from sandy and silty bedrock with deep red hues and varying amounts of gypsum. They can have gravelly surfaces, as petronodes in some places, which have eroded into the basin from upslope geologic formations. The soils tend to have very low resilience to disturbance and, as a result, commonly occur in eroded states and support a mostly shrubby plant community of mesquite and creosote bush. A large stretch of the Pecos River Valley flows through these materials, where flood plains and terraces are primarily composed of redbed sediments commonly high in gypsum. Although the riverine sediment landforms are in the Basin Alluvium subdivision, they are commonly mixed with scattered remnants of resilient red bedrock occurring as strath terrace or pediment features and are included in the Permian Redbeds.

Climate

Soils of this MLRA, which are generally ustic aridic, can have more ustic conditions (i.e., more moisture) at the higher elevations and in more northern parts. Temperatures trend from cooler to warmer in a north-to-south direction. As a result, sites within the Tucumcari Basin generally have a more positive annual water balance than those in the Pecos River Basin. However, local geography affects seasonal and diurnal temperature fluctuations. MAST (mean annual soil temperature) data collected from Salt Creek, for example, located along the flood plains of the Pecos River just north of Roswell, New Mexico, show geographic influence by diurnal cold air drainage: MAST on the flood plains is lower than in adjacent upland sites. The average annual precipitation is 10 to 19 inches (264 to 490 millimeters). The average annual temperature is 50 to 66 degrees F (10 to 19 degrees C).

Water

The available water resources range from surface water in streams and reservoirs to ground water in aquifers. For simplicity, the water supply is described separately for the Pecos and Canadian River basins.

The Canadian River basin, also known as the Tucumcari Basin, has access to ground water. The most reliable supplies are from high-quality, near-surface water tables within more recent alluvial deposits. The Jurassic sandstone of the Entrada Formation, which is coarse grained and only moderately cemented, provides artesian water to parts of the basin and is an important aquifer in the area. The Chinle and Morrison Formations locally yield some water to wells, but the other Mesozoic formations are not considered usable aquifers (Trauger et al., 1964).

The Canadian River provides water resources for agricultural, domestic, municipal, and industrial uses. A series of reservoirs was constructed to conserve runoff for these uses. Conchas Lake and Ute Dam are reservoirs along the Canadian River that retain and divert water for agricultural needs through hundreds of miles of canals. These canals irrigate over 41,000 acres of cropland.

In the Pecos River Basin, large volumes of ground water are available from the Roswell Basin Aquifer System (Robson and Banta, 1995). Most of the irrigation and municipal water for the Roswell to Carlsbad area is derived from karstic artesian limestone aquifers that are considered rechargeable. In areas of the Mescalero Sands of Chaves and Eddy Counties, New Mexico, water wells for domestic or livestock use have been recorded at a depth of about 40 feet (Roger and Peterson, 1988) with flow potentials of 5 to 10 gallons per minute. The sandy soils historically contained numerous springs and perched water tables hidden among the dunes. As irrigation depleted the Ogallala Aquifer, these springs dried up and the locations of most remain unknown (Haukos, 2011).

Although not extensive, playas and sinkholes are ecologically important features of the Pecos River Basin. They are in areas of extensive piedmont deposits and also on depressional surfaces that have undergone subsidence due to dissolution of subterranean evaporite deposits (Bachman, 1976). These localized depressions in the landscape serve to recharge the water table as well as provide sources of upland water to wildlife. In some places they collect water regularly, and in others rarely. In either case, they are islands of enhanced moisture and can be important during drier periods.

Soils

The soils of MLRA 70B include Aridisols, Entisols, and some isolated Vertisols. The soil temperature regime is thermic. The soil moisture regime is mostly ustic aridic. Texture classes range from sandy to fine; a small acreage has soils with skeletal components. Soils are commonly shallow and have contacts with lithic bedrock, petrocalcic horizons, and shales and mudstones with varying degrees of weaker cementation. Deeper soils tend to occur in areas with eolian sand deposits or on alluvial piedmonts, fans, stream terraces, and flood plains. Slopes are mainly less than 15 percent, but escarpments can have slopes ranging to 70 percent.

Common soil series:

Atoka series—Petrocalcids that formed in moderately fine calcareous sediments derived from limestone bedrock on piedmonts

Ima series—Haplocambids that formed in alluvium and eolian materials from sandstone and shale bedrock

Latom series—Ustorthents that formed as very shallow soils over indurated sandstone

Quay series—Haplocalcids that formed in alluvium from redbed sedimentary bedrock on fans and footslopes

Reagan series—Haplocalcids that formed in alluvium or eolian materials from limestone bedrock

Redona series—Calciargids that formed in fine textured alluvium from redbed sedimentary bedrock

Reeves series—Calcigypsids that formed in alluvium from saline Permian bedrock

Simona series—Petrocalcids that formed in calcareous sandy sediments from remnant piedmont surfaces

Tucumcari series—Haplargids that formed in fine textured alluvium from redbed sedimentary bedrock

Upton series—Petrocalcids that formed in old alluvium on remnant piedmont surfaces

Biological Resources

Natural fire was a dynamic part of the historic grasslands of MLRA 70B. Fires occurred naturally at least every 8 to 10 years and more frequently where fuel was more abundant (more than 1,000 pounds per acre annual production). The majority of these natural fires were set by lightning. They helped keep shrub populations to a minimum (Wester, 2007).

The reference plant community for most sites in this MLRA is dominated by warm-season shortgrasses with a few mid grasses and a smaller fraction of forbs and scattered shrubs. Mid grasses grow in areas that receive extra moisture. Forbs vary greatly from year to year depending on amount and timing of precipitation. Shrubs are mostly scattered with isolated small pockets of thicker cover. Except for some steeper, shallower soils, most sites classify as historic grasslands that can shift toward shrublands under deteriorating conditions.

On shallower soils of more gentle landscapes, grasses consist of black grama, sideoats grama, blue grama, alkali sacaton, little bluestem, galleta, needle and thread, New Mexico feathergrass, and threeawn. The shrubs include broom snakeweed, fringed sagewort, mormon tea, and juniper. Shallower soils on steeper escarpments and breaks support grasses such as sideoats, blue grama, hairy grama, little bluestem, sand bluestem, and New Mexico feathergrass. Oneseed juniper, twoneedle pinyon, skunkbush sumac, and wavyleaf oak make up the woody species. In alluvial bottom lands, grasses include blue grama, black grama, sideoats grama, alkali sacaton, western wheatgrass, galleta, buffalograss, sand dropseed, threeawn, wolftail, vine mesquite, and tobosa. The shrubs include fourwing saltbush, broom snakeweed, mesquite, and winterfat. On soils developing on sand sheets, the grasses consist of sand and little bluestem; blue, sideoats, and hairy grama; sand, mesa, spike, and giant dropseed; needle and thread; and threeawn. Small soapweed yucca, sand sagebrush, and winterfat are the dominant shrubs in the northern part of the MLRA. On the lower elevation ranges, shinnery oak is a common shrub and used to define plant communities.

Under stress, species such as sideoats grama, black grama, little bluestem, vine mesquite, and alkali sacaton decrease. They are replaced by blue grama, hairy grama, sand dropseed, threeawn, ring muhly, tobosa, sand sagebrush, cholla, small soapweed yucca, mesquite, and, at the lower elevations, creosote bush.

Land Use

Nearly all of this area is used for farms or ranches, and cattle and sheep grazing is the principal enterprise (fig. 70B-2). About 2 percent of the area is irrigated cropland. Canals from reservoirs provide irrigation water and shallow wells. The main irrigated crops are alfalfa, grain sorghum, and wheat.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of soil organic matter, and management of soil moisture. Conservation practices on cropland generally include conservation tillage, crop residue management, and irrigation water management. Conservation practices on rangeland generally include prescribed grazing, fencing, brush management, and development of watering facilities.

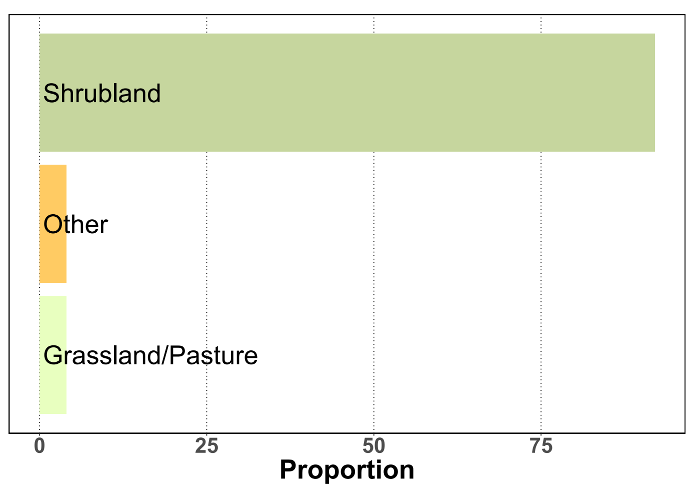

Figure 70B-2: Relative proportions (percentages) of land use in MLRA 70B.

H—Central Great Plains Winter Wheat and Range Region

Land Resource Region H (fig. H-1) is an agriculturally prominent zone of the Great Plains. It rises in elevation and becomes progressively drier from east to west toward the Rockies. The region's western half (the High Plains) consists of prodigious aprons of Paleogene and Neogene alluvium eroded from the Rocky Mountains. Its eastern half consists of exhumed Cretaceous and Paleozoic sedimentary rocks once largely covered by Paleogene and Neogene aprons. Loess deposits blanket the northern portions of the region in Kansas and southern Nebraska. Region H is least dissected in its southwestern corner, in MLRA 77C (the Llano Estacado), which is characterized by its flat surface, its ancient geomorphic surfaces, and consequently the formation of thick petrocalcic horizons that are buried by eolian sands. It is most dissected in northwestern Kansas, in MLRA 72 (Central High Tableland). Region H contains 17 major land resource areas. The extent of these MLRAs and their range in elevations are shown in table H-1.

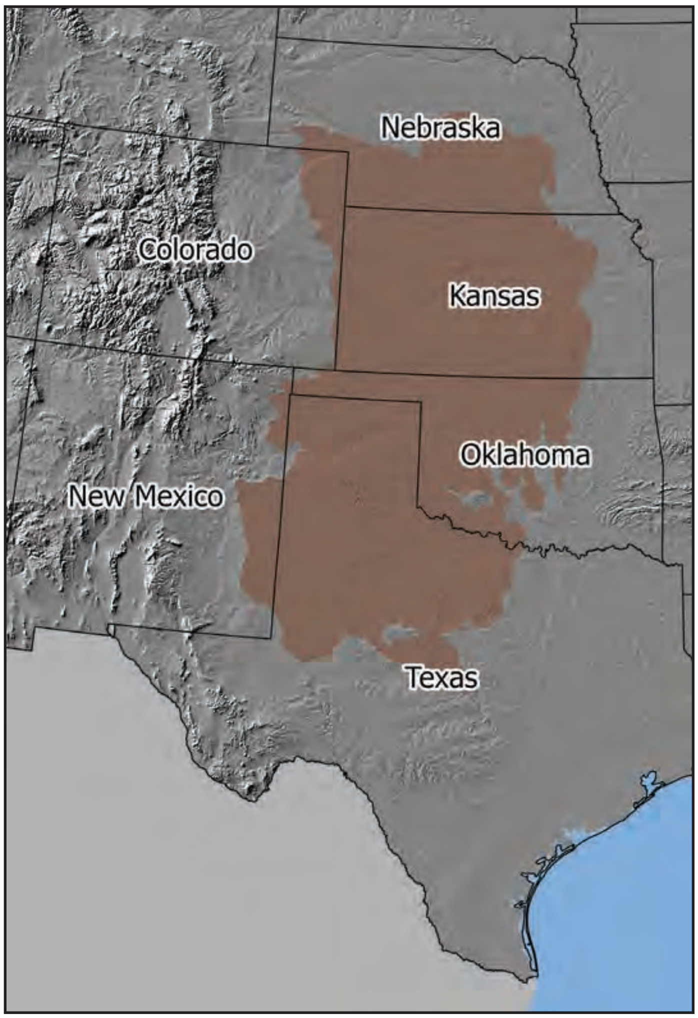

Figure H-1: Location and size of Land Resource Region H, which covers 570,090 square kilometers (220,115 square miles) of the Great Plains, extending from central Texas, across Oklahoma and Kansas, to central Nebraska.

The northern boundary between Regions H and G (fig. 1, page 5) marks a major change in land use and is especially distinct at the contact with the Nebraska Sand Hills (fig. 8, page 12). Region H has more cropland whereas Region G has more rangeland. The western boundary between Regions H and G marks the contact with the Colorado Piedmont, where the cover of Tertiary alluvium has been removed, exposing the underlying Cretaceous rock. Farther south the boundary between these regions occurs at the contact with the Pecos Valley in New Mexico, which is a transitional zone between the High Plains of Region H and the easternmost Basin and Range physiographic province of Region G.

To the east, the boundary between Regions H and M corresponds with the boundary between the unglaciated Great Plains and the glaciated Central Lowland in Nebraska and northeast Kansas. It also marks the transition between short-grass steppes and tall-grass prairies and provides the rationale for the boundary between Ustolls and Udolls.

To the southeast, the boundary between Regions H and J is the contact with the Cross Timbers ecosystem (where soils are largely Alfisols rather than Mollisols), which is so named because settlers had difficulty making their way through the tangled short oak trees. Farther south in Texas, the boundary between Regions H and J is a bioclimatic boundary that marks the approximate contact between typic ustic and udic ustic soil moisture regimes as well as the approximate contact between Paleozoic bedrock (Region H) and the Lower Cretaceous Trinity Group (Region J).

To the south, the boundary between Regions H and I is physiographic and geologic. It occurs along the boundary between the lithologically mixed Paleozoic sandstones and shales of the Osage Plains (Region H) and the Cretaceous limestones of the Edwards Plateau (Region I).

The average annual precipitation in most of Region H ranges from 17 to 36 inches (420 to 905 millimeters). Most of the precipitation falls during spring and fall thunderstorms. Snowfall provides only a small portion of the annual precipitation. The average annual temperature ranges from 49 to 64 degrees F (10 to 18 degrees C) in most of this region. The mean freeze-free period ranges from 155 to 240 days, increasing in length from north to south. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables H-2 and H-3.

The soils of Region H formed under native grassland vegetation in a semiarid climate and are mainly Mollisols (Ustolls) (fig. 2, page 6). Areas where a mollic epipedon has

Table H-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
71	21,830	8,430	420	1,400	530	1,750	680	2,230	830	2,720	950	3,140
72	74,395	28,725	690	2,280	880	2,880	1,030	3,400	1,250	4,110	1,460	4,790
73	66,875	25,820	380	1,260	500	1,650	680	2,250	830	2,750	1,010	3,330
74	11,930	4,605	340	1,120	380	1,260	420	1,390	480	1,580	570	1,870
75	19,200	7,415	380	1,260	460	1,500	510	1,700	660	2,180	780	2,580
76	34,290	13,240	220	740	320	1,050	390	1,300	450	1,480	530	1,760
77A	25,390	9,805	750	2,470	870	2,860	1,020	3,350	1,220	4,010	1,440	4,750
77B	7,690	2,970	1,090	3,580	1,220	4,020	1,370	4,510	1,540	5,070	1,770	5,830
77C	58,780	22,695	680	2,230	880	2,890	1,060	3,480	1,260	4,130	1,510	4,950
77D	22,745	8,780	780	2,560	880	2,910	1,190	3,900	1,360	4,470	1,610	5,280
77E	28,955	11,180	560	1,860	700	2,290	840	2,760	1,110	3,640	1,450	4,760
78A	11,820	4,565	330	1,080	380	1,270	490	1,610	580	1,920	690	2,260
78B	47,095	18,185	370	1,230	480	1,600	630	2,080	780	2,560	1,110	3,640
78C	52,925	20,435	300	980	380	1,250	520	1,720	650	2,160	850	2,790
79	17,970	6,935	320	1,050	400	1,320	510	1,680	630	2,090	720	2,370
80A	51,880	20,030	210	700	270	900	330	1,100	420	1,390	580	1,920
80B	16,330	6,305	210	710	290	960	360	1,200	460	1,530	590	1,960

Table H-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
71	8.9	48	9.2	49	9.7	49	10.4	51	10.7	51	140	142	155/155	168	175
72	8.6	48	9.8	50	10.7	51	12.4	54	13.1	56	135	153	162/165	176	190
73	9.3	49	10.4	51	11.8	53	12.8	55	13.8	57	155	163	174/175	186	195
74	11.1	52	11.7	53	12.6	55	13.2	56	13.4	56	175	177	188/185	194	200
75	9.9	50	10.3	51	10.5	51	11.1	52	11.7	53	160	166	171/170	174	180
76	11.3	52	12.2	54	13.1	56	14.5	58	15.6	60	175	184	197/195	207	215
77A	12.1	54	12.8	55	13.3	56	13.9	57	14.5	58	175	179	187/185	192	200
77B	10.7	51	11.7	53	12.6	55	13	55	13.6	56	155	168	178/175	180	190
77C	12.6	55	13.7	57	14.7	58	16.8	62	18.1	65	180	191	206/205	229	245
77D	12.6	55	14.3	58	15.5	60	17.9	64	18.3	65	175	195	210/215	238	240
77E	12.4	54	13.5	56	14.1	57	14.6	58	15.9	61	170	186	193/195	202	215
78A	16.9	62	17.6	64	17.9	64	18.7	66	18.9	66	225	233	239/240	243	250
78B	14	57	15.8	60	16.8	62	17.7	64	18.8	66	190	214	229/230	239	245
78C	13.1	56	14.2	58	15.4	60	17.8	64	18.8	66	180	192	213/215	240	245
79	12.9	55	13.1	56	13.4	56	14	57	14.8	59	185	187	193/195	204	210
80A	14	57	14.8	59	15.7	60	17.4	63	17.8	64	190	207	217/220	240	245
80B	17.3	63	17.6	64	18	64	18.6	66	18.9	66	225	232	240/240	244	260

Table H-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
71	560	22	582	23	648/645	26/25	704	28	750	29
72	390	15	437	17	470/475	19/19	522	21	570	22
73	480	19	537	21	587/600	23/24	690	27	750	29
74	670	27	726	29	763/765	30/30	803	32	850	33
75	590	23	647	25	720/710	28/28	757	30	800	31
76	700	28	817	32	901/905	35/36	996	39	1,090	43
77A	400	16	432	17	462/470	18/18	518	20	570	22
77B	380	15	405	16	420/420	17/17	433	17	450	18
77C	350	14	444	17	490/495	19/19	555	22	620	24
77D	320	13	366	14	405/400	16/16	432	17	480	19
77E	400	16	464	18	555/545	22/22	611	24	680	26
78A	610	24	654	26	685/685	27/27	717	28	760	30
78B	470	19	537	21	598/600	24/24	676	27	750	30
78C	560	22	623	25	686/690	27/27	758	30	860	34
79	590	23	649	26	757/750	30/30	853	34	980	38
80A	680	27	771	30	862/865	34/34	975	38	1,070	42
80B	680	27	713	28	772/780	30/31	853	34	940	37

not formed or has been eroded consist of Inceptisols, Alfisols, and Entisols. A prominent zone of Inceptisols occurs on the dissected red beds of sandstone, siltstone, and shale east of the Llano Estacado that trends northward across western Oklahoma into southern Kansas (fig. 2). Alfisols are most prominent in the southeast in areas of oak savanna vegetation and in the southwest in areas of sandy and loamy eolian sediments. Entisols occur throughout Region H where erosion has removed diagnostic horizons or where young eolian sediments or young alluvium has been deposited. The soils in this region commonly have carbonates, especially the ancient soils in the southwestern part of the region, which have some of the highest concentrations in the United States (fig. 5, page 9). Restrictive zones occur in many soil profiles as densic, lithic, or paralithic bedrock in the eastern part of Region H and as an abrupt textural change in some areas in Nebraska (fig. 9, page 13). Soils with petrocalcic horizons occur in the southwestern part of this region (fig. 11, page 15). Soils with argillic horizons commonly occur on the stable geomorphic surfaces (fig. 12, page 16). Amounts of soil organic carbon in Region H are higher than those in the drier regions to the southwest and lower than those in the tallgrass prairies to the northeast (fig. 14, page 18).

Land use in Region H is approximately half cropland and half grassland (fig. 8, page 12). The production of beef cattle is the dominant agricultural enterprise. Dry-farmed winter wheat and other small grains are grown for either cash or feed. Irrigated crops, mainly corn, soybeans, and sorghum, are major crops (fig. H-2). Cotton is a major crop in the southern High Plains. The native vegetation consists mainly of mid and tall prairie grasses, but some areas support short prairie grasses or a mixture of these and other prairie grasses. Small areas of oak savanna occur in the MLRAs in the southern part of the region. The major resource concerns on the grassland in this region are overgrazing and the spread of invasive plants and noxious weeds. The major resource concerns on cropland are wind erosion, water erosion, maintenance of the content of soil organic matter, and soil moisture management. The quality of surface water also is a concern. Sediment, nutrients, pesticides, and salinity are the major nonpoint sources of the pollution of surface water and ground water. Control of saline seeps on rangeland and salt management on irrigated land are concerns in some areas of the region.

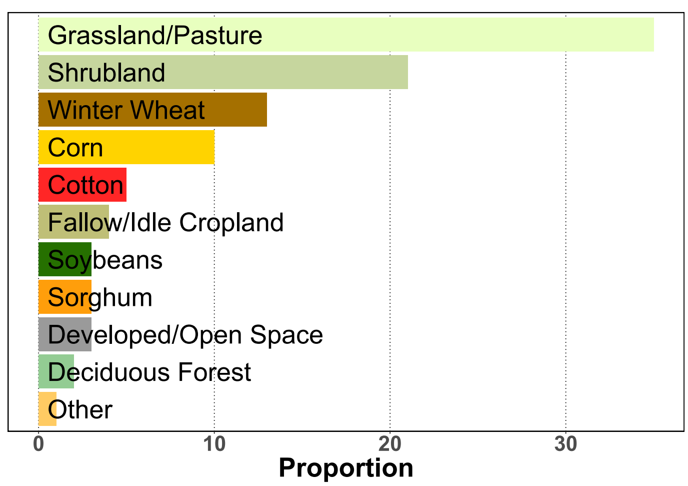

Figure H-2: Relative proportions (percentages) of land uses in Land Resource Region H (National Agricultural Statistics Service, 2018).

71—Central Nebraska Loess Hills

This MLRA (fig. 71-1) consists of nearly level to gently sloping, loess-mantled, narrow ridgetops separated by steep slopes bordering drainages. It is used to produce cash crops, feed grain, hay, and livestock. It is entirely in Nebraska and makes up about 8,429 square miles (21,832 square kilometers).

MLRA 71 has a distinct boundary based on physiography with MLRAs 65 (Nebraska Sand Hills), 73 (Rolling Plains and Breaks), 75 (Central Loess Plains), 106 (Nebraska and Kansas Loess-Drift Hills), and 102C (Loess Uplands) that follows the Cedar and Loup Rivers. It has a less apparent boundary with MLRA 102C, where it crosses the Platte River flood plain.

Physiography

This MLRA is in the High Plains section of the Great Plains province of the Interior Plains. It is the eastern extent of the fluvial plain created by ancient rivers that drained the rapidly eroding Rocky Mountains after they were uplifted. This smooth plain has been dissected by present-day rivers, and thick deposits of loess derived from the fluvial plain occur on ridges between the broad stream valleys. Elevation ranges from 1,400 to 3,140 feet (420 to 950 meters), increasing from east to west. Some stream valleys have nearly level flood plains and large stream terraces. Local relief is 20 to 100 feet (5 to 30 meters). The Platte River runs along the southern edge of this MLRA, and the North, Middle, and South branches of the Loup River join to form the Loup River in this area.

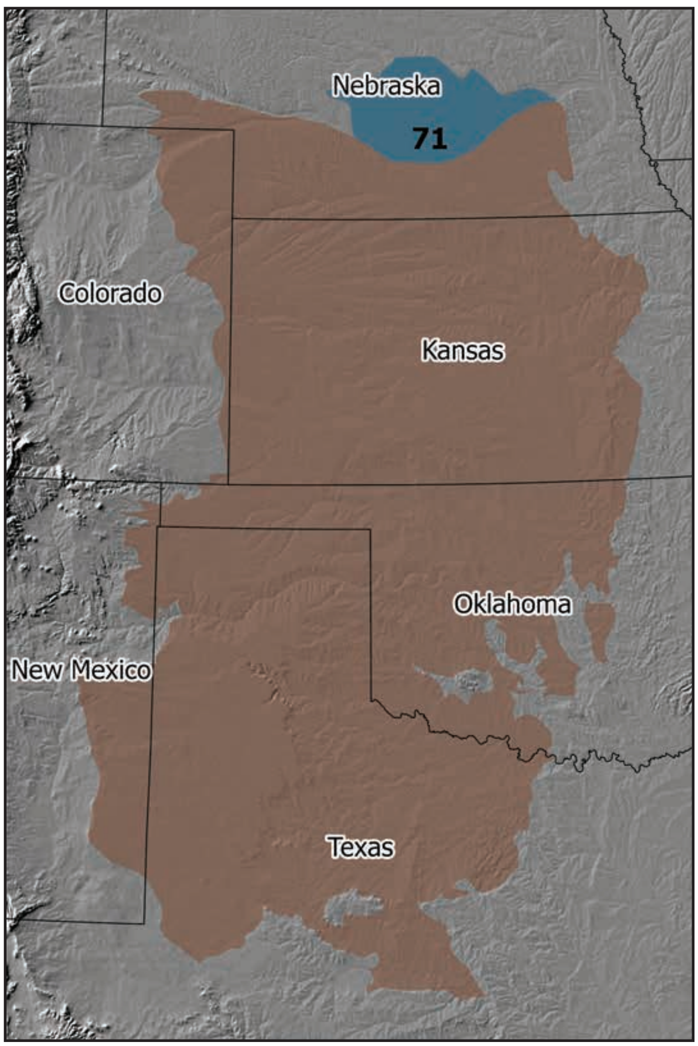

Figure 71-1: Location of MLRA 71, which covers 2,183,200 hectares (5,394,700 acres), within Region H.

Geology

Most of the uplands in this area are covered with thick deposits of loess. Extensive terraces are in the valleys along the Loup and Platte Rivers. These terraces contain silt, sand, and gravel, and the river valleys are filled with Quaternary and younger deposits of sand and gravel. The eastern extent of the Tertiary Ogallala Formation underlies most of this MLRA. Pierre Shale, Niobrara Chalk, and Cretaceous marine sediments underlie the eastern edge of the area.

Climate

The average annual precipitation is 22 to 29 inches (560 to 750 millimeters). Most of the precipitation falls from spring through autumn, and the maximum occurs from late spring to early summer. Rainfall occurs during frontal storms in spring and early summer and during high-intensity, convective thunderstorms in late summer and early autumn. Precipitation in winter typically occurs as snow. The average annual temperature is 48 to 51 degrees F (9 to 11 degrees C). The freeze-free period averages 155 days and ranges from 140 to 175 days, increasing in length from west to east.

Water

The low, erratic precipitation is the source of water for crops and native grasses in most of the area. The Loup and Platte Rivers provide water for irrigation along their valleys. This water is of good quality and is suitable for all uses. In much of the area, the abundant supply of good-quality ground water is used for domestic purposes and livestock and locally for irrigation. Ground water from Quaternary sand and gravel in valley fill aquifers and from eolian deposits of silt and fine sand is similar in quality to the ground water from the Tertiary Ogallala aquifer. It is a calcium-bicarbonate type and very hard. Gravity-irrigated farmland is concentrated on the terraces and river valleys, especially along the Platte River.

Soils

The dominant soil orders in this MLRA are Entisols and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They are generally very deep, well drained to excessively drained, and loamy or sandy.

The main soils and their series:

- Argiustolls that formed in loess over alluvium on stream terraces (Hall series); that formed in loess on uplands (Holdrege series)
- Haplustolls that formed in alluvium and loess on stream terraces and uplands (Cozad, Hord, and Uly series)
- Ustifluvents that formed in alluvium on flood plains and alluvial fans (Hobbs series)
- Ustipsamments that formed in sandy eolian material on dunes (Valentine series)
- Ustorthents that formed in loess on uplands (Coly series)

Biological Resources

The uplands in this area support short, mid, and tall grasses. Big bluestem, little bluestem, switchgrass, Indiangrass, sideoats grama, blue grama, and western wheatgrass are the major species on silty soils. Needle and thread, prairie sandreed, sand bluestem, little bluestem, and blue grama are the major species on sandy soils.

Major wildlife species in this area include white-tailed deer, coyote, raccoon, opossum, cottontail, muskrat, squirrel, mink, pheasant, prairie chicken, bobwhite quail, and mourning dove. Fish species include bass, bluegill, and channel catfish.

Land Use

Nearly all of this area is in farms and ranches, and almost two-fifths is dry-farmed (fig. 71-2). About one-half of the area supports native grasses used for grazing. Winter wheat, grain sorghum, and alfalfa are the major dry-farmed cash crops. Between 5 and 10 percent of the area, consisting of flood plains and terraces along the Platte River and its larger tributaries, is irrigated. Corn, soybeans, alfalfa, and seed crops are the principal irrigated crops. Alfalfa is commercially grown in the Platte River Valley.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of soil organic matter and tilth, and soil moisture management. The resource concerns on rangeland are wind erosion and water erosion; plant productivity, health, and vigor; and the spread of noxious and invasive plant species.

Conservation practices on cropland generally include the use of high-residue crops in the cropping system; systems of crop residue management, such as no-till and mulch-till systems; level terraces; contour farming; contour stripcropping; irrigation water management; and nutrient management. Conservation practices on rangeland generally include prescribed grazing, brush management, proper distribution of watering facilities, and control of noxious and invasive plant species.

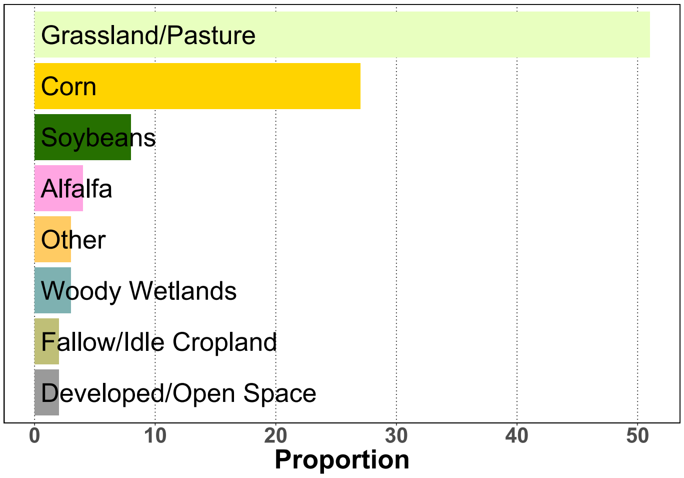

Figure 71-2: Relative proportions (percentages) of land use in MLRA 71.

72—Central High Tableland

This MLRA (fig. 72-1) consists of nearly level to slightly sloping loess plains with long slopes. It is used to produce cash crops, feed grain, hay, and livestock. This area is in Kansas (55 percent), Colorado (24 percent), and Nebraska (21 percent). It makes up about 28,724 square miles (74,395 square kilometers).

MLRA 72 has a distinct boundary based on physiography with MLRAs 65 (Nebraska Sand Hills), 73 (Rolling Plains and Breaks), and 77E (Southern High Plains, Breaks). It has a less apparent boundary with MLRAs 67A (Central High Plains, Northern Part), 67B (Central High Plains, Southern Part), and 77A (Southern High Plains, Northern Part).

Physiography

Almost all of this area is in the High Plains section of the Great Plains province of the Interior Plains. A small part of the area, where the South Platte River enters Nebraska, is in the Colorado Piedmont section of the same province and division. This MLRA consists of broad intervalley remnants of a smooth, fluvial plain. Elevation ranges from 2,280 to 4,790 feet (690 to 1,460 meters), increasing from east to west. Slopes generally are nearly level to gently rolling on this smooth tableland, but steep slopes border the major valleys. Broad, level flood plains and terraces are along the Arkansas and Platte Rivers and a few of their larger tributaries. Local relief on uplands has a range in meters, but valleys are tens of meters below the general level of the uplands.

The North Platte River forms the northern boundary of this MLRA. The South Platte River joins the North Platte River at the town of North Platte, Nebraska. The Arkansas River bisects the southern part of the MLRA. Other large rivers in the area between the North Platte and Arkansas Rivers include the Republican, Sappa, Prairie Dog, Solomon, Saline, and Smoky Hill Rivers. The Cimarron River is in the southeast corner of the area.

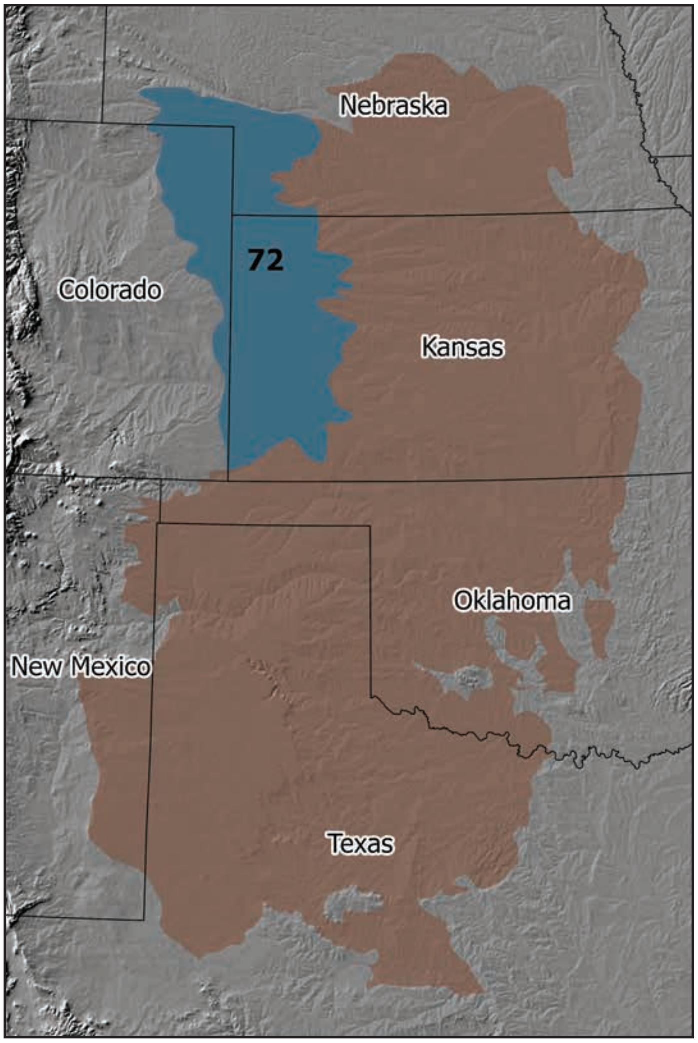

Figure 72-1: Location of MLRA 72, which covers 7,439,500 hectares (18,383,400 acres), within Region H.

Geology

The smooth tableland lying between the major river valleys in this MLRA has river-laid sediments that were washed out onto the plains following uplift of the Rocky Mountains in Colorado. In many areas the wind reworked these sediments, forming a hummocky, dune surface of eolian sand. A loess mantle occurs in other parts of the area. The Tertiary-age Ogallala and White River Formations cover Cretaceous Pierre Shale. The Ogallala Formation consists of loose to well cemented sand and gravel, and the White River Formation consists of ashy claystone and sandstone. Pierre Shale can be near the surface in the river valleys cut into the Tertiary sediments. Quaternary and more recent sand and gravel cover the shale in the river valleys.

Climate

The average annual precipitation is 15 to 22 inches (390 to 570 millimeters). It fluctuates widely from year to year. Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. The maximum precipitation occurs from late spring through early autumn. Precipitation in winter occurs as snow. The annual snowfall ranges from about 16 inches (40 centimeters) in the southern part of the area to 35 inches (90 centimeters) in the northern part. The average annual temperature is 48 to 56 degrees F (9 to 13 degrees C). The freeze-free period averages 165 days and ranges from 135 to 190 days, increasing in length from northwest to southeast.

Water

The low, erratic precipitation is the source of water for dry-farmed crops and pastures on uplands. Water from the Arkansas, Republican, North Platte, and South Platte Rivers is used for irrigation in the river valleys. The surface water is generally of good quality. It is suitable for all in-stream uses and for irrigation. In this MLRA, the quantity of the water is a much greater concern than the quality. However, water from the South Platte River is highly mineralized because of irrigation use and reuse in Colorado.

In most of this area, ground water is of good quality, adequate for domestic and livestock needs, and used locally for irrigation. It is scarce where shale is near the surface. Almost all of the ground water used for irrigation in the uplands comes from Quaternary sand and gravel deposits near the surface, the Ogallala Formation, and the Brule Formation, all of which are part of the High Plains aquifer. This water is typically low in total dissolved solids but hard or very hard. Some ground water is obtained from alluvium in the principal river valleys. The water from the alluvial aquifers is very hard. Shallow ground water can be contaminated by nitrate and atrazine from agricultural lands.

Soils

The dominant soil orders are Entisols and Mollisols. The soils in the area dominantly have a mesic temperature regime, an ustic or aridic moisture regime, and mixed or smectitic mineralogy. They generally are very deep and moderately well drained to excessively drained. Soil texture varies.

The main soils and their series:

Argiustolls that formed in loess on hills, plains, and stream terraces and in mixed loess (Keith, Kuma, and Richfield series); that formed in loamy eolian and outwash sediments on hills, plains, and stream terraces and in mixed loess (Manter and Satanta series); that formed in local alluvium on plains and in drainageways and depressions (Rago series)

Haplustolls that formed in loess on hills and plains (Ulysses series)

Paleustolls that formed in pedisediments on plains and tablelands (Platner series)

Torripsamments that formed in sandy eolian material on dunes (Valent series)
Ustorthents that formed in loess on hills and plains (Colby and Sulco series)

Biological Resources

This area supports short prairie grasses. Blue grama and buffalograss are the dominant species. Sideoats grama, blue grama, hairy grama, and little bluestem grow on the steeper valley walls along the major rivers. Major wildlife species include white-tailed deer, antelope, coyote, badger, raccoon, skunk, rabbit, prairie dog, pheasant, prairie chicken, quail, and mourning dove.

Land Use

Nearly all of this area is in farms or ranches and dominantly used for cash-grain farming and livestock production (fig. 72-2). More than two-thirds of the area is cropland used for dry-farmed crops. Winter wheat, typically grown in a winter wheat-fallow rotation, is the primary crop. Other small grains, grain sorghum, alfalfa, and grass hay crops also are widely grown, especially in the narrow irrigated areas along the Platte, Republican, and Arkansas Rivers. Corn, grain sorghum, and sugar beets are grown extensively on the nearly level uplands where ground water is used for irrigation. Pinto beans are grown on some broad, flat plains. Nearly one-third of the area, consisting of hilly and steep slopes bordering the drainageways, supports native grasses and shrubs used for grazing.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of soil organic matter and tilth, and soil moisture management. The resource concerns on rangeland are wind erosion; plant productivity, health, and vigor; the spread of noxious and invasive species; and inadequate wildlife habitat.

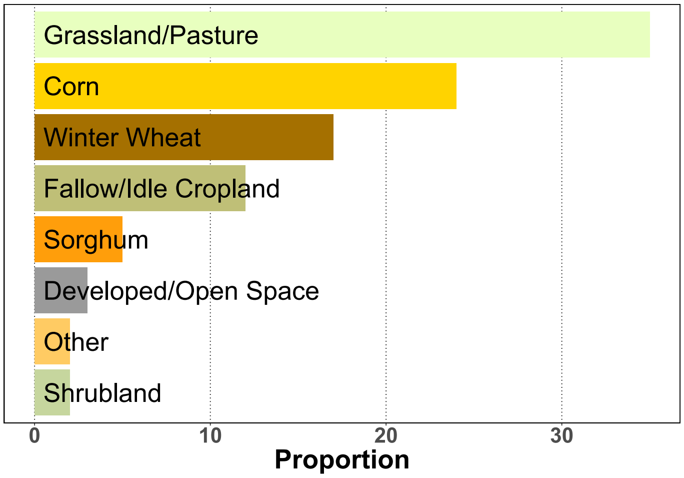

Figure 72-2: Relative proportions (percentages) of land use in MLRA 72.

Conservation practices on cropland generally include the use of high-residue crops in the cropping system; systems of crop residue management, such as no-till and mulch-till; level terraces; contour farming; contour stripcropping; conservation crop rotations; irrigation water management; and pest and nutrient management. Conservation practices on rangeland generally include prescribed grazing, brush management, management of upland wildlife habitat, proper distribution of watering facilities, and control of noxious and invasive plant species.

73—Rolling Plains and Breaks

This MLRA (fig. 73-1) is a sub-maturely to maturely dissected plateau. The dissected plains in this area have broad, undulating to rolling ridgetops and hilly to steep valley sides. The valleys are generally narrow, but broad flood plains and

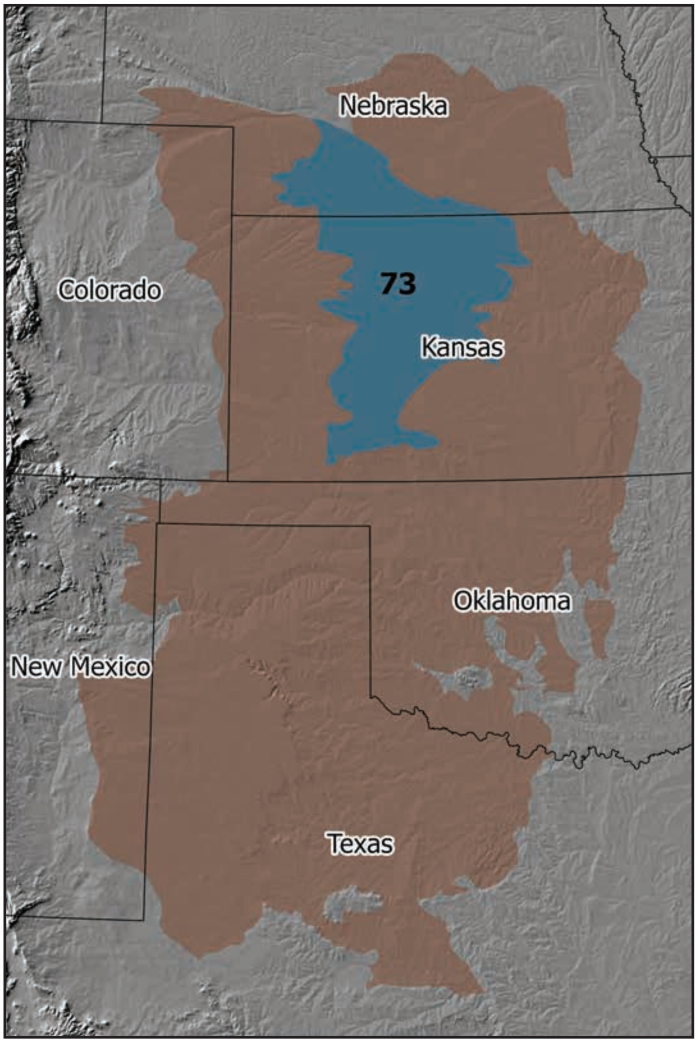

Figure 73-1: Location of MLRA 73, which covers 6,687,400 hectares (16,524,700 acres), within Region H.

terraces are along the Republican River and its larger tributaries. This area is in Kansas (77 percent) and Nebraska (23 percent). It makes up about 25,820 square miles (66,874 square kilometers).

The boundary between MLRAs 73 and 72 (to the west) is mainly based on precipitation, plant response to precipitation, and the change from the dissected land surface in MLRA 73 to the relatively flat land surface of MLRA 72. The boundary between MLRAs 73 and 75 (to the northeast) is based on physiography. The boundaries between MLRA 73 and MLRAs 77 and 78C (to the south), MLRA 79 (to the southeast), and MLRA 74 (to the east) are based on physiography and soil parent material.

Physiography

Almost all of this area is in the Plains Border section of the Great Plains province of the Interior Plains. The northwest and southwest corners are in the High Plains section of the same province and division. Elevation ranges from 1,260 to 3,330 feet (380 to 1,010 meters), increasing from east to west. Local relief ranges from meters to tens of meters.

The North Platte River forms the northern boundary of the MLRA, and the Republican River parallels the Nebraska-Kansas border. The Arkansas River bisects the southern part of the area. Other large rivers in this MLRA between the Republican and Arkansas Rivers include the Sappa, Prairie Dog, Solomon, Saline, and Smoky Hill Rivers. Medicine Creek is in the northwestern part of the area.

Geology

The western half of this MLRA and areas along the Arkansas River have remnants of the Tertiary river-laid sediments washed out onto the plains from erosion of the prehistoric Rocky Mountains in Colorado. In the valley of the Arkansas River, the wind reworked these sediments, forming a hummocky dune surface of eolian sand. A loess mantle occurs on the higher ground in the western half of the area. The Tertiary-age Ogallala and White River Formations cover Cretaceous Pierre Shale in the northern part of the area. The Ogallala Formation consists of loose to well cemented sand and gravel, and the White River Formation consists of ashy claystone and sandstone. Pierre Shale and Niobrara Chalk are at the surface in the valleys of the Republican, Smoky Hill, and Saline Rivers. Fort Hays limestone of the Niobrara Formation and the Blue Hill Shale member of the Carlile Shale Formation are at the surface in the valleys of the Saline and Smoky Hill Rivers. Shale is exposed in most of the eastern half of this MLRA, in Kansas. Quaternary and more recent sand and gravel partially cover the shale in the river valleys.

Climate

The average annual precipitation is 19 to 29 inches (480 to 750 millimeters). Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. The maximum precipitation occurs from midspring to early autumn. Precipitation in winter occurs as snow. The annual snowfall ranges from about 17 inches (45 centimeters) in the southern part of the area to 24 inches (60 centimeters) in the northern part. The average annual temperature is 49 to 57 degrees F (9 to 14 degrees C). The freeze-free period averages 175 days and ranges from 155 to 195 days, increasing in length from northwest to southeast.

Water

The moderate, erratic precipitation is the source of water for crops and pasture in much of this MLRA. The amount of surface water is limited throughout the area. The Republican and Platte Rivers and their larger tributaries provide surface water for irrigation along their valleys. The surface water is generally of good quality. It is suitable for all in-stream uses and for irrigation. Because of low flows, the rivers in Kansas are limited as sources of irrigation water.

Abundant supplies of ground water for irrigation and other uses are obtained from wells, primarily in the northern part of this MLRA. Alluvium in the valleys along the major rivers and their larger tributaries is one source of ground water, and Quaternary sand and gravel and the Ogallala Formation within the High Plains aquifer are other sources. The water from the Ogallala Formation is typically low in total dissolved solids but hard or very hard. The water from the alluvial aquifers is very hard. Shallow ground water can be contaminated by nitrate and atrazine from agricultural lands. Some deeper wells have been drilled to obtain more saline water from the Dakota Formation. Ground water becomes scarce in the eastern half of the MLRA, where the High Plains aquifer has eroded and Cretaceous Pierre Shale and Niobrara Chalk are at, or close to, the surface.

Soils

The dominant soil order in this MLRA is Mollisols. Entisols are of lesser extent. The soils in the area dominantly have a mesic temperature regime, an ustic moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, moderately well drained to somewhat excessively drained, and loamy or clayey. Most of the soils formed in loess on the uplands; in the valleys, soils developed from silty alluvium. Some bedrock-derived soils occur on the sloping to steep shoulders of valleys.

The main soils and their series:

- Argiustolls that formed in loess on uplands (Harney, Holdrege, and Spearville series)
- Calciustolls that formed in loamy sediments on uplands in the western part of the MLRA (Penden series)
- Haplustolls that formed in mixed loess, alluvium, and residuum on footslopes (Armo series); that formed in mixed loess and alluvium on stream terraces (Hord and

Eltree series); that formed in alluvium on flood plains and alluvial fans (Bridgeport and Roxbury series); that formed in loess on uplands (Uly series); that formed in residuum on hills and plains (Nibson and Wakeen series)
Ustorthents that formed in loess on uplands (Coly series)

Biological Resources

This area supports natural prairie vegetation. Little bluestem, big bluestem, switchgrass, western wheatgrass, and sideoats grama characterize the vegetation on loamy soils. Blue grama, buffalograss, and western wheatgrass characterize the vegetation on clayey soils on uplands.

Major wildlife species include mule deer, white-tailed deer, coyote, raccoon, pheasant, bobwhite quail, mourning dove, and meadowlark. Fish species include bass, bluegill, catfish, and bullhead.

Land Use

Nearly all of this area is in farms or ranches (fig. 73-2). More than half of the area is cropland used for dry-farmed crops. Winter wheat and grain sorghum are the major crops in much of the area. Corn is the main crop in the northern part of the area. Feed grains and hay crops also are widely grown. About 2 percent of the area, especially on the terraces and narrow bottom land along the Platte and Republican Rivers, is irrigated. Corn, soybeans, alfalfa, small grains, and grass for hay are grown extensively on the irrigated land. About 40 percent of the area, consisting of hilly and steep slopes bordering the drainageways, supports native grasses and shrubs used for grazing.

The major soil resource concerns are wind and water erosion, maintenance of the content of soil organic matter, and surface compaction. Soil moisture management is important in the western part of the area. The resource concerns on rangeland are plant productivity, health, and vigor; the spread of noxious and invasive plants; and inadequate wildlife habitat.

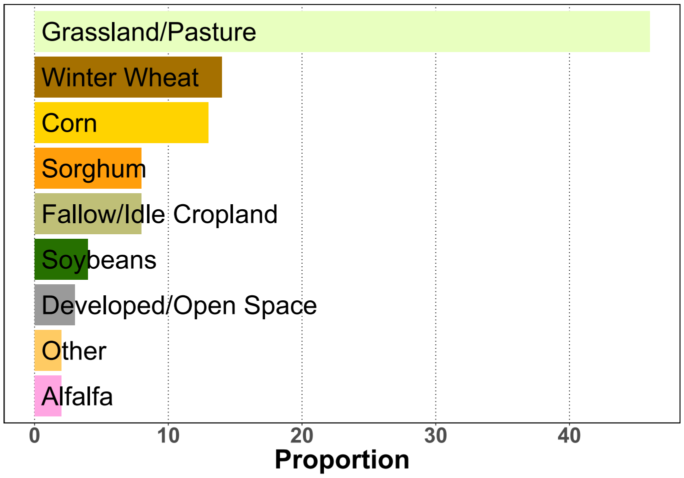

Figure 73-2: Relative proportions (percentages) of land use in MLRA 73.

Conservation practices on cropland generally include the use of high-residue crops in the cropping system; systems of crop residue management, such as no-till, strip-till, and mulch-till; level terraces in the western part of the area and gradient terraces and grassed waterways in the eastern part; contour farming; conservation crop rotations; irrigation water management; and nutrient and pest management. Conservation practices on rangeland generally include prescribed grazing, brush management, management of upland wildlife habitat, proper distribution of watering facilities, and control of noxious and invasive plant species.

74—Central Kansas Sandstone Hills

MLRA 74 (fig. 74-1) is underlain by Cretaceous sandstone and consists of an undulating to hilly, dissected plain and flood plains and terraces along large rivers. It is used to produce livestock, cash crops, feed grain, and hay. This area is in Kansas

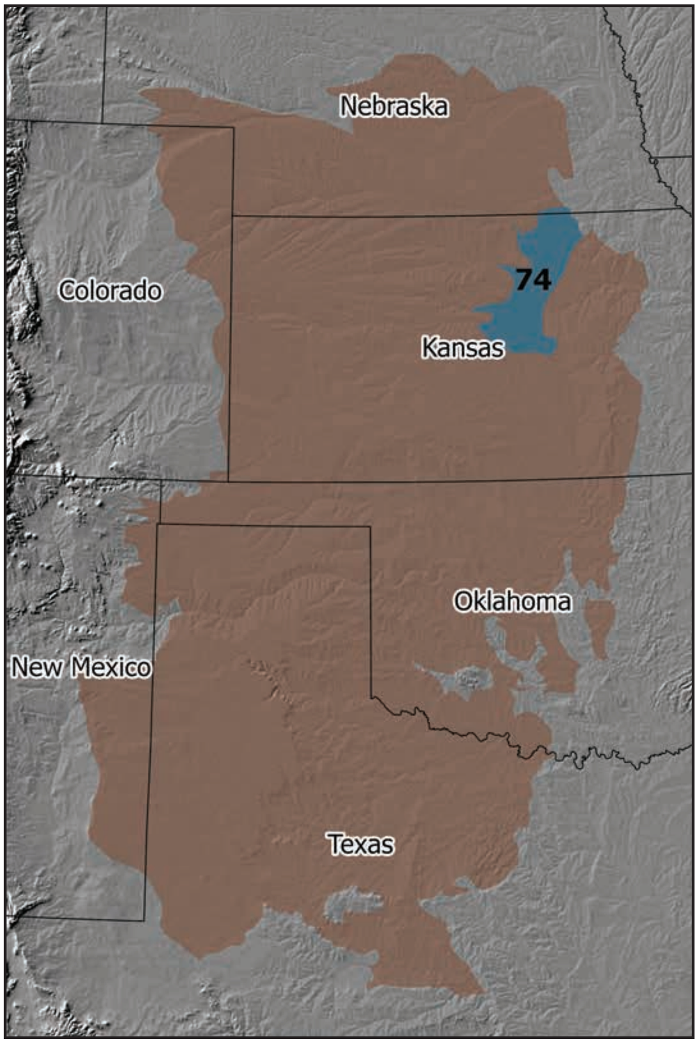

Figure 74-1: Location of MLRA 74, which covers 1,192,800 hectares (2,947,300 acres), within Region H.

(98 percent) and Nebraska (2 percent). It makes up about 4,605 square miles (11,928 square kilometers).

MLRA 74 borders MLRAs 73 (Rolling Plains and Breaks), 75 (Central Loess Plains), 76 (Bluestem Hills), and 106 (Nebraska and Kansas Loess-Drift Hills). The boundaries are based on major changes in geology and are not apparent.

Physiography

This area is in the Plains Border section of the Great Plains province of the Interior Plains. It consists of an undulating to hilly, dissected plain. Wide flood plains and terraces are along the larger rivers, and narrow bottom land is along the small streams. Elevation is generally 1,120 to 1,870 feet (340 to 570 meters), increasing from east to west. Local relief is typically 65 to 130 feet (20 to 40 meters). Rivers that cross the area, from north to south, include the Little Blue, Big Blue, Republican, Solomon, Salt, Saline, and Smoky Hill. The Solomon and Saline Rivers join the Smoky Hill River just south of Salina, Kansas.

Geology

This MLRA is underlain by Cretaceous sandstone bedrock that dips gently to the east. The bedrock is exposed in several areas. Shale occurs in a few places. Loess deposits mantle the uplands, and deposits of unconsolidated sand and some gravel occur in the major stream and river valleys.

Climate

The average annual precipitation is 27 to 33 inches (670 to 850 millimeters). Most of the precipitation occurs from spring through autumn, but the maximum is in midsummer. The rainfall typically occurs as high-intensity, convective thunderstorms. The annual snowfall averages almost 20 inches (50 centimeters). The average annual temperature is 52 to 56 degrees F (11 to 13 degrees C). The freeze-free period averages 185 days and ranges from 175 to 200 days.

Water

The moderate precipitation generally is adequate for crops and pasture if moisture is carefully conserved. The surface water is generally suitable for most uses if treated. Water is stored in reservoirs outside the MLRA for public supply, industry, and irrigation within this area. Some in-stream diversions also are used.

Ground water is adequate to meet domestic and livestock needs in most of the area and is used locally for irrigation, industry, and public supply. Most of the ground water used in this area is from the unconsolidated sediments in the valleys along the three large rivers that cross the MLRA. The water is very hard and requires softening when used for industry and domestic supplies. As freshwater is removed, brine moving up into this alluvial aquifer from deeper marine sediments can increase the salinity of the water. The water can be contaminated mainly because of agricultural chemicals, irrigation return flows, and the production of oil and gas in the area. Municipal waste discharges and seepage and runoff from landfills are concerns in the area of Salina.

Sandstone in the Great Plains aquifer is another source of rural and domestic water. Where it is close to the surface, the water in this aquifer is low in total dissolved solids. As depth increases, the levels of sulfate and chloride increase and the water becomes more saline and unsuitable for most uses. This water is very hard.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic temperature regime, an ustic moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, moderately well drained to somewhat excessively drained, and loamy or clayey.

The main soils and their series:

Argiustolls that formed in residuum on uplands (Edalgo, Lancaster, and Wells series); that formed in loess on uplands (Crete, Geary, Hastings, and Longford series)

Haplustolls that formed in residuum on uplands (Hedville series); that formed in alluvium on flood plains and stream terraces (Hord and Tobin series)

Biological Resources

This area supports mid and tall grasses. Little bluestem, big bluestem, switchgrass, sideoats grama, and western wheatgrass are the major species. Major wildlife species include white-tailed deer, cottontail, pheasant, prairie chicken, bobwhite quail, and mourning dove. Fish species include largemouth bass, bluegill, crappie, carp, channel catfish, flathead catfish, walleye, northern pike, white bass, and striped bass.

Land Use

Most of this area is in farms (fig. 74-2). Almost one-half of the area is cropland. Soybeans and corn are the principal crops. Winter wheat and other small grains, grain sorghum, hay, and alfalfa are other important crops. Some areas along the large rivers are irrigated. The crops grown in nonirrigated areas also are grown in irrigated areas, but more corn and less wheat are grown in the irrigated areas. Almost one-half of the area supports native grasses grazed by cattle.

The major soil resource concerns are water erosion, maintenance of the content of soil organic matter and tilth, and soil moisture management. The resource concerns on pasture and rangeland are the productivity, health, and vigor of plants and the spread of noxious and invasive species.

Conservation practices on cropland generally include the use of high-residue crops in the cropping system, systems of crop residue management (such as no-till and mulch-till), a

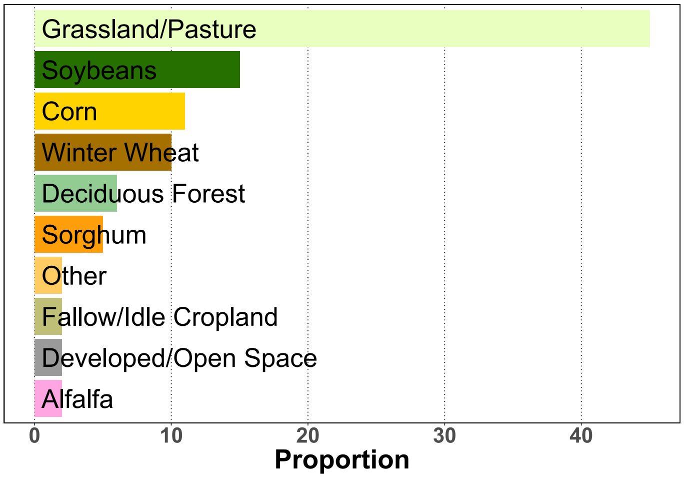

Figure 74-2: Relative proportions (percentages) of land use in MLRA 74.

combination of terraces and grassed waterways, contour farming, contour stripcropping, conservation crop rotations, and nutrient management. Conservation practices on rangeland generally include prescribed grazing, brush management, management of upland wildlife habitat, proper distribution of watering facilities, and control of noxious and invasive plant species.

75—Central Loess Plains

This MLRA (fig. 75-1) mainly consists of near level to gently rolling plains mantled by loess. It is used to produce cash crops, feed grain, hay, and livestock. This area is in Nebraska (97 percent) and Kansas (3 percent). It makes up about 7,413 square miles (19,200 square kilometers). Locally, much of the area south of the Platte River in Nebraska is called the Rainwater Basin.

MLRA 75 has a distinct boundary based on physiography with MLRAs 71 (Central Nebraska Loess Hills) and 73 (Rolling Plains and Breaks). It has a less apparent boundary with MLRAs 106 (Nebraska and Kansas Loess-Drift Hills) and 74 (Central Kansas Sandstone Hills).

Physiography

This MLRA is in the Great Plains province of the Interior Plains. The northern part, in Nebraska, is mostly in the High Plains section of the province, and the part along the Nebraska-Kansas border and in Kansas is in the Plains Border section. Most of the stream valleys are narrow and are not deeply incised. The major river valleys are broader, and terraces are common. Elevation ranges from 1,260 to 2,580 feet (380 to 780 meters), increasing from east to west. Local relief is generally 10 to 25 feet (3 to 8 meters), but it can be 100 to 165 feet (30 to 50 meters).

The Platte River runs along the northern edge of this MLRA, in Nebraska. The Little Blue River crosses from Nebraska into the small part of this area in Kansas.

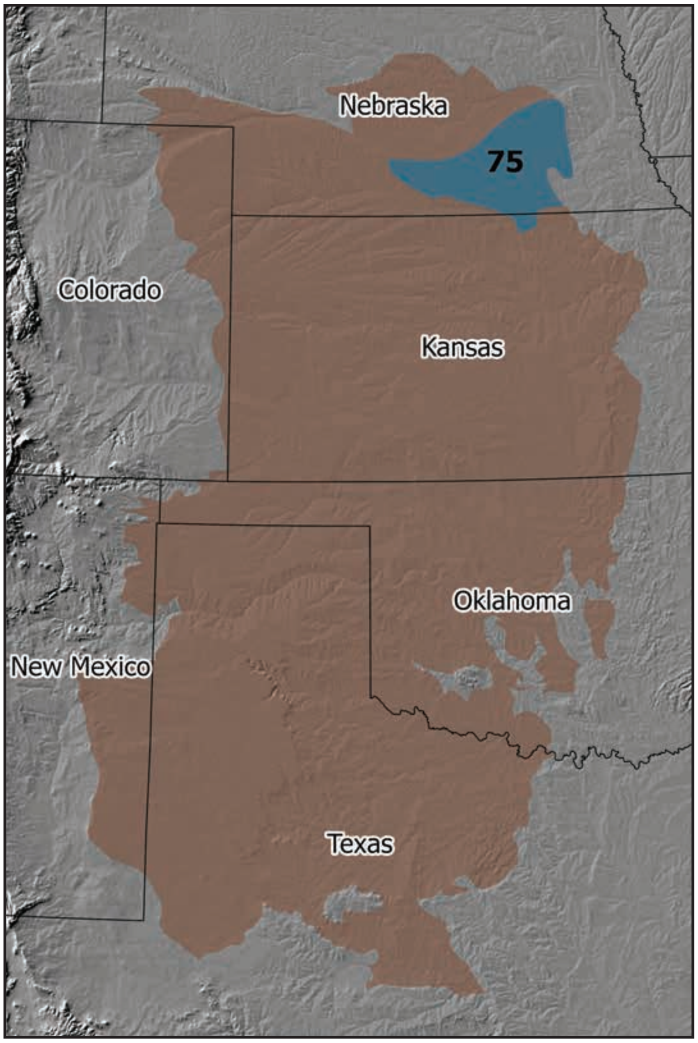

Figure 75-1: Location of MLRA 75, which covers 1,920,000 hectares (4,744,300 acres), within Region H.

Geology

Most of this area is mantled by loess. The present drainage pattern cuts into the upper loess mantle and exposes the older Loveland loess in places. Quaternary sand and gravel deposits lie beneath the loess in Nebraska, while unconsolidated sediments lie beneath the loess in northern Kansas. Unconsolidated sand deposits are in the valleys along the major rivers and on the terraces along these rivers.

Climate

The average annual precipitation is 23 to 31 inches (590 to 800 millimeters). The maximum precipitation occurs from midspring to the midautumn. Most of the rainfall occurs during high-intensity, convective thunderstorms. The low winter precipitation occurs as snow. The average annual temperature is 50 to 53 degrees F (10 to 12 degrees C), increasing from north to south. The freeze-free period averages 170 days and ranges from 160 to 180 days.

Water

The moderate, somewhat erratic precipitation is the source of water for grain crops, native grasses, and pasture. In the northwestern part of the area, the Platte River provides some water for irrigation. Reservoirs and in-stream diversions provide most of the water used in the part of this area in Kansas. The surface water is generally of good quality and requires minimal treatment for most uses.

Ground water that is hard but otherwise of good quality is abundant in the Quaternary sand and gravel in the High Plains aquifer underlying the part of this area in Nebraska. This aquifer is one of the most heavily used aquifers for irrigation water in Nebraska. Much of the recharge in this aquifer occurs from seepage beneath irrigated fields and directly from the Platte River. Ground water is scarce where shale and clay are near the surface.

Soils

The dominant soil order is Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are moderately deep to very deep, well drained to poorly drained, and loamy or clayey.

The main soils and their series:

- Argiaquolls that formed in mixed loess and alluvium on uplands and stream terraces (Butler series)
- Argiustolls that formed in loess (Crete, Geary, Holder, Holdrege, and Smolan series) and clayey sediments (Irwin and Ladysmith series) on uplands
- Haplustolls that formed in residuum on uplands (Clime series), in loess on uplands (Kenesaw series); that formed in alluvium on stream terraces (Muir series)
- Ustifluvents that formed in alluvium on flood plains (Hobbs series)

Biological Resources

This area supports mid and tall grasses. Big bluestem, little bluestem, switchgrass, Indiangrass, and sideoats grama characterize the vegetation on silty soils in the uplands. These grasses and western wheatgrass are on bottom land and in upland basins. Major wildlife species in this area include white-tailed deer, badger, skunk, cottontail, tree squirrel, ground squirrel, pocket gopher, pheasant, and bobwhite quail.

Land Use

Nearly all of this area is in farms (fig. 75-2). Almost three-fourths of the area is cropland. Corn and soybeans are the

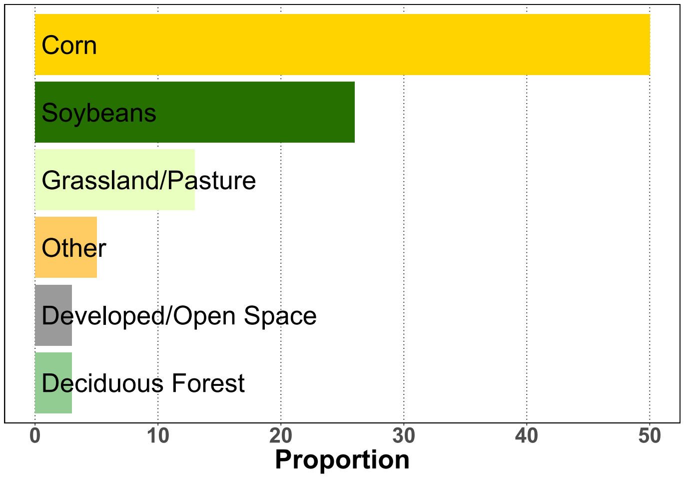

Figure 75-2: Relative proportions (percentages) of land use in MLRA 75.

main cash crops, but large acreages are planted to other small grains or hay. Most of the corn is irrigated by water from wells or canals. About one-fifth of the area is rangeland or pasture grazed by beef cattle.

The major soil resource concerns are water erosion, maintenance of the content of soil organic matter and tilth, surface compaction, and soil moisture management. The resource concerns on pasture and rangeland are the productivity, health, and vigor of plants and the spread of noxious and invasive plant species.

Conservation practices on cropland generally include the use of high-residue crops in the cropping system; systems of crop residue management, such as no-till and mulch-till; a combination of gradient terraces and grassed waterways; contour farming; contour stripcropping; and nutrient management. Conservation practices on rangeland generally include prescribed grazing, brush management, management of upland wildlife habitat, proper distribution of watering facilities, and control of noxious and invasive plant species.

76—Bluestem Hills

This MLRA (fig. 76-1) is known as the “Flint Hills” in Kansas and the “Osage Hills” in Oklahoma. It consists of rolling hills and cuestas that formed in dissected uplands. It is used to produce cash crops, feed grain, hay, and livestock. This area is in Kansas (91 percent) and Oklahoma (9 percent). It makes up about 13,240 square miles (34,291 square meters).

MLRA 76 has a distinct boundary based on physiography with MLRAs 112 (Cherokee Prairies) and 79 (Great Bend Sand Plains). It has a less apparent boundary based on major changes in geology with MLRAs 73 (Rolling Plains and Breaks), 74 (Central Kansas Sandstone Hills), 80A (Central Rolling Red Prairies), 84A (North Cross Timbers), and 106 (Nebraska and Kansas Loess-Drift Hills).

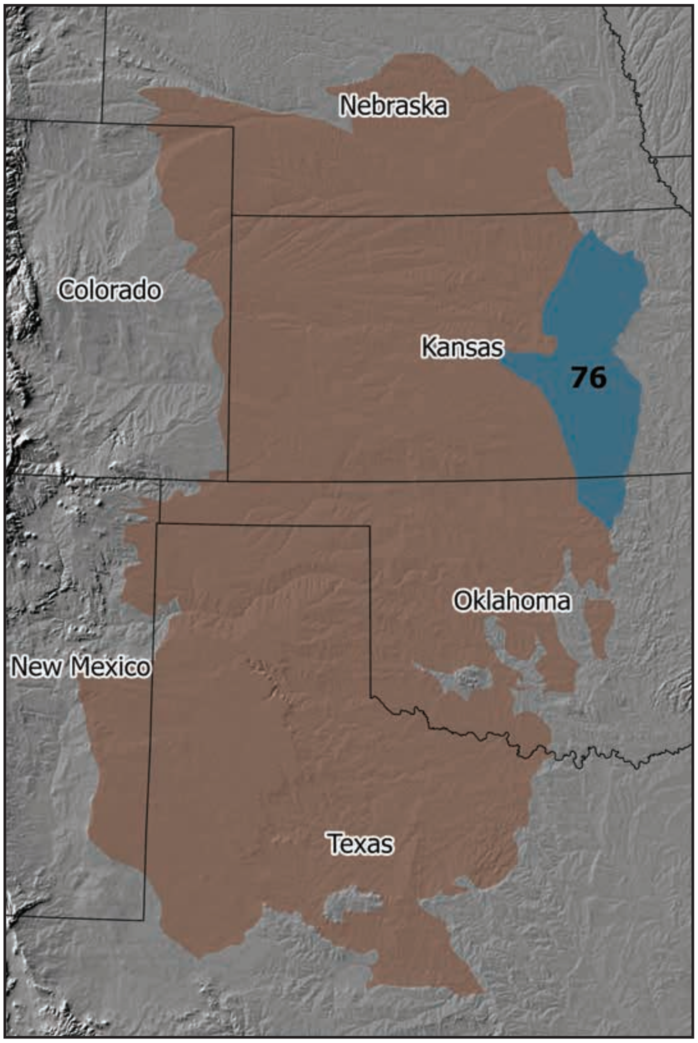

Figure 76-1: Location of MLRA 76, which covers 3,429,100 hectares (8,473,500 acres), within Region H.

Physiography

Most of this area is in the Osage Plains section of the Central Lowland province of the Interior Plains. The northern end of the area is in the Dissected Till Plains section of the same province and division. The rolling hills and cuestas typically have narrow divides and narrow, steep-sided valleys where Pennsylvanian limestone bedrock is dominant. Stream valleys are less box-like (broader) where the dominant bedrock is shale. Extensive flood plains occur only along a few large streams. Elevation ranges from 740 to 1,760 feet (220 to 530 meters). Local relief is generally 10 to 25 feet (3 to 8 meters), but it can be 100 to 165 feet (30 to 50 meters).

The area has two large rivers. The Kansas River crosses the northern part, and the Arkansas River runs along the southwestern edge. Smaller rivers that cross the area include the Vermillion, Mill, Neosho, Cottonwood, Fall, Verdigris, Grouse, Elk, Caney, and Bird Rivers.

Geology

The bedrock beneath this area is primarily Pennsylvanian and Permian shale and limestone. Chert (flint) in the limestone beds is the basis for the local name “Flint Hills” in Kansas. The chert is much less erodible than the limestone, so the soils in the area become stony as the limestone erodes away, leaving flint fragments. Mainly because of stoniness, the prairie in this area generally was never converted to cropland. The limestone beds beneath part of this area in Oklahoma are of Pennsylvanian age. Unconsolidated sand and gravel occur in river valleys and on terraces.

Climate

The average annual precipitation is 28 to 43 inches (700 to 1,090 millimeters). The maximum precipitation occurs from midspring through early autumn. Most of the rainfall occurs during high-intensity, convective thunderstorms. The annual snowfall averages 14 to 20 inches (35 to 50 centimeters). The average annual temperature is 52 to 60 degrees F (11 to 16 degrees C). The freeze-free period averages 195 days and ranges from 175 to 215 days, increasing in length to the south.

Water

The moderate precipitation provides water for pastures and crops. Much of the water for livestock is stored in small reservoirs and ponds. A small area in Oklahoma is irrigated with water from the Arkansas River. The surface water is generally of good quality and is suitable for most uses.

Ground water is used for rural and domestic supplies and as livestock water. In the areas of limestone, shallow wells yield moderate quantities of good-quality water, but very little water is available in the areas underlain by shale. Water from deep wells is highly mineralized. Ground water from the Chase and Council Grove aquifer along the west side of the MLRA, in Kansas, is very hard but is suitable for most uses. The levels of total dissolved solids and sulfate are high in some areas but do not limit use of the water.

Ground water is available in the unconsolidated sediments in the valleys along the Kansas and Arkansas Rivers. The water is very hard and requires softening before it is used for industry or domestic purposes. As freshwater is removed, brine moving up into this alluvial aquifer from deeper marine sediments can increase the salinity (the level of chlorides and sulfates) of the water. The water in the aquifer can be contaminated mainly because of agricultural chemicals, irrigation return flows, and the production of oil and gas in the area.

The Vamoosa-Ada aquifer occurs in the part of this area in Oklahoma. It has good-quality water suitable for drinking but is little used. Some parts of this aquifer have been contaminated by past activities in oil and gas exploration and production.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a mesic or thermic temperature regime, an ustic or udic moisture regime, and mixed or smectitic mineralogy. They are very shallow to very deep, moderately well drained to somewhat excessively drained, and generally loamy or clayey.

The main soils and their series:

- Argiustolls that formed in residuum (Benfield, Foraker, Florence, and Labette series), mixed loess and colluvium over residuum (Irwin and Ladysmith series), and mixed colluvium and alluvium (Tully series) on uplands
- Hapluderts that formed in shale residuum (Apperson series)
- Hapludolls that formed in alluvium on flood plains (Ivan and Verdigris series)
- Haplustolls that formed in residuum on uplands (Clime, Shidler, and Sogn series)
- Natrustolls that formed in residuum on uplands (Dwight series)
- Paleustolls that formed in mixed loess and colluvium over residuum (Konza series)

Biological Resources

This area supports tall prairie grasses. Big bluestem, Indiangrass, switchgrass, and little bluestem are the dominant species. Little bluestem and big bluestem grow on shallow soils. Very little of this area has been cultivated because of the abundance of cherty limestone near and at the surface. As a result, the MLRA has the last large, intact areas of the tallgrass ecosystem in the United States and is a focal area for the preservation of this ecosystem.

Major wildlife species include white-tailed deer, coyote, fox, badger, beaver, raccoon, skunk, civet, opossum, muskrat, mink, great blue heron, prairie chicken, and bobwhite quail. Fish species include bass, walleye, catfish, bullhead, and carp.

Land Use

Nearly all of this area is in farms or ranches (fig. 76-2). Nearly three-fourths of the area supports native grasses grazed by beef cattle. Nearly one-quarter of the area, consisting mainly of the deeper soils in valleys and on some of the uplands, is cropland. Some winter wheat is grown as a cash crop. Corn, soybeans, grain sorghum, alfalfa, and other kinds of hay are the major crops. These crops are grown mostly in the western part of the MLRA.

The major soil resource concerns are water erosion, surface compaction, moisture conservation, and maintenance of the content of soil organic matter. Maintenance of plant health and vigor and control of noxious and invading plants are the major management concerns on grassland.

Conservation practices on cropland generally include terraces, grassed waterways, grade-control structures, conservation tillage, and nutrient and pest management. Conservation practices on rangeland generally include brush management, control of noxious weeds, nutrient management, and proper grazing management.

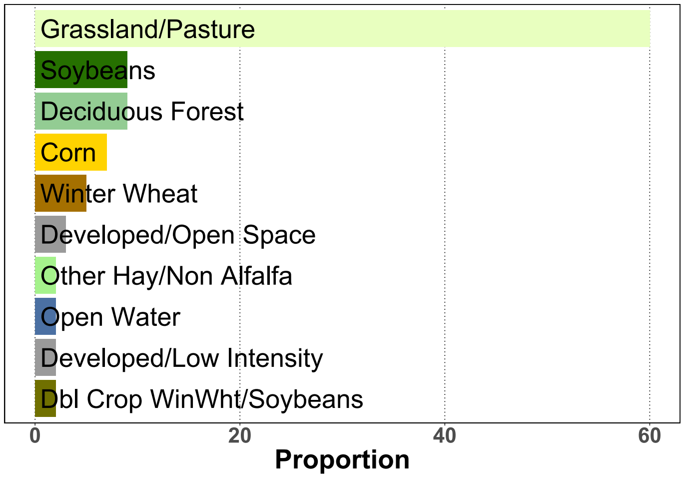

Figure 76-2: Relative proportions (percentages) of land use in MLRA 76.

77A—Southern High Plains, Northern Part

MLRA 77A (fig. 77A-1) is characterized by large expansive areas of nearly level to gently sloping eolian plains emplaced on the Ogallala Formation, an elevated plateau of ancient coalesced alluvial plain deposits. It is in Texas (44 percent), Oklahoma (41 percent), Kansas (14 percent), and Colorado (1 percent). It makes up about 9,804 square miles (25,392 square kilometers).

The area is bounded by the Cimarron River to the north, the Canadian Breaks to the south and east, and Rita Blanca Creek to the west. Its boundaries with neighboring MLRAs 72 and 67B to the north are distinct and based on the physical boundary of the Cimarron River. Its boundary with MLRA 77B to the west is gradual and based on a slightly drier soil moisture regime. Its boundary with MLRA 77E is distinct and based on physical properties associated with soil parent materials and geomorphic position. This contrast is easily discernable where the high plains plateau ends and the erosional hillslope of the dissected high plains begins.

Physiography

This MLRA is in the High Plains section of the Great Plains province of the Interior Plains. It is characterized by extensive areas of open plains on an elevated plateau. The area has several interspersed playa basins ranging from 5 to more than 100 acres (2 to 40 hectares) in size. Large streams and rivers (including the Beaver River, Goff Creek, Coldwater Creek, and

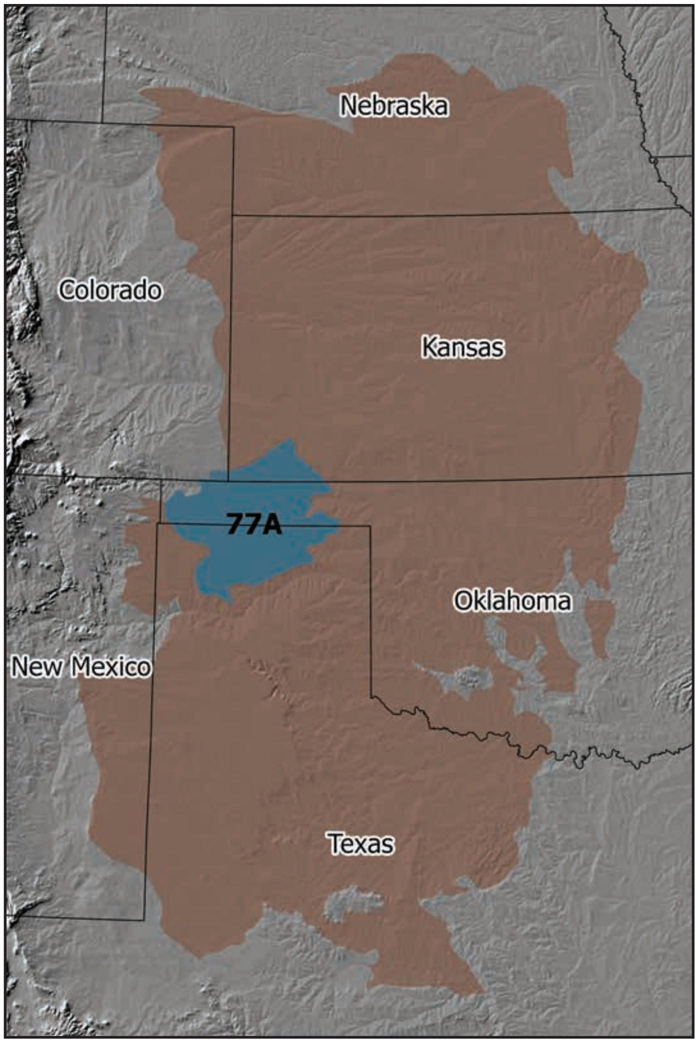

Figure 77A-1: Location of MLRA 77A, which covers 2,539,200 hectares (6,274,400 acres), within Region H.

Palo Duro Creek) incise the plateau, carving into the underlying Ogallala Formation. On the eastern margins of the MLRA, stream incision and hillslope retreat of the underlying Ogallala Formation have formed narrow interfluves of the remaining high plains plateau. Elevation is 4,760 feet (1,450 meters) in the western part of the area and gradually decreases to 2,300 feet (700 meters) along the eastern boundary. The plateau has a general northwest-to-southeast gradient of 8 to 12 feet per mile decrease in elevation. Where loess is the dominant soil parent material, the plains have nearly level to gentle slopes. Where eolian sands make up the dominant soil parent material, slopes range from nearly level (on sand sheets) to strongly sloping (on dunes).

Geology

The surface of this area is covered primarily by eolian loess and sand deposits of Late Pleistocene to Holocene age. These deposits are underlain by caliche bedrock, sandstone, and unconsolidated sands and gravel of the Ogallala Formation of Miocene-Pliocene age.

Climate

The average annual precipitation in this area is 15 to 23 inches (380 to 580 millimeters), fluctuating widely from year to year. Most of the rainfall occurs during high-intensity, convective thunderstorms in spring and fall. Most of the winter precipitation occurs as snow. The average annual air temperature is 53 to 58 degrees F (12 to 14 degrees C). The freeze-free period averages 185 days and ranges from 170 to 200 days, increasing in length from north to south.

Water

The moderately low, erratic precipitation is the source of water for range and dry-farmed crops. The flow of the Canadian River and its tributaries fluctuates widely from year to year, and the water in these rivers is little used for irrigation. The water is slightly saline because of natural sources of salts and because of irrigation return flows from cropland irrigated with ground water.

Sand and gravel in the High Plains, or Ogallala, aquifer yield an abundance of ground water for irrigation and public supply. The water table has dropped from historic levels because there are many high-yield wells tapping this aquifer. In some areas the declining water table and rising energy costs have led to the conversion of previously irrigated cropland to dry-farmed cropland.

Soils

The dominant soil orders in this area are Alfisols and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained, and loamy. Soil parent materials are loess, loamy eolian deposits, eolian sands, and clayey lacustrine deposits.

The main soils and their series:

- Argiustolls that formed in loess on plains (Balko, Belfon, Hugoton, Oslo, and Zella series); that formed in loamy eolian deposits (Forgan series)
- Calciustolls that formed in loamy eolian deposits on ridges and side slopes adjacent to drainageways (Conlen series); that are very shallow and shallow, have a petrocalcic horizon, and formed in loamy eolian material in sloping areas (Plack series)
- Epiaquerts that formed in lacustrine deposits on playa floors (Hansford series)
- Haplustalfs that formed in loess on plains (Bigbow and Canina series); that formed in loamy eolian deposits (Dalhart series); that formed in sandy eolian deposits (Eva series)

Haplusterts that formed in lacustrine deposits on playa floors (Knoblaw and Lautz series)
Paleustolls that formed in loess on plains (Gruver and Sherm series); that formed in loamy material on plains (Sunray series)
Ustipsamments that formed in eolian sands (Optima series)

Biological Resources

This area dominantly supports short or mid prairie grasses. Nearly level plains dominated by fine textured soils are characterized by a plant community of short grasses with a few mid grasses. Blue grama and buffalograss are common; blue grama is the dominant species. On very gently sloping and gently sloping plains dominated by moderately fine textured soils, the plant community is characterized by short and mid grasses with sideoats grama as the dominant species. In areas of sandy soils on gently to moderately sloping plains and sandhills, the plant community is characterized by tall grasses. Little bluestem and sand bluestem make up nearly half of these tall grasses. The woody shrubs on sandy soils include sand sage and skunkbush sumac.

Major wildlife species in this area include mule deer, white-tailed deer, antelope, coyote, badger, raccoon, skunk, jackrabbit, cottontail rabbit, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove.

Land Use

Farms and ranches make up nearly all of this area (fig. 77A-2). About three-fifths of the area is cropland, which is used mainly for wheat, grain sorghum, corn, and cotton. Almost two-fifths of the area is range or improved pasture. Confined animal-feeding operations, primarily for beef cattle and swine, are economically important in the MLRA. In some areas beef cattle graze small grain pastures throughout winter.

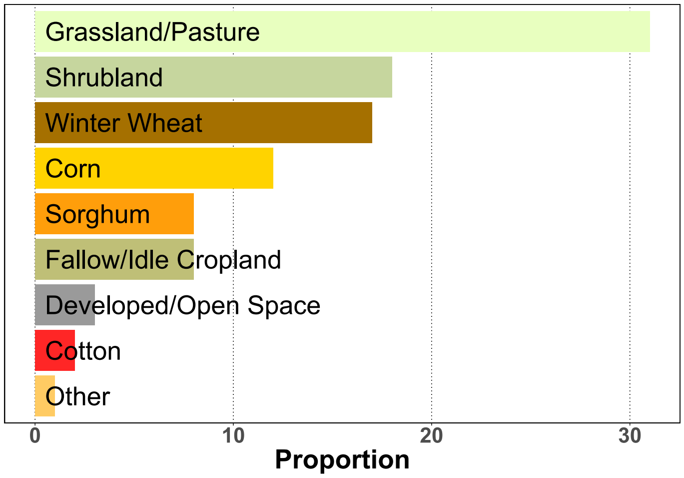

Figure 77A-2: Relative proportions (percentages) of land use in MLRA 77A.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for tillage), cover crops, windbreaks, vegetative wind barriers, stripcropping, and nutrient management. The dominant conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Haying commonly provides supplemental feed during winter.

77B—Southern High Plains, Northwestern Part

This MLRA (fig. 77B-1) is characterized by extensive areas of open plains on an elevated plateau. It is in New Mexico (51 percent), Texas (47 percent), and Oklahoma (2 percent). It makes up about 2,968 square miles (7,688 square kilometers). MLRA 77B has distinct boundaries where steep escarpments separate it from MLRAs to the west and south. It is bordered on the north by Coldwater Creek and on the east by Rita Blanca Creek.

Physiography

The eastern half of this area is in the High Plains section of the Great Plains province of the Interior Plains. The western half is in the Raton section of the same province and division. The elevated plateau is bordered by moderately steep escarpments to the west. A few draws with moderate to steep slopes and narrow flood plains are incised into the plateau and generally trend from northwest to southeast. Elevation is 5,600 feet (1,707 meters) in the northwestern part of the MLRA and gradually decreases to 3,800 feet (1,160 meters) in the southeastern part. The topographical relief is characterized by nearly level to gently sloping plains and gently sloping to strongly sloping sandhills.

Geology

The surface of this area is covered primarily by loamy and sandy eolian deposits of Holocene age. These deposits are underlain by sand and gravel of the Ogallala Formation of Miocene-Pliocene age. Unconsolidated sand and gravel deposits occur in the larger river valleys.

Climate

The average annual precipitation in this area is 15 to 17 inches (381 to 432 millimeters), fluctuating widely from year to year. Most of the rainfall occurs during high-intensity, convective thunderstorms in spring and fall. Most of the winter precipitation occurs as snow. The average annual temperature is

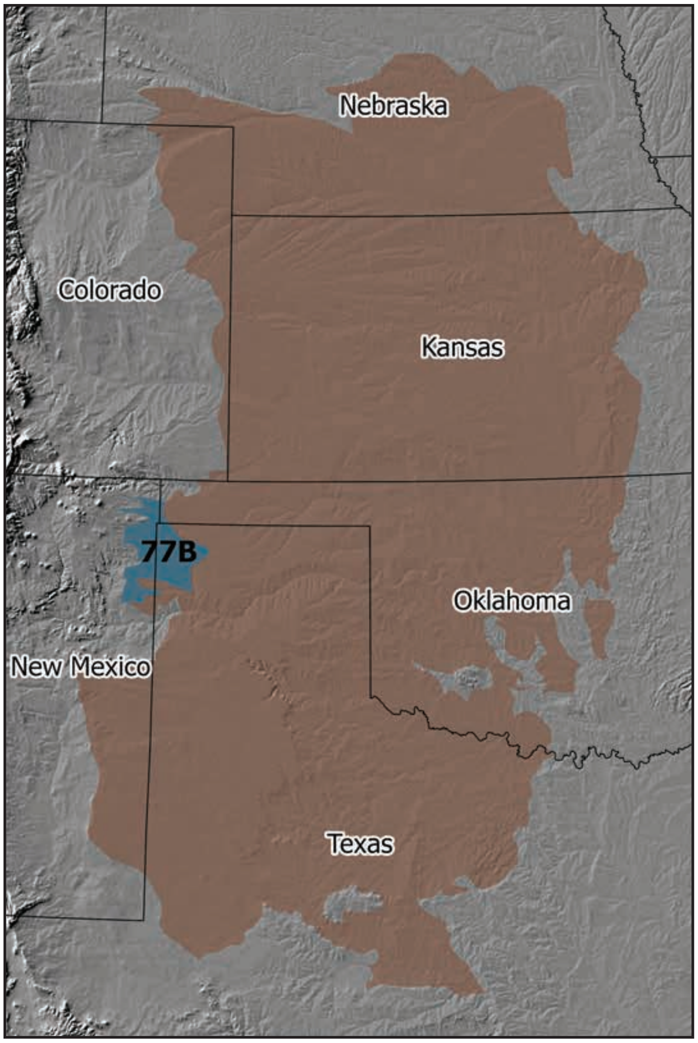

Figure 77B-1: Location of MLRA 77B, which covers 768,800 hectares (1,899,800 acres), within Region H.

52 to 57 degrees F (11 to 14 degrees C). The freeze-free period averages 185 days and ranges from 165 to 185 days, increasing in length from north to south.

Water

The moderately low, erratic precipitation is the source of water for range and dry-farmed crops. The flow in tributaries of the Canadian River fluctuates widely from year to year, and the water in these tributaries is little used for irrigation. Reservoirs provide some surface water for irrigation. Most of the surface water in the area is slightly saline because of natural sources of salts and because of irrigation return flows from cropland irrigated with ground water.

Sand and gravel in the High Plains, or Ogallala, aquifer yield an abundance of ground water for irrigation, but the water table is gradually declining. This aquifer is called the Eastern New Mexico Basin Fill aquifer in the part of this area in New Mexico. The High Plains aquifer is not actually a basin fill deposit, but its water is so similar in quality to the water in other basin fill aquifers in New Mexico that it is grouped with them. This water is very hard.

Soils

The dominant soil order is Alfisols. The soils in the area dominantly have a mesic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They generally are very deep, well drained, and loamy or sandy.

The main soils and their series:

- Paleustalfs that formed in loamy eolian sediments on nearly level to gently sloping plains (Dallam, Rickmore, and Perico series); that formed in calcareous eolian deposits on nearly level to moderately sloping plains and interdunes (Spurlock series); that formed in sandy eolian deposits on nearly level to moderately sloping dunes and hummocks (Vingo series)
- Torripsamments that formed on gently sloping to moderately steep dunes and hummocks (Valerian series)
- Ustifluvents that formed on nearly level flood plains (Corlena series)

Biological Resources

This area dominantly supports mid and tall prairie grasses. Nearly level to sloping plains and sandhills dominated by moderately fine textured to moderately coarse textured soils are characterized by a mixture of mid and tall grasses and a lesser amount of short grasses. On loamy soils, mid grasses dominate and sideoats grama is the dominant species. Woody shrubs, particularly yucca, catclaw, and sand sage, make up 5 percent or less of the plant community. On sandy soils, nearly half of the grasses in the plant community are tall grasses, such as little bluestem and sand bluestem. Woody shrubs, specifically sand sage, shin oak, and skunkbush, make up 20 to 30 percent of the plant community.

Major wildlife species in this area include mule deer, white-tailed deer, antelope, coyote, badger, raccoon, skunk, porcupine, jackrabbit, cottontail, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. Fish species include rainbow trout, bluegill, catfish, largemouth bass, and walleye.

Land Use

Rangeland and cropland make up nearly all of this MLRA (fig. 77B-2). The beef cattle industry is economically important in the MLRA. About two-thirds of the area is used for grazing. In some areas beef cattle graze small grain pastures throughout winter. Almost one-third of the area is cropland. Most of the crops are irrigated. Corn is the principal irrigated crop. Wheat and grain sorghum also are grown in irrigated areas.

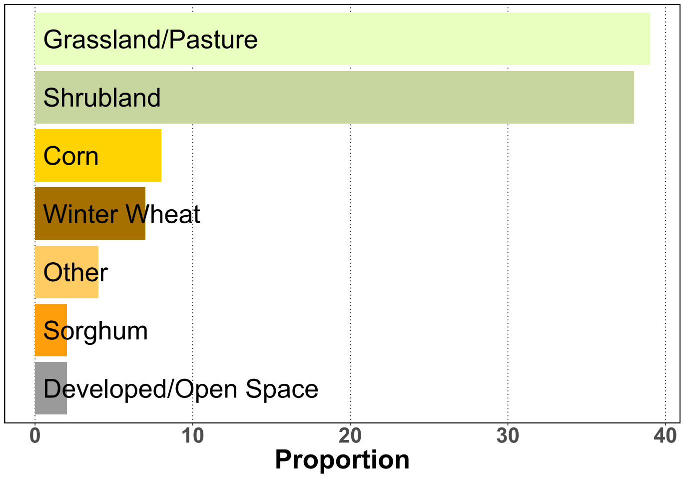

Figure 77B-2: Relative proportions (percentages) of land use in MLRA 77B.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for tillage), cover crops, windbreaks, vegetative wind barriers, stripcropping, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Haying commonly provides supplemental feed during the long winters.

77C—Southern High Plains, Southern Part

MLRA 77C (fig. 77C-1) is characterized by extensive areas of nearly level to gently sloping eolian plains on a distinct and elevated plateau known as the Llano Estacado ("Staked Plain"). The predominant land use is crop production, and cotton and corn are major crops. The MLRA is in Texas (90 percent) and New Mexico (10 percent). It makes up about 22,695 square miles (58,780 square kilometers).

The MLRA has a distinct boundary with the topographically distinct MLRA 77E (Southern High Plains, Breaks) to the north and with the steep escarpments rising over MLRA 78B (Central Rolling Red Plains, Western Part) to the east. To the south, the boundary is less distinct as the elevation gradually declines and merges into MLRA 81A (Edwards Plateau, Western Part). The western boundary with MLRA 77D (Southern High Plains, Southwestern Part) is also less apparent and based on the diffuse boundary between the ustic and aridic soil moisture regimes.

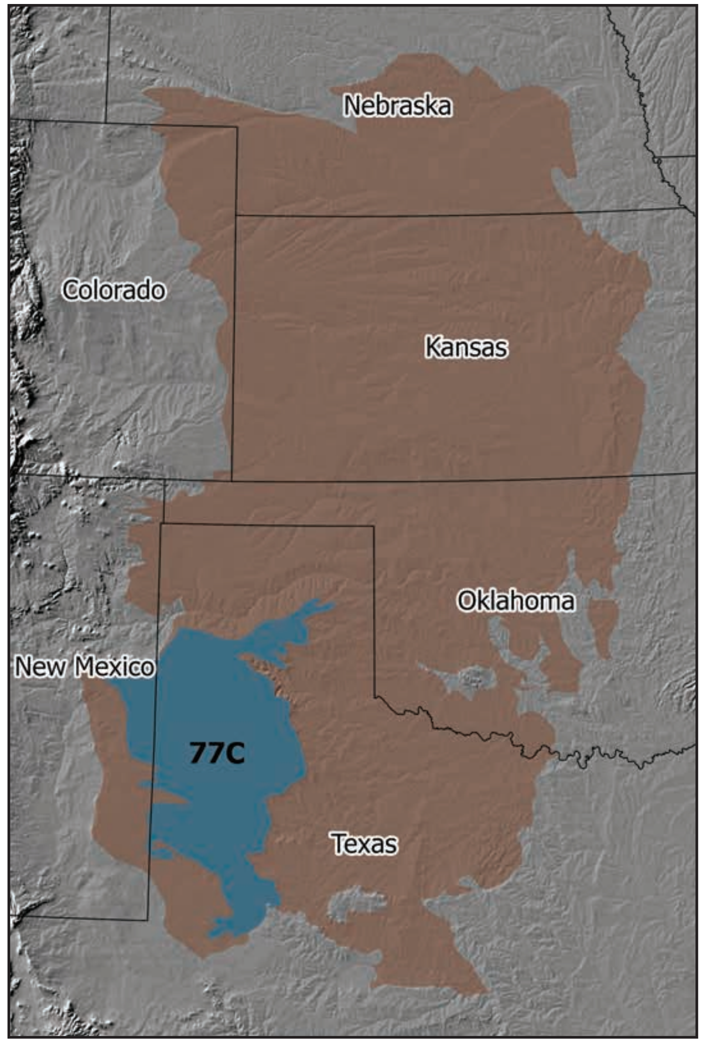

Figure 77C-1: Location of MLRA 77C, which covers 5,878,000 hectares (14,524,700 acres), within Region H.

Physiography

This area is in the High Plains section of the Great Plains province of the Interior Plains. A few draws with moderate to steep slopes and very narrow flood plains are incised into the plateau and trend generally from northwest to southeast. Numerous playa basins ranging from 5 to 160 acres (2 to 65 hectares) in size dot the landscape. Elevation is 4,600 feet (1,400 meters) in the northwestern part of the MLRA and gradually decreases to 2,600 feet (795 meters) in the southeastern part. The topographical relief is dominated by nearly level and very gentle slopes.

A few streams in the northern part of this area drain to the north into the Canadian River, which is outside the MLRA. Many headwater streams of the Red River are in this area, and some of the headwaters of the Brazos and Colorado Rivers are in the southern part of the area.

Geology

The surface of this area is covered primarily by eolian deposits of the Blackwater Draw Formation of Pleistocene age. Lacustrine deposits of dolomite with interbedded clastic sediments are laterally extensive where they are of Pliocene age (Blanco Formation) and more local where they are of Pleistocene age (Tule, Double Lakes, and Tahoka Formations). Locally, draws are through alluvial deposits of the Ogallala Formation of Miocene-Pliocene age.

Climate

The average annual precipitation in this area is 16 to 22 inches (406 to 560 millimeters), fluctuating widely from year to year. Most of the rainfall occurs during high-intensity, convective thunderstorms in late spring and early fall. The average annual temperature is 55 to 63 degrees F (13 to 17 degrees C). The freeze-free period averages 225 days and ranges from 195 to 255 days, increasing in length from north to south.

Water

The moderately low, erratic precipitation is the source of water for range and dry-farmed crops. Few perennial streams are in the area. Their flow fluctuates widely from year to year, and their water is little used for irrigation. The headwaters of both the Brazos and Colorado Rivers receive high salt loads from natural sources downstream from this area.

Irrigation water is obtained from wells in the High Plains, or Ogallala, aquifer. Because withdrawals are exceeding recharge, the water table is gradually declining. In some areas the declining water table and increasing energy costs have led to the conversion of previously irrigated cropland to dry-farmed cropland. The High Plains aquifer is called the Eastern New Mexico Basin Fill aquifer in the part of this area in New Mexico. The High Plains aquifer is not actually a basin fill deposit, but its water is so similar in quality to that of other basin fill aquifers in New Mexico that it is grouped with them. The ground water in this area is very hard.

Soils

The dominant soil orders are Alfisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They generally are moderately deep to very deep, well drained, and clayey, loamy, or sandy.

The main soils and their series:

- Calciustepts that formed in loamy eolian sediments on nearly level to gently sloping plains or playa steps within playa basins (Arch and Gomez series); that formed in loamy eolian sediments on dunes on the margins of playa basins (Drake series); that formed in loamy eolian sediments on plains and the side slopes of drainageways and playa basins (Midessa series)
- Calciustolls that formed in loamy eolian sediments on plains and the side slopes of drainageways and playa basins (Pep series); that formed in lacustrine deposits on plains and the side slopes of drainageways and playa basins (Portales series)
- Haplustalfs that formed in loamy eolian sediments on nearly level to gently sloping plains (Tokio series); that formed in sandy eolian sediments on nearly level to gently sloping plains (Yoakran series)
- Haplusterts that formed in clayey lacustrine deposits on playa floors within playa basins (Chapel, Lazbuddie, Lockney, McLean, Ranco, Randall, and Sparenberg series)
- Paleustalfs that formed in loamy eolian sediments on nearly level to gently sloping plains (Amarillo and Arvana series); that formed in sandy eolian sediments on nearly level to gently sloping plains (Brownfield, Patricia, and Plains series); that formed in loamy eolian sediments on nearly level to very gently sloping plains and the side slopes of drainageways and playa basins (Posey series)
- Paleustolls that formed in loamy and clayey eolian sediments on plains (Acuff, Friona, Olton, Pantex, and Pullman series); that formed in mixed alluvium and eolian sediments on plains and shoulder slopes along drainageways and in playa basins (Estacado and Bovina series); that formed in loamy eolian sediments on plains and shoulder slopes along drainageways and in playa basins (Mansker series)
- Ustipsamments that formed in sandy eolian sediments on dunes (Nutivoli series)

Biological Resources

The northeastern part of this area supports dominantly short and mid prairie grasses and sparse trees and shrubs. Fine textured soils on broad, nearly level plains support a plant community of short grasses and a few mid grasses. The most common species are blue grama and buffalograss; blue grama is dominant. In areas of moderately fine textured soils on very gently to moderately sloping plains, the plant community consists of mixed short and mid grasses with sideoats grama as the dominant species.

The southwestern part of this area primarily supports mixed prairie grasses and sparse trees and shrubs. Moderately fine textured and moderately coarse textured soils on nearly level to gently sloping plains and gently sloping to strongly sloping sandhills are characterized by a mixture of tall and mid grasses and lesser amounts of short grasses. On loamy soils, mid grasses tend to dominate and sideoats grama is the dominant species. Woody shrubs, particularly yucca, catclaw, and sand sage, make up 5 percent or less of the plant community.
On sandy soils, nearly half of the grasses in the plant

community are tall grasses, such as little bluestem and sand bluestem. Woody shrubs, specifically sand sage, shin oak, and skunkbush, make up 20 to 30 percent of the plant community on the sandy soils.

Major wildlife species in this area include mule deer, white-tailed deer, coyote, badger, raccoon, skunk, jackrabbit, cottontail, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. Fish species include bass, bluegill, catfish, and bullhead.

Land Use

Farmland, mainly cropland, makes up nearly all this area (fig. 77C-2). A small percentage of the farmland consists of rangeland, improved pasture, and wildlife habitat, primarily in the southern and western parts of the area. The principal crops are wheat, grain sorghum, and corn in the northern part of the MLRA and cotton, grain sorghum, and peanuts in the southern part. Minor crops include soybeans, sunflowers, alfalfa hay, and forage sorghum. Confined animal-feeding operations, primarily beef cattle and dairies, are economically important in the MLRA. In some areas beef cattle graze small grain pastures throughout winter.

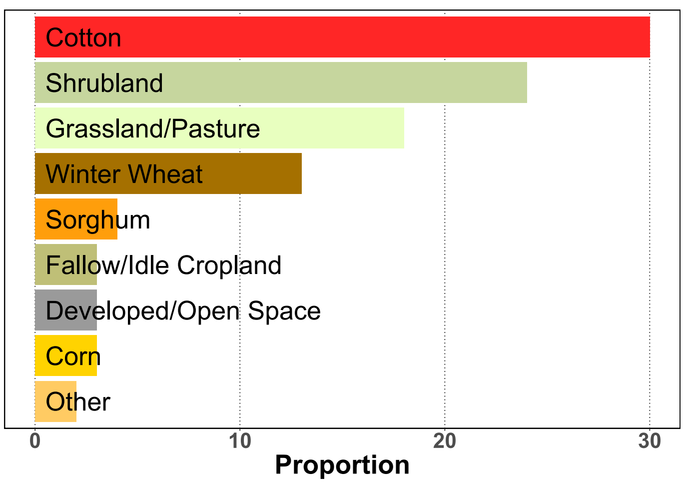

Figure 77C-2: Relative proportions (percentages) of land use in MLRA 77C.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for tillage), cover crops, windbreaks, vegetative wind barriers, stripcropping, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Haying commonly provides supplemental feed during the long winters.

77D—Southern High Plains, Southwestern Part

MLRA 77D (fig. 77D-1) is characterized by large areas of nearly level to gently sloping, open, eolian plains on the southwestern extent on an elevated plateau known as the Llano Estacado (“Staked Plain”). The main land use is livestock production although some cash crops and feed grains are produced. The MLRA is in New Mexico (58 percent) and Texas (42 percent). It makes up about 8,781 square miles (22,744 square kilometers).

MLRA 77D has a distinct boundary to the west with the physiographically dissimilar MLRA 70B (Upper Pecos River Valley). It has a less apparent boundary to the north and east with MLRA 77C (Southern High Plains, Southern Part) that is based on the diffuse boundary between the aridic and ustic soil moisture regimes. It has a distinct boundary to the south with the physiograpically dissimilar MLRA 81A (Edwards Plateau, Western Part).

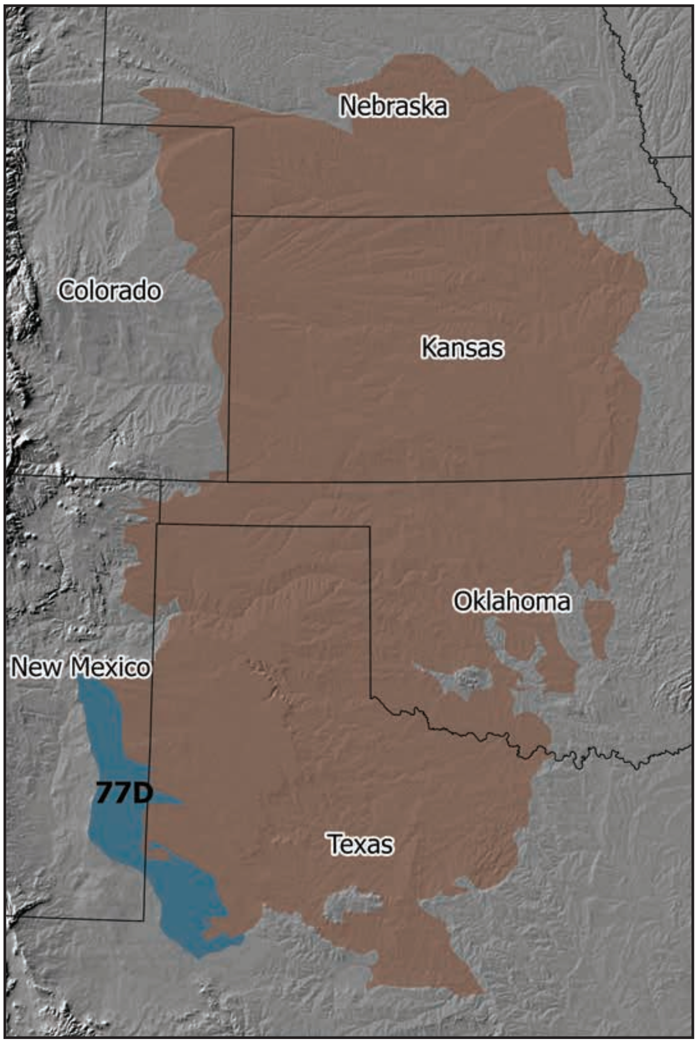

Figure 77D-1: Location of MLRA 77D, which covers 2,274,400 hectares (5,620,000 acres), within Region H.

Physiography

This MLRA is in the High Plains section of the Great Plains province of the Interior Plains. The far western part of the area has several large mesas surrounded by gently sloping plains. Sandhills and dunes are interspersed throughout the central and southwestern parts. The area has some interspersed playa basins ranging from 5 to more than 100 acres (2 to 40 hectares) in size. Elevation is 4,600 feet (1,402 meters) in the northwestern part of the area, in Roosevelt County, New Mexico, and gradually decreases to 2,600 feet (793 meters) in the southeastern part, in Glasscock County, Texas.

Some headwater streams of the Colorado and Concho Rivers cross the part of this MLRA in Texas. No large rivers are in the part in New Mexico. A few headwater tributaries of the Brazos River occur in the northern part of the area.

Geology

The surface of this area is covered primarily by eolian sediments of the Blackwater Draw Formation of Pleistocene age and sand sheets and dunes of Quaternary age. It is underlain by sand and gravel of the Miocene-Pliocene Ogallala Formation. Thin alluvial deposits are in a few large draws and valleys. A few, isolated, thin, alluvial deposits of Cretaceous age are around the larger salt-affected lake basins located throughout the MLRA.

Climate

The average annual precipitation in this area is 14 to 16 inches (356 to 406 millimeters), fluctuating widely from year to year. Most of the rainfall occurs during high-intensity, convective thunderstorms in spring and late summer. Winter precipitation mostly occurs as light snow and rainfall. The average annual temperature is 57 to 64 degrees F (14 to 18 degrees C). The frost-free period averages 210 days and ranges from 180 to 230 days, increasing in length from north to south.

Water

The headwaters of the Colorado and Concho Rivers receive high salt loads from natural sources in this MLRA. They flow into reservoirs to the east of this area, where the salinity levels are diluted by fresher runoff, which makes the water usable.

Irrigation water is obtained from wells in the High Plains, or Ogallala, aquifer. Because withdrawals are exceeding recharge, the water table is gradually declining. Some areas that formerly were irrigated are now dry-farmed. The High Plains aquifer is called the Eastern New Mexico Basin Fill aquifer in the part of this area in New Mexico. The High Plains aquifer is not actually a basin fill deposit, but its water is so similar in quality to the water in other basin fill aquifers in New Mexico that it is grouped with them. The ground water in this area is very hard.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic aridic soil moisture regime, and mixed or siliceous mineralogy. They are very shallow to very deep, well drained, and generally loamy or sandy.

The main soils and their series:

- Calciargids that formed in loamy eolian material on plains (Amarose series)
- Endoaquepts that formed in alluvium on playa steps within playa basins (Grier series)
- Haplargids that formed in sandy eolian and alluvial deposits on plains (Spantara and Triomas series)
- Paleargids that formed in alluvium on plains (Arizer series)
- Petrocalcids that formed in loamy material on plains, divides, and ridges (Blakeney, Conger, Douro, and Kimbrough series)
- Torripsamments that formed in sandy eolian deposits on plains and dunes (Penwell series)
- Ustipsamments that formed in sandy eolian deposits on plains and dunes (Milsand series)

Biological Resources

The northeastern part of this area dominantly supports short and mid grasses. This part is on nearly level plains dominated by moderately fine textured soils that support a mixture of short and mid grasses dominated by blue grama and sideoats grama.

The central and southwestern parts of this area dominantly support mixed prairie grasses. These parts are on nearly level to gently sloping plains and gently sloping to strongly sloping sandhills. The moderately fine textured and moderately coarse textured soils support a mixture of mid and tall grasses and lesser amounts of short grasses. On loamy soils, mid grasses tend to dominate and sideoats grama is the dominant species.

Woody shrubs, particularly yucca, catclaw, and sand sage, make up 5 percent or less of the plant community. On sandy soils, nearly half of the grasses in the plant community are tall grasses, such as little bluestem and sand bluestem. Woody shrubs, specifically sand sage, shin oak, and skunkbush, make up 20 to 30 percent of the plant community on sandy soils.

Major wildlife species in this area include mule deer, white-tailed deer, coyote, badger, raccoon, skunk, jackrabbit, cottontail, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. Fish species include bass, bluegill, catfish, and bullhead.

Land Use

Farms and ranches make up nearly all of this area (fig. 77D-2). Almost three-fourths of the area is rangeland.

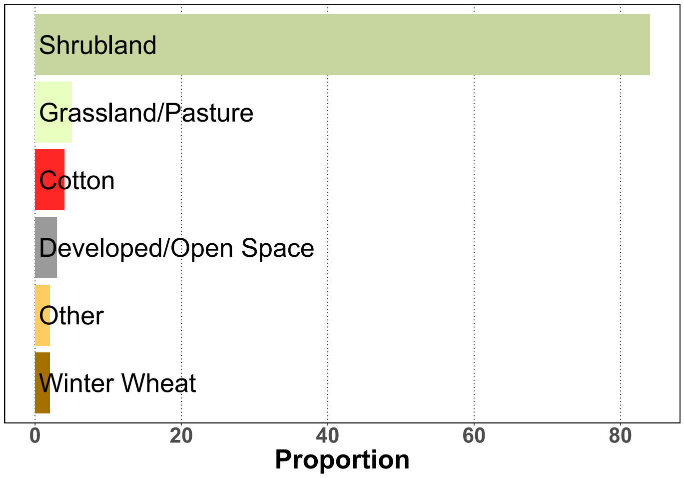

Figure 77D-2: Relative proportions (percentages) of land use in MLRA 77D.

The beef cattle industry is economically important in the area. In some areas beef cattle graze small grain pastures throughout winter. Almost one-fourth of the area is cropland. Nearly two-thirds of the cropland is irrigated. Cotton, wheat, grain sorghum, and alfalfa hay are the principal crops.

The major soil resource concerns are wind erosion, water erosion, maintenance of the organic matter content, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially reduced tillage systems), cover crops, windbreaks, vegetative wind barriers, stripcropping, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments are not used to increase forage production on the rangeland in this area. Haying commonly provides supplemental feed during the long winters.

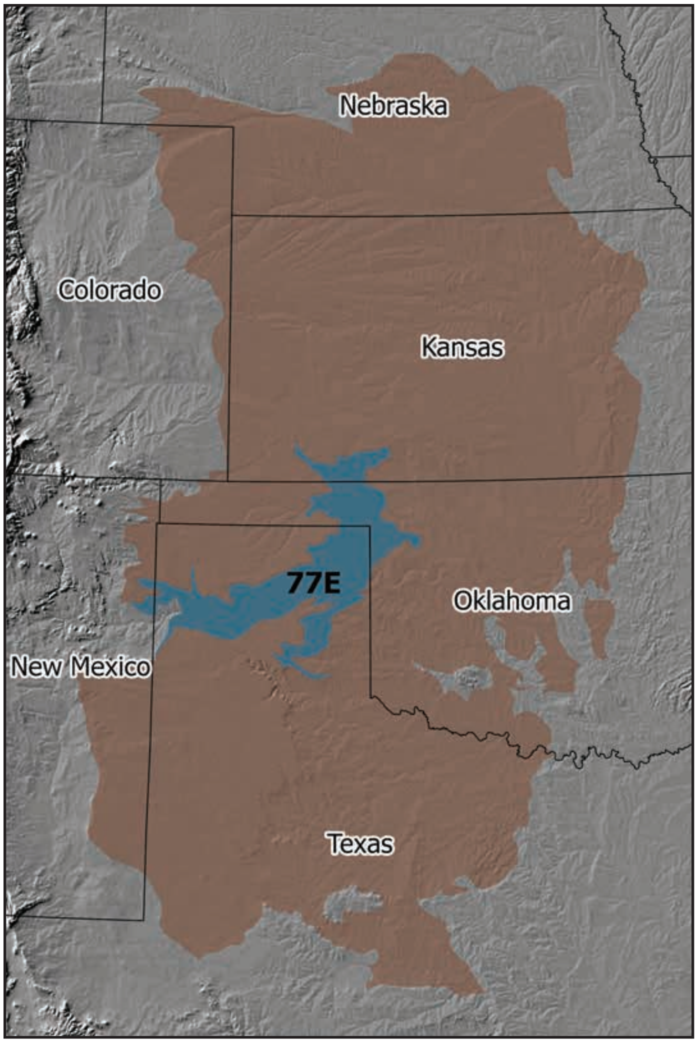

Figure 77E-1: Location of MLRA 77E, which covers 2,895,400 hectares (7,154,600 acres), within Region H.

77E—Southern High Plains, Breaks

MLRA 77E (fig. 77E-1) has undulating to hilly topography and well developed, dendritic drainage systems. It is characterized by steep escarpments, moderately steep to very gently sloping ridges, hills, hillslopes, and dunes, and gently sloping to level sand sheets, stream terraces, and flood plains. This multifaceted landscape was formed by stream incision and geologic erosion into the receding edge of the Ogallala Formation plateau. The area is bordered by the High Plains escarpment to the north, west, and south and by the Permian and Triassic-age red beds to the east. It is in western Texas (67 percent), northwestern Oklahoma (21 percent), southwestern Kansas (9 percent), and New Mexico (3 percent). It makes up 11,179 square miles (28,954 square kilometers).

The boundaries with neighboring MLRAs 77A, 77B, and 77C are typically distinct and based on landscape position—landscapes of MLRA 77E are below the High Plains “caprock” escarpment. The boundary with MLRA 78C is apparent and based on changes in geology and the associated colors of soil parent materials. This boundary is evident where the light brown and tan colors of the Ogallala Formation sharply transition to the bright red colors of the Permian and Triassic geologies. In some areas where eolian deposits drape the erosional hillslopes, the boundary is not easily discernable but can be determined with investigations of geomorphic position and adjacent stratigraphy.

Physiography

Most of this area is in the High Plains section of the Great Plains province of the Interior Plains. The northeastern third of the area is in the Plains Border section of the same province and division. This MLRA is defined by the receding erosional front of the Ogallala Formation. Geologic processes acting through stream incision and hillslope erosion have gradually changed the landscapes of this MLRA into an assemblage of very steep escarpments, very gently to moderately sloping plains, strongly sloping hills and ridges, and integrated dendritic drainage networks. Large streams and rivers (Beaver River, Cimarron River, South Canadian River, Goff Creek, Coldwater Creek, Palo Duro Creek, Sweetwater Creek, Washita River, and Wolf Creek) incise the Ogallala Formation, cutting valleys and transporting the weathered Ogallala sediments downstream. Stream terraces of varying age occur throughout these valleys. Some older terraces remain at elevations well above the current channel as fluvial processes have down cut into the Ogallala Formation. Elevation ranges from 1,860 feet (560 meters) in the southeastern part of the area to 4,760 feet (1,450 meters) in the northwestern part.

Geology

The surface of this area is covered primarily by loamy and sandy sediments of the Ogallala Formation of Miocene-Pliocene age. In general, the upper parts of this formation consist of highly calcareous caliche bedrock while the lower parts are a mixture of moderately cemented to strongly cemented sandstone and unconsolidated sands and gravel. Unconsolidated sand and gravel deposits occur in the larger river valleys. Along the major rivers and streams, eolian sands have been transported from flood plains and are emplaced upon and mixed with the Ogallala sediments, forming sand sheets and dune fields.

Climate

The average annual precipitation in this area is 15 to 26 inches (380 to 660 millimeters), fluctuating widely from year to year. Most of the rainfall occurs during high-intensity, convective thunderstorms in spring and fall. Winter precipitation occurs mainly as snow. The average annual temperature is 54 to 61 degrees F (12.4 to 15.9 degrees C). The freeze-free period averages 195 days and ranges from 170 to 215 days, increasing in length from north to south.

Water

The moderately low, erratic precipitation is the source of water for range and dry-farmed crops. The flow in the Canadian River and its tributaries fluctuates widely from year to year. The water in these rivers is not used for irrigation. Reservoirs provide some surface water for municipal and industrial uses. A large reservoir on the Canadian River, Lake Meredith, provides water for municipal and industrial uses in Amarillo, Texas. It also provides water to cities in MLRAs to the south via the Canadian River aqueduct. Most of the surface water in the area is slightly saline because of natural sources of salts and because of irrigation return flows from cropland irrigated with ground water.

Sand and gravel in the High Plains, or Ogallala, aquifer yield an abundance of ground water for irrigation and public supply. The water table has dropped from historic levels because of the number of high-yield wells tapping this aquifer. In some areas, because of the declining water table and rising energy costs, previously irrigated cropland has been converted to dry-farmed cropland.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They are shallow to very deep, well drained, and generally loamy or sandy.

The main soils and their series:

- Argiustolls that formed in loamy sediments on plains (Alibates series); that formed in old alluvium on terraces (Abbie and Irene series); that formed in loamy material on terraces (Kroeker and Texroy series)
- Calciustepts that formed in caliche colluvium on hillslopes (Ochiltree, Slapout, and Veal series); that formed in loamy old alluvium on hillslopes (Alopark series); that formed in loamy old alluvium over residuum on hillslopes (Alopark and Shalowood series)
- Calciustolls that formed in sandy and gravelly old alluvium on knobs and hillslopes (Tascosa series); that formed in loamy old alluvium on hillslopes (Mansic and Oklark series); that formed in weathered caliche on hillslopes (Catesby and Laverne series)
- Endoaquolls that formed in loamy over sandy alluvium on flood plains (Sweetwater series)
- Epiaquerts that formed in lacustrine deposits on playa floors (Rosston series)
- Haplocalcids that formed in weathered caliche on hills, ridges, and escarpments (Potter series)
- Haplustalfs that formed in loamy sediments on plains (Ady series); that formed in loamy material on stream terraces (Chiquita series); that formed in loamy eolian deposits on sand sheets (Lipscomb series); that formed in sandy eolian deposits on dunes (Vici series)
- Haplustepts that formed in alluvium on hillslopes (Berda and Mobeetie series); that formed in coarse textured sediments on flood plains (Guadalupe and Persimmon series)
- Haplustolls that formed in alluvium on flood plains (Bippus, Gilhula, Sprone, and Wespur series); that formed in mixed alluvium and colluvium on hillslopes (Paloduro series)
- Paleustalfs that formed in loamy sediments on plains (Plemons series)
- Paleustolls that formed in loamy sediments on plains (Manson series)
- Ustifluvents that formed in sandy alluvium on flood plains (Touzalin series)
- Ustipsamments that formed in wind-reworked sandy alluvium (Likes series); that formed in eolian sands on dunes (Dreyfoos series)

Ustorthents that formed in sandy old alluvium on hillslopes (Mocane series)

Biological Resources

This area supports mixed prairie grasses and a lesser amount of woody species, including yucca, pricklypear, sand sagebrush, and hackberry. Cottonwood and western soapberry are along major stream channels. On very gently to moderately sloping plains dominated by fine textured soils, the plant community consists of short grasses and a few mid grasses. The most common species are blue grama and buffalograss, and blue grama is the dominant species. Fine textured to coarse textured soils on strongly sloping hills, ridges, or scarp slopes support a mixture of tall and mid grasses and a lesser amount of short grasses. In strongly sloping areas of loamy, calcareous soils, mid grasses tend to dominate and sideoats grama is the dominant species. Woody shrubs, particularly yucca, catclaw, and sand sage, make up a minor percentage of the plant community. On sandy soils, nearly half of the grasses in the plant community are tall grasses, such as little bluestem and sand bluestem. Woody shrubs, specifically sand sage, shin oak, and skunkbush, make up about one-fourth of the plant community on the sandy soils. Invasion by woody species is a growing concern. Saltcedar has invaded flood plains where the water table is near the surface. Eastern redcedar has invaded the eastern parts of the MLRA, and mesquite has invaded areas along the South Canadian River in the Texas Panhandle.

Major wildlife species in this area include mule deer, white-tailed deer, antelope, coyote, badger, raccoon, skunk, jackrabbit, cottontail rabbit, turkey, pheasant, Canada goose, scaled quail, bobwhite quail, and mourning dove. Fish species include bass, bluegill, carp, gar, and catfish.

Land Use

Farms and ranches make up nearly all of this area (fig. 77E-2). Most of the area is used for ranching, and the beef cattle industry is economically important. In some areas beef cattle graze small grain pastures throughout winter. The cropland is primarily in the northeastern part of the MLRA. Wheat, grain sorghum, and hay are the principal crops. The crops are grown mainly on non-irrigated land, but a small percentage of the cropland is irrigated.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems that reduce the need for tillage), cover crops, windbreaks, vegetative wind barriers, stripcropping, and nutrient management. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural treatments

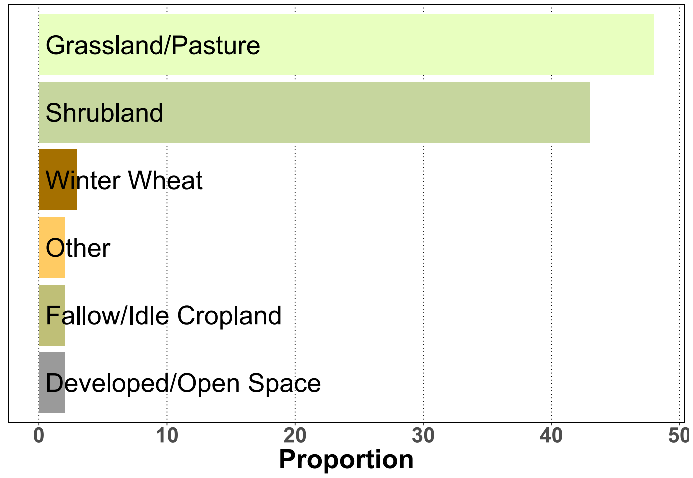

Figure 77E-2: Relative proportions (percentages) of land use in MLRA 77E.

are not used to increase forage production on the rangeland in this area. Haying commonly provides supplemental feed during winter.

78A—Rolling Limestone Prairie

This MLRA (fig. 78A-1) is characterized by generally strongly sloping to moderately steep Permian-age limestone uplands and nearly level to gently sloping alluvial plains. It is entirely in Texas and makes up about 4,563 square miles (11,818 square kilometers).

The Brazos River is the northern boundary of MLRA 78A, separating it from MLRA 80B (Texas North-Central Prairies). The Colorado River valley is the southern border, separating it from MLRA 81B (Edwards Plateau, Central Part). The eastern border is a gradual transition area of intermixed Pennsylvanian and Cretaceous-age sandstone and shale.

Physiography

The northern part of this area is in the Osage Plains section of the Central Lowland province of the Interior Plains. The southern part is in the Central Texas section of the Great Plains province of the Interior Plains. This MLRA is on a moderately dissected, rolling plain with prominent ridges and valleys and stream terraces associated with incised river systems. The rolling landscape developed over interbedded limestones and shales. Limestone outcrops form escarpments and cuestas, and limestone surface fragments cover colluvium on the adjacent side slopes. Very deep, clayey soils are common in the valleys, most of which are underlain by shale. Elevation ranges from 2,280 feet (695 meters) in the southwestern part of the area to 1,220 feet (370 meters) in the northeastern part. Maximum local relief is about 165 feet (50 meters), and average local relief is

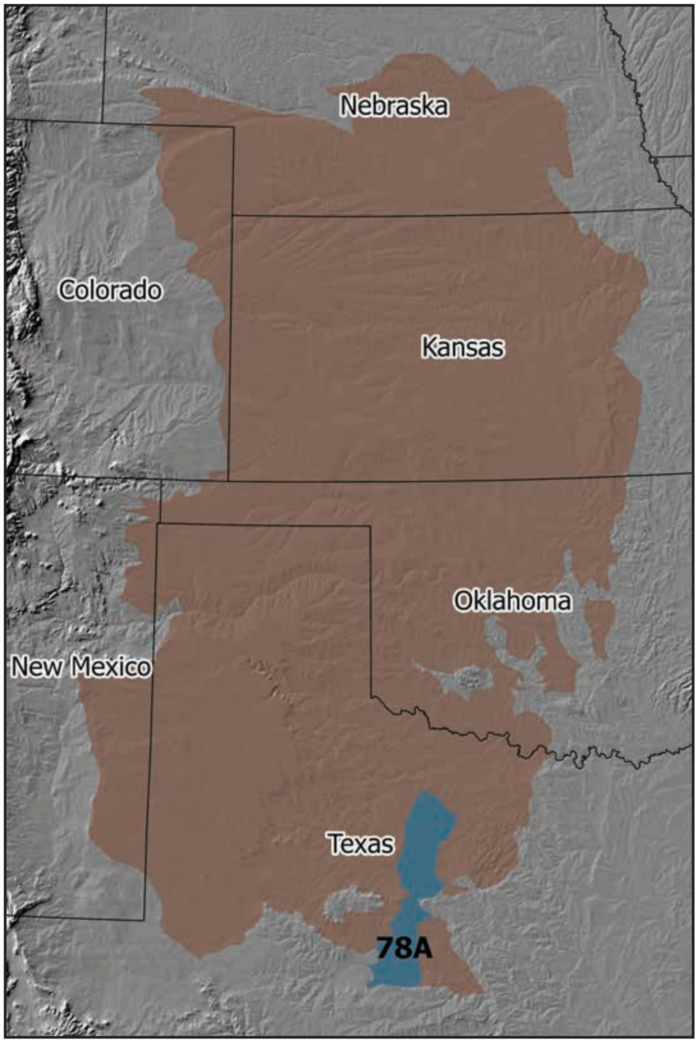

Figure 78A-1: Location of MLRA 78A, which covers 1,181,800 hectares (2,920,200 acres), within Region H.

about 15 feet (5 meters). Tributaries of the Brazos River are in the northern end of this area, and the Colorado River cuts across the southern end.

Geology

This area is underlain by interbedded light gray and white limestones and gray shales of Permian age. Geologic erosion has produced a subdued, terraced landscape. Prominent limestone scarps 15 to 85 feet (5 to 25 meters) high are common throughout the area. Large rivers and their watersheds have cut through the limestone beds, depositing large boulders on colluvial slopes. Stones and boulders are embedded in soils that formed on colluvial slopes below fractured limestone outcrops. Sandy and loamy stream terrace deposits are associated with streams that generally flow from northwest to southeast. Erosional remnants of older stream terraces are on uplands. Limestone and caliche quarries provide road material in this MLRA. Oil and gas production is important in some areas.

Climate

The average annual precipitation is 23 to 29 inches (585 to 735 millimeters). Most of the rainfall occurs comes from convective thunderstorms during the growing season. Precipitation in winter occurs as snow. The average annual snowfall is about 4 inches (10 centimeters). The average annual temperature is 63 to 66 degrees F (17 to 19 degrees C). The freeze-free period averages 250 days and ranges from 240 to 265 days.

Water

The moderate, somewhat erratic precipitation provides water for range and crops. Small ponds on individual farms provide water for livestock. Some of the larger ponds on individual farms are used for flood control, recreation, irrigation water, or water for livestock. A few large ponds and reservoirs provide municipal and irrigation water. The Colorado River and tributaries of the Brazos River are potential sources of water for irrigation. The river water is typically saline because of contamination by human activities and natural sources of salts.

The Trinity Group aquifer (limestone) underlies part of the southern half of this MLRA. The water is very hard. Ground water levels are declining in this aquifer because of heavy pumping. Deep sand and gravel deposits beneath river valley floors yield some ground water. The quality of this water is comparable to that in the Trinity Group aquifer. Ground water is scarce in sloping areas where underlying sandstone and shale are near the surface.

Soils

The dominant soil orders in this MLRA are Entisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, mixed, or carbonatic mineralogy. They are very shallow to very deep, well drained, and generally loamy or clayey.

The main soils and their series:

- Argiustolls that formed in clayey and loamy sediments over limestone bedrock (Rowden and Swenson series); that formed in clayey and loamy alluvium on alluvial plains (Sagerton series)
- Calciustolls that formed in residuum on ridges and plains (Lueders, Springcreek, and Talpa series); that formed in old alluvium on hills and knobs (Pitzer series); that formed in loamy alluvium on stream terraces, alluvial fans, and plains (Nuvalde and Rowena series)
- Haplustepts that formed in residuum on escarpments and plains (Owens and Throck series)

Haplusterts that formed in clayey alluvium in valleys (Leeray series)
Haplustolls that formed in loamy and clayey alluvium on flood plains (Clearfork, Gageby, and Nukrum series)
Ustorthents that formed in residuum on escarpments and plains (Harpersville series)

Biological Resources

This area is in the central part of the mixed grass prairie. Loamy and clayey soils on uplands favor mid and tall grasses. Big bluestem, little bluestem, Indiangrass, sideoats grama, Texas cupgrass, vine mesquite, buffalograss, and Texas wintergrass are the dominant species. Abundant forbs include catclaw sensitive briar, heath aster, Engelmann's daisy, gaura, prairie clover, dalea, plains blackfoot, and verbena. Scattered motts of live oak, elm, Bumelia, and hackberry are common. Mesquite has invaded areas throughout the MLRA, except for areas of shallow soils. Pricklypear cacti are invasive on some shallow soils. Soils on low stream terraces and flood plains favor the growth of bluestems, Indiangrass, switchgrass, grama grasses, Texas wintergrass, and western wheatgrass. Hackberry, pecan, elm, and cottonwood are common on the bottom land.

Major wildlife species in this area include white-tailed deer, turkey, bobwhite quail, mourning dove, fox squirrel, ducks, geese, fox, ring-tail cat, coyote, bobcat, rabbits, badgers, songbirds, and rattlesnakes. Rivers, constructed ponds, and reservoirs provide good opportunities for fishing.

Land Use

Farms and ranches make up nearly all of this area (fig. 78A-2). The farmland is used mostly for the production of cattle and, to a lesser extent, sheep and horses. The cropland in the area is limited to soils that formed on terraces and flood plains. It is commonly used to produce small grains or hay for livestock and wildlife. Forage sorghum and alfalfa are grown for livestock. Wheat, cotton, and sorghum are the principal crops grown in the area. Some cropland has been converted to pasture. The leasing of lands for hunting and other kinds of recreation is common.

The major soil resource concerns are water erosion, maintenance of the content of soil organic matter, and conservation of soil moisture. The major management concerns on rangeland are proper stocking rates, a dependable water supply, brush management, and food and cover for wildlife.

Conservation practices on cropland generally include a combination of terraces and grassed waterways, contour farming, and crop residue management. Conservation practices on rangeland generally include proper grazing use, brush management, fencing, watering facilities, and measures that improve wildlife habitat.

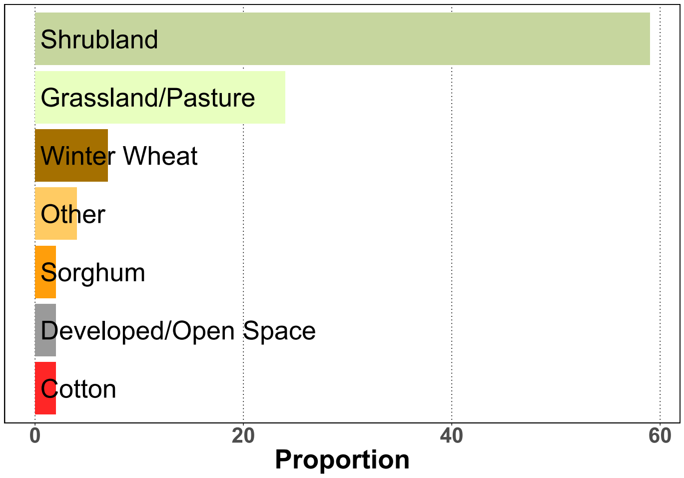

Figure 78A-2: Relative proportions (percentages) of land use in MLRA 78A.

78B—Central Rolling Red Plains, Western Part

This MLRA (fig. 78B-1) is characterized by red soils weathered from silty sandstone, siltstone, and claystone on rolling plains with ancient stream terraces or terrace remnants associated with stream dissection. The expansive dissected plains are carved and reworked by several large rivers and their tributaries. The MLRA is in Texas (92 percent) and Oklahoma (8 percent). It makes up about 18,184 square miles (47,095 square kilometers).

MLRA 78B has distinct western and southern boundaries with MLRAs 77C (Southern High Plains, Southern Part) and 81A (Edwards Plateau, Western Part) due to distinct escarpments in most areas. It has less distinct eastern and northern boundaries, marked by the eastern edge of the Blaine Formation, which consists of interbedded gypsum, dolomite, and siltstone.

Physiography

Most of this area is in the Osage Plains section of the Central Lowland province of the Interior Plains. The southern end is in the Central Texas section of the Great Plains province of the Interior Plains, and the western one-third is in the High Plains section of the same province and division. Gypsum interbedded with limestones and dolomites forms a karst landscape with steep escarpments. Low, stabilized dunes associated with wind-reworked sandy alluvium are in scattered areas throughout the MLRA. The erosional surface has stream channels entrenched in gently dipping bedrock.

Elevation is 1,450 feet (440 meters) in the eastern part of the area and gradually increases to about 2,940 feet (895 meters) in the western part. Maximum local relief is about 180 feet (55 meters), but relief is considerably lower in most of the area. The major rivers crossing this area, from north to south, include the Prairie Dog Town Fork of the Red River, the Pease and Wichita

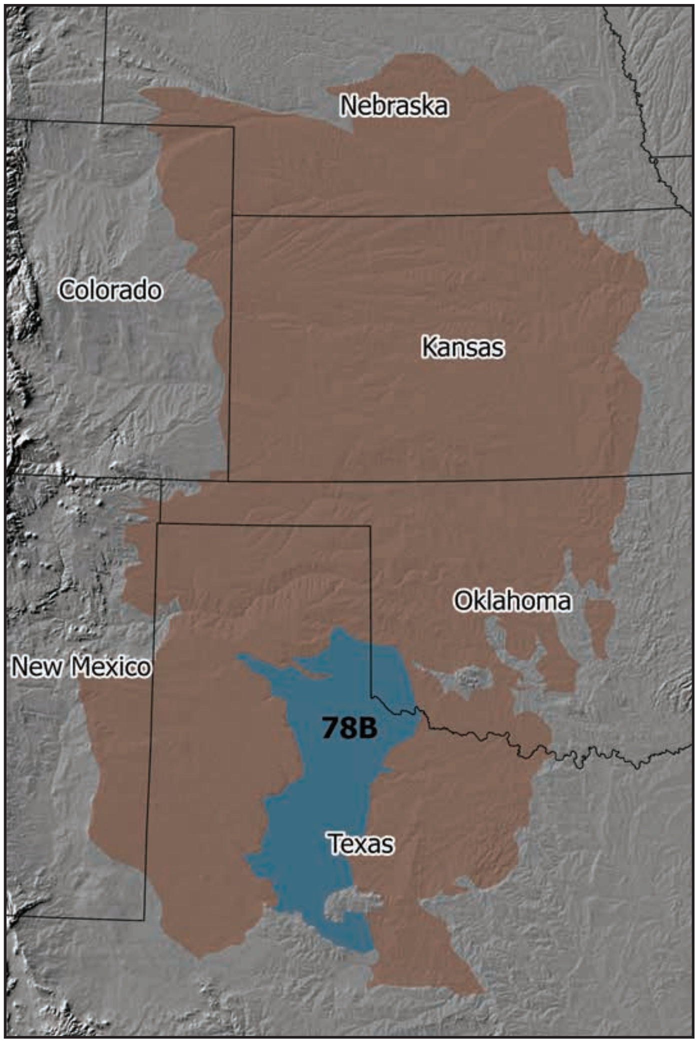

Figure 78B-1: Location of MLRA 78B, which covers 4,709,500 hectares (11,637,400 acres), within Region H.

Rivers, the Salt Fork of the Brazos River, the Double Mountain Fork of the Brazos River, and the Colorado River.

Geology

In this MLRA, loamy, sandy, and clayey sediments of Quaternary age overlie Triassic and Permian deposits on fan remnants and stream terraces. Triassic sediments include calcareous sandstone, shale, clay, and conglomerate in the Dockum Group. Most of the area is characterized by red soils weathered from sediments of the Permian Redbeds. Permian deposits include interbedded shale, sandstone, gypsum, and dolomite in the Whitehorse and Blaine Formations. A surface veneer of siliceous gravel can indicate thin, ancient terrace deposits. Mining operations for gypsum and gravel are in scattered areas throughout the MLRA. Oil and gas production is important in some areas.

Climate

The average annual precipitation is 19 to 26 inches (485 to 660 millimeters), increasing from west to east across the MLRA. Most of the rainfall occurs during convective thunderstorms in late spring and early fall. Annual precipitation, which occurs as snow in winter, averages about 3 inches (76 millimeters). The average annual temperature is 57 to 65 degrees F (14 to 18 degrees C). The freeze-free period averages 235 days and ranges from 215 to 260 days.

Water

The moderate, somewhat erratic precipitation provides water for range and crops. Small ponds on individual farms provide water for livestock. Some larger ponds on individual farms are used for flood control, recreation, irrigation water, or water for livestock. A few large ponds and reservoirs are sources of municipal and irrigation water. In the southern part of the area, the Colorado River and tributaries of the Brazos River are potential sources of water for irrigation. The river water is saline because of contamination from human activities and natural sources of salts. The salinity levels in reservoirs are diluted by fresher water inflows from other areas.

Most of the ground water in this area comes from the alluvial and bolson deposits in Texas. The ground water is very hard. Ground water is scarce in sloping areas where the underlying sandstone and shale are near the surface.

The Dog Creek-Blaine aquifer in the extreme southwest corner of Oklahoma occurs in this MLRA. Water from this aquifer is somewhat saline and very hard. It is used for irrigation but is unsuitable for public supply. This water has the highest median levels of total dissolved solids and the highest levels of sulfate and is the hardest of all the water from aquifers in Oklahoma.

Soils

The dominant soil orders are Alfisols, Entisols, Inceptisols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime. The soil moisture regime is aridic ustic in the southwestern third of the MLRA associated with Triassic-age sediments. It is typic ustic in the rest of the MLRA. The soils have mixed or carbonatic mineralogy. They are very shallow to very deep, are well drained, and generally are sandy, loamy, or clayey.

The main soils and their series:

- Argiustolls that formed in clayey and loamy alluvium on stream terraces and alluvial plains (Frankirk, Sagerton, and Westill series)
- Calciustepts that formed in loamy, calcareous colluvium and slope alluvium on hillslopes and side slopes (Aspermont and Veal series)
- Calciustolls that formed in residuum on hills and ridges (Talpa series)

Haplustalfs that formed in loamy residuum on plains (Paducah series)
Haplustepts that formed in residuum on hills and ridges (Obaro, Spade, and Tilvern series)
Paleustalfs that formed in sandy and loamy alluvium, commonly reworked by the wind, on stream terraces and plains (Delwin, Heatly, Miles, and Nobscot series)
Torriorthents that formed in residuum on hills and ridges (Latom series)
Ustifluvents that formed in sandy, loamy, or clayey alluvium on flood plains (Colorado, Lincoln, Mangum, and Yomont series)
Ustipsamments that formed in sandy eolian deposits on dunes adjacent to the major rivers (Eda, Jester, and Tivoli series)
Ustorthents that formed in residuum on hills and ridges (Cottonwood and Knoco series)

Biological Resources

This area is in the central part of the mixed grass prairie. Loamy and clayey soils favor the growth of buffalograss, curly-mesquite, sideoats grama, blue grama, vine mesquite, little bluestem, sand bluestem, Arizona cottontop, silver bluestem, Texas wintergrass, and tobosagrass. Mesquite, lotebush, and redberry juniper are common brushy invaders. Sandy soils favor bluestems, switchgrass, sand lovegrass, sand dropseed, and sand sagebrush. Some sandy areas support thick stands of shinnery oak. Saltcedar has invaded areas on flood plains where the water table is near the surface.

Common wildlife species in this area include white-tailed deer, desert mule deer, coyote, bobcat, black-tailed jackrabbit, cottontail rabbit, prairie dog, feral hogs, turkey, bobwhite quail, blue quail, mourning dove, ducks, and geese. Antelope and mountain lion inhabit a few areas.

Land Use

Ranches and farms make up nearly all of this area (fig. 78B-2). Soils that formed on the Permian Redbeds, which make up almost three-fourths of the area, are used as rangeland. Soils that formed in Quaternary deposits on terraces or flood plains, which make up just under one-fourth of the area, are used as cropland. Areas of these nearly level and very gently sloping soils are commonly used to grow small grains for livestock and for wildlife grazing during fall and winter. Cotton, wheat, and sorghums are the main crops. Cotton, alfalfa, and peanuts are grown under irrigation where there is an adequate amount of good-quality water. Many of the farms and ranches lease access for hunting or other forms of recreation.

The major soil resource concerns include wind erosion, water erosion, maintenance of the content of soil organic matter, and management of soil moisture. The major management concerns on rangeland include proper stocking rates, brush control, and the availability of stock water in periods of inadequate rainfall.

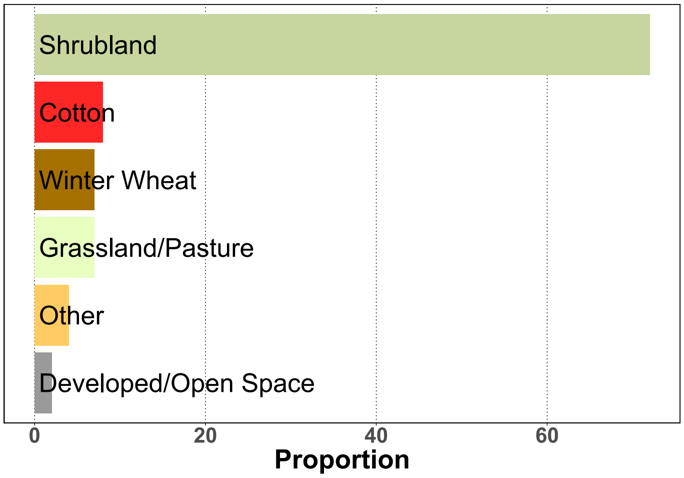

Figure 78B-2: Relative proportions (percentages) of land use in MLRA 78B.

Conservation practices on cropland generally include a combination of terraces and grassed waterways. They also include contour farming and crop residue management. Conservation practices on rangeland generally include proper grazing use, brush control (which improves wildlife habitat and forage production), fencing, watering facilities, and measures that improve wildlife habitat.

78C—Central Rolling Red Plains, Eastern Part

This MLRA (fig. 78C-1) is characterized by red soils and a mixed grass prairie on smooth to rolling hills and valleys. The expansive dissected plains are carved and reworked by several large rivers and their tributaries. The MLRA is in Oklahoma (55 percent), Texas (35 percent), and Kansas (10 percent). It makes up about 20,434 square miles (52,924 square kilometers).

The northern boundary of the MLRA is gradual as the climate grades into the mesic soil temperature regime. The northwestern boundary with MLRA 77A (Southern High Plains, Northern Part) is distinct, typified by the eastern extent of the Ogallala Formation. The eastern boundary with MLRAs 78B and 78C (Central Rolling Red Prairies, Western and Eastern Parts) is gradual as the soil moisture regime grades to udic ustic. The southern boundary with MLRA 81A (Edwards Plateau, Western Part) is distinct.

Physiography

Most of this area is in the Osage Plains section of the Central Lowland province of the Interior Plains. The southwest tip is in the Central Texas section of the Great Plains province of the Interior Plains, and the northern tip is in the Plains Border section of the same province and division. This MLRA consists of moderately dissected, rolling plains with prominent ridges

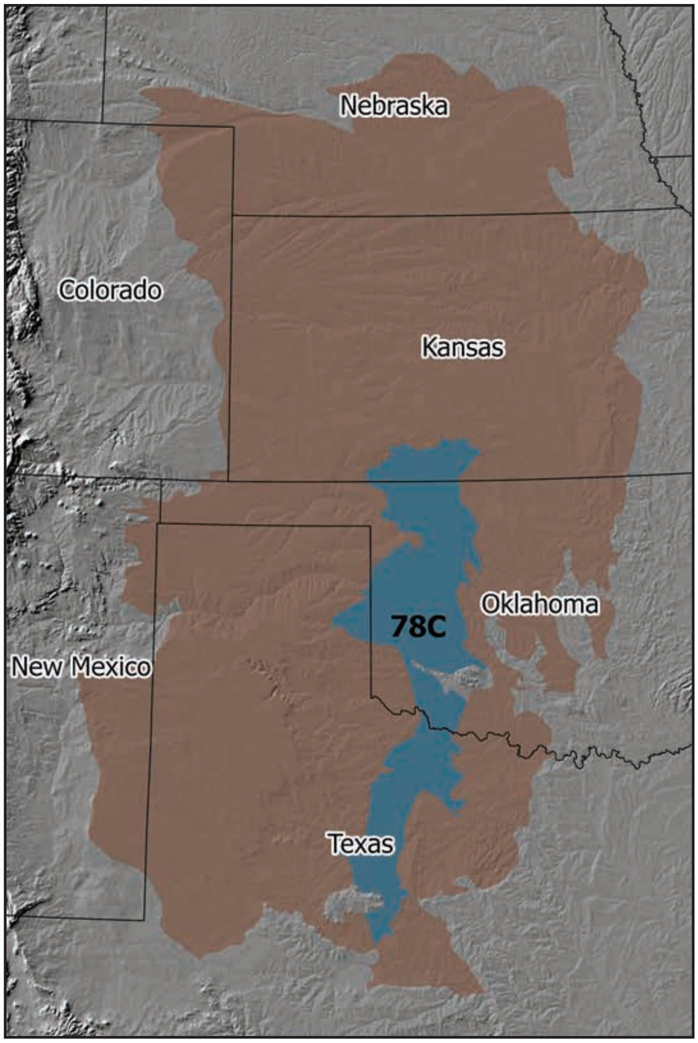

Figure 78C-1: Location of MLRA 78C, which covers 5,292,400 hectares (13,077,700 acres), within Region H.

and valleys, some local areas of badlands, and numerous stream terraces. Elevation ranges from about 1,000 feet (305 meters) along the Red River to 2,000 feet (610 meters) in Oklahoma. Maximum local relief is about 300 feet (90 meters), and the average local relief is about 100 feet (30 meters).

Major rivers in this area include, from north to south, the Mule River and Salt Fork of the Arkansas River in Kansas; the Cimarron, North Canadian, Canadian, and Washita Rivers and North Fork of the Red River in Oklahoma; and the Pease, Wichita, and Brazos Rivers in Texas. The Red River forms the boundary between Texas and Oklahoma in this MLRA.

Geology

This area is underlain primarily by soft, calcareous sandstones, siltstones, and shales in red beds of the Wellington Formation, El Reno Group, Whitehorse Group, Cloud Chief Formation, and Quartermaster Formation of Permian age in Oklahoma and of the Wichita and Clear Fork Groups of Permian age in Texas. The characteristic red soils in most of the area formed from the underlying sedimentary rocks of the Permian Redbeds.

Climate

The average annual precipitation in this area is 22 to 30 inches (560 to 760 millimeters). Most of the rainfall comes from convective thunderstorms during the growing season. Winter precipitation, occurring as snow, averages about 6 inches (152 millimeters). The average annual temperature is 56 to 65 degrees F (13 to 18 degrees C). The freeze-free period averages 230 days and ranges from 200 to 260 days.

Water

The moderate, somewhat erratic precipitation provides water for range and crops. Small ponds on individual farms provide water for livestock. Some larger ponds on individual farms are used for flood control, recreation, irrigation water, or livestock water. A few large ponds and reservoirs are sources of municipal and irrigation water. Many of the major rivers that cross this area are potential sources of irrigation water. Much of this river water, however, has a high content of salts because of contamination from human activities and natural sources of salts (brine seeps).

Most of the ground water in this area comes from alluvial and terrace aquifers and is used for irrigation and domestic supply. The high amounts of total dissolved solids are the result of gypsum in the alluvium. This ground water is very hard. Ground water is scarce in sloping areas where the underlying sandstone and shale are near the surface.

Soils

The dominant soil orders are Alfisols, Inceptisols, and Mollisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are moderately deep to very deep, well drained and moderately well drained, and loamy or clayey.

The main soils and their series:

Argiustolls that formed in loamy alluvium on stream terraces (Abbie, Abilene, Carey, St. Paul, and Selman series)

Haplustepts that formed in residuum on hills and ridges (Quinlan, Vernon, and Woodward series); that formed in mixed alluvium and colluvium on hills and stream terraces and in valleys (Burford, Deepwood, Hardeman, and Shrewder series)

Paleustolls that formed in residuum on hills and ridges (Tillman and Deandale series)

Ustifluvents that formed in alluvium on flood plains (Beckman, Clairemont, Lincoln, and Westola series)

Ustipsamments that formed in sandy eolian deposits on dunes adjacent to the major rivers (Tivoli and Jester series)

Biological Resources

This area is in the central part of the mixed grass prairie. Most of the rangeland in the area supports buffalograss, vine mesquite, blue grama, tobosagrass, Arizona cottontop, silver bluestem, little bluestem, and sideoats grama. It also has several hackberry trees and scattered infestations of mesquite. Sandy and loamy soils on alluvial plains and stream terraces support little bluestem, silver bluestem, switchgrass, sideoats grama, blue grama, dropseeds, buffalograss, and vine mesquite. Bottom land supports blue grama, little bluestem, silver bluestem, switchgrass, Indiangrass, sedges, sideoats grama, Texas wintergrass, and vine mesquite. The woody vegetation on bottom land includes cottonwood and elm along with some encroaching saltcedar. Major wildlife species in this area include white-tailed deer, mule deer, coyote, black-tailed jackrabbit, prairie dog, bobwhite quail, blue quail, ducks, and geese.

Land Use

Farms and ranches make up nearly all of this area (fig. 78C-2). They produce a combination of grain crops and livestock. Most of the MLRA is used as rangeland. The more gently sloping areas are used for pasture or dry-farmed crops. Small grains, cotton, and grain sorghum are the principal crops. A few small areas with a reliable water supply are irrigated.

Water erosion and conservation of soil moisture are the major management concerns on cultivated soils and overgrazed rangeland. Conservation practices on cropland generally include contour farming and crop residue management. Those on rangeland generally include proper grazing use, fencing, and development of watering facilities.

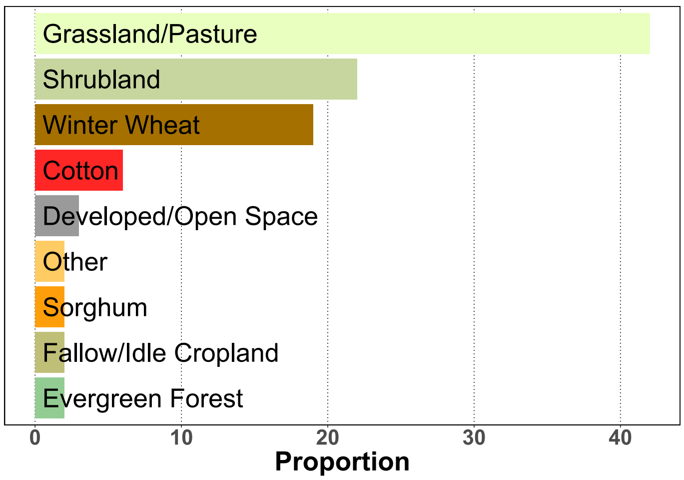

Figure 78C-2: Relative proportions (percentages) of land use in MLRA 78C.

79—Great Bend Sand Plains

This MLRA (fig. 79-1) consists of undulating to rolling sand plains, broad paleoterraces that generally have narrow valleys, and broad flood plains and terraces along the Arkansas River and its larger tributaries. This area is entirely in Kansas and makes up about 6,937 square miles (17,968 square kilometers).

MLRA 79 has a distinct boundary based on physiography (i.e., the Arkansas River Valley) with MLRAs 73 (Rolling Plains and Breaks) and 76 (Bluestem Hills). It has a less apparent boundary based on the boundary between the mesic and thermic soil temperature regimes with MLRAs 78C (Central Rolling Red Plains, Eastern Part) and 80A (Central Rolling Red Prairies).

Physiography

Most of this area is in the Plains Border section of the Great Plains province of the Interior Plains. The eastern third is in the

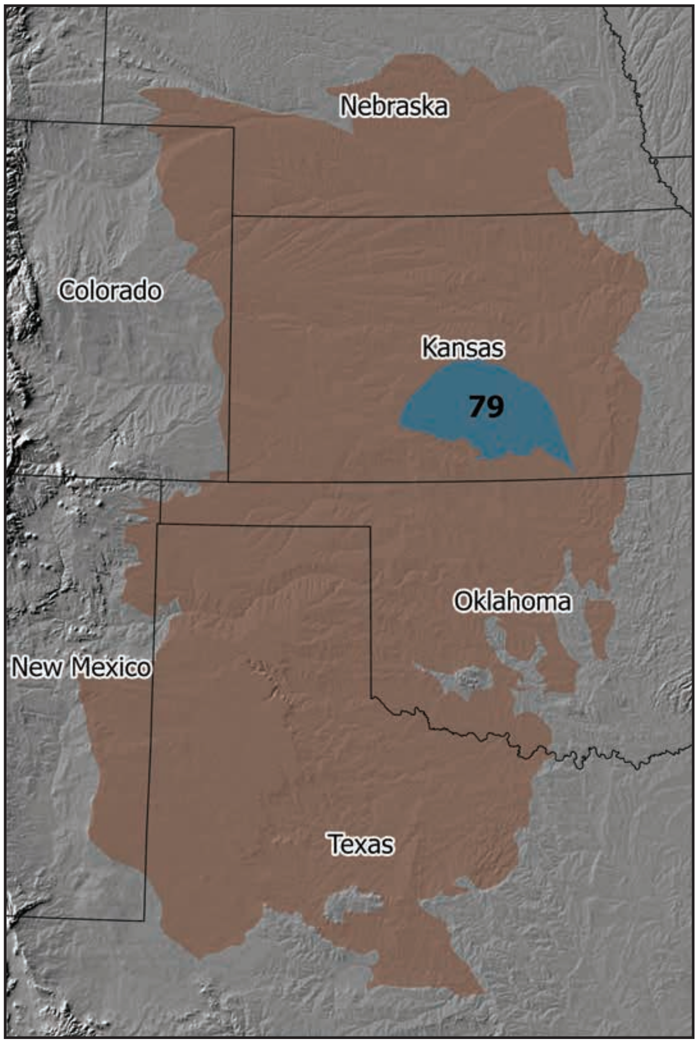

Figure 79-1: Location of MLRA 79, which covers 1,796,800 hectares (4,439,900 acres), within Region H.

Osage Plains section of the Central Lowland province of the Interior Plains. Elevation ranges from 1,050 to 2,370 feet (320 to 720 meters), increasing from east to west.

The Arkansas River bisects the northern part of this MLRA, and the Ninnescah River crosses the southern part. In this MLRA, Rattlesnake Creek flows north and the Little Arkansas River flows south into the Arkansas River.

Geology

This area is covered by a thick mantle of windblown clays, silts, and sand and sandy outwash material of Holocene and Late Pleistocene age. Alluvium consisting of silty and clayey material and coarse gravel was deposited along the Little Arkansas and Arkansas Rivers. Young, low-elevation dunes consisting of fine to medium quartz sand are adjacent to the alluvial areas.

Climate

The average annual precipitation in this area is 23 to 38 inches (590 to 980 millimeters). Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. The maximum precipitation occurs from midspring to early autumn. The annual snowfall ranges from about 14 inches (35 centimeters) in the southern part of the area to 20 inches (50 centimeters) in the northern part. The average annual temperature is 55 to 59 degrees F (13 to 15 degrees C). The freeze-free period averages 195 days and ranges from 185 to 210 days, increasing in length from northwest to southeast.

Water

The source of water for crops and pasture is the moderate, somewhat erratic precipitation. In the northern part of the area, the Arkansas River is a potential source of irrigation water but currently is little used for this purpose. The Ninnescah River is another potential source of surface water in the area.

Deep sand in the High Plains, or Ogallala, aquifer yields an abundance of good-quality ground water. This aquifer provides water primarily for irrigation but also for domestic supply and livestock in rural areas and for industry and public supply in Wichita and in other towns and cities in the MLRA. The ground water in this aquifer has the lowest levels of total dissolved solids of any aquifer in Kansas.

Soils

The dominant soil orders in this MLRA are Mollisols, Alfisols, and Entisols. Most of the soils in the area have a mesic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. They are moderately deep to very deep, poorly drained to excessively drained, and loamy or sandy.

The main soils and their series:

- Argiaquolls that are nearly level and moderately extensive throughout the MLRA, in depressions and in areas with no defined drainage pattern (Carbika series)
- Argiustolls that are nearly level and gently undulating and formed in loamy alluvium on paleoterraces in river valleys (Naron and Farnum series)
- Endoaquolls that formed in loamy alluvium on flood plains (Ninnescah series)
- Haplustalfs that formed in loamy alluvium on terraces (Nickerson series); that formed in sandy eolian deposits on dunes on paleoterraces (Pratt series)
- Haplustolls on flood plains (Imano series) and terraces along the major streams (Willowbrook series)
- Natrustalfs that formed in loamy, calcareous alluvium on terraces (Darlow series)
- Ustipsamments on the steeper sandy eolian deposits on hummocks and dunes (Tivin series)

Biological Resources

This area supports tall prairie grasses. Sand bluestem, big bluestem, little bluestem, switchgrass, and Indiangrass are the dominant species. Sand bluestem, little bluestem, sand lovegrass, and giant sandreed grow on sandy soils. Major wildlife species in this area include white-tailed deer, mule deer, coyote, black-tailed jackrabbit, prairie dog, bobwhite quail, blue quail, ducks, and geese.

Land Use

Nearly all of this area is in farms or ranches (fig. 79-2). Most of the area is cropland. Cash-grain farming is the principal enterprise. Hard winter wheat is the major crop, but grain sorghum and alfalfa also are grown. The grassland consists of sandy soils and steeply sloping areas. It supports native grasses grazed by beef cattle.

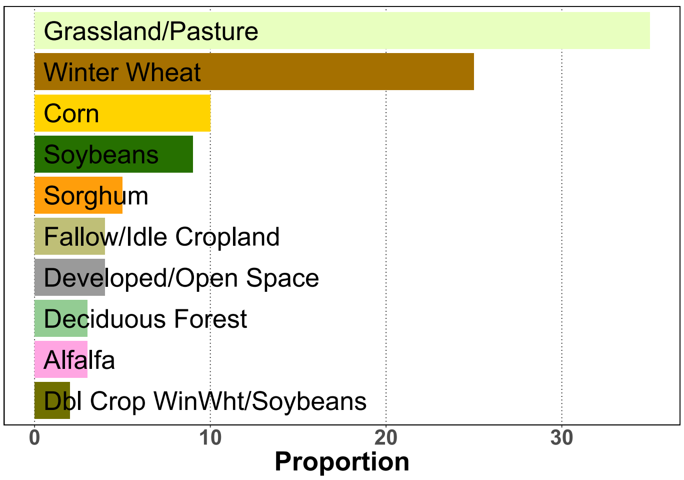

Figure 79-2: Relative proportions (percentages) of land use in MLRA 79.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of soil organic matter, and soil moisture management. The major management concerns on grassland are plant health and vigor and control of noxious and invasive weeds.

Conservation practices on cropland generally include the use of high-residue crops in the cropping system; systems of crop residue management, such as no-till and strip-till; conservation crop rotations; stripcropping; and nutrient and pest management. Conservation practices on rangeland generally include brush management, prescribed burning, control of noxious weeds, pest management, watering facilities, and proper grazing use.

80A—Central Rolling Red Prairies

This MLRA (fig. 80A-1) is characterized by generally red, well drained, loamy or clayey soils over dark red Permian sandstones or shales on gently sloping plains. This area is in Oklahoma (81 percent), Texas (12 percent), and Kansas (7 percent). It makes up about 20,031 square miles (51,881 square kilometers).

This MLRA lies between the distinct boundaries of the Permian and Pennsylvanian Cross Timbers to the east and the drier Permian Rolling Red Plains to the west. The largest part of the MLRA is in central Oklahoma and includes areas such as the Chisolm Trail and the Unassigned Lands associated with the Land Rush of 1989.

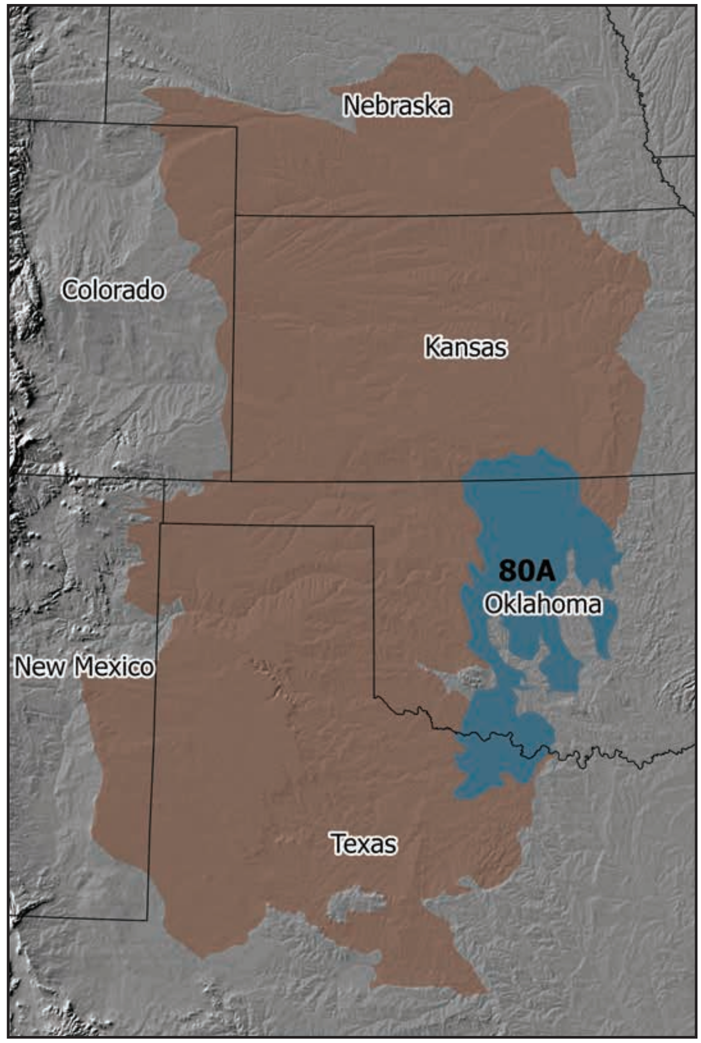

Figure 80A-1: Location of MLRA 80A, which covers 5,188,100 hectares (12,820,100 acres), within Region H.

Physiography

This area is in the Osage Plains section of the Central Lowland province of the Interior Plains. The plains are dissected by rivers flowing from northwest to southeast. Elevation ranges from about 900 to 1,390 feet (270 to 420 meters). Local relief commonly is less than 100 feet (30 meters).

From north to south, the major rivers draining this area include the Chickaskia and Bluff Rivers in Kansas; the Salt Fork of the Arkansas River and the Cimarron, North and South Canadian, Washita, Cache, and Red Rivers in Oklahoma; and branches of the Wichita River in Texas.

Geology

The plains in this area consist mainly of Pleistocene-age loamy and clayey sediments that overlie Permian sandstones and shales. The Pleistocene sediments are primarily stream terrace deposits that follow the gradient of the major streams from northwest to southeast. The shales and sandstones are part of the El Reno Group. They dip gently southwestward toward the Anadarko Basin.

Climate

The annual average precipitation in this area is 30 to 38 inches (771 to 975 millimeters). The amount may fluctuate widely from year to year. Most of the rainfall occurs during high-intensity, convective thunderstorms in spring and fall. The average annual temperature is 59 to 63 degrees F (15 to 18 degrees C). The freeze-free period averages 220 days and ranges from 207 to 240 days.

Water

The moderate, somewhat erratic precipitation is the source of water for crops and pasture. Several large rivers that cross the area from west to east are potential sources of irrigation water. A fairly high content of salts in these rivers limits use of the water. The North Canadian and Washita Rivers have good-quality water and are used for municipal supplies. Small ponds on individual farms provide flood control, recreation, irrigation water, and livestock water. A few large ponds and reservoirs are sources of municipal water and used for recreation.

Most of the ground water in this area comes from alluvial and terrace aquifers and is used for irrigation, livestock, and domestic supply. The Garber-Wellington aquifer is along the southeastern edge of this MLRA in Oklahoma. This aquifer provides drinking water to many communities in the area near Oklahoma City. The water in this aquifer is as hard as the water in the alluvial and terrace deposits. Ground water is scarce and generally highly mineralized in sloping areas where the underlying sandstone and shale are near the surface. There are no significant aquifers in the part of this MLRA in Texas.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed, siliceous, or smectitic mineralogy. They generally are shallow to very deep, well drained, and loamy or clayey.

The main soils and their series:

- Argiustolls that formed in clayey and loamy alluvium of Pleistocene age on plains (Teller and Pond Creek series); that formed in Permian sandstone residuum on ridges and hillslopes (Zaneis, Coyle, Mulhall, Grant, and Kingfisher series)
- Haplustalfs that formed in Permian shale residuum on hillslopes (Grainola and Steedman series)
- Haplustolls that formed in Permian sandstone residuum on ridges and hillslopes (Lucien series); that formed in Holocene alluvium on flood plains (Port, Ashport, Dale, Miller, and Reinach series)
- Paleustolls that formed in clayey and loamy alluvium of Pleistocene age on plains (Bethany, Tabler, Renfrow, Kirkland, Norge, Foard, and Deandale series)

Biological Resources

This area supports tall and mid prairie grasses with bottom-land timber along the water courses. Tracts of native vegetation still occur on some farms and ranches throughout the area, and many non-crop areas are planted to Bermudagrass or other introduced species. The plant diversity on native tracts can be high, including grasses, forbs, legumes, and woody species. Woody species such as eastern redcedar have encroached upon many acres due to an altered fire regime. Sericea lespedeza is another invasive species prominent in the eastern portions of the MLRA.

Major wildlife species include white-tailed deer, coyote, cottontail rabbit, bobwhite quail, doves, meadowlark, scissor-tailed flycatcher, ducks, and geese. Numerous manmade reservoirs and ponds provide good opportunities for fishing. Invasive, feral hogs may be encountered, especially near creeks and rivers.

Land Use

Farms and ranches make up nearly all of the private land in this area. Cropland and grassland (rangeland and pasture) make up nearly all of the land area (fig. 80A-2). Most farms include both cropland and grassland and produce a combination of grain crops and beef cattle. Wheat is the principal crop, but soybeans, corn, grain sorghum, and cotton also are grown. The grassland in the area is used for cow-calf and stocker cattle operations.

The main resource concerns on cropland include water erosion, surface compaction, conservation of soil moisture, and maintenance of the content of soil organic matter. The main resource concerns on grassland include plant health and vigor and control of noxious and invasive species.

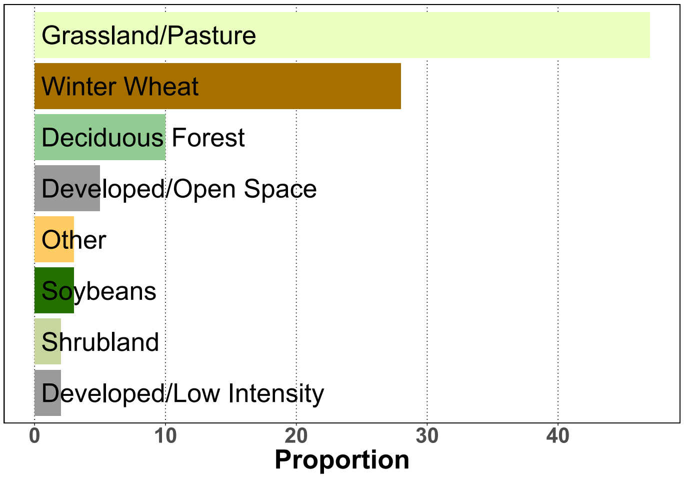

Figure 80A-2: Relative proportions (percentages) of land use in MLRA 80A.

Conservation practices on cropland generally include the use of high-residue crops in the cropping system; systems of crop residue management, such as no-till and strip-till; conservation crop rotations; and nutrient and pest management. Conservation practices on grassland generally include brush management, prescribed burning, control of noxious weeds, pest management, development of watering facilities, and proper grazing use.

80B—Texas North-Central Prairies

This MLRA (fig. 80B-1) is characterized by the Llano Arch. It primarily consists of eroded cuesta-like hills and strike valleys. Its soils formed in parent material from Pennsylvanian-age limestone, sandstone, conglomerate, and shale under a subhumid climate. The MLRA is entirely in Texas and makes up about 6,305 square miles (16,330 square kilometers).

The boundaries with neighboring MLRAs to the east are distinct and based on physical characteristics. Those to the west

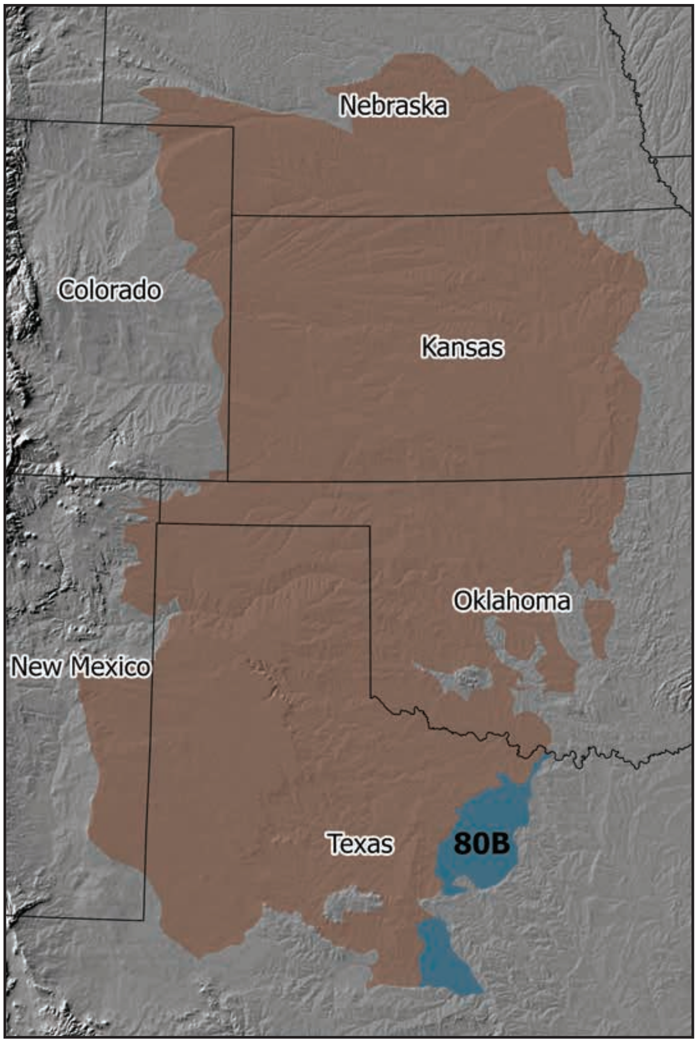

Figure 80B-1: Location of MLRA 80B, which covers 1,633,000 hectares (4,035,100 acres), within Region H.

and north are gradual and not apparent, due to subtle differences in physical and biological characteristics.

Physiography

The northern part of this area is in the Osage Plains section of the Central Lowland province of the Interior Plains. The most rugged portion of this area is known as the Palo Pinto Country, or locally as the Palo Pinto Mountains. The southern part is in the Central Texas section of the Great Plains province of the Interior Plains. This portion of the MLRA is known as the Lowland along the Colorado. This lowland is north of the Edwards Plateau and south of the Callahan Divide and Lampasas Cut Plain.

The Llano Arch, a post-Permian marginal uplift, tipped the Paleozoic strata of north and central Texas a few degrees to the west. Subsequent erosion and dissection have obscured the cuesta and strike valley topography in many places. Southeastward-facing scarp slopes and upper portions of dip slopes reflect the dip of the underlying strata to the west-northwest. The dip slopes are dissected with well defined drainage networks associated with the underlying interbedded strata. These drainage networks obscure the cuesta-like topography. Broad strike valleys have a steep scarp slope along the west-northwest valley margin. Stream terraces and flood plains are associated with present-day streams, and paleoterraces are indicative of relict stream courses. Well developed flood plains and stream terraces are associated with river valleys of the Brazos River, the Clear Fork of the Brazos River, and the Colorado River.

The Brazos River and the Clear Fork of the Brazos River drain the northern part of this area, and the Colorado River drains the southern part. Elevation ranges from 960 to 1,530 feet (290 to 460 meters). Local relief is mostly 15 to 100 feet (5 to 30 meters), but increases to more than 325 feet (100 meters) in many places.

Geology

This area is underlain primarily by limestone, sandstone, conglomerate, and shale of Pennsylvanian age. The Early to Middle Pennsylvanian-age Bend Group consisting of shale and sandstone of the Smithwick Shale Formation outcrops in the Lowland along the Colorado. The Middle Pennsylvanian-age Strawn Group is extensive along the eastern margin of both portions of this MLRA. The Strawn Group consists of the Lazy Bend, Grindstone Creek, Buck Creek Sandstone, Mingus, Brazos River, and Mineral Wells Formations. The Late Pennsylvanian-age Canyon Group outcrops throughout most of the area. It consists of the Adams Branch Limestone, Cedarton Shale, Palo Pinto, Wolf Mountain Shale, Winchell Limestone, Placid Shale, Ranger Limestone, Colony Creek Shale, and Home Creek Limestone Formations.

The Late Pennsylvanian- to Early Permian-age Cisco Group consists of interbedded limestone, sandstone, and shale. The Cisco Group represents the transition from the dominantly light gray and brown parent material of Pennsylvanian age to the characteristic brick red parent material of Permian age (MLRA 78A). Its geologic units include the Thrifty and Graham, Harpersville, Pueblo, Moran, Sedwick, and Santa Anna Branch Shale Formations. North of the Brazos River, the Late Pennsylvanian-age to Early Permian-age Bowie Group consists of sandstone, mudstone, and conglomerate of the Markley and Archer City Formations (the transition from MLRA 80B to MLRA 80A).

Climate

The average annual precipitation is 28 to 34 inches (713 to 853 millimeters). Most of the rainfall occurs during high-intensity, convective thunderstorms in spring and fall. The average annual temperature is 64 to 66 degrees F (18 to 19 degrees C). The freeze-free period averages 240 days and ranges from 232 to 244 days.

Water

The moderate, somewhat erratic rainfall is the source of water for crops and range. Summer droughts are common. The larger rivers, such as the Brazos and Colorado Rivers, flow most of the year, but local streams flow intermittently. The area has several large lakes and flood-detention reservoirs. Some rural residents depend on rural water systems supplied by lakes; others depend on private lakes. Most livestock water comes from streams or ponds. Ground water is scarce.

Soils

The dominant soil orders in this MLRA are Alfisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed, carbonatic, siliceous, or smectitic mineralogy. Most of the soils formed in material weathered from Pennsylvanian-age sedimentary rocks. The soils are very shallow to very deep, well drained or moderately well drained, and generally loamy or clayey.

The main soils and their series:

Argiustolls that are shallow to moderately deep, are nearly level to gently sloping, and formed over limestone bedrock on hills and ridges (Rowden and Speck series); that are very deep, are nearly level to gently sloping, and formed on stream terraces (Sagerton series)

Calciustolls that are deep, are gently sloping to steep, and formed over shale bedrock on hills and ridges (Set series)

Haplustalfs that are shallow to moderately deep, are gently sloping to moderately steep, and formed over sandstone bedrock on hills and ridges (Bluegrove, Exray, and Newcastle series); that are moderately deep, are gently sloping to moderately sloping, and formed over limestone bedrock on hills and ridges (Lindy series); that are very deep, are nearly level to gently sloping, and formed in alluvium on base slopes of ridges (Thurber series)

Haplustepts that are shallow to deep, are gently sloping to steep, and formed over shale bedrock on scarp slopes, hills, and ridges (Owens and Throck series)

Haplusterts that are very deep, are nearly level to gently sloping, and formed on base slopes of ridges and stream terraces (Leeray series); that are very deep, are nearly level, and formed on flood plains (Padgett series)

Haplustolls that are very shallow or shallow, are gently sloping to moderately steep, and formed over limestone bedrock on hills and ridges (Palopinto series); that are very deep, are nearly level to gently sloping, and formed on base slopes of ridges and stream terraces (Nukrum series); that are very deep, are nearly level, and formed on flood plains (Deleon and Gowen series)

Paleustalfs that are moderately deep or deep, are gently sloping, and formed over sandstone or shale bedrock on hills and ridges (Bonti and Truce series); that are moderately deep, are strongly sloping to very steep, and formed in colluvium of conglomerate and shale over residuum from shale on scarp slopes (Shatruce series); that are very deep, are gently sloping to strongly sloping, and formed on base slopes of ridges and stream terraces (Weswind and Winters series)

Ustifluvents that are very deep, are nearly level, and formed on flood plains (Bunyan, Lincoln, Santo, and Westola series)

Biological Resources

This area supports oak savanna vegetation with an understory of tall grasses. Little bluestem, big bluestem, Indiangrass, and switchgrass grow on the deeper soils. Texas wintergrass, little bluestem, silver bluestem, buffalograss, and sideoats grama are dominant on shallow soils. Post oak, blackjack oak, sumac, Bumelia, mesquite, juniper, and elm are the dominant woody species. The area supports numerous perennial forbs, including Maximilian sunflower, heath aster, bush sunflower, and Engelmann’s daisy.

Major wildlife species in this area include white-tailed deer, coyote, cottontail rabbit, bobwhite quail, doves, meadowlark, scissor-tailed flycatcher, ducks, and geese. Numerous manmade reservoirs and ponds provide good opportunities for fishing.

Land Use

Farms and ranches make up nearly all this area (fig. 80B-2). The dominant land uses are rangeland and pasture, most of which is grazed by beef cattle but a small acreage is grazed by sheep and goats. Many ranches are managed not only for livestock but also for wildlife, including white-tailed deer, dove, and quail. A minor acreage of cropland in areas of deep soils is used for wheat, oats, cotton, or grain sorghum.

The main resource concerns in this area are the encroachment of woody species, conservation of soil moisture, and control of water erosion. The important conservation practices generally include practical stocking rates and rotational grazing.

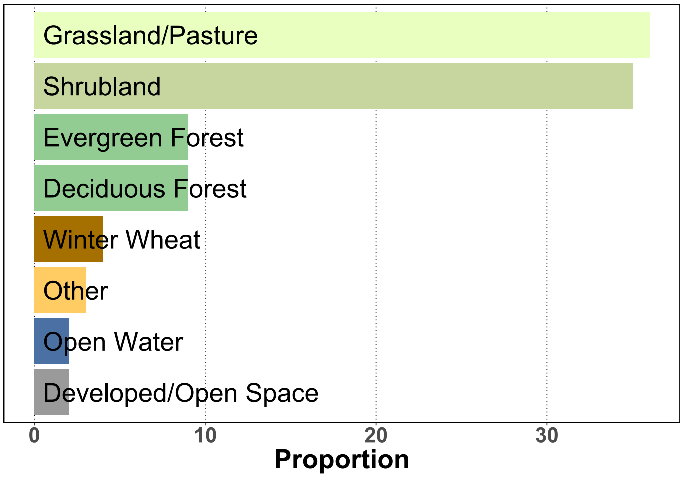

Figure 80B-2: Relative proportions (percentages) of land use in MLRA 80B.

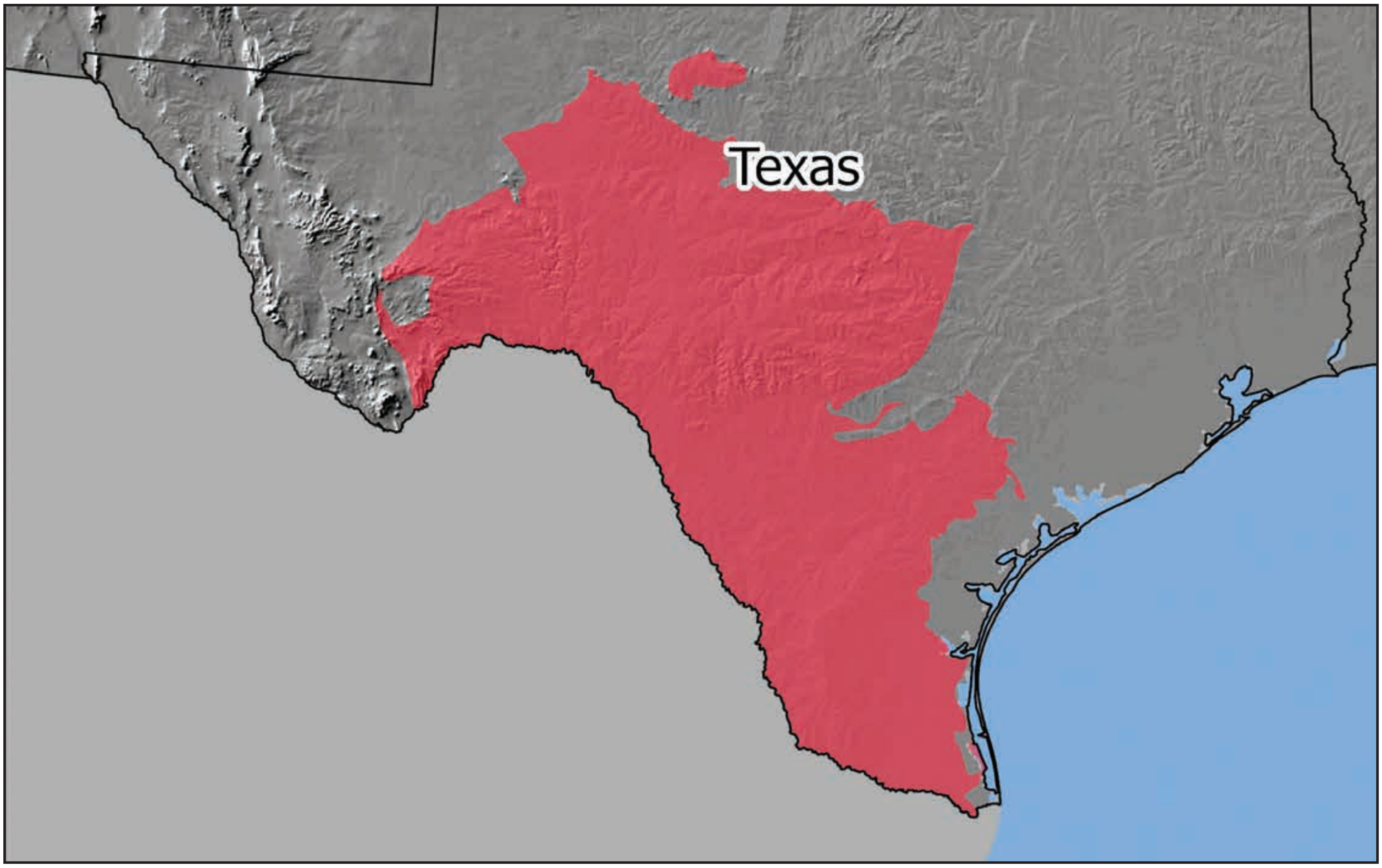

Figure I-1: Location and size of Land Resource Region I, which covers 191,350 square kilometers (73,880 square miles) in south-central Texas.

I—Southwest Plateaus and Plains Range and Cotton Region

Land Resource Region I (fig. I-1) is a semiarid to arid region superimposed over two physiographic provinces: the Great Plains to the west and, across the Balcones Fault, the Coastal Plain to the east. The Great Plains section of Region I, which is the warmest part of the Great Plains, consists of mesquite and juniper savannas on limestone mesas, plateaus, and ridges deeply incised by many canyons and valley floors. The Coastal Plain consists of unconsolidated geologic formations dipping toward the coast with the older more dissected formations occurring progressively inland. Region I contains 10 major land resource areas. The extent of these MLRAs and their range in elevations are shown in table I-1.

Region I has a boundary to the north with Region H (fig. 1, page 5) that marks a shift from Cretaceous limestone to Paleozoic clastic rock and Tertiary fans. The boundary to the west with Regions D and G marks a change from Cretaceous limestone to alluvium and igneous rock as well as a change from savanna and grasslands to shrublands of the Chihuahuan Desert. The boundary with Region J is a gradual climatic boundary where the change to slightly cooler and moister conditions is accompanied by a change from open grassland vegetation with scattered mesquite, live oak, and other trees to more areas of cropland and Alfisols. The boundary with Region T is where the rangeland of the ustic soil moisture regime (Region I) changes to the cropland of the udic and aquic soil moisture regimes (Region T).

Climatically, soil temperatures increase from thermic in the northern half of Region I to hyperthermic in the southern half. Soil moisture decreases from typic ustic in the east to typic aridic in the west. Mean temperatures (65 to 74 degrees F; 18 to 23 degrees C) and precipitation (13 to 32 inches; 330 to 813 millimeters) for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables I-2 and I-3.

Most soils are in Region I are Mollisols that formed primarily in semiarid grasslands and savannas of the southern Great Plains (fig. 2, page 6). Inceptisols occur on the side slopes of ridges in the Great Plains, and Alfisols formed on uplifted Precambrian granite parent material. Aridisols occur in the dry, western part of Region I, and Vertisols formed on the marl

Table I-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
81A	44,805	17,300	270	900	520	1,710	750	2,470	1,010	3,310	1,980	6,520
81B	30,285	11,690	300	1,000	520	1,730	660	2,190	750	2,460	840	2,780
81C	20,875	8,060	130	420	260	860	400	1,320	600	1,980	730	2,410
81D	7,045	2,720	340	1,110	520	1,700	740	2,430	1,080	3,560	1,780	5,850
82A	5,995	2,315	220	730	310	1,020	430	1,420	530	1,750	640	2,090
83A	30,020	11,590	0	0	60	200	130	440	260	850	550	1,830
83B	22,940	8,860	40	130	100	330	170	580	300	990	510	1,670
83C	11,130	4,300	0	20	60	200	140	470	220	740	280	940
83D	7,435	2,870	0	0	0	10	20	70	110	380	170	580
83E	10,825	4,180	0	0	0	10	30	100	120	390	230	780

Table I-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
81A	14.7	58	17.6	64	18.3	65	19.7	68	21.3	70	210	223	239/240	260	305
81B	17	63	17.6	64	18.2	65	18.6	66	19.7	67	210	222	231/235	246	260
81C	17.2	63	18.1	65	19.1	66	19.9	68	21	70	210	234	254/250	269	290
81D	16.2	61	18.6	65	19.6	67	20.4	69	22.3	72	220	252	261/260	266	285
82A	18	64	18.4	65	18.7	66	19.1	66	19.6	67	220	232	242/245	258	265
83A	19.5	67	20.8	69	21.4	71	22.1	72	22.9	73	250	272	293/290	304	350
83B	20	68	21.3	70	22.2	72	23.3	74	23.9	75	260	292	303/310	350	365
83C	21.8	71	22	72	22.3	72	23.2	74	23.6	74	295	302	314/320	353	365
83D	22.8	73	23.2	74	23.5	74	23.7	75	23.8	75	335	354	365/360	365	365
83E	22.2	72	22.5	72	22.7	73	23.2	74	23.5	74	305	319	336/340	365	365

Table I-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
81A	330	13	372	15	462/470	18/18	571	22	710	28
81B	440	17	531	21	630/635	25/25	742	29	830	33
81C	620	24	738	29	829/820	33/32	893	35	950	37
81D	230	9	259	10	334/335	13/13	403	16	450	18
82A	640	25	688	27	723/725	28/29	767	30	820	32
83A	500	20	571	22	696/705	27/28	865	34	1,010	40
83B	460	18	504	20	533/545	21/21	593	23	650	26
83C	500	20	528	21	568/580	22/23	661	26	730	29
83D	490	19	517	20	584/585	23/23	659	26	700	27
83E	530	21	553	22	620/620	24/24	693	27	750	29

geologic formations of the Coastal Plain in the eastern part. Alfisols, Inceptisols, and Entisols are also closely associated with geologic formations of the Coastal Plain. Carbonates are common in this region due to the dry climate and an abundance of limestone (fig. 5, page 9). Restrictive zones occur in many soil profiles in the region, mainly as lithic and paralithic bedrock on the Edwards Plateau and densic bedrock on the Coastal Plain (fig. 9, page 13) but also as petrocalcic horizons (fig. 11, page 15). Argillic horizons are less common, and organic carbon occurs in lower concentrations on the Edwards Plateau than on the Coastal Plain (figs. 12 and 14, pages 16 and 18).

Land use in Region I is dominantly shrubland (fig. I-2; and fig. 8, page 12). Cotton is the main crop in most of the region, but wheat, grain sorghum, and other small grain crops are grown where soils, topography, and moisture supply are favorable. Irrigated cotton is an important crop in the southeastern part of the region. Citrus fruits and winter vegetables are grown in the Lower Rio Grande Valley. The major resource concern is overgrazing. The invasion of undesirable species also is a concern.

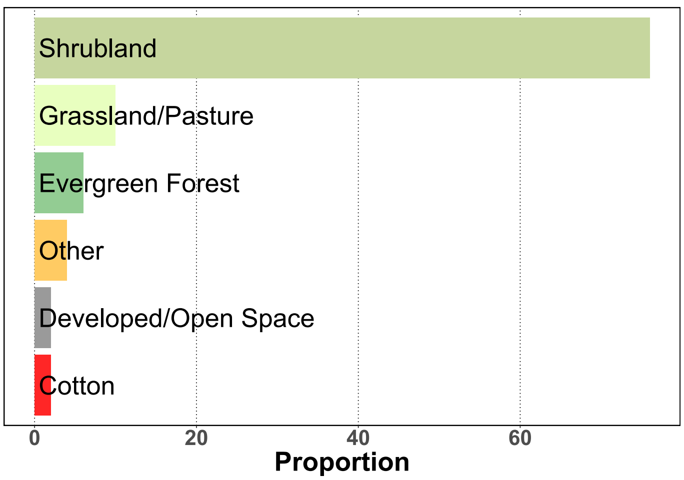

Figure I-2: Relative proportions (percentages) of land uses in Land Resource Region I (National Agricultural Statistics Service, 2018).

81A—Edwards Plateau, Western Part

This MLRA (fig. 81A-1) is characterized by rolling to steep topography with shallow soils over limestone bedrock and a plant community of shrubs and short or mid grasses. The MLRA has broad flat plateaus and deeply dissected valleys and canyons. It is entirely in Texas and makes up about 17,299 square miles (44,803 square kilometers).

The boundary of MLRA 81A to the east with MLRA 81B (Edwards Plateau, Central Part) is gradual as the geology and vegetation are very similar. The main difference is that the rainfall increases to the east. The boundary to the north with MLRAs 77C (Southern High Plains, Southern Part), 77D (Southern High Plains, Southwestern Part), and 78B (Central Rolling Red Plains, Western Part) is distinct as the geology and vegetation change

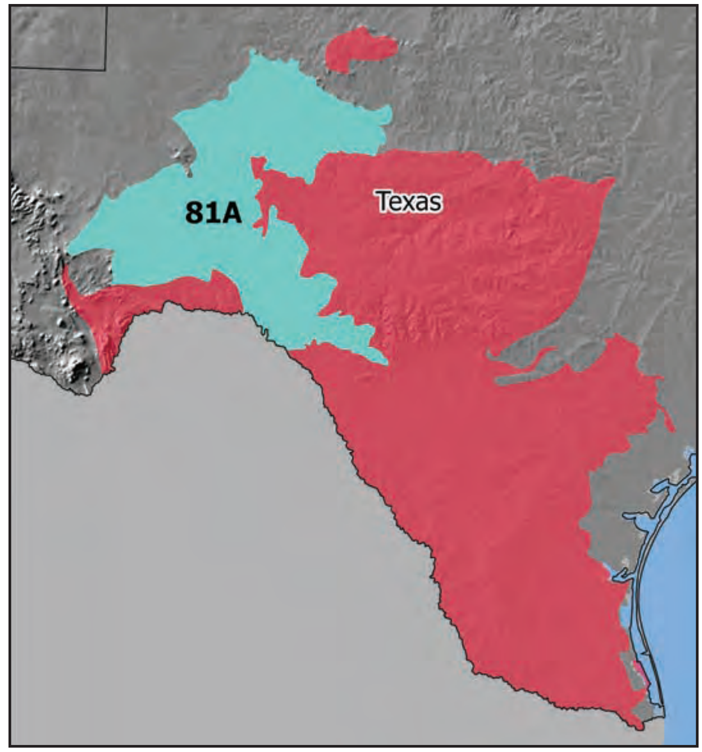

Figure 81A-1: Location of MLRA 81A, which covers 4,480,300 hectares (11,071,000 acres), within Region I.

over a short distance. The boundary to the northeast with MLRA 78A is gradual with a slight change in topography and plant species as climate becomes warmer and drier. The boundary to the northwest with MLRA 70B is distinct as the geology is mostly alluvial. The boundary to the west with MLRA 42A (Trans-Pecos Mountains, Plateaus, and Basins) is gradual as the main difference is a decrease in rainfall to the west. In addition, areas of limestone ridges are fewer and there are more alluvial plains. The southern boundary of MLRA 81A with the Southern Edwards Plateau (MLRA 81D) is distinct as vegetation changes, because the soil temperature regime changes from thermic to hyperthermic.

Physiography

This area is primarily in the Edwards Plateau section of the Great Plains province of the Interior Plains. The southwest corner is in the Mexican Highland section of the Basin and Range province of the Intermontane Plateaus. Mesas, plateaus, and limestone ridges and hills with deep canyons and nearly level to gently sloping valley floors characterize the area. Elevation of the Rio Grande decreases from 1,200 feet (365 meters) at the western end of the MLRA to 1,000 feet (305 meters) at the eastern end, and the upland areas increase in elevation northward to 2,700 feet (825 meters) on plateaus and mesas.

The Concho and Pecos Rivers and the Big Canyon and Devil's Rivers, northern tributaries of the Rio Grande, drain this area. The International Amistad Reservoir, on the Rio Grande, is in the southern part of the area.

Geology

This area is underlain primarily by limestones of the Austin Chalk, Boquillas Flags, Devil's River, Edwards, Buda, and Del Rio Clay Formations of Cretaceous age. Quaternary alluvium is in river valleys.

Climate

The average annual precipitation is 15 to 26 inches (380 to 660 millimeters) in most of this area, but it is 13 to 15 inches (330 to 380 millimeters) in the southwestern third. Precipitation fluctuates widely from year to year and occurs mainly in spring and fall. The average annual temperature is 61 to 69 degrees F (16 to 21 degrees C). The freeze-free period averages 275 days and ranges from 220 to 325 days.

Water

Water is scarce throughout the area because of limited and erratic precipitation and few perennial streams. Reservoirs outside San Angelo provide public supply and municipal water and some limited amounts of irrigation water. The reservoir behind Amistad Dam, on the Rio Grande, also provides some irrigation water. The surface water is not of good quality. High suspended sediment and salt loads limit its use.

Ground water is generally very deep in the Edwards-Trinity Plateau aquifer and very hard. This aquifer provides water for livestock, domestic use, and irrigation. About 35 percent of the samples from this aquifer contained nitrate in excess of the national drinking water standard. Rio Grande valley fill deposits provide some ground water for irrigation in the area. The ground water is recharged by the river, so the water quality is similar to that of the Rio Grande.

Soils

The dominant soil order is Mollisols. Most of the soils are Calciustolls or Haplustolls. They are well drained and generally shallow and have a skeletal particle-size class. They have a thermic or hyperthermic soil temperature regime, an ustic soil moisture regime, and carbonatic or mixed mineralogy. Rock outcrop makes up a significant portion of the area.

The main soils and their series:

Calciustolls that are shallow and formed on mesas, plateaus, and hills underlain by limestone bedrock (Ector and Langtry series); that are shallow, have a petrocalcic horizon, and formed on uplands and footslopes (Mailtrail series); that are very deep and formed in nearly level to gently sloping areas in valleys and on flood plains (Angelo series)

Haplustolls that are very deep and formed in nearly level to gently sloping areas in valleys and on flood plains (Rio Diablo and Dev series)

Biological Resources

This area supports a plant community of shrubs and short or mid grasses. The vegetation includes juniper, mesquite, lotebush, shin oak, sumac, Texas pricklypear, tasajillo, kidneywood, agarito, yucca, Lindheimer's silktassel, sotol, catclaw, Mexican persimmon, sideoats grama, threeawn, Texas grama, hairy grama, curly-mesquite, buffalograss, and hairy tridens. Major wildlife species in the area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Ranches managed for grazing and wildlife habitat make up nearly all of this area (fig. 81A-2). Livestock grazing is the principal land use. Some of the cropland is irrigated.

The major soil resource concern is erosion caused by overgrazing. Conservation practices on rangeland generally include practical stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation.

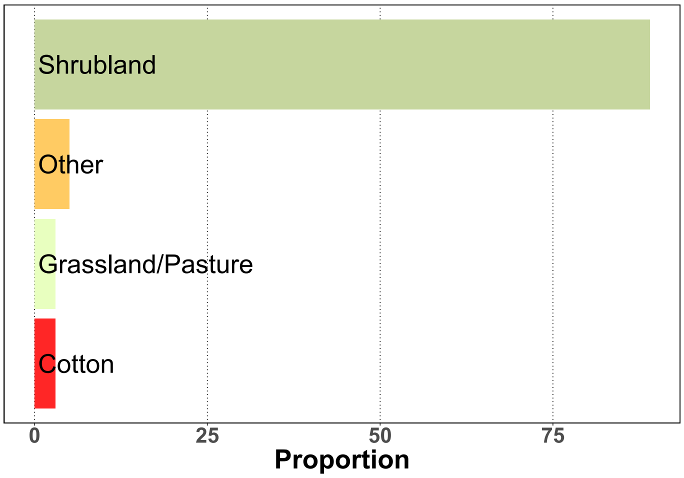

Figure 81A-2: Relative proportions (percentages) of land use in MLRA 81A.

81B—Edwards Plateau, Central Part

This MLRA (fig. 81B-1) is characterized by rolling to steep topography with shallow soils over limestone bedrock and a plant community of trees, shrubs, and short or mid grasses. The MLRA is entirely in Texas and makes up about 11,692 square miles (30,283 square kilometers).

The MLRA boundary to the east with MLRA 81C (Edwards Plateau, Eastern Part) is a gradual transition as the geology and vegetation are very similar. The main difference is that rainfall increases to the east. The boundary to the north with MLRAs 78A (Rolling Limestone Prairie), 80B (Texas North-

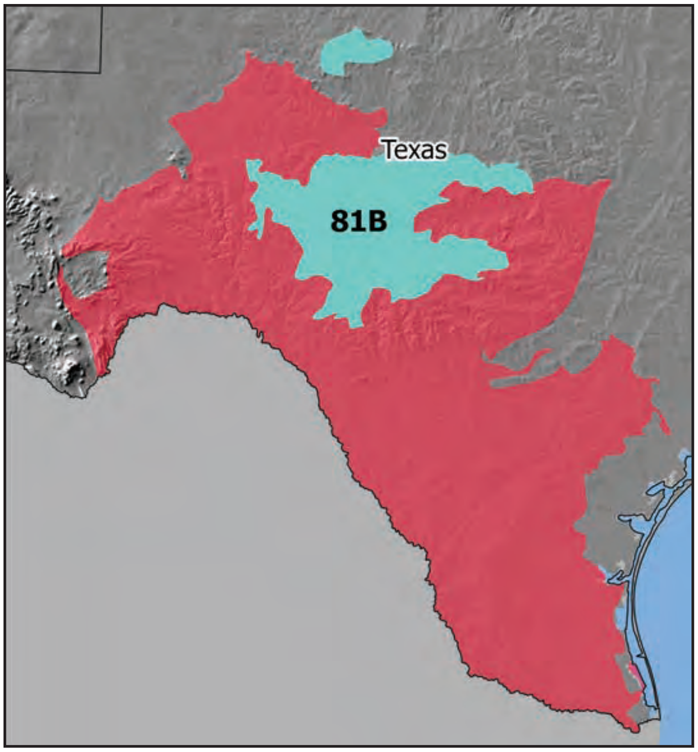

Figure 81B-1: Location of MLRA 81B, which covers 3,028,300 hectares (7,483,100 acres), within Region I.

Central Prairies), and 85A (Grand Prairie) is a distinct transition as the geology and vegetation change over a short distance. The boundary to the west with MLRA 81A (Edwards Plateau, Western Part) is a gradual boundary as the main difference is that rainfall decreases to the west. The east-central part of MLRA 81B borders MLRA 82A (Texas Central Basin). This boundary is distinct as the geology changes to mostly igneous and metamorphic rocks.

Physiography

Most of this area is in the Edwards Plateau section of the Great Plains province of the Interior Plains. The northern part is in the Central Texas section of the same province and division. Plateaus and limestone hills, incised by deep canyons, and nearly level to gently sloping valley floors characterize the area. Elevation is 900 feet (275 meters) at the southern end of the area and increases northward to 2,500 feet (760 meters) on the limestone plateaus.

The Guadalupe, Pedernales, West Nueces, Llano, and San Saba Rivers drain this area. The Colorado River crosses the northeast tip of the area.

Geology

This area is underlain primarily by limestones in the Austin Chalk, Boquillas Flags, Segovia, Fort Terrett, Devil's River, Salmon Peak, McKnight, Edwards, Buda, and Del Rio Clay Formations of Cretaceous age. Quaternary alluvium is in river valleys.

Climate

The average annual precipitation in this area is 19 to 32 inches (485 to 815 millimeters). Most of the rainfall occurs in spring and fall. The average annual temperature is 62 to 68 degrees F (17 to 20 degrees C). The freeze-free period averages 250 days and ranges from 230 to 270 days.

Water

The amount of water is limited throughout most of the area but is abundant along the spring-fed, perennial streams. The surface water generally is of good quality, although high salt loads decrease water quality in a downstream direction. Most of the surface water is used for livestock or irrigation.

Ground water is generally very deep in the Edwards-Trinity Plateau aquifer and very hard. This aquifer provides water for livestock, domestic use, and irrigation. About 35 percent of the samples from this aquifer contained nitrate in excess of the national drinking water standard. The Edwards-Trinity Plateau aquifer does not occur in the northeastern part of the area. Valley fill deposits along some of the larger streams supply some ground water for livestock, domestic use, and irrigation.

Soils

Most of the soils in this MLRA are Calciustolls and Haplustolls. The soils in the area are well drained, are generally shallow, and have a skeletal particle-size class. They have a thermic soil temperature regime, an ustic soil moisture regime, and carbonatic or mixed mineralogy. Rock outcrop makes up a significant portion of the area.

The main soils and their series:

Calciustolls that are shallow and formed on mesas, plateaus, and hills underlain by limestone bedrock (Tarrant series); that are very deep and formed in nearly level to gently sloping valleys (Nuvalde and Knippa series)

Haplustolls that are shallow and formed on mesas, plateaus, and hills underlain by limestone bedrock (Eckrant series); that are very deep and formed on flood plains (Oakalla series)

Biological Resources

This area supports a plant community of trees, shrubs, and short or mid grasses. The vegetation includes live oak, juniper, Texas red oak, shin oak, cedar elm, netleaf hackberry, flameleaf sumac, agarito, Mexican persimmon, Texas pricklypear, kidneywood, saw greenbrier, Texas wintergrass, little bluestem, curly-mesquite, Texas grama, Hall's panicum, purple threeawn, hairy tridens, cedar sedge, two-leaved senna, mat euphorbia, and rabbit-tobacco. Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Nearly all of the MLRA is used for livestock grazing and wildlife habitat (fig. 81B-2). Some areas are used as dry-farmed or irrigated cropland. Small grains and forage sorghum are the principal crops.

The major soil resource management concern is erosion caused by overgrazing and cultivation. Conservation practices on cropland generally include terraces, grassed waterways, conservation tillage, and irrigation water management.

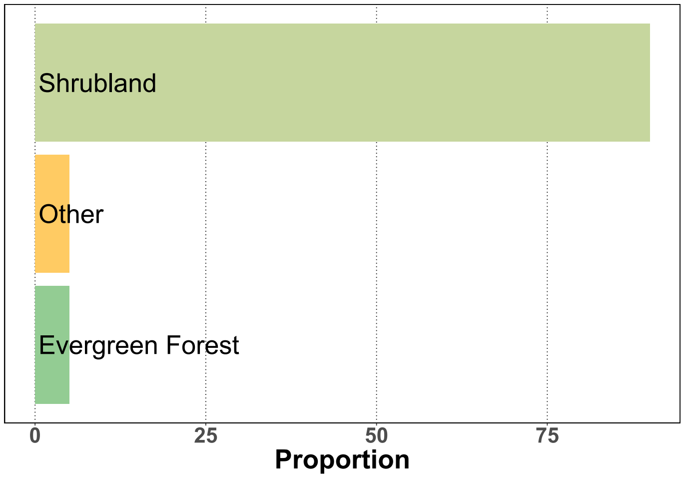

Figure 81B-2: Relative proportions (percentages) of land use in MLRA 81B.

81C—Edwards Plateau, Eastern Part

This MLRA (fig. 81C-1) is characterized by rolling to steep topography with shallow soils over limestone bedrock and a plant community of trees, shrubs, and mid or tall grasses. In much of the MLRA, soil parent material consists of bedrock; softer limestone beds with thin harder beds of limestone create a stair-step topography. The Balcones Fault Zone is in this area and impacted the topography and ground water systems. The MLRA is entirely in Texas and makes up about 8,059 square miles (20,873 square kilometers).

MLRA 81C has a distinct boundary to the east with MLRA 86A (Texas Blackland Prairie, Northern Part) based on differences in geology, vegetation, climate, and land uses. It has a gradual boundary to the north with MLRA 85A (Grand Prairie) as the geology and vegetation are very similar. It has a distinct boundary to the west with MLRA 82A (Texas Central Basin) as the geology changes to mostly igneous and metamorphic rocks. It also borders MLRA 81B (Edwards Plateau, Central Part) to the west. This boundary is gradual as the main differences are a decrease of rainfall and more

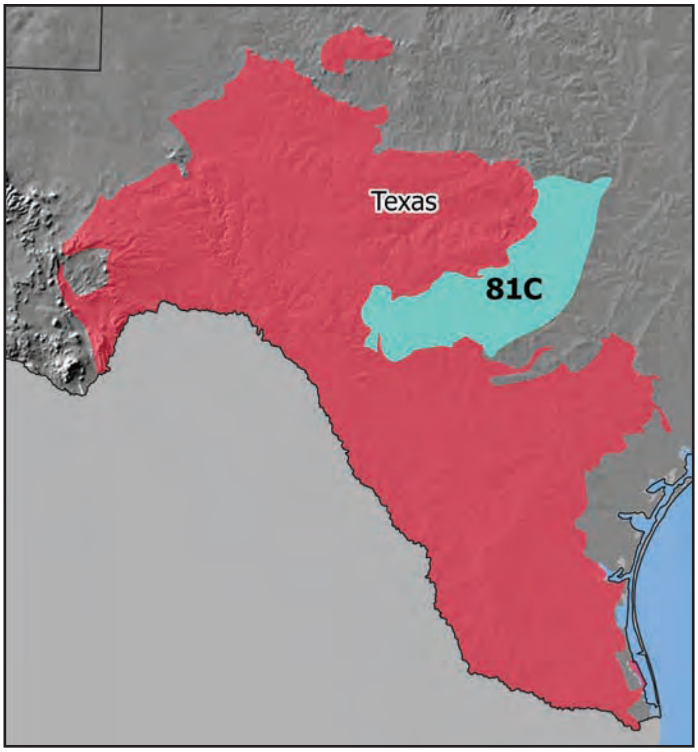

Figure 81C-1: Location of MLRA 81C, which covers 2,087,300 hectares (5,157,700 acres), within Region I.

indurated limestone geology to the west. MLRA 81C has a distinct boundary to the south with MLRA 83A (Northern Rio Grande Plain) as the topography becomes flatter, geology and vegetation change, and the soil temperature regime transitions from thermic to hyperthermic.

Physiography

The southern two-thirds of this MLRA are in the Edwards Plateau section of the Great Plains province of the Interior Plains. The northern third is in the Central Texas section of the same province and division. Limestone ridges and canyons and nearly level to gently sloping valley floors characterize the area. Elevation is 900 feet (275 meters) at the eastern end of the area and increases westward to 2,000 feet (610 meters) on ridges. From northeast to southwest, the Colorado, Pedernales, Blanco, Guadalupe, Medina, Frio, and Nueces Rivers cross this area.

Geology

This area is underlain primarily by limestones of the Glen Rose, Fort Terrett, and Edwards Formations of Cretaceous age. Quaternary alluvium is in river valleys.

Climate

The average annual precipitation in most of this area is 24 to 30 inches (610 to 760 millimeters). It is as high as 35 inches

(890 millimeters) in the northeastern part. Most of the rainfall occurs in spring and fall. The average annual temperature is 63 to 68 degrees F (17 to 20 degrees C). The freeze-free period averages 275 days and ranges from 235 to 310 days, lengthening to the south.

Water

The amount of water is limited throughout most of the area but is abundant along spring-fed, perennial streams. A series of large reservoirs on the Colorado River in an area west of Austin provide abundant, good-quality surface water for public supply and municipal and industrial uses. The Pedernales River empties into these reservoirs.

Ground water is generally deep. Three of the seven principal aquifers in Texas are beneath this MLRA. Sandstone and carbonate layers in the Trinity Group are the principal aquifers. The ground water in these layers is very hard. About 30 percent of the samples from this aquifer exceeded the national drinking water standard for nitrate. The aquifer provides water for livestock, domestic use, public supply, and some irrigation.

The Edwards-Trinity Plateau aquifer underlies the southwestern part of this MLRA. Its water is very hard. This aquifer provides water for livestock, domestic use, and some irrigation. About 35 percent of the samples from this aquifer contained nitrate in excess of the national drinking water standard.

The Edwards-Balcones Fault Zone aquifer is in the southeastern part of this MLRA and along its eastern boundary. It provides large amounts of water from springs. The water is near the surface and very hard. It is used for public supply.

Valley fill deposits along some of the larger streams in this MLRA provide some ground water for livestock, domestic use, and irrigation.

Soils

The dominant soil orders in this MLRA are Inceptisols and Mollisols. Most of the soils are Calciustolls, Haplustolls, or Haplustepts. The soils are well drained and generally shallow and have a skeletal particle-size class. They have a thermic soil temperature regime, an ustic soil moisture regime, and carbonatic or mixed mineralogy. Rock outcrop makes up a significant portion of the area.

The main soils and their series:

- Calciustolls that are shallow and formed on the summit on ridges (Tarrant series); that are very deep and formed in nearly level to gently sloping valleys (Lewisville series)
- Haplustepts that are shallow and moderately deep and formed on the side slopes of ridges (Brackett and Kerrville series)
- Haplustolls that are shallow and formed on the summit of ridges (Eckrant series); that are very deep and formed in nearly level to gently sloping valleys (Krum series); that are very deep and formed on flood plains (Frio series)

Biological Resources

This area supports a plant community of trees, shrubs, and mid or tall grasses. Vegetation includes live oak, juniper, Texas red oak, shin oak, cedar elm, evergreen sumac, escarpment cherry, saw greenbrier, mescal bean, poison oak, twistleaf yucca, elbowbush, cedar sedge, little bluestem, Neally grama, Texas grama, meadow dropseed, Texas wintergrass, curly-mesquite, pellitory, noseburn, spreading sida, woodsorrel, and mat euphorbia. Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Most of the MLRA is used for grazing and wildlife habitat (fig. 81C-2). A few areas are used as cropland. Small grains and forage sorghum are the principal crops.

The major soil resource concern is erosion caused by overgrazing and cultivation. Conservation practices on rangeland generally include practical stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation. The important conservation practices on cropland include terraces, grassed waterways, conservation tillage, and irrigation water management.

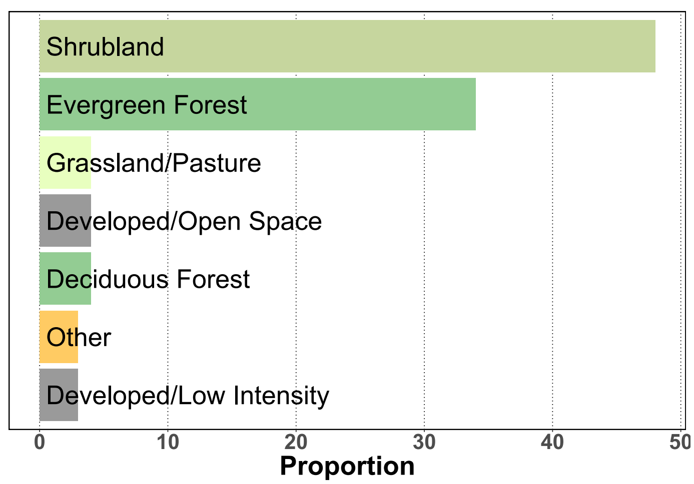

Figure 81C-2: Relative proportions (percentages) of land use in MLRA 81C.

81D—Southern Edwards Plateau

This MLRA (fig. 81D-1) is characterized by rolling to steep topography with shallow soils over limestone parent material and a desert plant community of low shrubs and short or mid

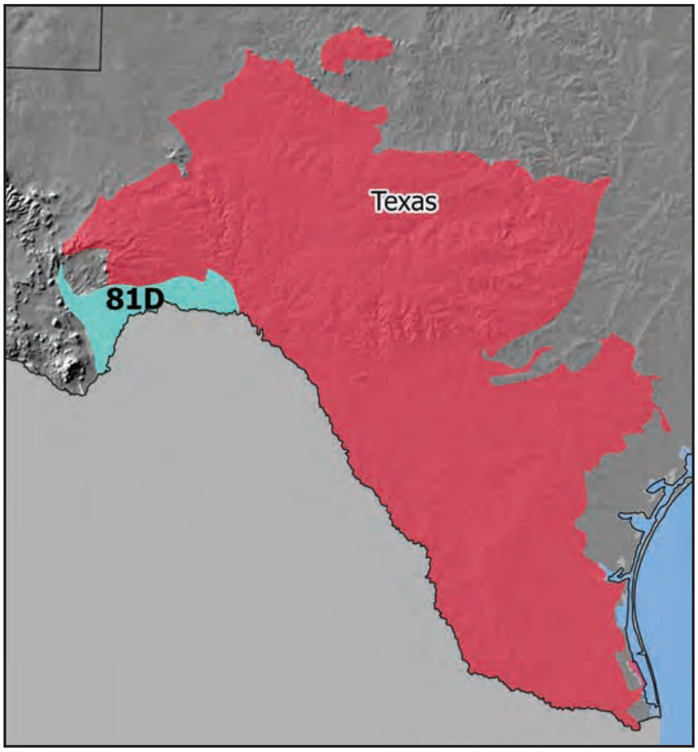

Figure 81D-1: Location of MLRA 81D, which covers 704,700 hectares (1,741,300 acres), within Region I.

grasses. In much of this area, soils formed in parent material from limestone and support vegetation suited to a hyperthermic soil temperature regime. The MLRA is entirely in Texas and makes up about 2,721 square miles (7,047 square kilometers).

MLRA 81D has a gradual boundary to the west with MLRA 42A (Trans-Pecos Mountains, Plateaus, and Basins) as the main difference is a decrease in rainfall to the west. There is a gradual decline of limestone ridges and an increase in alluvial plains and other mixed geologies. MLRA 81D has a distinct boundary to the north with the Edwards Plateau, Western Part (MLRA 81A) as vegetation changes due to the change in the soil temperature regime from hyperthermic to thermic.

Physiography

The eastern half of this MLRA is in the Edwards Plateau section of the Great Plains province of the Interior Plains. The western half is in the Mexican Highland section of the Basin and Range province of the Intermontane Plateaus. Steep limestone hills and mountains with deep canyons and nearly level to gently sloping valley floors characterize the area. Elevation of the Rio Grande decreases from 1,800 feet (550 meters) at the western end of the area to 1,200 feet (365 meters) at the eastern end, and upland areas increase in elevation northward to 3,500 feet (1,065 meters) in the mountains.

Short tributaries to the Rio Grande cross this area. From west to east, they include the Maravillas Canyon, San Francisco, and Big Canyon Rivers. The Pecos River joins the Rio Grande in the far eastern part of the area.

Geology

This area is underlain primarily by limestones of the Austin Chalk, Boquillas Flags, Devil's River, Santa Elena, Buda, and Del Rio Clay Formations of Cretaceous age. Quaternary sand and gravel are in the river valleys.

Climate

The average annual precipitation is 10 to 15 inches (255 to 380 millimeters) in most of this MLRA. It increases to 18 inches (455 millimeters) in the far eastern part. The precipitation fluctuates widely from year to year. Most of the precipitation occurs in late summer. The average annual temperature is 63 to 70 degrees F (17 to 21 degrees C). The freeze-free period averages 270 days and ranges from 245 to 295 days.

Water

Water is scarce throughout the MLRA because of limited and erratic precipitation and few perennial streams. Water in the Rio Grande is generally accessible only in the southeast and southwest corners of the area. The water is saline during low flows in winter and carries a heavy load of suspended sediment. Some of the water is diverted for livestock.

Ground water is generally very deep and very hard in the Edwards-Trinity Plateau aquifer in this area. This aquifer provides water for livestock, domestic use, and some limited irrigation. Rio Grande valley fill deposits provide some ground water for livestock, domestic use, and limited irrigation. The ground water is recharged by the river, so the water quality is similar to that of the Rio Grande.

Soils

The dominant soil orders in this MLRA are Aridisols and Entisols. Most of the soils are Calcids, Cambids, or Orthents. The soils are well drained, are generally shallow, and have a skeletal particle-size class. They have a thermic or hyperthermic soil temperature regime, an aridic soil moisture regime, and carbonatic or mixed mineralogy. Rock outcrop makes up a significant portion of the area.

The main soils and their series:

- Haplocalcids that are shallow and formed on limestone hills (Lozier series); that are very deep and formed in nearly level to gently sloping valleys (Reagan series)
- Haplocambids that are very deep and formed on alluvial fans, uplands, and footslopes (Sanderson series)
- Petrocalcids that are shallow and formed on alluvial fans, uplands, and footslopes (Upton series)
- Torriorthents that are shallow and formed on limestone hills (Mariscal series)

Biological Resources

This area supports a desert plant community of low shrubs and short or mid grasses. Limestone hills and footslopes support black grama, bush muhly, Chino grama, fluffgrass, and sideoats grama with a diverse shrub community that includes cacti, creosote bush, feather dalea, lechuguilla, mariola, skeleton-leaf goldeneye, and scattered juniper. Valleys and narrow drainageways support grasses such as black grama, burrograss, cane bluestem, sideoats grama, tobosagrass, and vine mesquite. Shrubs in narrow drainageways include fourwing saltbush, tarbush, and hackberry. Major wildlife species include javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Most of this area is used for grazing and wildlife habitat (fig. 81D-2). The Federal land in the MLRA is in parks and recreational areas along the Rio Grande. The major soil resource concerns are wind erosion and water erosion caused by overgrazing. Conservation practices on rangeland include practical stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation.

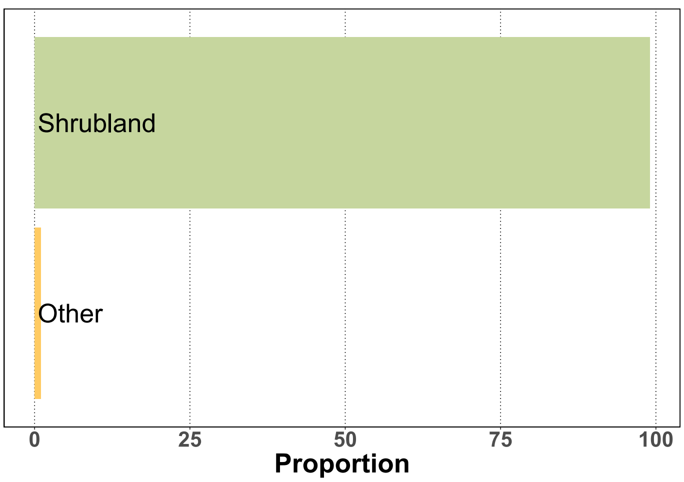

Figure 81D-2: Relative proportions (percentages) of land use in MLRA 81D.

82A—Texas Central Basin

This MLRA (fig. 82A-1) is characterized by soils that formed over igneous and metamorphic rocks with some sedimentary sandstones and a plant community of mixed oak savanna and mid and tall grasses. Some areas have extensive rock outcrops of granite. The landscape is composed of rolling to steep hills and ridges dissected by drainage systems. Soils are shallow on hills and ridges and deeper along drainageways. The MLRA is entirely in Texas and makes up about 2,314 square miles (5,994 square kilometers).

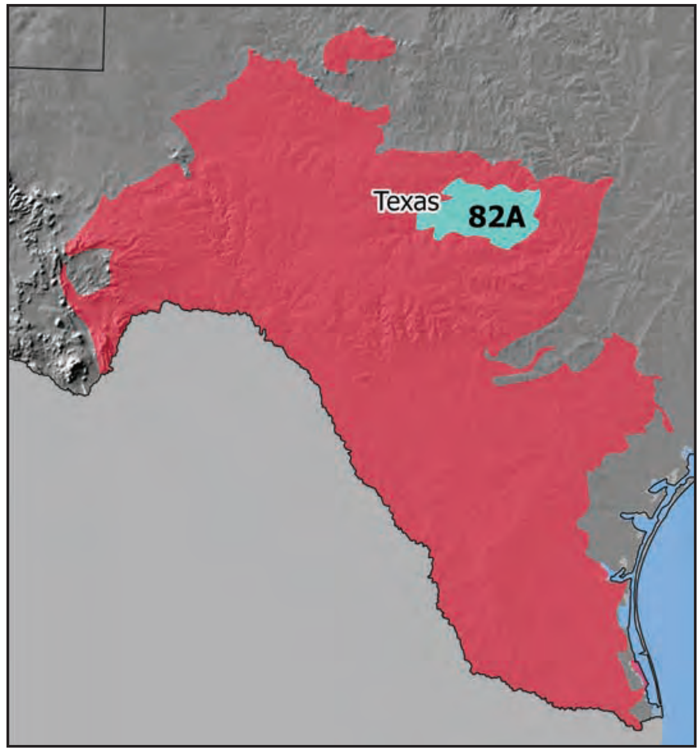

Figure 82A-1: Location of MLRA 82A, which covers 599,400 hectares (1,481,000 acres), within Region I.

This MLRA is completely surrounded by MLRA 81. The boundary is distinct and based on changes in geology and vegetation.

Physiography

This area is in the Central Texas section of the Great Plains province of the Interior Plains. Hills, ridges, and plains characterize the area. Elevation is 1,200 feet (365 meters) at the eastern end of the area and increases westward to 2,200 feet (670 meters) on ridges. The San Saba River cuts across the northwest corner of the MLRA, and the Llano River drains the central part. Lakes Buchanan, Lyndon B. Johnson, and Marbles Falls, three major reservoirs on the Colorado River, are at the eastern end of the MLRA.

Geology

This area is underlain primarily by igneous, metamorphic, and sedimentary rocks. Igneous and metamorphic outcrops include the Valley Spring Gneiss, Packsaddle Schist, and Town Mountain Granite of Precambrian age. Sedimentary rocks include the Hickory Sandstone and Lion Mountain Sandstone of Cambrian age and the Hensell Sand of Cretaceous age. Holocene alluvium is on flood plains.

Climate

The average annual precipitation in this MLRA is 24 to 31 inches (610 to 785 millimeters). Rainfall usually is higher in the eastern part. Most of the rainfall occurs in spring and fall. The average annual temperature is 65 to 67 degrees F (18 to 19 degrees C). The freeze-free period averages 260 days and ranges from 245 to 270 days.

Water

The amount of water is limited throughout most of the MLRA but is abundant along perennial streams and in the three major reservoirs on the Colorado River. Only a small quantity of water in the Llano and Colorado Rivers and the reservoirs is used for public supply, livestock, or irrigation in this area. The rivers are spring fed from the limestone aquifers outside the MLRA and mainly have good-quality water. Surface runoff, however, brings in salt loads, which degrade water quality.

There are no principal aquifers in nearly all of the MLRA. Ground water is in valley fill deposits along the perennial streams and generally shallow. These deposits provide water for livestock, domestic use, and some limited irrigation. The quality of the ground water is similar to that of the surface water.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Inceptisols, and Mollisols. Most of the soils are Ustalfs, Ustepts, Orthents, or Ustolls. The soils are well drained and range from deep to shallow. They have a thermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. Rock outcrop makes up a significant portion of the area.

The main soils and their series:

- Argiustolls that are moderately deep and formed on plains (Rumple series)
- Haplustalfs that are shallow and moderately deep and formed on the summits of hills and ridges (Click and Oben series)
- Haplustepts that are shallow and formed on the side slopes of hills and ridges (Keese series)
- Haplustolls that are shallow and formed on plains (Harper series)
- Paleustalfs that are deep and moderately deep and formed on plains (Pedernales and Castell series)
- Ustorthents that are shallow and formed on the side slopes of hills and ridges (Nebgen series)

Biological Resources

This area supports a mixed oak savanna community of live oak, post oak, and blackjack oak and mid and tall grasses such as little bluestem, sideoats grama, Indiangrass, switchgrass, sand lovegrass, plains lovegrass, green sprangletop, purpletop tridens, pinhole bluestem, and plains bristlegrass. Forbs, such as orange zexmania, bush sunflower, Engelmann's daisy, and trailing ratany, grow throughout the area. A mid grass community, with scattered live oak and post oak occurring as individual trees or in groves, occurs on the shallow and more droughty soils. The major grass species on these soils are sideoats grama, meadow dropseed, pinhole bluestem, Arizona cottontop, vine mesquite, Texas wintergrass, and little bluestem.

Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Almost all of this area is used for grazing and wildlife habitat (fig. 82A-2). A few areas are used as cropland. Small grains and forage sorghum are the principal crops.

The major soil resource concern is erosion caused primarily by overgrazing. Conservation practices on rangeland generally include practical stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation. The important conservation practices on cropland are terraces, grassed waterways, conservation tillage, and irrigation water management.

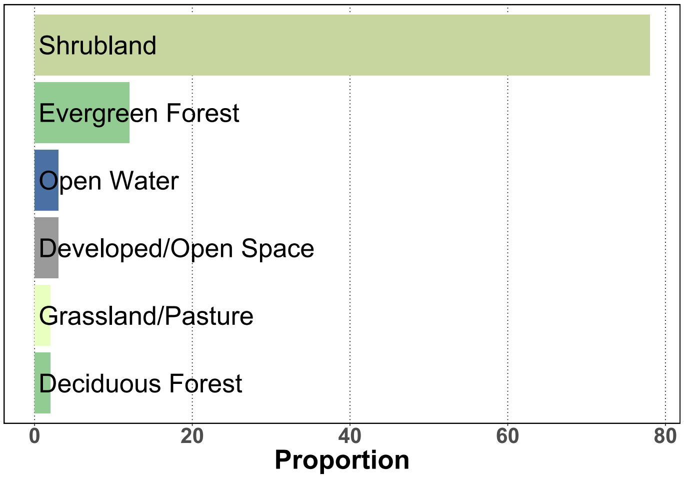

Figure 82A-2: Relative proportions (percentages) of land use in MLRA 82A.

83A—Northern Rio Grande Plain

This MLRA (fig. 83A-1) is characterized by areas of grass, cropland, and pasture interspersed with tall, thick shrubs. It consists dominantly of very deep soils overlying soft bedrock. The MLRA is entirely in Texas and makes up about 11,590 square miles (30,018 square kilometers).

This MLRA has an apparent boundary to the north and a more gradual boundary to the east, south, and west. Boundaries are based on changes in soil temperature regimes, vegetation, and soil depth.

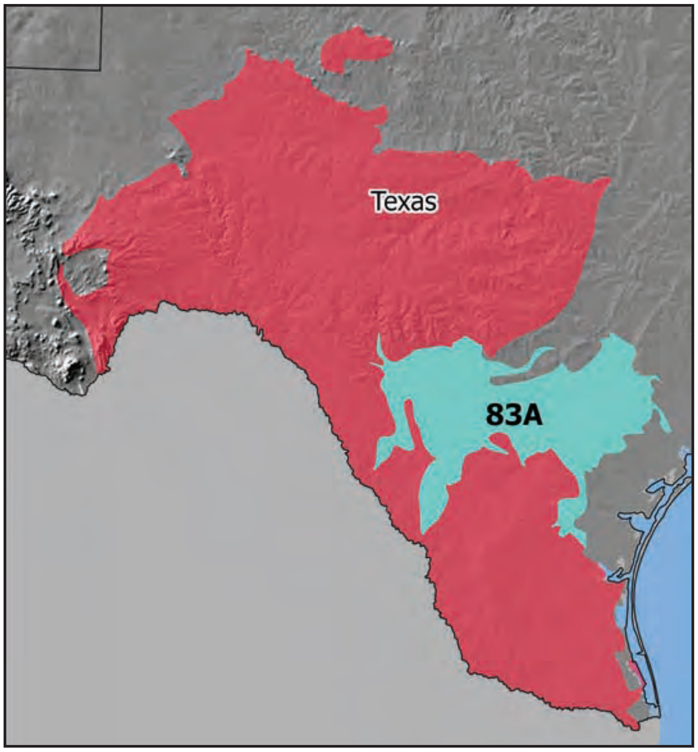

Figure 83A-1: Location of MLRA 83A, which covers 3,001,800 hectares (7,417,600 acres), within Region I.

Physiography

This area is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. This plain generally is nearly level, but smooth hills and valleys are gently rolling. The valleys are narrow to broad. The hills are mostly in the eastern part of the MLRA. Elevation ranges from 200 feet (60 meters) in the southeastern part of the area to 1,000 feet (305 meters) in the northwestern part.

The Frio, Hondo, Leona, Medina, Nueces, Atascosa, Sabinal, and San Antonio Rivers cross this area. The Guadalupe River crosses the northeastern tip.

Geology

Cretaceous limestone deposits underlie the northern edge of this MLRA. Most of the MLRA, however, lies within the coastal plain created when Cretaceous seas retreated towards the present-day Gulf of Mexico throughout the Tertiary Period. Lagoonal, estuarine, beach, and deltaic sediments were deposited in a wide swath paralleling the current coastline of Texas and other Gulf States. Fine textured sediment deposited in lagoons became shale layers, and the coarser textured sediments became sandstone layers. These Tertiary rocks are at the surface in this MLRA and are progressively younger from west to east. Several commercially mined lignite coal and uranium ore seams, as well as natural gas production, occur in these sediments. The sandstone layers are present-day aquifers.

Climate

The average annual precipitation is 21 to 37 inches (535 to 940 millimeters) in most of this area. Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. The annual precipitation increases from southwest to northeast. The typical storm pattern changes in the southern part of the area, where most of the rainfall occurs during moderate-intensity, tropical storms that produce large amounts of rain in winter. Hurricanes from the Gulf of Mexico occasionally trigger heavy rainfall early in autumn. The average annual temperature is 67 to 72 degrees F (20 to 22 degrees C). The freeze-free period averages 315 days and ranges from 275 to 350 days, increasing closer to the coast.

Water

The rainfall is adequate for rangeland grasses but marginal for cultivated crops. High temperatures and high evaporation and transpiration rates limit crop production. The Nueces River provides some water for irrigation, and ponds provide some water for livestock and domestic use. Some irrigation and public supply water (primarily for Corpus Christi, which is outside this MLRA) is obtained from large reservoirs in the area, but most of the water used is ground water. The limited amount of surface water in this area is suitable for almost all uses. During late summer, low flows in the part of the San Antonio River below San Antonio consist primarily of municipal and industrial waste discharges.

Deep wells provide water for irrigation, livestock, public supply, and domestic use. The Balcones Fault Zone in the Edwards limestone aquifer underlies the northern edge of this MLRA, and the Gulf Coast aquifer system underlies the eastern edge. The Carrizo-Wilcox aquifer underlies most of the area. Water from this aquifer is moderately hard. Heavy pumping from this aquifer for irrigation has caused more saline water to leak into the aquifer from adjacent bedrock units. The Gulf Coast aquifer provides water for both public supply and irrigation. Its water is very similar in quality to the water in the Carrizo-Wilcox aquifer. Deeper wells in both these aquifers encounter soft water where sodium is replacing calcium. Water from the Edwards aquifer is used primarily for public supply, but some wells also provide irrigation water. Much of the flow from the Frio, Leona, and Medina Rivers is lost to this aquifer as they cross it, but springs downstream from the seepage zone in the Balcones Fault Zone add some surface flow back to those rivers. The ground water in the Edwards aquifer is similar in quality to that in the other aquifers but is much harder. In addition, this aquifer has more wells with nitrate levels that exceed the national drinking water standard.

Soils

The dominant soil orders in this MLRA are Alfisols, Mollisols, and Vertisols. The soils in the area dominantly have a hyperthermic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. A small area in the northern part of the MLRA has a thermic soil temperature regime. The soils are generally very deep, well drained or moderately well drained, and loamy or clayey.

The main soils and their series:

- Argiustolls that formed in loamy sediments on uplands (Weesatche series)
- Calciustolls that formed in alluvium on stream terraces and uplands (Knippa, Olmos, and Uvalde series); that formed in loamy sediments on uplands (Sarnosa series)
- Gypsiusterts that formed in clayey sediments on uplands (Esseville series)
- Haplustalfs that formed in residuum on plains (Duval series)
- Haplusterts that formed in clayey sediments on uplands (Monteola and Montell series)
- Haplustolls that formed in alluvium on natural levees and low stream terraces (Odem series)
- Paleustalfs that formed in loamy sediments on uplands (Floresville and Wilco series); that formed in mixed loamy and clayey sediments on marine terraces, stream terraces, and plains (Miguel and Papalote series); that formed in residuum on uplands (Webb series)
- Paleustolls that formed in alluvium in drainageways (Poteet series)

Biological Resources

This area supports open grassland vegetation with scattered mesquite, live oak, and other trees. Little bluestem, sideoats grama, lovegrass tridens, fourflower trichloris, Arizona cottontop, plains bristlegrass, and other mid grasses are dominant on the deeper soils. The soils support several forbs, including orange zexmania, catclaw sensitive briar, western indigo, and bush sunflower. Open grassland with scattered low-growing brush, such as guajillo, blackbrush, elbowbush, and kidneywood, characterizes the shallower soils. Arizona cottontop, sideoats grama, green sprangletop, and twoflower trichloris are the dominant mid grasses on these soils.

Major wildlife species in this area include white-tailed deer, coyote, bobcat, beaver, raccoon, cottontail, fox squirrel, turkey, bobwhite quail, and mourning dove. Fish species include largemouth bass, sunfish, catfish, and crappie.

Land Use

About four-fifths of this area is rangeland grazed mainly by beef cattle and wildlife (fig. 83A-2). A large acreage is cultivated. Grain sorghum, cotton, corn, wheat, and small grain for grazing are the main crops. Some areas, mostly in the western part of the MLRA, are used for irrigated vegetables. Hunting leases for deer, quail, and mourning dove are an important source of income.

The major soil resource concerns are maintenance of soil quality, water erosion where slopes are more than 1 percent, and wind erosion. An adequate quantity of good-quality irrigation

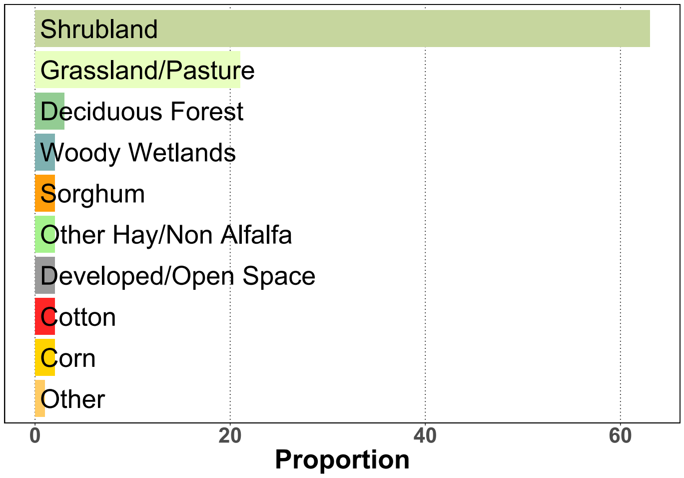

Figure 83A-2: Relative proportions (percentages) of land use in MLRA 83A.

water is a concern in the western part of the area. A major management concern is controlling brush and cactus that invade the grasslands.

Conservation practices on rangeland and pasture generally include prescribed grazing, fencing, development of watering facilities, and nutrient and pest management. The important conservation practices on cropland are conservation crop rotations, crop residue management, grassed waterways, contour farming and terraces (where slopes are more than 1 percent), nutrient management, and pest management. Sprinkler irrigation systems, conveyance pipelines for irrigation water, furrow diking, grassed waterways, and irrigation water management are important conservation practices and are used mainly on the cropland in the western part of the area.

83B—Western Rio Grande Plain

This MLRA (fig. 83B-1) is characterized by desert grasslands intermixed with droughty shrubs on low hills with sandstone escarpments. Nearly the entire area is rangeland grazed by wildlife and beef cattle. The boundaries with neighboring MLRAs are gradual, based on subtle differences in vegetation, climate, and geology. MLRA 83B is entirely in Texas and makes up about 8,858 square miles (22,942 square kilometers).

Physiography

This MLRA is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. It consists mainly of low hills with sandstone escarpments. Most of the escarpments are in the western half of the area. The area is gently undulating and somewhat dissected by intermittent streams. Elevation ranges from 165 feet (50 meters) in the southeastern part of the area to 1,200 feet (365 meters) in the northwestern part. The Rio Grande forms the international border between Texas and Mexico in this area.

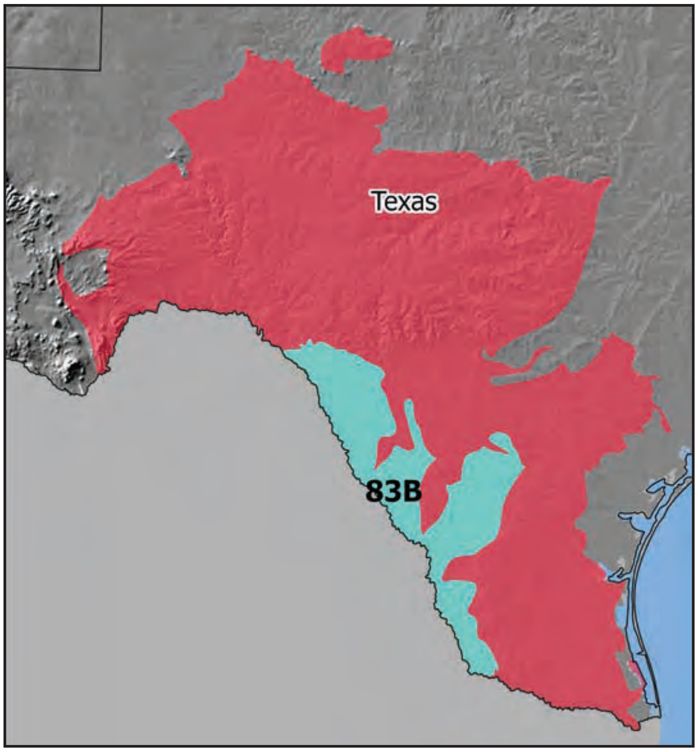

Figure 83B-1: Location of MLRA 83B, which covers 2,294,200 hectares (5,669,100 acres), within Region I.

Geology

Surficial Cretaceous limestone and shale deposits occur in the northernmost part of this area. Most of the MLRA, however, lies within the coastal plain created when the Cretaceous seas retreated towards the present-day Gulf of Mexico throughout the Tertiary Period. Lagoonal, estuarine, beach, and deltaic sediments were deposited in a wide swath paralleling the current coastline of Texas and other Gulf States. Fine textured sediment deposited in lagoons became shale layers, and the coarser textured sediments became sandstone layers. These Tertiary rocks are at the surface in this area and are progressively younger from west to east. Several commercially mined lignite coal seams, as well as natural gas production, occur in these sediments. The sandstone layers are present-day aquifers. The Rio Grande flows on the southwest side of the Rio Grande Embayment, a structural feature that formed in the Tertiary Period when extension due to plate tectonics caused a rift zone to form. This rift zone became a low-lying area where the Rio Grande eventually flowed. Recent alluvial sediments are adjacent to the Rio Grande.

Climate

The average annual precipitation is 18 to 25 inches (455 to 635 millimeters) in most of the area. It increases from north to south. Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. The average annual temperature is 67 to 73 degrees F (20 to 23 degrees C). The freeze-free period averages 325 days and ranges from 285 to 365 days.

Water

The rainfall is adequate for the rangeland grasses. In most years it is inadequate for cropland because saline soils, high temperatures, and high evaporation and transpiration rates limit available moisture. The Rio Grande is the major perennial stream in this MLRA. Other major streams flow intermittently. Two major reservoirs have been constructed on the Rio Grande by the United States and Mexico. The International Amistad Reservoir is just outside the northern end of this area, and the International Falcon Reservoir is just southeast of the town of Laredo. The water quality in the Rio Grande is poor upstream from the International Amistad Reservoir. It improves dramatically in the area between the Amistad and Falcon Reservoirs. The Rio Grande water is used for irrigation in this area. The Choke Canyon Reservoir lies just west of Three Rivers. Away from the valley of the Rio Grande, ponds provide water for livestock, wildlife, domestic use, and irrigation.

Deep wells provide water for livestock, domestic use, and irrigation. The Carrizo-Wilcox aquifer underlies the central third of the MLRA. Other than the Rio Grande valley fill, there are no principal aquifers under the northern and southern thirds of the area. Water from the Carrizo-Wilcox aquifer is moderately hard. Heavy pumping from this aquifer for irrigation has caused more saline water to leak into the aquifer from adjacent bedrock units. Valley fill deposits of the Rio Grande provide some ground water for irrigation in this area. The ground water is recharged by the river, so its quality is similar to that of the Rio Grande.

Soils

The dominant soil orders in this MLRA are Alfisols, Aridisols, Inceptisols, Mollisols, and Vertisols. The soils in the area have a hyperthermic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They generally are moderately deep to very deep, well drained or moderately well drained, and loamy or clayey.

The main soils and their series:

- Calciustepts that formed in mixed colluvium and residuum on uplands (Copita series)
- Calciustolls that formed in alluvium on stream terraces (Elindio, Jimenez, and Uvalde series)
- Haplargids that formed in residuum on uplands (Pryor series)
- Haplustalfs that formed in loamy sediments on uplands (Brennan and Hebbronville series)
- Haplustepts that formed in residuum on uplands (Maverick series)
- Haplusterts that formed in mixed alluvium and colluvium on plains and in drainageways (Catarina series); that formed in outwash or alluvium on plains and in drainageways (Montell series)

Natrustalfs that formed in alluvium on stream terraces (Brundage series)
Paleustalfs that formed in residuum on uplands (Brystal series)
Petrocalcids that formed in eolian deposits on plains and ridges (Kimbrough series)

Biological Resources

This area supports open grassland vegetation with scattered shrubs. Mid grasses, such as alkali sacaton, twoflower trichloris, pink pappusgrass, white tridens, whiplash pappusgrass, and vine mesquite, are dominant on deep, clayey soils. Guayacan, spiny hackberry, desert yaupon, and fourwing saltbush are the principal shrubs. Bundleflower, bush sunflower, Texas varilla, and other forbs make up a minor but significant part of the plant communities. The more gravelly soils support a semi-open grassland of mid grasses interspersed with low-growing shrubs. Guajillo, blackbrush, and kidneywood are the principal shrubs. Arizona cottontop, sideoats grama, pink pappusgrass, pinhole bluestem, green sprangletop, and tanglehead are the dominant grasses. Several species of forbs grow on these soils, mainly bush sunflower, orange zexmania, snoutbean, dalea, and gaura.

Major wildlife species include white-tailed deer, javelina, coyote, fox, bobcat, ring-tail cat, beaver, nutria, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, mourning dove, and white-winged dove. Fish species include channel catfish, black bass, and sunfish.

Land Use

Almost all of this area is rangeland grazed by beef cattle and wildlife (fig. 83B-2). About 3 percent of the area is cropland used mainly for grain sorghum, small grain, cotton, and improved pasture. Small grain generally is grazed as winter pasture. Watermelons, cantaloupes, and onions are grown under irrigation in alluvial areas along the Rio Grande. Hunting leases for deer, quail, mourning dove, wild turkey, and javelina are an important source of income.

The major soil resource concerns are maintenance of soil quality, water erosion where slopes are more than 1 percent, and soil salinity. Wind erosion also is a concern on sandy and loamy soils where irrigated cropland is left fallow. Soil moisture is a major concern throughout most of the MLRA. Locally, saline and alkali soils are a land use concern. An adequate quantity of good-quality irrigation water is a concern along the Rio Grande. A major management concern is controlling brush and cactus that invade the native grasslands.

Conservation practices on rangeland and pasture generally include prescribed grazing, fencing, development of watering facilities, and nutrient and pest management. The important conservation practices on cropland are conservation crop rotations; irrigation systems, including micro irrigation; irrigation water conveyance pipelines; and irrigation water management.

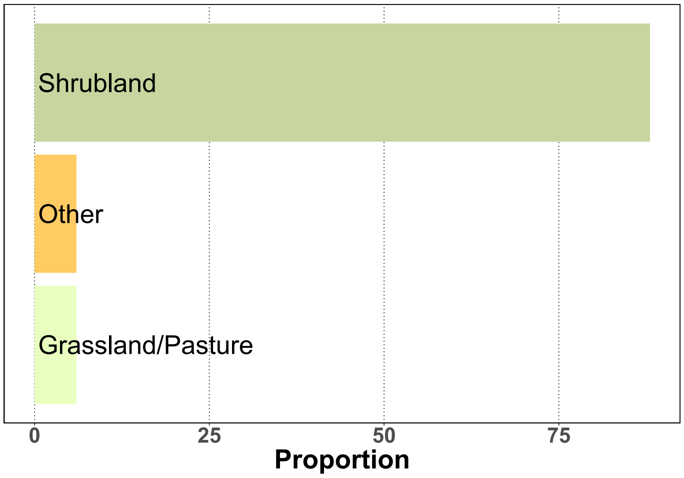

Figure 83B-2: Relative proportions (percentages) of land use in MLRA 83B.

83C—Central Rio Grande Plain

This MLRA (fig. 83C-1) is characterized by prairie grasslands interspersed with shrubs and a few scattered trees on a nearly level to gently undulating plain that is weakly dissected by intermittent drainageways. Most of the area is used as rangeland. Boundaries with neighboring MLRAs are gradual, based on subtle differences in vegetation, climate, and geology. The MLRA is entirely in Texas and makes up about 4,298 square miles (11,131 square kilometers).

Physiography

This area is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. The landscape features are influenced by thin eolian deposits occurring as a surficial sand sheet that covers most of the area. The eolian deposits were transported from southeast to northwest in the prevailing wind direction. Elevation ranges from 150 feet (45 meters) on the east side of the area to 860 feet (260 meters) on the west side. The Nueces and Frio Rivers are the only major streams in this area.

Geology

This area is underlain by Tertiary sediments that trend generally parallel to the Texas Gulf Coast and are progressively younger approaching the coastline (eastward). The western part of the area is underlain by calcareous clays, claystones, and friable sandstones with some beds of white volcanic ash of the Jackson Group of Eocene age. The central part is underlain by soft or weakly cemented siltstones, sandstones, and tuff of the Catahoula Formation of Miocene age. The eastern part is underlain by clays, sandy clays, and weakly cemented sandstones of the Fleming Formation of Miocene age and the overlying Goliad Formation of Pliocene

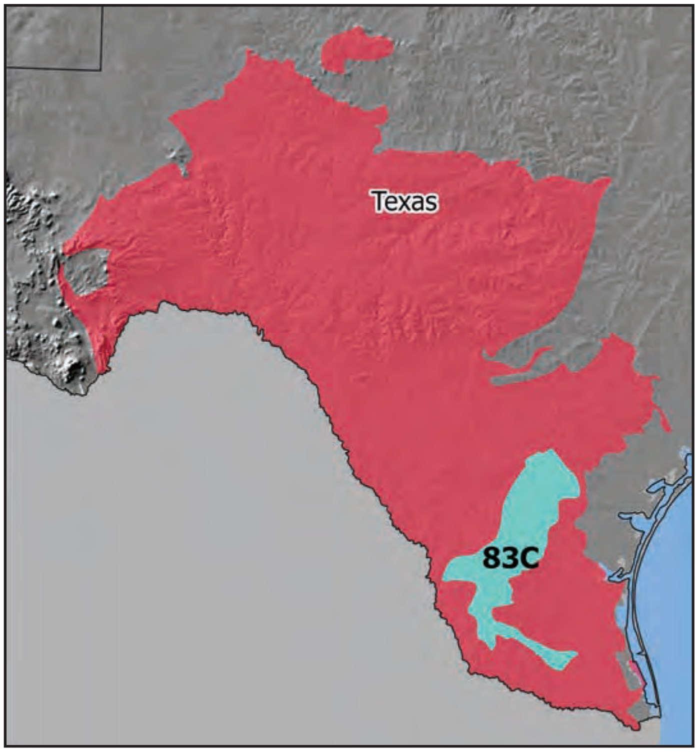

Figure 83C-1: Location of MLRA 83C, which covers 1,113,100 hectares (2,750,400 acres), within Region I.

age. Recent alluvial sediments are along the Nueces and Frio Rivers.

Climate

The average annual precipitation in this area is 21 to 29 inches (535 to 735 millimeters). Most of the rainfall occurs during the growing season. Hurricanes from the Gulf of Mexico trigger heavy rainfall from time to time in late summer and early fall. The average annual temperature is 70 to 73 degrees F (21 to 23 degrees C). The freeze-free period averages 335 days and ranges from 305 to 365 days.

Water

The rainfall is adequate for the rangeland vegetation. Crop yields, however, are limited by periods of moisture stress caused by high temperatures and high evaporation and transpiration rates. Ponds provide water for livestock, domestic use, wildlife, and some irrigation and public supply. The surface water is generally of good quality and suitable for most uses. The precipitation that accompanies hurricanes and major storms cannot be discharged by the small drainage systems in the area. Local drainageways may be flooded for days, even weeks, following a major storm.

Deep wells provide water for livestock, domestic use, wildlife, and some irrigation and public supply. The Carrizo-Wilcox aquifer system is beneath the northwest corner of the MLRA. Water from this aquifer is moderately hard. The Gulf Coast aquifer system underlies most of the area. It consists of a complex of young, interbedded clays, silts, sands, and gravel. The water from this aquifer is generally of good quality and hard. Deeper wells in both the Gulf Coast and Carrizo-Wilcox aquifers encounter soft water where sodium is replacing calcium. There are no principal aquifers in the southwestern third of this MLRA.

Soils

The main soil orders in this MLRA are Alfisols, Inceptisols, Mollisols, and Vertisols. The soils in the area dominantly are Ustalfs, Ustolls, Ustepts, and Usterts. They are shallow to very deep and moderately coarse textured or coarse textured. They have a hyperthermic soil temperature regime, an ustic soil moisture regime, and carbonatic or mixed mineralogy.

The main soils and their series:

Calciustepts that are very shallow and well drained, have an indurated caliche horizon, and formed on plains in the western part of the MLRA (Zapata series); that are moderately deep and well drained and formed in clayey sediments over sandstone bedrock in the western part of the MLRA (Copita series)

Calciustolls that are shallow and well drained, have an indurated caliche horizon, and formed in limestone alluvium in undulating areas (Olmos series); that are deep and well drained and formed in calcareous sediments in nearly level to gently sloping areas (Hidalgo series)

Haplustalfs that are nearly level to gently undulating and formed on loamy eolian plains in the central and western parts of the MLRA (Brennan and Hebbronville series)

Haplusterts that are deep, fine textured, and well drained and formed in sediments overlying weakly consolidated shale, siltstone, or sandstone that contains volcanic ash (Tordia series); that are deep, fine textured, and moderately well drained or somewhat poorly drained and formed in clayey alluvium along rivers (Coquat, Cochina, and Buchel series)

Paleustalfs that are very deep and well drained and formed in sandy sediments on sandy eolian plains (Comitas, Nueces, and Sarita series); that are shallow and moderately deep, are nearly level to gently sloping, have a strongly cemented caliche horizon, and formed on eolian plains in the central and eastern parts of this area (Delmita and Randado series); that are deep and moderately well drained and formed on loamy eolian plains in the central and eastern parts of the MLRA (Delfina series)

Biological Resources

This area supports prairie vegetation with a few scattered trees and shrubs. The major species on deep soils that have a surface layer of fine sand are tall and mid grasses, such as seacoast bluestem, Indiangrass, crinkleawn, and tanglehead, with a variety of perennial legumes and forbs. The common species on loamy soils in the central and eastern parts of the area are mid grasses such as Arizona cottontop, fourflower trichloris, tanglehead, plains lovegrass, and pinhole bluestem. Many forbs and low-growing shrubs, including condalia, vine ephedra, and guajillo, also grow on these loamy soils. Woody vegetation consists of mesquite, huisache, and a few oak trees. Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, white-winged dove, and mourning dove.

Land Use

Almost all of this area is rangeland grazed by beef cattle and wildlife (fig. 83C-2). About 7 percent of the area is cropland used mainly for grain sorghum, cotton, wheat, and small grains for grazing. Some areas are irrigated. Hunting leases for deer, wild turkey, quail, mourning dove, javelina, and exotic game animals are an important source of income in this area.

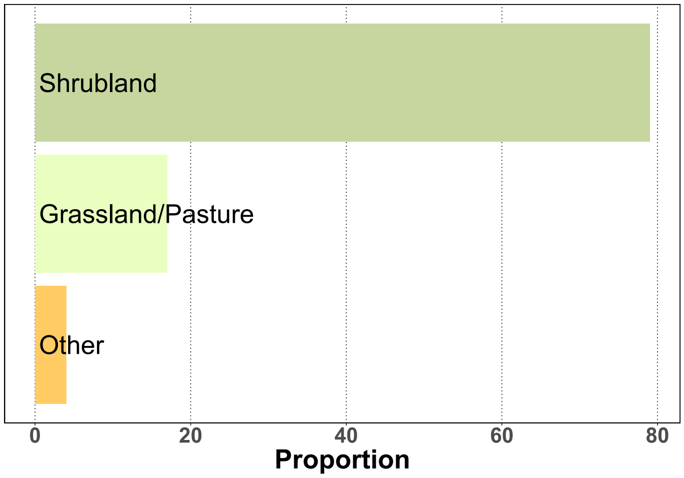

Figure 83C-2: Relative proportions (percentages) of land use in MLRA 83C.

The major soil resource concerns include wind erosion and water erosion. In some areas, accessory soil minerals, including salts, are a concern. Rangeland site suitability and plant productivity, health, and vigor are major management concerns because of the invasion of brush and cactus.

Conservation practices on rangeland generally include brush control, range planting, prescribed grazing management, prescribed burning, firebreaks, fences, adequate water distribution systems, and development of upland wildlife habitat. Important conservation practices on cropland are crop rotations, nutrient management, pest management, crop residue management, and mulch tillage and no-till systems. On the more sloping cropland, terraces and grassed waterways may be needed, depending on the type of crop residue management and tillage system being used.

83D—Lower Rio Grande Plain

This MLRA (fig. 83D-1) is characterized by distinct vegetation, prairie grassland with large areas of cropland, and the specialty crops citrus and sugar cane. It also contains the only sizeable urban area in south Texas. The landscape is a broad, nearly level alluvial plain associated with the delta of the Rio Grande. The MLRA is entirely in Texas and makes up about 2,871 square miles (7,435 square kilometers).

The boundaries with neighboring MLRAs are distinct, based on differences in vegetation, climate, and geology. The Rio Grande forms the international boundary between the United States and Mexico in this MLRA. It flows into the Gulf of Mexico just east of the MLRA.

Physiography

This area is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. Drainageways are shallow and have low gradients. Elevation ranges from about 15 feet (5 meters) in the eastern part of the MLRA to about 600 feet (185 meters) in the northwestern part. It is mainly less than 275 feet (85 meters).

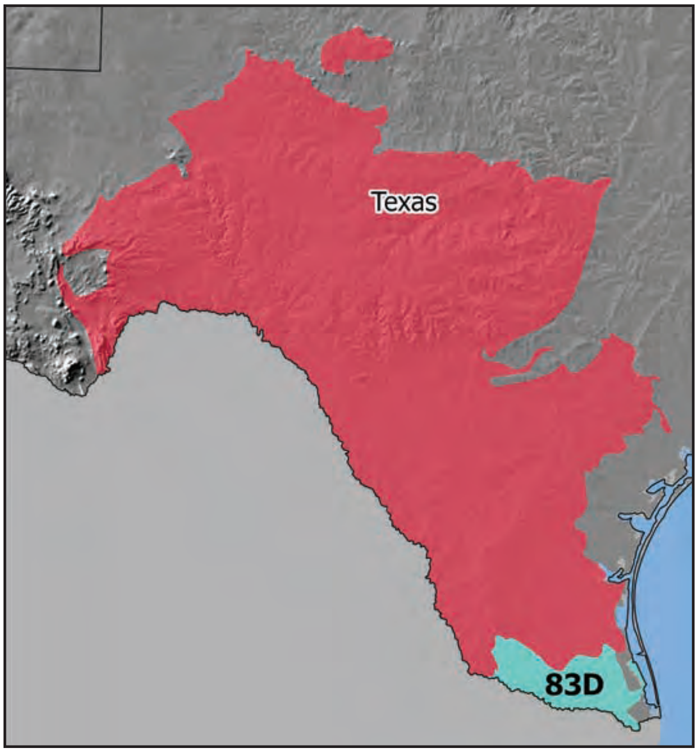

Figure 83D-1: Location of MLRA 83D, which covers 743,500 hectares (1,837,200 acres), within Region I.

Geology

Most of this MLRA is on the coastal plain that formed when Cretaceous seas retreated towards the present-day Gulf of Mexico throughout the Tertiary Period. Lagoonal, estuarine, beach, flood-plain, and deltaic sediments were deposited in a wide swath paralleling the current coastline of Texas and other Gulf States. Fine textured sediments deposited in lagoons became shale layers, and the coarser textured sediments became sandstone layers. The rocks at the surface are primarily alluvial sediments of the Goliad Formation of Miocene age and the Beaumont Formation of Pleistocene age. Older sandstone layers below the alluvial sediments in this area yield saline ground water. Recent alluvial sediments are adjacent to the Rio Grande.

Climate

The average annual precipitation is 22 to 27 inches (560 to 685 millimeters) in most of this area. Most of the rainfall occurs during low- to moderate-intensity, Pacific frontal storms in winter. Hurricanes from the Gulf of Mexico occasionally trigger heavy rainfall in late summer and early fall. The average annual temperature is 72 to 74 degrees F (22 to 23 degrees C). The freeze-free period averages 350 days and ranges from 330 to 365 days.

Water

The rainfall is adequate for the rangeland grasses. It is low in the western and central parts of the MLRA and marginal in the eastern part. High temperatures and high evaporation and transpiration rates limit crop production. The Rio Grande, the only perennial stream in the area, provides water for irrigation and public supply. Two major reservoirs on the Rio Grande upstream from the MLRA, the International Amistad and Falcon Reservoirs, dramatically improve the water quality in the river. In the uplands away from the valley of the Rio Grande, ponds provide water for livestock, domestic use, and irrigation. Reservoirs have been constructed on most of the larger, although intermittent, tributaries of the Rio Grande. Many irrigation and drainage channels are throughout this area.

Deep wells provide water for livestock, domestic use, public supply, and irrigation. The ground water in the part of the Gulf Coast aquifer beneath this MLRA is typically more saline than that in the rest of this aquifer. Water from the upper part of the aquifer is moderately hard, but it becomes soft at greater depths as sodium replaces calcium. As more water is pumped from this aquifer, even more saline water at greater depths can move up into the pumping zone.

Soils

The dominant soil orders are Alfisols, Mollisols, Vertisols, and Inceptisols. The soils in the area have a hyperthermic soil temperature regime, an ustic soil moisture regime, and mixed or smectitic mineralogy. They are generally very deep, well drained or moderately well drained, and loamy or clayey.

The main soils and their series:

- Argiustolls that formed in alluvium on deltas and stream terraces and in drainageways (Racombes and Willacy series)
- Calciustepts that formed in loamy sediments on old terraces and uplands (McAllen series)
- Calciustolls that formed in alluvium on deltas and stream terraces and in drainageways (Hidalgo and Raymondville series)
- Haplustalfs that formed in mixed colluvium and residuum on ridges (Brennan series)
- Haplusterts that formed in alluvium on stream terraces (Harlingen and Mercedes series)
- Haplustolls that formed in alluvium on deltas and stream terraces and in drainageways (Laredo and Ramadero series)
- Paleustalfs that formed in loamy sediments on old terraces and uplands (Delfina series)

Biological Resources

The open grassland in this area supports mid prairie grasses with scattered woody plants and some perennial forbs and legumes in the uplands. Twoflower and fourflower trichloris, plains bristlegrass, and lovegrass tridens are among the dominant grasses in these areas. Desert yaupon, spiny hackberry, and blackbrush are the major woody plants. Tall and mid grasses, such as switchgrass, giant sacaton, fourflower trichloris, big sandbur, little bluestem, and southwestern bristlegrass, are dominant in savanna plant communities on bottom land. Hackberry, mesquite, elm, and palm trees are the major woody plants. Forbs are important but minor components of the plant communities. Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Most of this area is cropland or improved pasture that is extensively irrigated (fig. 83D-2). A large acreage is rangeland grazed mainly by beef cattle and wildlife. The major crops are cotton, grain sorghum, citrus, onions, cabbage, and other truck crops. Almost all of the crops are grown under irrigation. Hunting leases for white-tailed deer, quail, white-winged dove, and mourning dove are an important source of income in the area. There is some urban land, mainly in the southern part of the MLRA.

The major soil resource concerns are soil quality, salinity, subsurface drainage, water erosion, wind erosion, and an adequate quality and quantity of irrigation water. The major

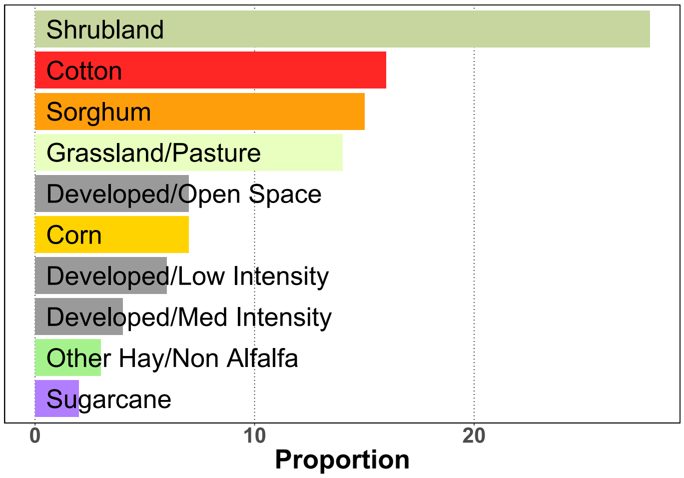

Figure 83D-2: Relative proportions (percentages) of land use in MLRA 83D.

land use concerns are saline soils and inadequate subsurface drainage on cropland.

Conservation practices on cropland generally include conservation crop rotations, nutrient management, pest management, crop residue management, surface roughening, irrigation systems, conveyance pipelines for irrigation water, and irrigation water management. Conservation practices on rangeland include practical stocking rates, proper grazing use, timely deferment of grazing, and pasture rotation.

83E—Sandsheet Prairie

This MLRA (fig. 83E-1) is characterized by a nearly level to undulating eolian landscape covered in prairie grasslands interspersed with tall shrubs. The boundaries with neighboring MLRAs are distinct and based on landscape shape, soil textures, and vegetation. MLRA 83E is entirely in Texas and makes up about 4,179 square miles (10,824 square kilometers).

Physiography

This MLRA is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. It is a nearly level to undulating eolian sand sheet. The surface consists of small mounds or elongated ridges and closed saline depressions aligned from southeast to northwest according to prevailing southeasterly winds. These features result from the deposition of windblown sand into elongated dunes and from erosion of elongated blowouts or wind-eroded depressions. Native grasses and live oaks have stabilized most of the dune ridges. Dunes that have not been stabilized are active and move slowly to the northwest during dry summer months. Elevation ranges from sea level near the shore of the Gulf of Mexico in the eastern part of the area to 920 feet (280 meters) in the western part. This area has no major rivers.

Figure 83E-1: Location of MLRA 83E, which covers 1,082,400 hectares (2,674,600 acres), within Region I.

Geology

In this MLRA, Recent (Holocene) alluvium and wind-deposited sand sheet, silt sheet, clay dune, and base-level plain sediments were deposited on Pleistocene and Tertiary geologic formations. The eolian sediments conceal these formations in most of the area. These older formations include (from east to west) the Beaumont and Lissie Formations of Pleistocene age, the Goliad Formation of Pliocene age, the Catahoula Formation of Miocene age, and the Frio Formation of Oligocene age.

The soils in this MLRA formed during the Holocene, but the duration of soil formation depended on landform stability and the period when eolian deposition ended. Soil formation initiated with sand dune stabilization. Wind-deposited silts and fine sands of the Riviera Loess Sheet are in the extreme northern part of the MLRA. The soils in this part have a higher content of clay and salts, particularly in the subsoil, than similar soils in other parts of the MLRA. This MLRA includes loamy dunes, locally referred to as clay dunes, which are wind-deflation deposits that border the western and northern margins of relict lakes. These dunes resulted from eolian deposition of sand-sized aggregates of silt and clay particles that eroded from dry lakebed sediments.

Climate

The average annual precipitation in this area is 22 to 28 inches (560 to 710 millimeters). Most of the rainfall occurs in spring and fall. The average annual temperature is 71 to 73 degrees F (22 to 23 degrees C). The freeze-free period averages 345 days and ranges from 325 to 365 days.

Water

The rainfall is adequate for the rangeland vegetation. Crop yields, however, are limited by periods of moisture stress caused by high evaporation and transpiration rates and, in some areas, salinity. Ponds provide water for livestock, limited irrigation, and domestic use. This area does not have an integrated stream drainage network. The small amount of surface water is somewhat saline and generally not suitable for most uses. The amount of rainfall that accompanies hurricanes and major storms cannot be discharged by the small drainage systems. As a result, broad areas may be flooded for weeks following a major storm.

Deep wells in the Gulf Coast aquifer system provide water of fairly good quality for livestock, limited irrigation, and domestic use. This aquifer consists of a complex of young, interbedded clays, silts, sands, and gravel. The water is hard and slightly saline. Wells more than 500 feet deep encounter soft water where sodium is replacing calcium.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Inceptisols. Most of the soils are Ustalfs, Psamments, Aqualfs, or Aquepts. The soils in the area are deep or very deep and are moderately coarse textured or coarse textured. They have a hyperthermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. Natrustalfs, Natraqualfs, and Halaquepts are associated with salt-affected areas near Laguna Madre and inland depressions and flats.

The main soils and their series:

Halaquepts that are very deep and poorly drained and formed on nearly level, low coastal terraces adjacent to tidal flats (Saucel series)

Natraqualfs that are deep and somewhat poorly drained and formed on nearly level, low coastal terraces adjacent to tidal flats (Sauz series)

Natrustalfs that are deep and moderately well drained and have a thick surface layer of sand and a sandy to loamy subsoil with redoximorphic features (Palobia, Quiteria, and Padrones series)

Paleustalfs that are well drained and formed in sandy sediments on the stabilized parts of the sand sheet landscape (Sarita and Nueces series)

Ustipsamments that are very deep and excessively drained and formed on recently stabilized sand dunes (Falfurrias series)

Biological Resources

The dominantly open grassland in this area has a mixture of mid and tall grasses and perennial forbs. Stable dunes support live oaks in the form of thickets and large motts separated by low-lying areas of grassland. Gulf cordgrass is dominant on salt-affected, poorly drained or very poorly drained soils.

Seacoast bluestem, brownseed paspalum, tanglehead, switchgrass, Indiangrass, snoutbean, and western indigo are dominant on soils that formed in the thicker deposits of sand. Once denuded, the sands are very difficult to revegetate. As thickness of the sandy surface soil decreases to less than 20 inches (50 centimeters), fourflower trichloris, Arizona cottontop, plains bristlegrass, hooded windmill grass, and partridge pea become more dominant and make up a major part of the vegetation. A mixture of brush species also dominates the soils during retrogression.

Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, white-winged dove, and mourning dove.

Land Use

Most of this area is rangeland grazed by beef cattle and wildlife (fig. 83E-2). Some areas have been converted to pasture, which generally is seeded to coastal Bermudagrass or kleingrass. Hunting leases for deer, wild turkey, quail, mourning dove, white-winged dove, javelina, and numerous species of exotic game are an important source of income in the area.

The major soil resource concerns are accessory soil minerals, including salts, and rangeland site stability. Plant productivity, health, and vigor and undesirable woody species and cactus, which compete with adapted grassland species, are other major concerns.

Conservation practices on rangeland generally include brush control, range planting, prescribed grazing management, prescribed burning, firebreaks, fencing, adequate water distribution systems, and development of upland wildlife habitat.

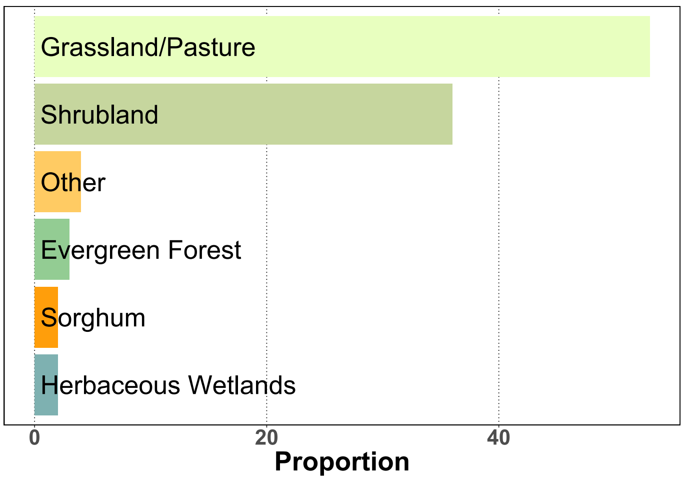

Figure 83E-2: Relative proportions (percentages) of land use in MLRA 83E.

J—Southwestern Prairies Cotton and Forage Region

Land Resource Region J (fig. J-1) is a climatically transitional area (progressively drier westward) of prairies and savannas superimposed across two major physiographic provinces—the Central Lowland and the Coastal Plain. Its western portion consists of limestones and shales of the Central Lowland province. Its east portion consists of the unconsolidated sediments of the Coastal Plain. This region has a northern spike extending through Oklahoma into southern Kansas called the Cross Timbers, so named because settlers had difficulty making their way through the tangled short oak trees. Region J contains 10 major land resource areas. The extent of these MLRAs and their range in elevations are shown in table J-1.

Region J has a boundary to the east with Region P (fig. 1, page 5) which is not geologic, since both regions are on the Coastal Plain, but rather bioclimatic. Region J dominantly consists of native prairies, has an ustic udic soil moisture regime, and has Alfisols with notable amounts of soil carbonate. Region P is dominantly forested, has a udic soil moisture regime, and has Ultisols with no carbonate (see Introduction, figs. 2, 6, and 9). Region J also has a bioclimatic boundary to the west with Region H. This boundary marks the approximate contact between the typic ustic soil moisture regime (Region H) and the udic ustic soil moisture regime (Region J). Region J has a boundary to the southwest with Region I that follows the Balcones escarpment separating the Edwards Plateau from the Coastal Plain. At its southern contact with Region I, the boundary corresponds to the boundary between the thermic and hyperthermic soil temperature regimes and the change in vegetation to open grassland with scattered mesquite, live oak, and other trees. Region J has a boundary to the southeast with Region T that reflects the change from a cuesta landscape to a younger, less-dissected landscape as well as the change from a thermic soil temperature regime to a hyperthermic regime. Region T also contains more cropland than Region J.

Climatically, temperatures decrease from north to south and precipitation decreases from east to west. Mean temperatures (61 to 68 degrees F; 16 to 20 degrees C) and precipitation (32 to 46 inches; 813 to 1,168 millimeters) for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables J-2 and J-3.

Figure J-1: Location and size of Land Resource Region J, which covers 153,490 square kilometers (59,260 square miles) from southern Kansas to central Texas.

Table J-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
82B	2,130	825	300	990	370	1,220	440	1,440	540	1,780	750	2,460
84A	20,535	7,930	180	600	240	800	290	960	360	1,190	520	1,710
84B	15,290	5,905	160	530	210	700	300	990	470	1,550	660	2,180
84C	3,570	1,380	120	410	170	560	200	670	240	800	300	980
85A	21,650	8,360	120	390	200	650	280	940	440	1,440	600	1,970
85B	4,755	1,835	160	550	230	750	290	970	360	1,180	430	1,410
86A	39,345	15,190	70	230	120	390	160	530	210	700	310	1,030
86B	7,260	2,805	30	120	70	230	100	330	130	420	180	590
87A	26,450	10,210	20	90	60	210	110	360	150	500	240	800
87B	12,500	4,825	60	220	100	330	140	460	180	600	260	870

Table J-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
82B	15.4	60	15.9	61	16.3	61	16.6	62	16.9	62	210	221	230/230	236	240
84A	13.3	56	14.6	58	15.9	61	16.5	62	17.3	63	195	206	223/220	234	245
84B	16.7	62	17.2	63	17.8	64	18.3	65	18.9	66	220	232	241/240	245	260
84C	17	63	17.3	63	18.5	65	18.9	66	19.2	67	245	245	252/255	261	265
85A	17.2	63	17.8	64	18.5	65	19.1	66	19.7	67	225	242	251/250	264	275
85B	16.2	61	16.4	61	16.5	62	17	63	17.4	63	210	221	231/230	240	245
86A	17.1	63	17.5	64	18.8	66	20	68	21.2	70	240	245	257/260	272	300
86B	19	66	19.9	68	20.2	68	20.6	69	21.1	70	250	268	277/275	282	295
87A	18.5	65	19	66	19.9	68	20.7	69	21.2	70	250	258	270/270	282	300
87B	16.8	62	17.1	63	17.5	64	18.2	65	18.9	66	230	238	242/245	251	270

Table J-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
82B	720	29	758	30	822/810	32/32	851	34	880	34
84A	800	32	921	36	1,008/995	40/39	1,061	42	1,130	44
84B	690	27	766	30	884/890	35/35	1,033	41	1,130	44
84C	900	36	939	37	968/980	38/39	1,040	41	1,080	42
85A	740	30	780	31	873/870	34/34	962	38	1,030	40
85B	950	37	971	38	1,023/1,015	40/40	1,050	41	1,100	43
86A	750	30	876	35	983/990	39/39	1,131	45	1,210	47
86B	900	36	947	37	1,011/1,025	40/40	1,118	44	1,190	47
87A	710	28	872	34	1,006/995	40/39	1,117	44	1,210	48
87B	1,020	40	1,088	43	1,147/1,155	45/46	1,237	49	1,290	51

The soils are primarily Alfisols, Vertisols, and Mollisols. Alfisols are dominant in the more humid eastern part of the region. Vertisols are dominant in the central part, where they formed in clayey Coastal Plain parent materials. Mollisols are dominant in the drier semiarid western part (fig. 2). Inceptisols occur on older terraces, and Entisols form the modern flood plains. Carbonates are common in this region, especially in soils that formed from marly parent materials (fig. 5, page 9). Organic carbon concentrations are also high in the marly calcareous soils (fig. 14, page 18). In contrast these calcareous soils hinder formation of argillic horizons (fig. 12, page 16). Restrictive zones occur in many soil profiles, mainly as lithic, paralithic, and densic bedrock (fig. 9). All of the soils in the region have a thermic soil temperature regime, and most have an ustic soil moisture regime.

Land use in Region J is dominantly grassland and pasture, deciduous forest, shrubland, and urban development (fig. J-2). Cropland is primarily in the central part of the region (fig. 8, page 12). The native vegetation consists mainly of grasses and scattered trees. The trees are concentrated in the Cross Timbers area. Grasslands include mixtures of range, pasture, and improved pasture. Grazing by beef cattle is the dominant land use in most of the region, but hay, grain sorghum, and small grains are grown where the soils, topography, and moisture supply are favorable. Other locally important crops include corn, cotton, and peanuts. Pecans are grown on well drained soils that are not commonly flooded and are on the higher terraces along many of the major rivers crossing the region. Vegetables are grown where irrigation water is available. The major resource concerns are overgrazing and the invasion of undesirable plant species. Water erosion also is a major resource concern, especially on cropland. Surface compaction, moisture management, and maintenance of the content of soil organic matter are additional concerns for cropland.

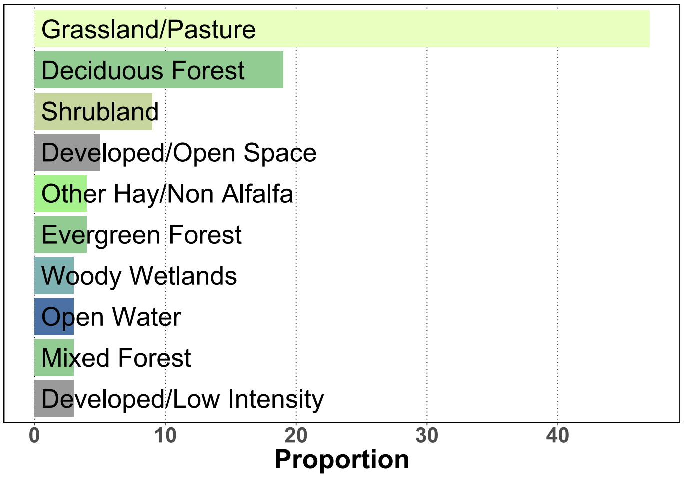

Figure J-2: Relative proportions (percentages) of land uses in Land Resource Region J (National Agricultural Statistics Service, 2018).

82B—Wichita Mountains

This MLRA (fig. 82B-1) is a remnant an ancient mountain range dominated by granite, rhyolite, and limestone formations. Its hills and mountains are a stark contrast to the surrounding rolling plains. The MLRA is entirely in Oklahoma and makes up about 823 square miles (2,131 square kilometers).

The area is bounded by the Permian Redbeds on all sides. The boundaries with neighboring MLRAs 78C and 80A are distinct and based on geology, topology, and the distinct red color of the Permian-age rock.

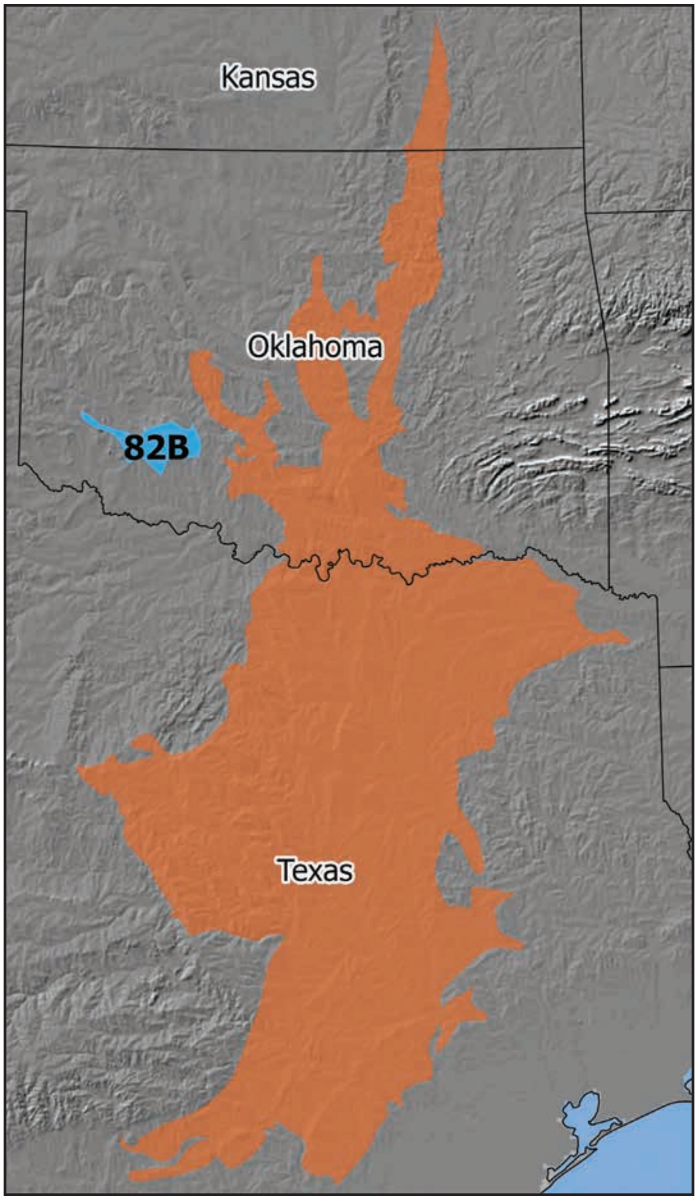

Figure 82B-1: Location of MLRA 82B, which covers 213,100 hectares (526,500 acres), within Region J.

Physiography

This area is in the Osage Plains section of the Central Lowland province of the Interior Plains. The landscape is characterized by rugged hills and mountains made up mainly of extrusive granite. Areas where the granite is at the surface are nearly barren of vegetation. The faulted granite blocks stand (at the highest point) about 1,000 feet (305 meters) above the surrounding plains. A smooth, nearly level to moderately sloping erosional surface (pediment) is at the base of the hills and mountains. Elevation ranges from 1,100 feet (335 meters) to 2,020 feet (615 meters). The North Fork of the Red River crosses the west end of this area, and Cache Creek and Medicine Creek drain the eastern part.

Geology

The surface geology of this MLRA is dominated by intrusive igneous rocks (primarily granite) of Precambrian age with associated limestone, sandstone, dolomite, chert, and shale of Cambrian age. This area is underlain by both igneous and sedimentary rocks in a structurally complex setting. Igneous rocks primarily include granite, rhyolite, gabbro, and anorthosite of Precambrian age. Sedimentary rocks include limestone, sandstone, dolomite, and chert of the Lower Arbuckle Formation (Timber Hills Group) of Cambrian age and limestone with minor inclusions of sandstone, chert, dolomite, and shale of the Upper Arbuckle Formation of Ordovician age. A large outcrop known as the “Slick Hills” is part of this unit. The Meers Fault is a prominent geologic feature in this area.

Climate

The average annual precipitation is 26 to 31 inches (660 to 785 millimeters). The amount may fluctuate widely. Most of the rainfall occurs in spring and fall. The average annual temperature is 59 to 62 degrees F (15 to 17 degrees C). The freeze-free period averages 230 days and ranges from 220 to 245 days.

Water

Water is scarce throughout the MLRA because of the low and erratic precipitation and few perennial streams. The 48,000-acre area of irrigated cropland is served by the Luger-Altus Irrigation District, which delivers water by canal from Lake Altus-Lugert on the North Fork of the Red River. Naturally occurring brine seeps make the river water saline.

Ground water in this area is used for domestic purposes, livestock, and some limited irrigation. Many springs and seeps occur locally throughout the area. The Arbuckle-Timbered Hills aquifer occurs in a very small area in Oklahoma within this MLRA. It provides water for domestic use and irrigation. Naturally high levels of chloride and fluoride preclude use of the water for public supply. The only other principal aquifer in the MLRA is a valley fill deposit in the valley of the North Fork of the Red River, in the northwest corner of the area. This aquifer provides water primarily for livestock and some limited irrigation. The ground water is similar in quality to the surface water.

Soils

Most of the soils in the MLRA are Mollisols or Ustolls. The soils in the area have a thermic soil temperature regime, an ustic soil moisture regime, and mixed mineralogy. Much of this area is covered by highly fractured, barren, granitic rock outcrop.

The main soils and their series:

Argiustolls that are deep and nearly level to moderately sloping and formed on pediment surfaces (Lawton series); that are very deep, are moderately sloping to steep, and formed in cobbly, granitic colluvium on footslopes below granitic mountains (Brico series)

Haplustolls that are shallow, are very gently sloping to steep, and formed in limestone residuum (Kiti series)

Biological Resources

This area supports mid and tall prairie grasses interspersed with trees, particularly along fault lines. The diverse vegetation includes big bluestem, Indiangrass, little bluestem, switchgrass, sideoats grama, blue grama, buffalograss, post oak, blackjack oak, maple, buckbrush, goldenrod, scurfpea, gayfeather, and Maximilian sunflower.

Major wildlife species in this area include American bison, Rocky Mountain elk, white-tailed deer, coyote, black-tailed jackrabbit, prairie dog, bobwhite quail, ducks, and geese. Many manmade lakes provide good opportunities for recreational fishing.

Land Use

Farms and ranches make up nearly all of the private land in this area. Livestock grazing is the dominant land use (fig. 82B-2), and most of the rangeland is used for cow-calf

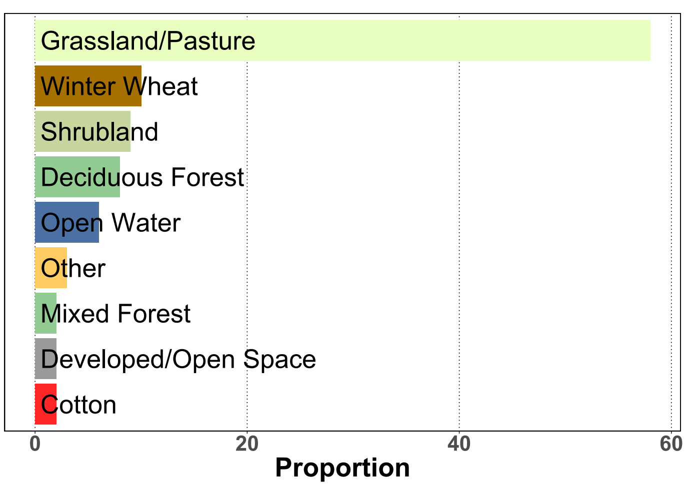

Figure 82B-2: Relative proportions (percentages) of land use in MLRA 82B.

operations. Cropland makes up less than one-third of the area. Small grains, cotton, and grain sorghum are the principal crops. Recreation and tourism are important to the local economy. Two large areas of this MLRA are under Federal jurisdiction: Fort Sill Army Post, which covers 93,709 acres, and the Wichita Mountains Wildlife Refuge, which covers 59,020 acres.

The major soil resource concerns on cropland are control of water erosion and conservation of soil moisture. The major concern on rangeland is overgrazing. Conservation practices on cropland generally include conservation tillage, pest management, and irrigation water management. Conservation practices on rangeland generally include practical stocking rates, proper grazing use, and timely deferment of grazing.

84A—North Cross Timbers

This MLRA (fig. 84A-1) is characterized by its post oak-blackjack oak savanna vegetation. Its soils formed in Cretaceous-age sandstone and mudstone under a subhumid climate. The area lies between the Cherokee Prairies and woodlands to the east and the Central Rolling Red Prairies to the west. The boundaries to the west with neighboring MLRAs are subtle and based on biological characteristics, while the boundary with the West Cross Timbers (MLRA 84B) is distinct and based on physical characteristics. The MLRA is in Oklahoma (90 percent) and Kansas (10 percent). It makes up about 7,928 square miles (20,534 square kilometers).

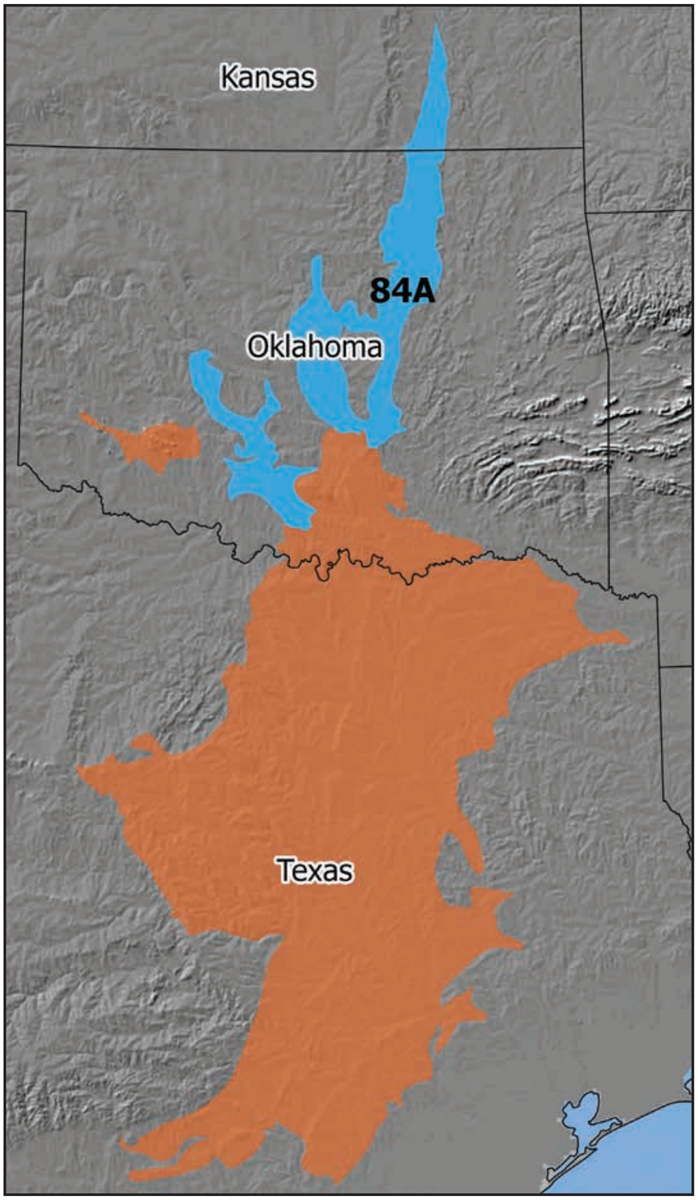

Figure 84A-1: Location of MLRA 84A, which covers 2,053,400 hectares (5,074,000 acres), within Region J.

Physiography

This area is in the Osage Plains section of the Central Lowland province of the Interior Plains. It is an area of rolling to hilly uplands. Summits and divides on the hilltops are nearly level to strongly rolling and narrow to moderately broad. Stream valleys are narrow and have steep gradients. Rock outcrops occur on both the hilltops and hillsides. Elevation ranges from 800 to 1,190 feet (240 to 360 meters). Local relief is mostly 65 to 100 feet (20 to 30 meters), but the large valleys are 165 feet (50 meters) or more below the adjacent uplands.

The major rivers in the area include the Verdigris River in Kansas and the Arkansas, Cimarron, and South Canadian Rivers in Oklahoma. There are many large reservoirs on tributaries to these rivers in this area.

Geology

Sandstones and shales of Permian age underlie the western part of this area. The eastern part, including the part in Kansas, is underlain by Pennsylvanian-age shale and sandstone. Pleistocene stream terraces are a minor part of the area. They are alongside the rivers.

Climate

The average annual precipitation is 36 to 42 inches (921 to 1,061 millimeters) in most of this area. It is closer to 30 inches (760 millimeters) in the extreme western part of the area. The maximum precipitation occurs in spring, and a small amount occurs in winter. Most of the rainfall occurs during high-intensity, convective thunderstorms in spring and summer. The annual snowfall ranges from 12 inches (30 centimeters) in the northern part of the area to 4 inches (10 centimeters) in the southern part. The average annual temperature is 58 to 62 degrees F (15 to 17 degrees C). The freeze-free period averages 220 days and ranges from 206 to 245 days.

Water

The moderate and somewhat erratic rainfall is the source of water for rangeland and cropland. Large reservoirs provide water for cities and towns and for recreation and flood control. Farm ponds are a major source of water for livestock.

In most of this area, shallow wells supply water for domestic use, but ground water is scarce where sandstone and shale are near the surface. The Vamoosa-Ada aquifer, in Pennsylvanian-age sandstone, underlies most of the area. It supplies soft to hard ground water primarily for public supply and municipal and industrial uses. This water is suitable for drinking unless there is local contamination due to oil and gas exploration and development activities.

The Rush Springs aquifer underlies the western part of this MLRA. It provides water primarily for irrigation. The water is very hard, but it can be used for public supplies, except in local areas where levels of chloride and sulfate exceed the national drinking water standards.

Ground water is pumped from alluvial sediments and terrace deposits along the major rivers that cross this area. This water is used primarily for irrigation and domestic supply. It has a slightly higher median level of total dissolved solids than the water in the Rush Springs aquifer but otherwise is very similar in quality.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Mollisols, and Inceptisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic or udic soil moisture regime, and mixed, siliceous, or smectitic mineralogy. They generally are shallow to very deep, somewhat excessively drained to somewhat poorly drained, and loamy or clayey.

The main soils and their series:

- Eutrudepts that formed in residuum on hills (Bigheart series)
- Hapludalfs that formed in residuum on hills (Niotaze and Bartlesville series)
- Hapludolls that formed in alluvium on flood plains (Verdigris series)
- Haplustalfs that formed in alluvium on stream terraces (Dougherty and Konawa series); that formed in residuum on hills (Newalla, Steedman, and Stephenville series)
- Haplustepts that formed in residuum on hills (Darnell series)
- Paleudalfs that formed in colluvium and residuum on footslopes (Prue series)
- Paleustalfs that formed in colluvium on footslopes (Harrah series)
- Ustifluvents that formed in alluvium on flood plains (Pulaski series)

Biological Resources

This MLRA is one of the three subdivisions of the Cross Timbers ecosystem, which is thought to be one the least disturbed forest types remaining in the Eastern United States. It supports open stands of oak trees, dominantly post oak and blackjack oak, with an understory of mid and tall grasses, forbs, and low woody plants. Big bluestem, little bluestem, Indiangrass, sunflower, and lespedezas are the major species in the herbaceous understory. Many acres have been encroached by woody species such as eastern redcedar due to an altered fire regime. Sericea lespedeza is another invasive species prominent throughout the MLRA.

Major wildlife species in this area include white-tailed deer, coyote, fox, bobcat, badger, beaver, raccoon, opossum, skunk, muskrat, jackrabbit, cottontail, mink, squirrel, prairie dog, bobwhite quail, mourning dove, Mississippi kite, and rattlesnake. Fish species include black bass and channel catfish. Invasive, feral hogs may be encountered, especially near creeks and rivers.

Land Use

Much of this area is in farms and ranches (fig. 84A-2). More than one-half is rangeland, less than one-third is woodland, less than one-tenth is pasture, and less than one-tenth is cropland. Some areas are used for urban development. Most of the rangeland, woodland, and pasture are grazed by beef cattle. Some areas are used for dairy cattle. Small grains, grain sorghum, cotton, alfalfa, and other hay crops are important in much of the area. Peanuts, tree fruits, and vegetables are grown on a large acreage in the southern part of the area.

The major soil resource concerns are water erosion, moisture conservation, and conservation of soil organic matter. Plant health, plant vigor, and noxious and invading plants are the

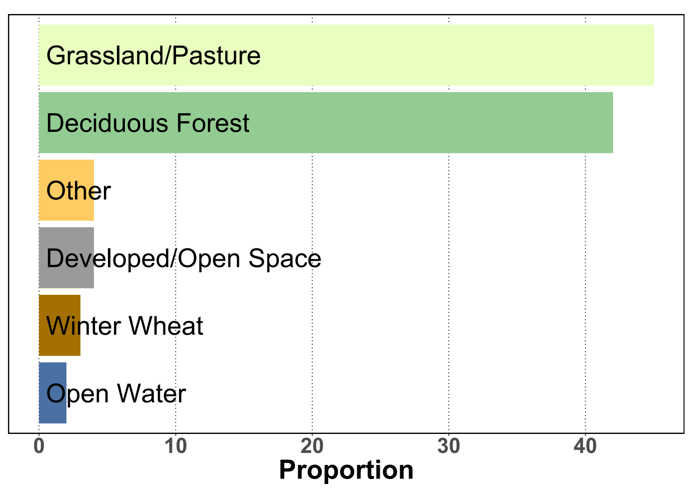

Figure 84A-2: Relative proportions (percentages) of land use in MLRA 84A.

major management concerns on grassland. Conservation practices on cropland generally include terraces, grassed waterways, nutrient management, grade-control structures, conservation tillage, and pest management. Conservation practices on rangeland generally include brush management, prescribed fire, fencing, proper grazing, and range planting.

84B—West Cross Timbers

This MLRA (fig. 84B-1) is characterized by post oak-blackjack oak savanna vegetation. It consists of undulating hillslopes that are moderately dissected. Its soils formed in Cretaceous-age sandstone and mudstone under a subhumid climate. The boundaries with neighboring MLRAs are distinct and based on physical and biological characteristics. MLRA 84B is in Texas (77 percent) and Oklahoma (23 percent). It makes up about 5,904 square miles (15,290 square kilometers).

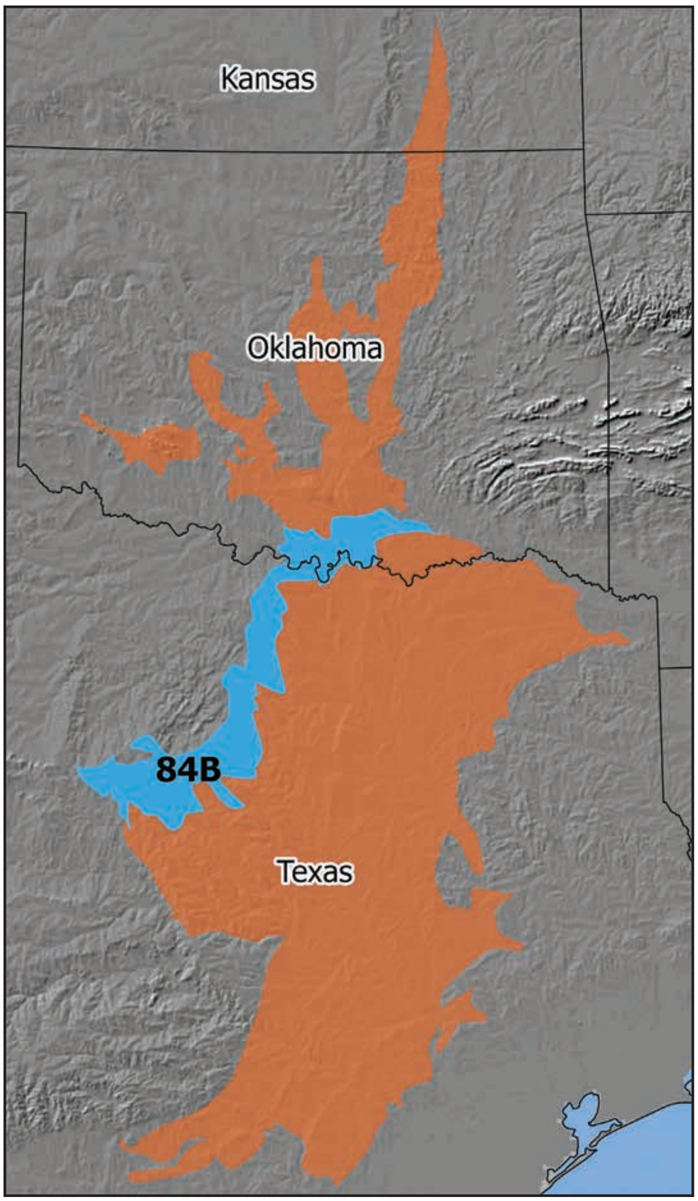

Figure 84B-1: Location of MLRA 84B, which covers 1,529,000 hectares (3,778,200 acres), within Region J.

Physiography

This MLRA lies within the Central Texas section of the Great Plains province of the Interior Plains and represents the distinct boundary with the Osage Plains section of the Central Lowland province of the Interior Plains. The western part of this area is known as the Callahan Divide, and the central part is known as the Comanche Plateau. The northern part represents the transition from the Interior Plains to the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. This part has a higher average slope gradient than the southern part, has been significantly affected by water erosion, and is gullied. The southern part is nearly level to undulating and has been significantly affected by wind and water erosion. Elevation is mainly 750 to 1,700 feet (225 to 525 meters), but it ranges down to about 550 to 650 feet (175 to 200 meters) along the Paluxy, Brazos, Trinity, Red, and Washita Rivers and up to 2,000 feet (625 meters) atop the Callahan Divide. Local relief is mostly 15 to 65 feet (5 to 20 meters) but ranges up to 100 feet (30 meters) due to inclusions of limestone hills and ridges.

Portions of this MLRA lie at the headwaters of several watersheds, including the Pecan Bayou, Leon, Bosque, Paluxy, and Trinity Rivers. The Brazos, Trinity, Red, and Washita Rivers flow through this area. The Red River separates the States of Oklahoma and Texas in this area.

Geology

Early Cretaceous sandstone, mudstone, and conglomerate of the Trinity and Fredericksburg Groups distinguish this area from inclusions of the Grand Prairie. These outcrops serve as the recharge zone for the Trinity aquifer throughout the extent of this MLRA. Because of the east-to-southeast dip of these rocks, the oldest units are exposed along the north and west portions of the area and successively younger units are exposed to the south and east. From youngest to oldest, the units include the Paluxy Sand, upper Antlers Sand, Glen Rose Limestone, Twin Mountains Formation, and lower Antlers Sand. The Paluxy Sand and upper Antlers Sand are primarily very fine to fine grained sandstone with thin interbedded mudstone strata. The Glen Rose Limestone serves as the base level for many streams in the south-central portion of this area. Soils derived from the Glen Rose Limestone are considered inclusions of the Grand Prairie within this MLRA. The Twin Mountains Formation and lower Antlers Sand consist of alternating beds of sandstone, mudstone, and conglomerate with a basal conglomerate resting above the underlying Paleozoic strata. Thicker sequences of mudstone strata in the Twin Mountains Formation and lower Antlers Sand contribute to soils with higher clay contents in the subsoil as compared to those derived from the Paluxy Sand and upper Antlers Sand.

Climate

The average annual precipitation in most of this MLRA is 26 to 42 inches (660 to 1,065 millimeters). It is 26 to 30 inches (660 to 760 millimeters) in the extreme southern part of the area. It decreases from east to west. Most of the rainfall occurs during high-intensity, convective thunderstorms in late spring and late summer to early fall. July and August are typically dry. Almost 75 percent of the total annual precipitation falls during the freeze-free period. The typical summer moisture deficit ranges from about 7 to 10 inches (180 to 255 millimeters). Snow can occur in this area, but it does not remain on the ground for long periods. The average annual temperature is 62 to 66 degrees F (17 to 19 degrees C). The freeze-free period averages 255 days and ranges from 230 to 275 days.

Water

The moderate and somewhat erratic rainfall is the source of water for pasture and crops. Farm ponds are a major source of water for livestock. Local streams flow intermittently. A few large reservoirs provide water for cities and towns and for recreation and irrigation. The surface water is generally of good quality and suitable for almost all uses.

In most of this area, shallow wells supply water for domestic use, but ground water is scarce near the contact with the underlying Paleozoic strata. The sandstone and carbonate layers in the Trinity Group are the primary aquifers throughout this area, which serves as the principal recharge zone. Water in these units is very hard. About 30 percent of the wells sampled in areas of these aquifers showed levels of nitrate in excess of the national drinking water standard. Wells for public supply, irrigation, and some industrial supply occur throughout the MLRA. Shallow wells for irrigation are common in the southern part of the area, but the availability and quantity of water vary greatly. Water levels have been declining because of overuse, so future development of ground water resources is in jeopardy. Contamination from nitrate sources is a problem in these shallow aquifers.

Another source of ground water in this area is the unconsolidated deposits of sand and gravel that fill the major river valleys. This calcium-magnesium, carbonate-bicarbonate type of water is very hard. This aquifer may also contain large concentrations of nitrate.

Soils

The dominant soil orders in this MLRA are Alfisols and Entisols. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and mixed or siliceous mineralogy. They generally are deep or very deep, well drained or moderately well drained, and loamy or clayey.

The main soils and their series:

- Haplustalfs that are moderately deep to deep, are gently sloping to strongly sloping, and formed over interbedded sandstone and mudstone on crests and side slopes of ridges and hillslopes (Cisco and Keeter series); that are very deep, are nearly level to gently sloping, and formed in drainageways and on stream terraces (May series)
- Paleudalfs that are very deep, are nearly level to strongly sloping, and formed over interbedded sandstone and mudstone on ridges and hillslopes (Bernow series)
- Paleustalfs that are deep to very deep, are gently sloping to moderately sloping, and formed over interbedded sandstone and mudstone on crests and side slopes of ridges (Duffau, Pedernales, Weatherford, and Windthorst series); that are very deep, are nearly level to moderately sloping, and formed in locally reworked eolian sands over thick sequences of sandstone on interfluves and side slopes of ridges (Demona, Nimrod, and Patilo series); that are deep to very deep, are nearly level to moderately sloping, and formed on drainageways and base slopes of ridges (Chaney, Hassee, and Selden series)
- Ustifluvents that are very deep, are nearly level, and formed on flood plains (Bunyan, Energy, and Pulexas series)

Biological Resources

This MLRA is one of the three subdivisions of the Cross Timbers ecosystem, which is thought to be one the least disturbed forest types remaining in the Eastern United States. It supports open stands of oak trees, dominantly post oak and blackjack oak, and has mid to tall grasses interspersed with the trees and underbrush. Little bluestem, purpletop tridens, Indiangrass, switchgrass, big bluestem, sand lovegrass, coralberry, and greenbrier with an overstory of post oak and blackjack oak were the historically dominant species. Engelmann's daisy, Maximilian sunflower, and trailing wildbean are among the numerous perennial forbs. In the southwestern part of this MLRA, many areas that were previously farmed but not converted to pasture or hayland have been encroached by honey mesquite or juniper. These native species were less prevalent historically. In the northern part of this MLRA, many areas that were previously farmed but not converted to pasture or hayland have transitioned to closed canopy woodland with an understory dominated by greenbrier.

Major wildlife species in this area include white-tailed deer, coyote, fox, bobcat, raccoon, skunk, opossum, rabbit, armadillo, squirrel, quail, and mourning dove. Fish species include largemouth bass, channel catfish, and bream.

Land Use

Most of this MLRA is in farms and ranches (fig. 84B-2). About 70 percent of the area is native grass pasture, improved pasture, or noncommercial oak forests that are used for grazing. Most areas of pasture, rangeland, and woodland are grazed by beef cattle, but dairy cattle are important in some areas. Generally, the acreage of cropland is decreasing and that of improved pasture is increasing. The main crops are peanuts, grain sorghum, small grains, and forage sorghum. Improved Bermudagrass and other hay crops also are important in the MLRA. Locally, peaches, apples, pecans, and vegetables are important crops. About one-tenth of the area is used for urban development and other purposes.

The major natural resource concerns include wind erosion; water erosion (gully, sheet, and rill erosion); water quality; streambank erosion; plant productivity, health, and vigor; and water for livestock. Conservation practices on cropland generally include nutrient and pest management, crop residue management, critical area planting, development of ponds, and streambank and shoreline protection. Conservation practices on pasture, rangeland, and forestland generally include riparian forest buffers, fencing, forage harvest management, brush management, prescribed burning, and proper grazing use.

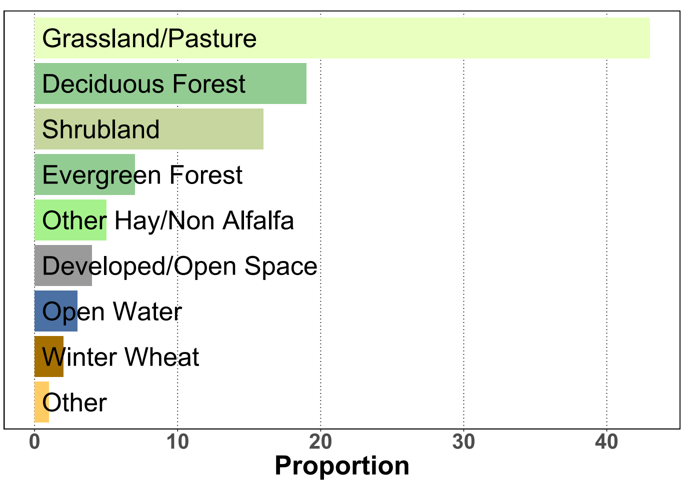

Figure 84B-2: Relative proportions (percentages) of land use in MLRA 84B.

84C—East Cross Timbers

This MLRA (fig. 84C-1) is characterized by gently sloping to rolling uplands that are moderately dissected. The area historically supported post oak-blackjack oak savanna vegetation, but much of it has been subject to fragmentation and urban sprawl. Its soils formed in interbedded sandstone and shale of the Late Cretaceous-age Woodbine Formation under a moist subhumid climate. The boundaries with neighboring MLRAs are distinct and based on physical and biological characteristics. MLRA 84C is entirely in Texas and makes up about 1,378 square miles (3,569 square kilometers).

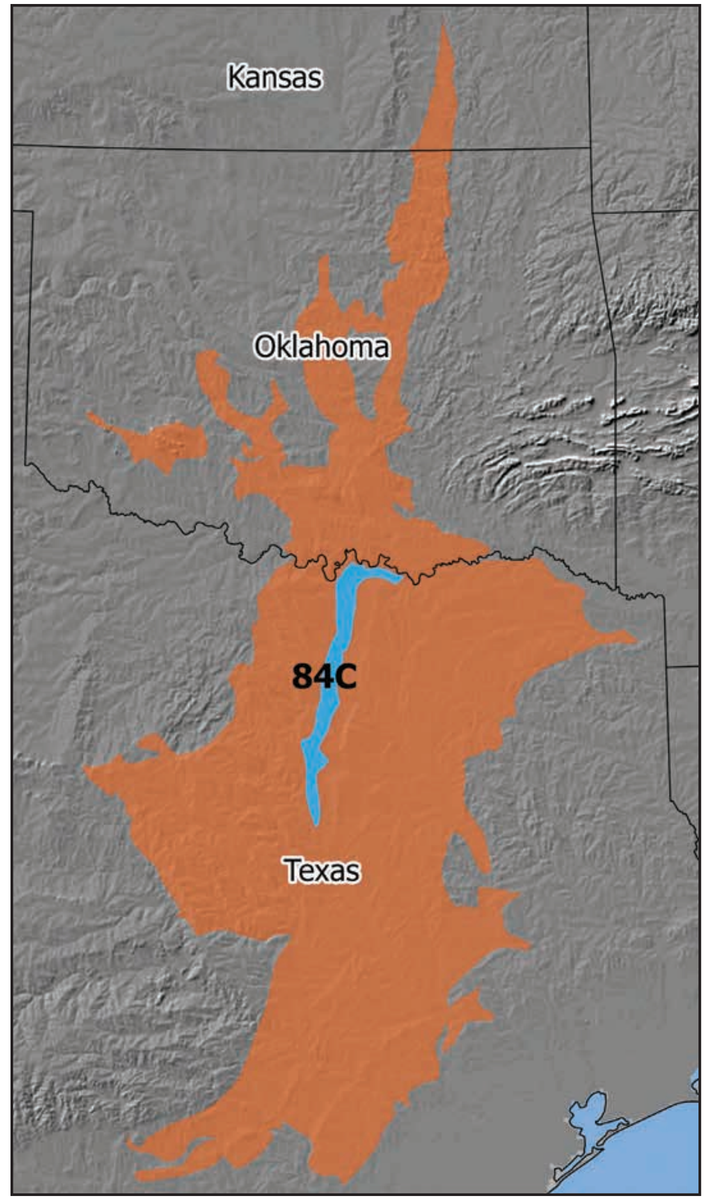

Figure 84C-1: Location of MLRA 84C, which covers 356,900 hectares (882,000 acres), within Region J.

Physiography

This area represents the distinct boundary between the Central Texas section of Great Plains province of the Interior Plains and the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. In northern Texas, the East Cross Timbers separate the Comanche Plateau or Grand Prairie to the west from the Blackland Prairie to the east. Sandstone-capped hills and ridges rise prominently above the surrounding landscape. Elevation is mainly 490 to 1,015 feet (150 to 310 meters), but it ranges to about 400 feet (125 meters) along the Brazos and Trinity Rivers. Local relief is mostly 3 to 50 feet (10 to 25 meters), but ranges up to 100 feet (35 meters) in the northern part of the MLRA and near bluffs adjacent to river valleys.

The Brazos, Red, and Trinity Rivers dissect the MLRA. Lake Texoma, on the Red River, is in the northern part of the area. Lakes Arlington, Grapevine, Lewisville, and Ray Roberts are in the central part, on tributaries of the Trinity River. Lake Aquilla is in the southern part of the MLRA, on a tributary of the Brazos River.

Geology

This area is underlain by interbedded sandstone and shale of the Woodbine Formation of Late Cretaceous age. These sediments are composed largely of terrigenous material eroded from Paleozoic sedimentary and weakly metamorphosed sedimentary rocks associated with the Llano Arch and Arbuckle Uplift in what is present-day north-central Texas and south-central Oklahoma. The eroded sediments were deposited in a complex of nearshore environments that included fluvial systems, deltaic systems, and shelf-strand plain systems.

The Woodbine Formation is subdivided into several geologic members. Because of the east-to-southeast dip of these rocks, the oldest units are exposed along the north and west portions of the MLRA and successively younger units are exposed to the south and east. From youngest to oldest, the geologic members include the Templeton, Lewisville, Red Branch, and Dexter Members. These units are mapped separately north of Lake Ray Roberts in Cooke, Grayson, and Fannin Counties, in Texas, and Marshall and Bryan Counties, in Oklahoma. Elsewhere the Woodbine Formation is mapped undivided.

The Templeton Member is primarily gray, glauconitic shale interbedded with thin sandstone strata. The Lewisville Member is primarily gray to brown sandstone interbedded with shale. The Red Branch Member is interbedded sandstone, shale, and lignite and is indistinguishable from the Lewisville Member in most of the MLRA. The Dexter Member is primarily sandstone with some silty clay lenses. On this gently sloping to rolling landscape, the more resistant sandstones form interfluves and crests of ridges and the more erodible shales and sandstones form hillslopes and drainage networks.

Climate

The average annual precipitation in this area is 34 to 41 inches (865 to 1,040 millimeters). Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is about 24 to 26 inches (610 to 660 millimeters). The average annual temperature is 62 to 66 degrees F (17 to 19 degrees C). The freeze-free period averages about 265 days and ranges from 255 to 280 days.

Water

The moderate and somewhat erratic rainfall is generally sufficient for native forage production and for watering livestock. It also is the major source of water for pasture and crops. Local streams flow intermittently. Large reservoirs on the major streams provide water for cities and towns. The lake water is used for public supply, industry, and recreation. Farm ponds are a major source of water for livestock. The surface water is generally of good quality and suitable for most uses.

In rural areas, wells supply water for domestic use. A few small irrigation wells supply a limited quantity of water. Sandstone and carbonate layers of the Paluxy aquifer are the principal ground water source in this MLRA. The ground water in this aquifer is very hard. About 30 percent of the samples exceeded the national drinking water standard for nitrate. Falling water tables limit the use of this aquifer.

Soils

The dominant soil orders are Alfisols, Entisols, and Mollisols. The soils in the area are moderately deep or deep, medium textured to coarse textured, and moderately well drained to somewhat excessively drained. They have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, siliceous, or mixed mineralogy.

The main soils and their series:

- Haplustalfs that are shallow to moderately deep, are gently sloping to moderately steep, and formed over sandstone on crests and side slopes of ridges and hillslopes (Rayex series)
- Haplustolls that are very deep, are nearly level, and formed on flood plains (Whitesboro series)
- Arenic Paleustalfs that are very deep, are nearly level to moderately sloping, and formed in locally reworked eolian sands over thick sequences of sandstone (Silstid series)
- Lamellic Paleustalfs that are very deep, are nearly level to gently sloping, and formed in locally reworked eolian sands on stream terraces (Aquilla series)
- Udertic Paleustalfs that are deep, are gently sloping to strongly sloping, and formed over shale on crests and side slopes of ridges (Crosstell series)
- Udic Paleustalfs that are very deep, are gently sloping to moderately sloping, and formed over interbedded sandstone and shale on side slopes and base slopes of ridges (Callisburg series); that are very deep, are nearly level to gently sloping, and formed on stream terraces (Bastsil series)
- Ultic Paleustalfs that are moderately deep, are gently sloping to moderately steep, and formed over interbedded sandstone and shale on crests and side slopes of ridges (Birome series); that are very deep, are nearly level to moderately sloping, and formed over interbedded

sandstone and shale on interfluves, side slopes, and base slopes of ridges (Gasil and Konsil series)
Ustifluvents that are very deep, are nearly level, and formed on flood plains (Pulexas and Bunyan series)

Biological Resources

This MLRA is one of the three subdivisions of the Cross Timbers ecosystem, which is thought to be one the least disturbed forest types remaining in the Eastern United States. It supports post oak-blackjack oak savanna vegetation with an understory of mid and tall grasses in a native state. Little bluestem, purpletop tridens, Indiangrass, switchgrass, big bluestem, post oak, blackjack oak, elm, coralberry, American beautyberry, Bumelia, greenbrier, and elbowbush are some of the dominant species. Engelmann's daisy, lespedezas, and trailing wildbean are among the numerous perennial forbs. Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Most of this MLRA is in farms and ranches, but sizable tracts in the central part are rapidly being converted to urban uses (fig. 84C-2). Some of the large tracts are being fragmented into smaller ranches. Most rural areas are used as improved pasture, native grass pasture, or noncommercial oak forest and are grazed mainly by beef cattle. Some areas are used for peanuts, small grains, forage sorghum, fruits, or vegetables.

The major resource concerns are water quality, wind erosion, and water erosion. Important conservation practices for water quality are nutrient management and riparian buffers. In addition, proper management of septic tank absorption fields can help prevent pollution of the lakes. Wildlife habitat is an important management objective of landowners in the MLRA.

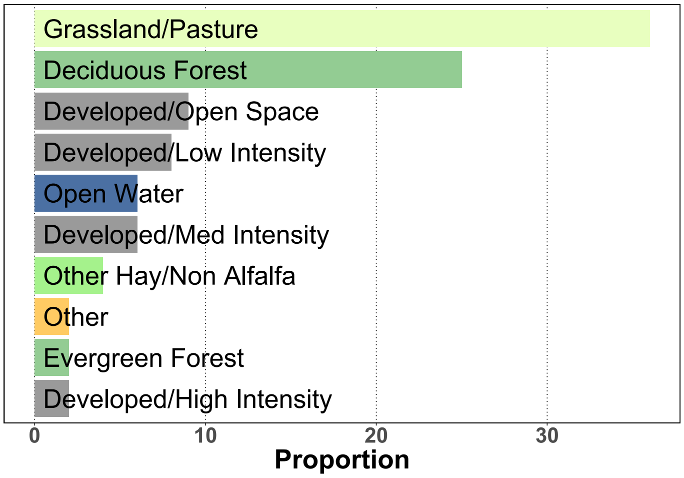

Figure 84C-2: Relative proportions (percentages) of land use in MLRA 84C.

Warm-season improved pastures are established to protect the area from erosion and to produce forage for livestock.

85A—Grand Prairie

This MLRA (fig. 85A-1) is characterized by soils that formed in parent material from Early Cretaceous limestone and interbedded calcareous mudstone under a subhumid climate. It supports a mixture of Texas live oak savanna and tallgrass prairie. Within the MLRA, two areas are distinguishable by subtle differences in climate, physiography, relief, biota, and land use. North of the Brazos River, the Washita Prairie was

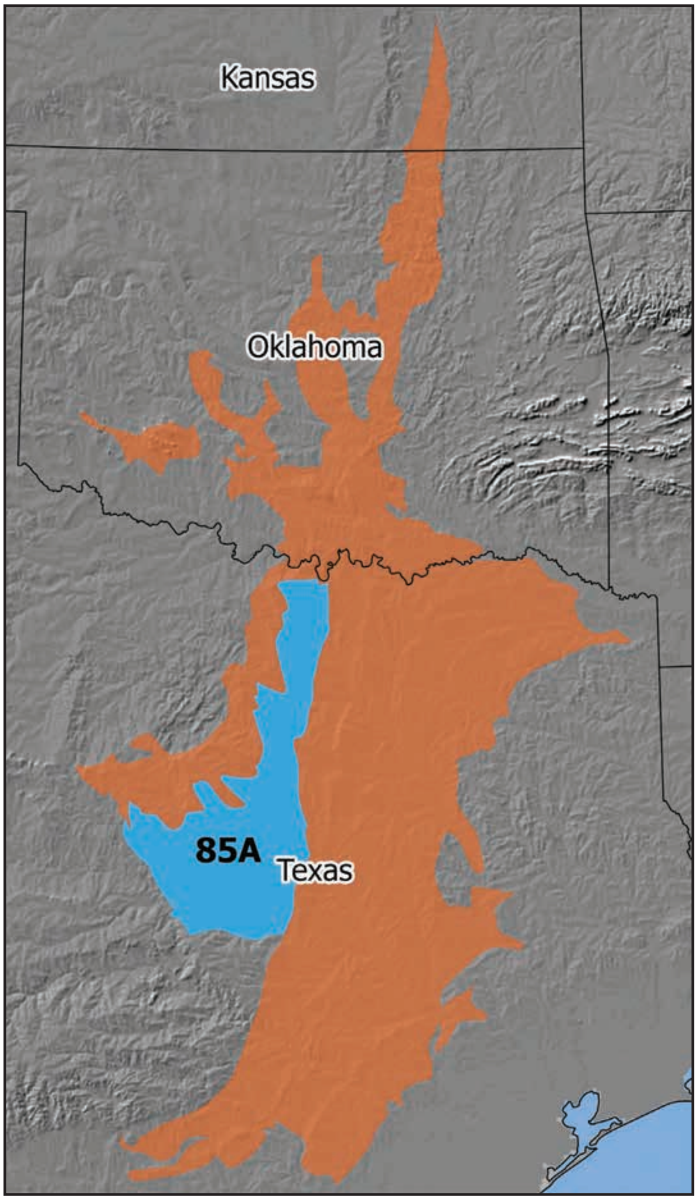

Figure 85A-1: Location of MLRA 85A, which covers 2,164,900 hectares (5,349,500 acres), within Region J.

historically dominated by tallgrass prairie, almost void of trees. South of the Brazos River, the ecologically diverse Lampasas Cut Plain was dominated by a mixture of savanna and tallgrass prairie. Today, shrublands dominated by juniper woodland and honey mesquite are prevalent throughout the Lampasas Cut Plain but are largely absent from the Washita Prairie.

The MLRA is entirely in Texas and makes up about 8,359 square miles (21,649 square kilometers). The boundaries with neighboring MLRAs to the north, east, and west are distinct and based on physical and biological characteristics. To the south, the boundary with MLRA 81C (Edwards Plateau, Eastern Part) is gradual and only apparent south of the Colorado River where the benched topography of the Lampasas Cut Plain is replaced by the steep erosional landscape of the Balcones Canyonlands.

Physiography

This MLRA is within the Central Texas section of the Great Plains province of the Interior Plains. Collectively, the area is known as the Comanche Plateau, but individual parts are known as the Lampasas Cut Plain and Washita Prairie. The Lampasas Cut Plain is a dissected limestone plateau characterized by undulating to rolling ridges and hillslopes with steep escarpments rimming the valley margins. It is further divided into the Walnut Prairie and Glen Rose Prairie. These local subdivisions represent unique landscapes in which the soils, geology, and vegetation are closely tied.

North and east of the Lampasas Cut Plain, the Washita Prairie is an undulating to rolling dissected plain with a steep scarp slope along the western margin at the contact with the West Cross Timbers (MLRA 84B). The eastern margin is marked by the East Cross Timbers (MLRA 84C). The Washita Prairie is further divided into the Gainesville Prairie, Bosqueville Prairie, and Fort Worth Prairie. The Fort Worth Prairie is the most extensive and representative of this area.

Elevation ranges from 500 to 1,500 feet (150 to 475 meters). Local relief in the Lampasas Cut Plain is mostly 50 to 150 feet (15 to 45 meters) but ranges up to 200 feet (60 meters). In the Washita Prairie, local relief is mostly 15 to 50 feet (5 to 15 meters).

The major watersheds within this MLRA are the Bosque and Leon River watersheds, which encompass most of the Brazos River watershed within the Lampasas Cut Plain. North of the Brazos River, tributaries of the Red and Trinity Rivers are within the Washita Prairie. The Colorado River marks the southern boundary in some places, and the watershed of the western margin of the Lampasas Cut Plain flows south to the Colorado River.

Geology

Early Cretaceous limestone and calcareous mudstone of the Trinity, Fredericksburg, and Washita Groups define the central concept of the Grand Prairie. The more resistant members form the summits of ridges and hills, and the less resistant members form hillslopes and valleys. In many areas interbedded limestone and calcareous mudstone (marl) weathered to form hillslopes with a benched or stepped topography. Across most of the area, there is a subtle eastward dip of 0.2 degree, or 15 feet per mile (3 meters per kilometer). The average dip decreases to approximately 5 feet per mile (1 meter per kilometer) to the west, near the Callahan Divide, and increases to about 22 feet per mile (4 meters per kilometer) to the east in the Washita Prairie.

In the Washita Prairie, the youngest rocks of the Washita Group are exposed. From youngest to oldest (east to west), they include the Buda Limestone, Grayson Marl, Mainstreet Limestone, Pawpaw Formation, Weno Limestone, Denton Clay, Fort Worth Limestone, and Duck Creek Formation. Below the Washita Group, along the western margin of the Washita Prairie, and in the Lampasas Cut Plain, the older rocks of the Fredericksburg Group are exposed. From youngest to oldest, they include the Kiamichi Clay, Edwards Limestone, Comanche Peak Limestone, Goodland Limestone, and Walnut Clay. Across much of the Lampasas Cut Plain, the rocks of the Glen Rose Limestone of the Trinity Group are the oldest, and resistant beds within the Glen Rose Limestone control the base level of many streams. The Grand Prairie also includes the calcareous Travis Peak Formation, which directly overlies the Paleozoic rocks of MLRAs 80B and 81B in the Lowland along the Colorado.

Climate

The average annual precipitation in this area is 27 to 41 inches (685 to 1,040 millimeters). Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is 23 to 26 inches (585 to 660 millimeters). The average annual temperature is 60 to 67 degrees F (16 to 19 degrees C). The freeze-free period averages 260 days and ranges from 235 to 290 days.

Water

In most years the moderate and often erratic rainfall is adequate for crops, pasture, and rangeland. Summer droughts commonly reduce yields. The large rivers flow all year, and large reservoirs provide municipal water and opportunities for recreation. Most of the lakes and reservoirs within the Brazos River watershed are brackish and used mainly for flood control and recreation. Small farm ponds are an important source of water for farm use (primarily livestock), fish, and wildlife.

Ground water is abundant in the Cretaceous limestone and sandstone layers of the Trinity Group aquifer. This aquifer outcrops as the Glen Rose Limestone throughout much this area in the Lampasas Cut Plain. To the north and west of this MLRA, the West Cross Timbers (MLRA 84B) serve as an important recharge zone. Many seeps, springs, and local streams provide water, mostly during spring and winter. The water is very hard. About 30 percent of all the wells tested in this aquifer have nitrate concentrations that exceeded the national drinking water standard. This aquifer is heavily used for public supply, municipal and industrial water, and irrigation. In some areas where water levels have dropped significantly, pumping from this aquifer is being limited.

Soils

The dominant soil orders in this MLRA are Mollisols, Vertisols, and Inceptisols. The soils that formed in residuum over resistant beds are generally shallow to moderately deep, and those that formed in calcareous clayey alluvium or slope alluvium are generally deep or very deep. The soils in the area are well drained to moderately well drained. Surface horizons are loamy to clayey. Rock content varies according to cementation and weatherability of the parent material. The soils generally have a thermic soil temperature regime, an ustic soil moisture regime, and carbonatic, smectitic, or mixed mineralogy. Limited areas of rock outcrop occur on free faces of escarpments and intermixed with very shallow soils on interfluves of ridges.

The main soils and their series:

Argiustolls that are shallow, are nearly level to gently sloping, and formed over limestone bedrock on ridges and plateaus (Speck and Tarpley series)

Calciustolls that are shallow and very shallow, are gravelly and stony, and formed over limestone bedrock in gently sloping areas (Aledo, Cho, and Purves series); that are moderately deep and deep, are well drained, and formed over limestone or calcareous mudstone bedrock primarily in gently sloping areas (Bolar, Denton, Mosheim, Nuff, and Topsey series); that are shallow, have carbonatic mineralogy, and formed in limestone residuum in gently sloping to steep areas (Doss and Real series); that are very deep and well drained and formed on stream terraces and base slopes (Rumley, Sunev, and Venus series)

Haplustepts that are shallow, have carbonatic mineralogy, and formed in limestone residuum in sloping to steep areas (Brackett series)

Haplusterts that are moderately deep to very deep, have smectitic mineralogy, and typically formed in nearly level to gently sloping areas (Crawford, Sanger, and Slidell series)

Haplustolls that are shallow with smectitic mineralogy and formed in limestone residuum in gently sloping to moderately steep areas on plateaus (Eckrant series); that are very deep and well drained and formed on stream terraces and in drainageways (Krum series); that are very deep and well drained, have significant accumulations of organic matter, and formed on flood plains (Frio and Bosque series)

Ustorthents that are very shallow, have carbonatic mineralogy, and formed in limestone residuum in gently sloping to moderately steep areas on ridges (Maloterre series)

Biological Resources

The native vegetation in the Lampasas Cut Plain consists of mid and tall grasses interspersed with scattered oaks and oak savanna. In the Washita Prairie, the native vegetation consists of tallgrass prairie. Little bluestem, Indiangrass, big bluestem, and switchgrass are typical species on the deeper soils. Texas wintergrass, little bluestem, silver bluestem, and sideoats grama, as well as Texas red oak, Texas live oak, elm, ash, and juniper, are the characteristic plant species on shallow soils and on soils below escarpments. Areas of deteriorated rangeland commonly have increased amounts of cool-season grasses, short grasses, annuals, pricklypear, elm, honey mesquite, or juniper. Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Most of this area is in ranches, farms, and other private holdings (fig. 85A-2). The dominant land use is livestock grazing on rangeland. A smaller acreage is used as cropland or improved pasture. Many ranches are involved in wildlife management. The major crops in the area are small grains and forage sorghum, which are used as supplemental feed for livestock and wildlife. Pastured areas mainly support improved Bermudagrass and kleingrass. Native pecan orchards are common on flood plains. Hunting leases for deer and wild turkey are an important source of income in the southern part of the area. Urban land is rapidly expanding adjacent to the major cities.

The major resource concerns include land use change, water erosion, and water quality. The major resource concerns on cropland are encroachment of woody species, maintenance of the content of soil organic matter, conservation of soil moisture, and water erosion. The major resource concerns on rangeland are overgrazing and the invasion of undesirable plant species.

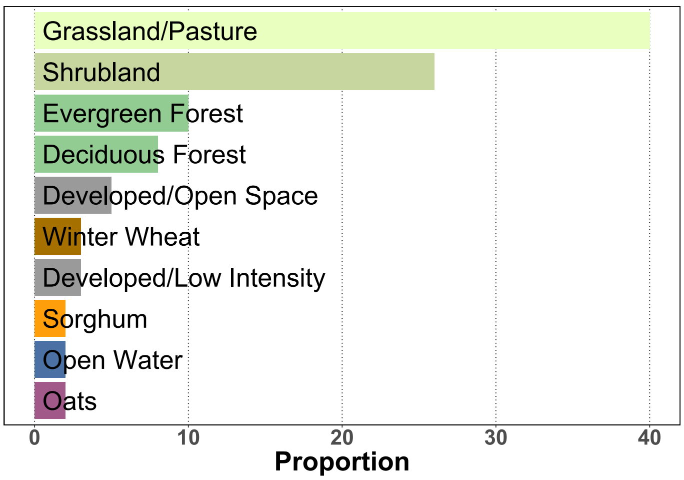

Figure 85A-2: Relative proportions (percentages) of land use in MLRA 85A.

Conservation practices on cropland generally include grassed waterways and terraces. Conservation practices on rangeland include brush management, practical stocking rates, and rotational grazing.

85B—Arbuckle Uplift

This MLRA (fig. 85B-1) is characterized by the structurally complex Arbuckle Uplift. The soils formed in parent materials of varied lithology under a subhumid climate. The plant communities range from tallgrass prairie to post oak savanna and woodland. The boundaries with neighboring MLRAs are distinct where based on physiography and geology and less apparent where based on biological and climatic characteristics. The MLRA is entirely in Oklahoma and makes up about 1,837 square miles (4,757 square kilometers).

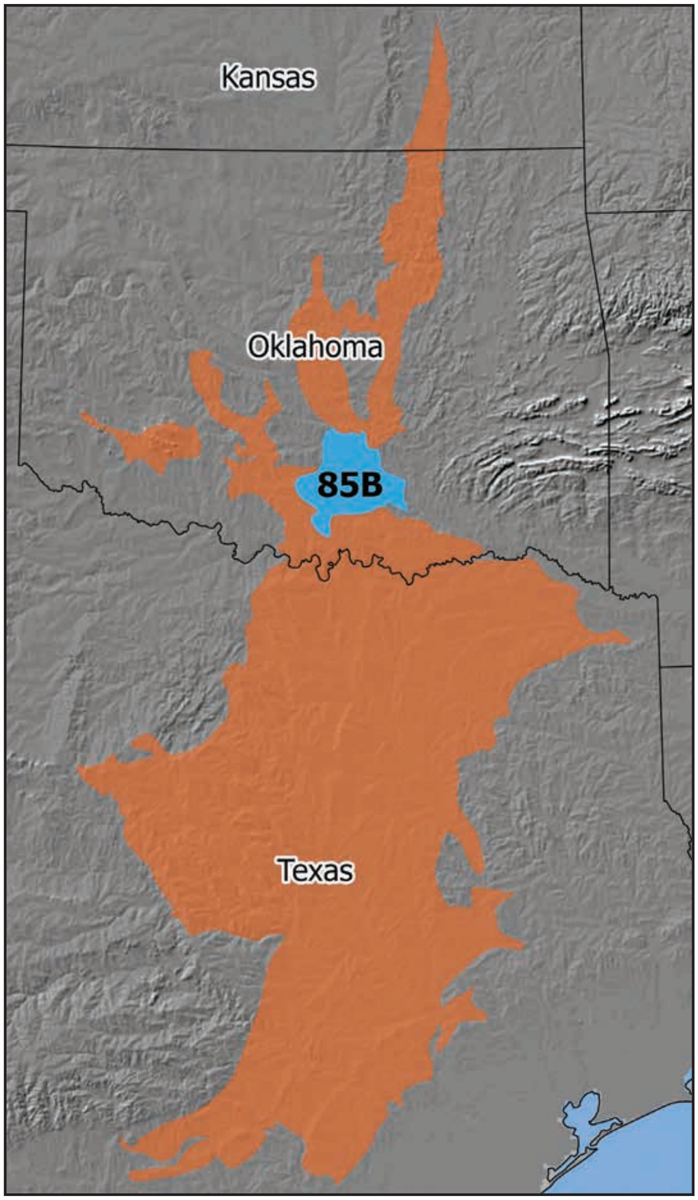

Figure 85B-1: Location of MLRA 85B, which covers 475,700 hectares (1,175,400 acres), within Region J.

Physiography

This MLRA is within the Osage Plains section of the Central Lowland province of the Interior Plains. Collectively, this area is locally known as the Arbuckle Mountains. It can be subdivided into the Arbuckle Hills and Arbuckle Plains. This MLRA also includes the Ardmore Basin. The Arbuckle Hills are composed of low to moderate hills chiefly of Cambrian- to Mississippian-age limestones. In these hills, steeply dipping strata are completely folded and faulted. The Arbuckle Plains are characterized by gently rolling hills and plains that developed on granites of Precambrian age and gently dipping limestones chiefly of Ordovician age. The Ardmore Basin is a lowland of folded Mississippian- and Pennsylvanian-age shales and sandstones between the Arbuckle Mountains and the Dissected Coastal Plain. Elevation ranges from 600 to 1,300 feet (175 to 400 meters). Local relief is mostly 15 to 65 feet (5 to 20 meters) but increases to more than 110 feet (35 meters).

The major river systems associated with this MLRA are the Washita, Canadian, and Red Rivers. The Washita River and its tributaries are the dominant watershed in this area.

Geology

Paleozoic and Precambrian rocks of various lithology and age, ranging from Precambrian to Pennsylvanian, characterize this area. Lithology in this structurally complex landscape is primarily limestone and dolostone but also includes sandstone, shale, mudstone, conglomerate, and massive chert. These geologic units are exposed as alternating beds of Paleozoic rocks that have been faulted, tilted, and deformed into a tombstone-like topography. Deep oil and gas wells have been drilled into these folded sediments. This area also has significant exposures of granite, rhyolite, and gabbro of Cambrian and Precambrian age.

Climate

The average annual precipitation in this area is 38 to 42 inches (950 to 1,050 millimeters). Most of the rainfall occurs in spring and fall. The average annual temperature is 60 to 63 degrees F (16 to 17 degrees C). The freeze-free period averages 223 days and ranges from 211 to 240 days.

Water

In most years the moderate and often erratic rainfall is adequate for crops, pasture, and rangeland. Summer droughts commonly reduce yields. The large rivers flow all year, and large reservoirs provide municipal water and opportunities for recreation. Small farm ponds are an important source of water for farm use (primarily livestock) and wildlife.

The primary ground water resource is the Arbuckle-Simpson aquifer. The water is very hard and generally of good quality, although chloride and fluoride levels exceed the national drinking water standards in some areas.

Soils

The dominant soil orders in this MLRA are Mollisols, Vertisols, Alfisols, and Inceptisols. The soils generally have a thermic soil temperature regime, an ustic soil moisture regime, and mixed, siliceous, or smectitic mineralogy. Rock outcrop occurs throughout the area.

The main soils and their series:

- Argiustolls that are shallow to deep, are gently sloping to steep, and formed on ridges and hillslopes (Scullin series)
- Haplustalfs that are moderately deep to deep, are gently sloping to steep, and formed on ridges and hillslopes (Bromide series); that are very deep, are nearly level to gently sloping, and formed on stream terraces (Konawa series)
- Haplustepts that are very shallow to deep, are gently sloping to steep, and formed on ridges and hillslopes (Travertine and Tussy series)
- Haplusterts that are deep to very deep, have smectitic mineralogy, are gently sloping to moderately steep, and formed on ridges and hillslopes (Clarita and Heiden series); that are very deep, have smectitic mineralogy, are nearly level to gently sloping, and formed on stream terraces (Burleson series)
- Haplustolls that are very shallow to shallow, are gently sloping to steep, and formed on ridges and hillslopes (Kiti, Rayford, and Timhill series); that are very deep and nearly level and formed on flood plains along the major drainageways (Dale series)
- Paleustalfs that are very deep, are nearly level to gently sloping, and formed on stream terraces (Bastrop series)
- Ustifluvents that are very deep and nearly level and formed on flood plains along the major drainageways (Yahola series)

Biological Resources

The native vegetation in this area consists of mid and tall grasses. Sideoats grama and little bluestem are the major species. Indiangrass, big bluestem, switchgrass, hairy grama, dropseed, and forbs are common. Sycamore and willow grow along creeks. Prairie fires restrict the spread of sumac, skunkbush, and other shrubs. Resource deterioration results in a higher percentage of short grasses, annuals, pricklypear, and eastern redcedar. Major wildlife species in the area include white-tailed deer, elina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Most of this area is in ranches, farms, and other private holdings (fig. 85B-2). The dominant land use is livestock grazing on rangeland. A smaller acreage is used as cropland or improved pasture. Many ranches are involved in wildlife management. The major crops in the area are small grains and forage sorghum, which are used as supplemental feed for livestock and wildlife. Pastured areas support mainly improved Bermudagrass and kleingrass.

The major resource concerns include water erosion and water quality. Specific resource concerns on cropland are encroachment of woody species, maintenance of the content of soil organic matter, conservation of soil moisture, and water erosion. On rangeland, overgrazing and the invasion of undesirable plant species are resource concerns.

Conservation practices on cropland generally include grassed waterways and terraces. Conservation practices on rangeland include control of brush and invasive weeds, practical stocking rates, and rotational grazing.

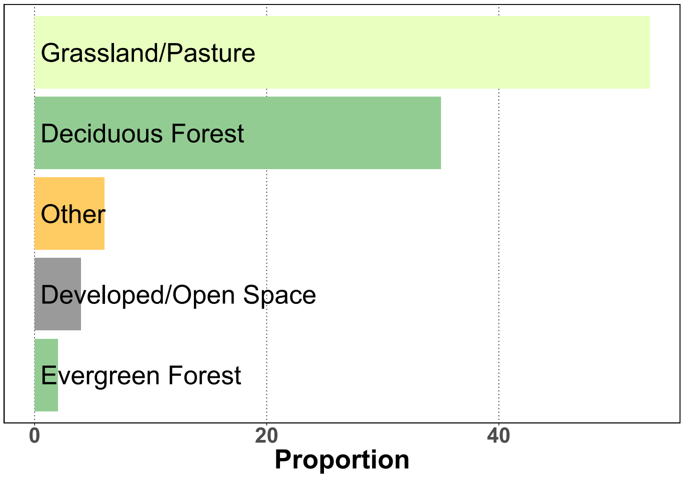

Figure 85B-2: Relative proportions (percentages) of land use in MLRA 85B.

86A—Texas Blackland Prairie, Northern Part

This MLRA (fig. 86A-1) is part of the larger tallgrass prairie continuum stretching from Canada to Mexico. The term “Blackland” refers to the dark clay soils with a high shrink-swell capacity that occur in much of the area. The generally flat to gently rolling land is fertile and has a high potential for crop production. The northern part of this prairie has less rainfall than the southern part (in MLRA 86B). The MLRA is entirely in

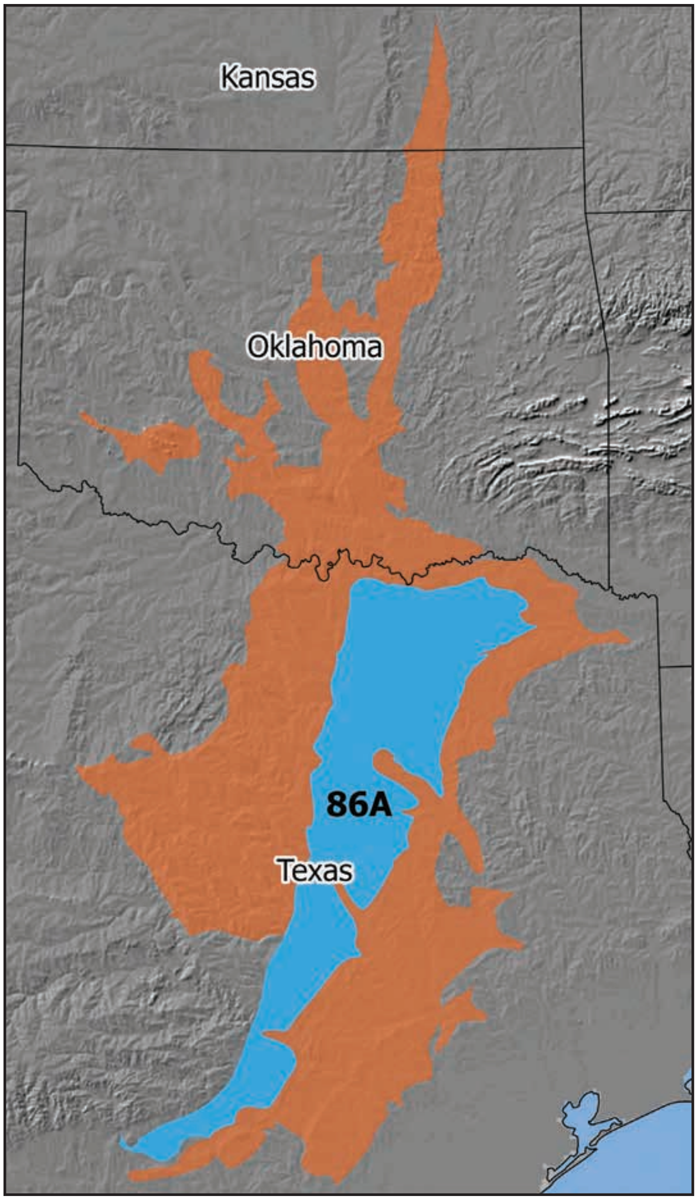

Figure 86A-1: Location of MLRA 86A, which covers 3,934,700 hectares (9,722,900 acres), within Region J.

Texas and makes up about 15,192 square miles (39,347 square kilometers).

The boundary to the west with the Edwards Plateau is distinct and based on geology and rainfall. The boundary to the east with the claypan savanna is more gradual as the amount of rainfall and the abundance of oak species increase.

Physiography

Almost all of this area is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. The west-central edge of the area is in the Central Texas section of the Great Plains province of the Interior Plains. Most of this MLRA is a nearly level to gently sloping, dissected plain. Dissected areas with steeper slopes occur along entrenched river and creek valleys. Broad meander belts are associated with the major streams, and wide flood plains are flanked by nearly level stream terraces. Elevation ranges from 300 to 600 feet (90 to 185 meters), increasing gradually from southeast to northwest. Areas of hilly land are associated with the Austin Chalk escarpment near the western edge of the area.

The headwaters of the Sabine and Sulphur Rivers are in the northern end of this MLRA. The Trinity and Brazos Rivers cross the center of the area. The rivers in the south end of the area include the Colorado, Lavaca, Guadalupe, and San Antonio Rivers.

Geology

This area is underlain by chalk, claystone, marl, and shale in the Eagle Ford Group, the Austin Chalk, and the Navarro Group (including Taylor Marl) of Cretaceous age. These Cretaceous rocks are incised by several major stream systems. Quaternary stream terraces and alluvium are associated with the rivers, and drainage patterns are controlled by the more resistant Cretaceous bedrock.

Climate

The average annual precipitation is 30 to 46 inches (760 to 1,170 millimeters) in most of this area, but it is less than 30 inches in the southern tip. Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is about 24 to 26 inches (610 to 660 millimeters). The average annual temperature is 63 to 69 degrees F (17 to 21 degrees C). The freeze-free period averages about 280 days and ranges from 250 to 310 days. Average annual temperatures and the length of the freeze-free period increase to the south.

Water

In most years the moderate rainfall is adequate for crops and pasture, but summer droughts commonly reduce crop yields. Large reservoirs on the major streams provide municipal water. The water from the reservoirs is supplemented by some ground water. The reservoirs not only provide water for public supply and industry but also serve as recreational facilities. Small farm ponds are an important source of water for farm use (primarily livestock) and recreation. The surface water is of good quality and suitable for almost all uses.

Shallow ground water is scarce throughout the MLRA, but several areas obtain small quantities of ground water from wells. Sandstone and carbonate layers in the Trinity Group are the principal aquifers in the MLRA. This ground water is very hard. About 30 percent of the samples from this aquifer exceeded the national drinking water standards for nitrate. Falling water tables limit the use of this aquifer.

Soils

The dominant soil orders are Entisols, Mollisols, and Vertisols. The soils in the area are well drained or moderately well drained and fine textured or medium textured. They have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, carbonatic, or mixed mineralogy.

The main soils and their series:

Calciustolls that are very deep and gently sloping and formed on stream terraces and footslopes below hills and ridges (Lewisville and Venus series)

Hapluderts that are very deep and nearly level and formed on flood plains (Kaufman, Tinn, and Trinity series)

Haplustalfs that are very deep, are nearly level to gently sloping, and formed on ancient stream terraces (Wilson series)

Haplusterts that are moderately deep to very deep, are nearly level to gently sloping, and formed on uplands and stream terraces (Branyon, Burleson, Heiden, Houston Black, Dalco, Leson, and Fairlie series); that are deep and very deep, are gently sloping to strongly sloping, and formed on hillsides (Ellis, Ferris, and Vertel series)

Haplustolls that are moderately deep to very deep, are gently sloping to moderately sloping, and formed on side slopes and stream terraces (Austin, Krum, Lott, and Stephen series); that are very deep and nearly level and formed on flood plains (Gowen series)

Paleustalfs that are very deep, are nearly level to gently sloping, and formed on ancient stream terraces (Crockett and Mabank series)

Ustorthents that are shallow, are gently sloping to strongly sloping, and formed on hillsides and breaks (Eddy series)

Biological Resources

This area supports mixed tall and mid prairie grasses. Little bluestem is the dominant species. Indiangrass, big bluestem, switchgrass, tall dropseed, silver bluestem, sideoats grama, eastern gamagrass, and vine mesquite are the major herbaceous species. The plant community has many forbs, such as prairie clover, western ragweed, Maximilian sunflower, gayfeather, rattlesnakemaster, and Indian plantain. Areas along the major rivers and streams support savanna vegetation. Oak, elm, cottonwood, hackberry, and pecan trees make up a canopy cover of about 30 percent. Major wildlife species in this MLRA include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Nearly all of this area is improved pasture, cropland, or rangeland (fig. 86A-2). Urban development is rapidly increasing adjacent to the major cities. Cotton, corn, and grain sorghum are the major crops. Other crops are small grains, soybeans, and hay. Native and improved pecan orchards are common on the flood plains where there is better drainage or less frequent flooding. The current land use trend is a decrease in the acreage of cropland on the more sloping and eroded soils and an increase in the acreage of improved pasture. The main type of livestock is beef cattle.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include terraces, grassed waterways, buffer strips, crop residue management in reduced-till and no-till systems, and nutrient management. Conservation practices on pasture and hayland generally include grazing management systems, applications of the proper kinds and amounts of fertilizer, and control of brush and weeds. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural practices are not used to increase forage production on the rangeland in this area.

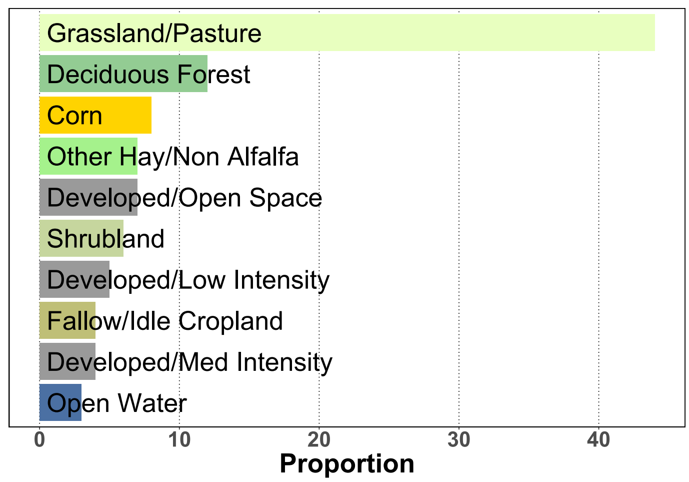

Figure 86A-2: Relative proportions (percentages) of land use in MLRA 86A.

86B—Texas Blackland Prairie, Southern Part

This MLRA (fig. 86B-1) is part of the larger tallgrass prairie continuum stretching from Canada to Mexico. The term “Blackland” refers to the dark clay soils with a high shrink-swell capacity that occur in much of the area. The generally flat to gently rolling land is fertile and has a high potential for crop production. The southern part of this prairie has more rainfall and higher temperatures than the northern part (in MLRA 86A). Its soils formed primarily on Coastal Plain parent material of Tertiary age. Some areas in the MLRA also have clay deposits over sandstone. MLRA 86B is entirely in Texas and makes up about 2,803 square miles (7,259 square kilometers).

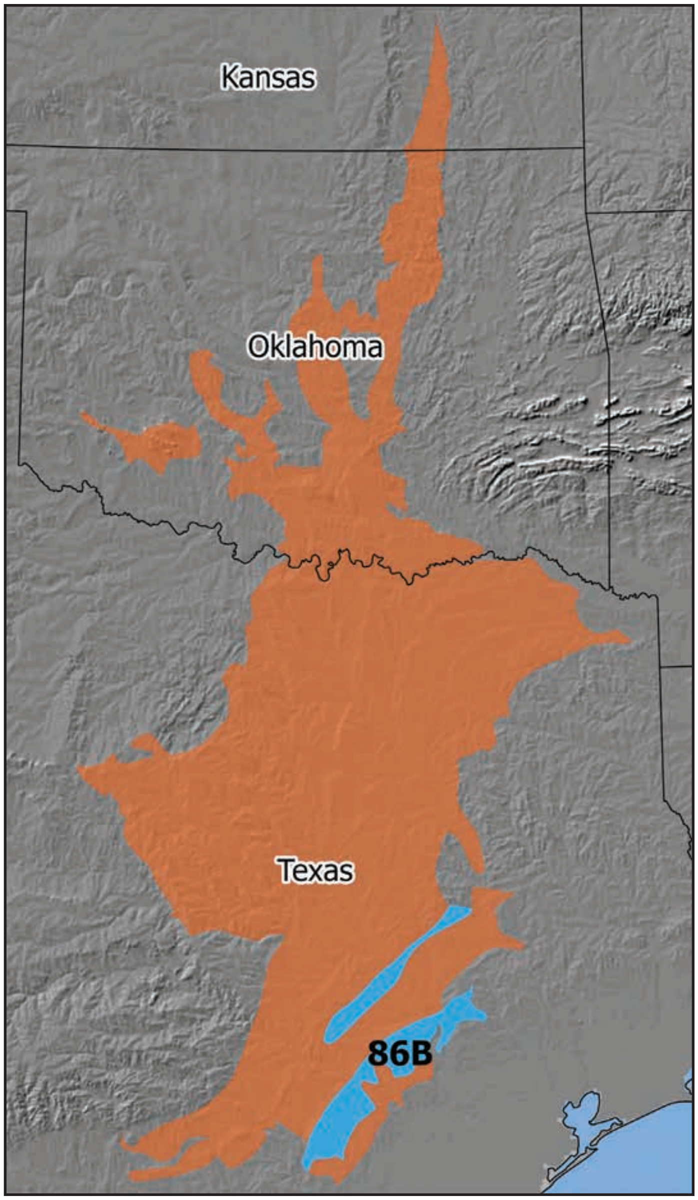

Figure 86B-1: Location of MLRA 86B, which covers 725,900 hectares (1,793,800 acres), within Region J.

The boundary to the west with the Edwards Plateau is distinct and based on geology and rainfall. The boundary with the claypan savanna to the east is more gradual as the amount of rainfall and the abundance of oak species increase. The boundary with the surrounding claypan savanna is gradual as the abundance of oak species increases. The boundary to the northeast with the Western Coastal Plain is distinct and marked by the tall pine forests.

Physiography

This area is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. Most of the area is a nearly level to gently sloping, dissected plain. Dissected areas with steeper slopes occur along entrenched river and creek valleys. Broad meander belts are associated with major streams, and wide flood plains are flanked by nearly level stream terraces. Elevation ranges from 200 to 600 feet (60 to 185 meters), increasing gradually from southeast to northwest. Hilly areas are associated with the more deeply eroded places adjacent to the major streams.

Major rivers crossing the eastern part of this MLRA include the Navasota, Brazos, Colorado, San Bernard, and Lavaca Rivers. Major rivers crossing the western part include the Navasota, Brazos, and Yegua Rivers.

Geology

This area is underlain by calcareous clays, sandstones, and marls in the Fleming Formation and Oakville Sandstone of Miocene age and the Cook Mountain Formation of Eocene age. These Tertiary sediments trend generally parallel to the Texas Gulf Coast and are incised by several major stream systems. Quaternary stream terraces and alluvium are associated with the meander belts of the major streams.

Climate

The average annual precipitation is 35 to 44 inches (890 to 1,120 millimeters). Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is about 29 inches (735 millimeters). The average annual temperature is 66 to 69 degrees F (19 to 21 degrees C). The freeze-free period averages about 295 days and ranges from 270 to 320 days.

Water

In most years the moderate rainfall is adequate for crops and pasture, but summer droughts commonly reduce crop yields. Large reservoirs on the major streams provide some municipal water. The water from these reservoirs is supplemented by ground water. The reservoirs primarily provide water for irrigation, but they are also used for recreation. Small farm ponds are an important source of water for farm use (primarily livestock) and recreation. The surface water is of good quality and suitable for almost all uses.

The principal source of ground water in the eastern part of this MLRA is the Oakville Sandstone, which is underlain by impermeable clays. This unit is part of the Gulf Coast aquifer system, which consists of a complex of young interbedded clays, silts, sands, and gravel. The water from this aquifer is hard and generally of good quality. In the western part of this MLRA, ground water is obtained from the Carrizo-Wilcox aquifer system. The water from this aquifer is moderately hard. Where this aquifer is pumped heavily for irrigation, more saline water from the adjacent aquifers may move into it. Deeper wells in both the Gulf Coast and the Carrizo-Wilcox aquifers encounter soft water where sodium is replacing calcium.

Soils

The dominant soil orders are Vertisols, Inceptisols, Mollisols, and Entisols. The soils in the area are deep or very deep, well drained or moderately well drained, and medium textured to fine textured. They have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, mixed, or carbonatic mineralogy.

The main soils and their series:

Argiustolls that are moderately well drained and fine textured, have vertic properties and smectitic mineralogy, and formed on ridges (Benchley series); that are fine-loamy, have significant accumulations of organic matter, and formed on flood plains and low stream terraces (Smithville series)

Calciusterts that are very deep and moderately well drained, have smectitic mineralogy, and formed in very gently sloping to moderately steep areas (Frelsburg and Latium series)

Calciustolls that are very deep and formed in very gently sloping to moderately sloping areas associated with silty clays and marls of the Fleming Formation (Brenham series); that are moderately deep and formed in gently sloping to moderately steep areas associated with Oakville Sandstone escarpments (Carbengle series)

Haplustalfs that are very deep, moderately well drained, and fine textured, have a seasonal high water table and smectitic mineralogy, and formed on stream terraces (Wilson series)

Haplustepts that are fine-silty, have an irregular decrease in organic matter content with depth, and formed on flood plains (Weswood series)

Haplusterts that are very deep and moderately well drained, have smectitic mineralogy, and formed on nearly level to gently sloping uplands (Bleiblerville, Dimebox, and Luling series); that are very deep and moderately well drained, have smectitic mineralogy, and formed on stream terraces (Burleson series); that are clayey and very slowly permeable and formed on flood plains (Ships series)

Haplustolls that are shallow and formed in gently sloping to moderately steep areas associated with Oakville Sandstone escarpments (Renish series); that are fine-silty, have significant accumulations of organic matter, and formed on flood plains and low stream terraces (Bergstrom series)

Paleustalfs that are moderately well drained and fine textured, have vertic properties and smectitic mineralogy, and formed on ridges (Crockett series); that are very deep, moderately well drained, and fine textured, have a seasonal high water table and smectitic mineralogy, and formed on stream terraces (Mabank series)

Ustifluvents that are coarse-loamy, have an irregular decrease in organic matter content with depth, and formed on flood plains (Yahola series); that are coarse-silty, have an irregular decrease in organic matter content with depth, and formed on flood plains (Coarsewood series)

Biological Resources

This area supports mixed tall and mid prairie grasses. Little bluestem is the dominant species. Additional herbaceous species include sedges, Virginia and Canada wildrye, rustyseed paspalum, beaked panicum, switchgrass, Indiangrass, big bluestem, eastern gamagrass, sideoats grama, and vine mesquite. Many forbs grow in the area, including tickclover, trailing wildbean, lespedezas, and gayfeather. Areas along the major rivers and streams support a savanna plant community. Oak, elm, cottonwood, hackberry, and pecan trees make up a canopy cover of about 30 percent. Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Pasture and rangeland make up about 80 percent of this area (fig. 86B-2). Cotton, corn, and grain sorghum are the major crops. Other important crops are small grains, soybeans, and hay. Native and improved pecan orchards are common on flood plains where there is better drainage or less frequent flooding. The current land use trend is a decrease in the acreage of cropland on the more sloping and eroded soils and an increase in the acreage of improved pasture. The main type of livestock is beef cattle.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include terraces, grassed waterways, buffer strips, crop residue management in reduced-till and no-till systems, and nutrient management. Conservation practices on pasture and hayland generally include grazing

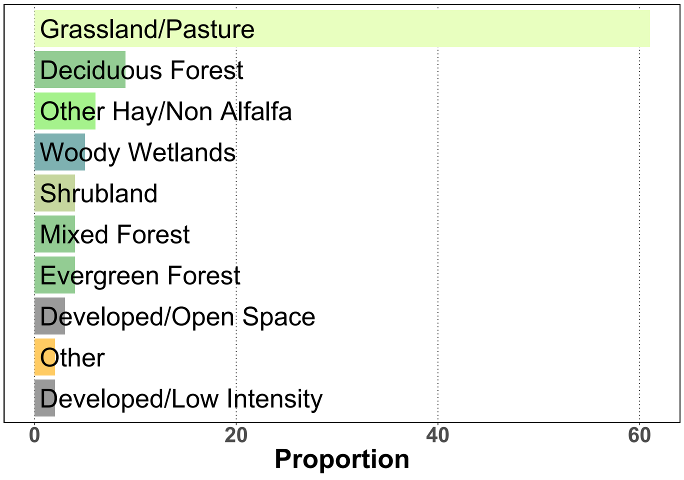

Figure 86B-2: Relative proportions (percentages) of land use in MLRA 86B.

management systems, applications of the proper kinds and amounts of fertilizer, and control of brush and weeds. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural practices are not used to increase forage production on the rangeland in this area.

87A—Texas Claypan Area, Southern Part

This MLRA (fig. 87A-1) is a gently rolling, moderately dissected post oak savanna. The term “claypan” refers to the heavier clay subsoils underlying the sandy and loamy soils. The vegetation is adapted to fairly droughty conditions due to restricted rooting depth and water transmission. The southern part of the claypan area has higher temperatures and more clastic parent material with more restrictive depths than the northern part (in MLRA 87B). The MLRA is entirely in Texas and makes up about 10,212 square miles (26,450 square kilometers).

The boundary to the west with the Blackland Prairies is gradual as vegetation transitions from tree to herbaceous species and the amount of precipitation decreases. The boundary to the east with the Southern Coastal Plain is distinct and marked by the tall pine species.

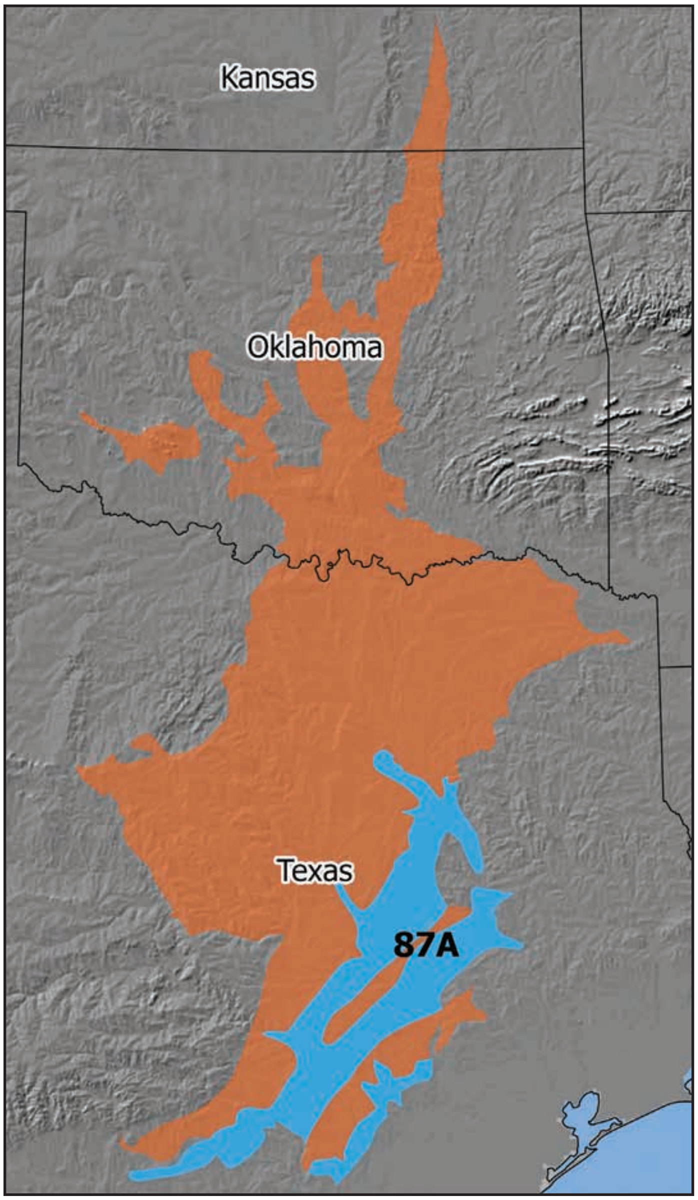

Figure 87A-1: Location of MLRA 87A, which covers 2,645,000 hectares (6,535,800 acres), within Region J.

Physiography

This area occurs in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. It is a nearly level to gently sloping plain that is dissected by broad river systems. Gently sloping uplands merge into narrow valleys that have sloping valley walls. Large rivers with broad, long valleys cross the area. Elevation ranges from 200 to 750 feet (60 to 230 meters), increasing gradually from south to north. Slopes generally range from 1 to 8 percent.

From north to south, the major rivers crossing this area are the Trinity, Navasota, Brazos, Colorado, Lavaca, and Guadalupe Rivers. Several large reservoirs are in the area.

Geology

This area is underlain by fluviodeltaic and marine sediments of Tertiary age. Tertiary units include the Wilcox Group, Carrizo Sand, Reklaw Formation, Queen City Sand, Weches Formation, Sparta Sand, and Yegua Formation of Eocene age; the Jackson Group of Eocene and Oligocene age; and the Catahoula Formation of Miocene age. Sediments in these Tertiary units consist of interbedded sandstone, siltstone, and shale and unconsolidated to weakly coherent sands, silts, and clays. The boundaries of these Tertiary sediments, which are incised by several major stream systems, trend generally parallel to the Texas Gulf Coast. Quaternary stream terraces and alluvium are associated with the meander belts of the major rivers.

Climate

The average annual precipitation in this area is 27 to 45 inches (685 to 1,145 millimeters). Most of the rainfall occurs in spring and fall. The average precipitation during the freeze-free period is about 30 inches (760 millimeters). The average annual temperature is 64 to 70 degrees F (18 to 21 degrees C). The freeze-free period averages about 285 days and ranges from 260 to 310 days.

Water

In most years the moderate rainfall is adequate for crops and pasture, but summer droughts commonly reduce yields. Large reservoirs on the major streams provide municipal and irrigation water and also serve as recreational facilities. Ponds provide water for farm use. The surface water is generally of good quality and suitable for almost all uses.

Ground water in this area is used for domestic purposes, livestock, and some irrigation. The principal source of ground water is the Oakville Sandstone, which is underlain by impermeable clays. This unit is part of the Gulf Coast aquifer system, which consists of a complex of young interbedded clays, silts, sands, and gravel. The water in this aquifer is hard and generally of good quality. Deep wells in the Gulf Coast aquifer can encounter soft water where sodium is replacing calcium.

Soils

The dominant soil orders are Alfisols, Vertisols, Mollisols, and Entisols. The soils in the area are very deep to moderately deep and are somewhat excessively drained to somewhat poorly drained. They have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic, siliceous, or mixed mineralogy.

The main soils and their series:

- Endoaquerts that are very deep and fine textured and formed on flood plains (Gladewater series)
- Fluvaquents that are deep, are coarse and medium textured, and formed on flood plains (Nahatche series)
- Hapluderts that are very deep and fine textured and formed on flood plains (Trinity, Ships, and Zilaboy series)
- Haplustepts that are deep, are coarse and medium textured, and formed on flood plains (Sandow, Uhland, and Weswood series)
- Haplusterts that are very deep, fine textured, and nearly level to gently sloping and formed on terraces and uplands (Burleson and Lexton series)
- Haplustolls that are very deep and medium textured and formed on flood plains and low terraces (Bergstrom, Gowen, Smithville, and Whitesboro series)
- Paleustalfs that are moderately well drained and well drained, are fine textured, and border on a udic soil moisture regime (Arol, Chazos, Edge, Gredge, Shiro, and Singleton series); that are moderately well drained, very slowly permeable, and fine textured, border on a udic soil moisture regime, and have vertic properties (Axtell, Crockett, Normangee, Zack, and Zulch series); that are very deep, very slowly permeable, and fine textured, have vertic properties, and have a seasonal high water table (Lufkin, Mabank, and Tabor series); that are moderately deep and very deep and fine textured and formed over weakly cemented sandstone bedrock (Burlewash, Falba, and Rosanky series); that are very deep, moderately well drained, and fine textured and have a perched water table (Rader and Straber series); that are very deep, coarse textured, and gently sloping, have a sandy surface layer, and formed in nearly level to sloping areas (Demona, Robco, Silstid, and Tremona series); that are deep, moderately well drained, and coarse textured and formed on stream terraces (Ellen series); that are very deep, well drained, and coarse textured and have a thick, sandy surface layer and a sandy subsoil (Padina and Faula series)
- Udic Paleustalfs that are very deep and deep, medium textured, and gently sloping and formed in gently sloping areas (Margie series)
- Ultic Paleustalfs that are very deep and deep, medium textured, and gently sloping and formed in gently sloping areas (Gasil and Silawa series)
- Quartzipsamments that are very deep, well drained, and coarse textured and have a thick, sandy surface layer and a sandy subsoil (Arenosa series)
- Ustifluvents that are deep, are coarse and medium textured, and formed on flood plains (Yahola series); that are deep, are coarse and medium textured, and formed on flood plains (Hatliff series)

Biological Resources

This area supports oak savanna vegetation. Little bluestem is dominant on most sites. Little bluestem and beaked panicum are dominant on poorly drained soils. Indiangrass, brownseed paspalum, beaked panicum, switchgrass, and big bluestem grow throughout the area. The woody species are dominantly post oak and blackjack oak. The area supports a wide variety of forbs, legumes, shrubs, and woody vines, such as dayflower, spiderwort, bundleflower, lespedezas, sensitive brier, hackberry, hawthorn, yaupon, elbowbush, greenbrier, and honeysuckle. Some mixed pine-hardwood forests are in the southwestern part of the area. Hardwood forests of oak, elm, pecan, and other species are on bottom land.

Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Most of the farmland in this MLRA is used for pasture and livestock grazing (fig. 87A-2). Most of the pastured areas were formerly cultivated. About one-half of the present-day pasture supports improved grasses that are fertilized. Urban land is expanding in several areas. Although significant areas of rangeland have been overgrazed, conservation efforts are improving the rangeland condition. The cropland in the MLRA is used primarily for corn. Other important crops are cotton, peanuts, hay, and truck crops.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include reduced-till or no-till systems, crop residue management, and nutrient management. Conservation practices on pasture and hayland include grazing management, applications of the proper kinds and amounts of fertilizer and lime, and control of brush and weeds. The most important conservation practice on rangeland is prescribed grazing. Generally, cultural practices are not used to increase forage production on the rangeland in this area.

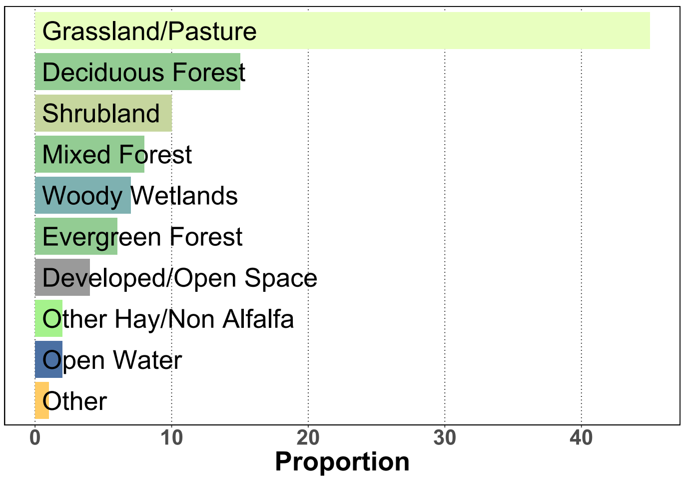

Figure 87A-2: Relative proportions (percentages) of land use in MLRA 87A.

87B—Texas Claypan Area, Northern Part

This MLRA (fig. 87B-1) is a gently rolling, moderately dissected post oak savanna. The term “claypan” refers to the heavier clay subsoils underlying the sandy and loamy soils. The vegetation is adapted to fairly droughty conditions due to restricted root depth and water transmission. The northern part of the claypan area has more rainfall, cooler temperatures, more trees, and more unconsolidated soil parent material than the southern part. This area is in northeastern Texas (80 percent) and southeastern Oklahoma (20 percent). It makes up about 4,827 square miles (12,501 square kilometers).

This MLRA is a transitional area between the cropland of MLRA 86A to the west and the forested MLRA 133B to the east. The boundary to the west with the Blackland Prairies is gradual as vegetation transitions from trees to herbaceous species and the amount of precipitation decreases. The boundary to the east with the Southern Coastal Plain is distinct and marked by the tall pine species.

Physiography

This MLRA is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. It is a nearly level to gently sloping, dissected plain. Dissected areas with steeper slopes occur along entrenched river and creek valleys. Broad meander belts are associated with the major streams, and wide flood plains are flanked by nearly level stream terraces. Elevation ranges from 250 to 750 feet (75 to 230 meters).

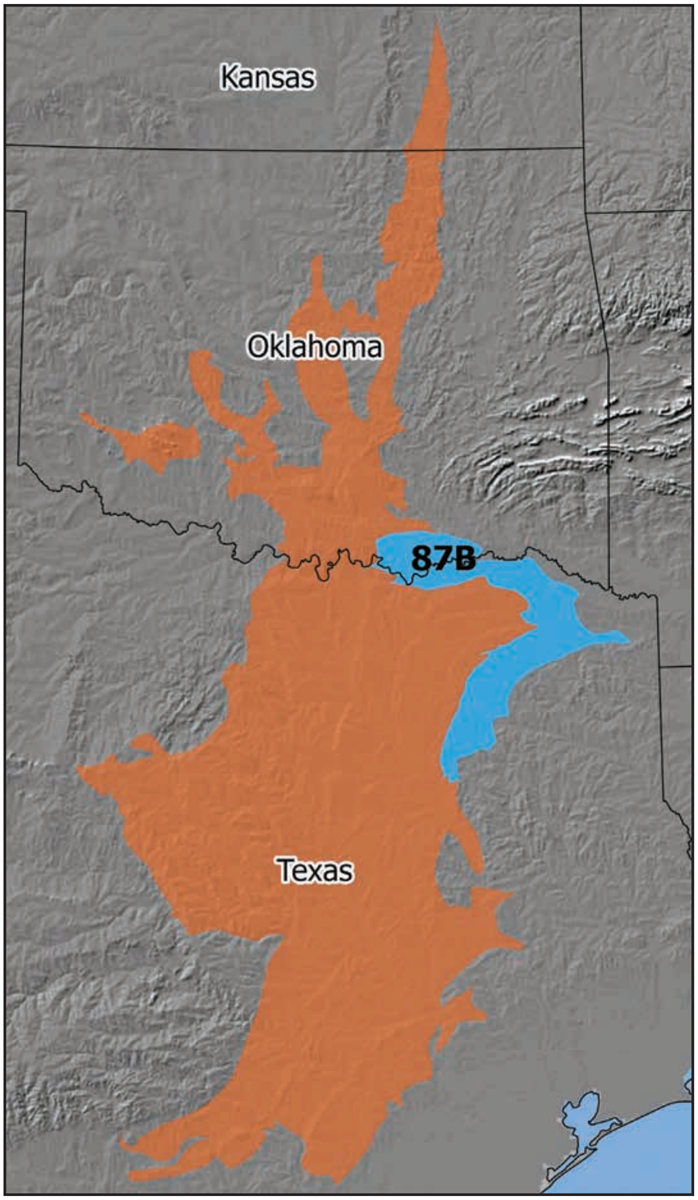

Figure 87B-1: Location of MLRA 87B, which covers 1,250,100 hectares (3,089,100 acres), within Region J.

The border between Oklahoma and Texas is formed by the Red River in this MLRA. The Sulphur and Sabine Rivers cross the part of this area in Texas. Lake Texoma forms the northwest corner of the MLRA.

Geology

This area is underlain by unconsolidated to weakly coherent marine sands, silts, and clays, mainly in the Wilcox Group of Eocene age. The boundaries of these Tertiary sediments are incised by several major stream systems, trend generally parallel to the Texas Gulf Coast. Quaternary stream terraces and alluvium are associated with the meander belts.

Climate

The average annual precipitation is 39 to 45 inches (990 to 1,145 millimeters) in most of this area, but it can be as much as 49 inches (1,245 millimeters) in the northeast corner. Most of the rainfall occurs in spring and winter. The average annual temperature is 62 to 66 degrees F (17 to 19 degrees C). The freeze-free period averages 260 days and ranges from 245 to 275 days.

Water

Precipitation is the main source of water for agricultural use. It is supplemented by water from ponds and small reservoirs. Summer rainfall is erratic, and in most years crop yields are affected by reduced amounts of soil moisture. Large reservoirs on the major streams provide municipal water and also serve as recreational facilities. The surface water is generally of good quality and suitable for almost all uses.

The Carrizo-Wilcox and Trinity Group aquifer systems provide water for municipal use, domestic use, livestock, and some irrigation in this area. The eastern part of the area obtains its ground water from the Carrizo-Wilcox aquifer system. The water from this aquifer is moderately hard. Where this aquifer is pumped heavily for irrigation, more saline water from adjacent aquifers may move into it. Deep wells in the Carrizo-Wilcox aquifer can encounter soft water where sodium is replacing calcium.

The western part of this area obtains its ground water from sandstone and carbonate layers in the Trinity Group aquifer system. This ground water is very hard. About 30 percent of the samples from this aquifer exceeded the national drinking water standard for nitrate. Falling water tables limit the use of this aquifer.

Soils

The dominant soil orders are Alfisols, Vertisols, and Ultisols. The soils in the area are deep and have a medium textured or moderately coarse textured surface layer and a moderately permeable to very slowly permeable, clayey or loamy subsoil. They have a thermic soil temperature regime, a udic soil moisture regime, and mixed or smectitic mineralogy. They are well drained to poorly drained and nearly level to gently sloping.

The main soils and their series:

- Entisols that are very deep and formed on flood plains (Nahatche, Oklared, and Severn series)
- Epiaqualfs that are poorly drained (Ivanhoe series)
- Glossaqualfs that are poorly drained (Talco, Wrightsville, and Derly series)
- Aquic Glossudalfs that are moderately well drained and formed on high stream terraces and the erosional remnants of terraces (Raino series)
- Hapludalfs that are well drained and moderately well drained (Woodtell, Karma, and McKamie series)
- Hapluderts that are moderately well drained and formed on flood plains (Kaufman and Billyhaw series); that are somewhat poorly drained and formed on flood plains (Gladewater and Texark series)
- Hapludults that are well drained and moderately well drained (Kirvin series)
- Haplusterts that are moderately well drained and very slowly permeable and formed on clayey terraces along the Trinity and Red Rivers (Burleson series)
- Paleudalfs that are well drained and moderately well drained (Annona and Freestone series)
- Arenic Paleudalfs that are very deep and well drained and have a thick sandy surface layer (Wolfpen series)
- Glossic Paleudalfs that are moderately well drained and formed on high stream terraces and the erosional remnants of terraces (Bernaldo, Whakana, and Vesey series)
- Grossarenic Paleudalfs that are very deep and well drained and have a thick sandy surface layer (Pickton series)
- Paleudults that are well drained and moderately well drained (Ruston series)

Biological Resources

This area supports oak savanna vegetation. Hardwoods consist of post oak, blackjack oak, hickory, and red oak. Native pines grow in some areas. Pinehill bluestem is dominant on most sites. Pinehill bluestem and beaked panicum are dominant on poorly drained soils. Brownseed paspalum, purpletop tridens, longleaf uniola, Indiangrass, and beaked panicum grow throughout the area. The area also supports a wide variety of forbs, legumes, shrubs, and woody vines, such as spiderwort, bundleflower, lespedeza, sensitive brier, hackberry, hawthorn, yaupon, elbowbush, greenbrier, and honeysuckle. Major wildlife species in this area include white-tailed deer, javelina, coyote, fox, bobcat, raccoon, skunk, opossum, jackrabbit, cottontail, turkey, bobwhite quail, scaled quail, white-winged dove, and mourning dove.

Land Use

Farmland makes up nearly all of this MLRA (fig. 87B-2). Most of the farmland is used as pasture or woodland, and most of the woodland is in pine plantations. In general, the soils in the area have moderate to high suitability for woodland. Some of the pasture was formerly cultivated cropland. About one-half of the present-day pasture supports improved grasses that are fertilized. The cropland in the MLRA is used primarily for corn, peanuts, or hay. Truck crops are important in some areas. Urban land is expanding in several areas.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include reduced-till or no-till systems, grassed waterways, buffer strips, crop residue management, and nutrient management. Conservation practices on pasture generally include grazing management systems, applications of the proper amounts and kinds of fertilizer and lime, and control of brush and weeds. The most important conservation practices on woodland are control of runoff and understory management.

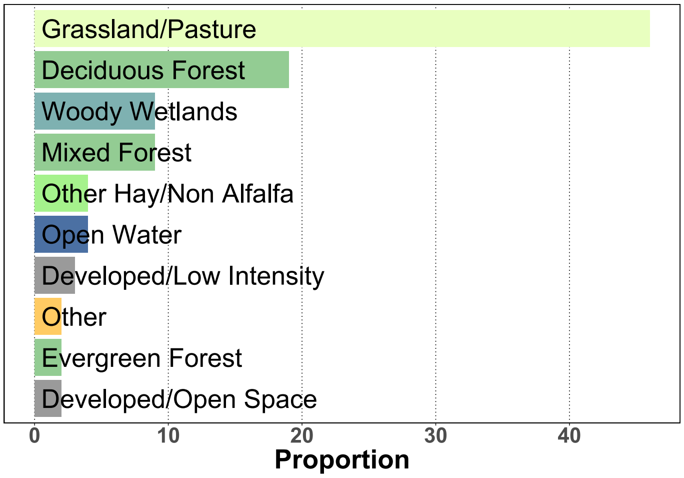

Figure 87B-2: Relative proportions (percentages) of land use in MLRA 87B.

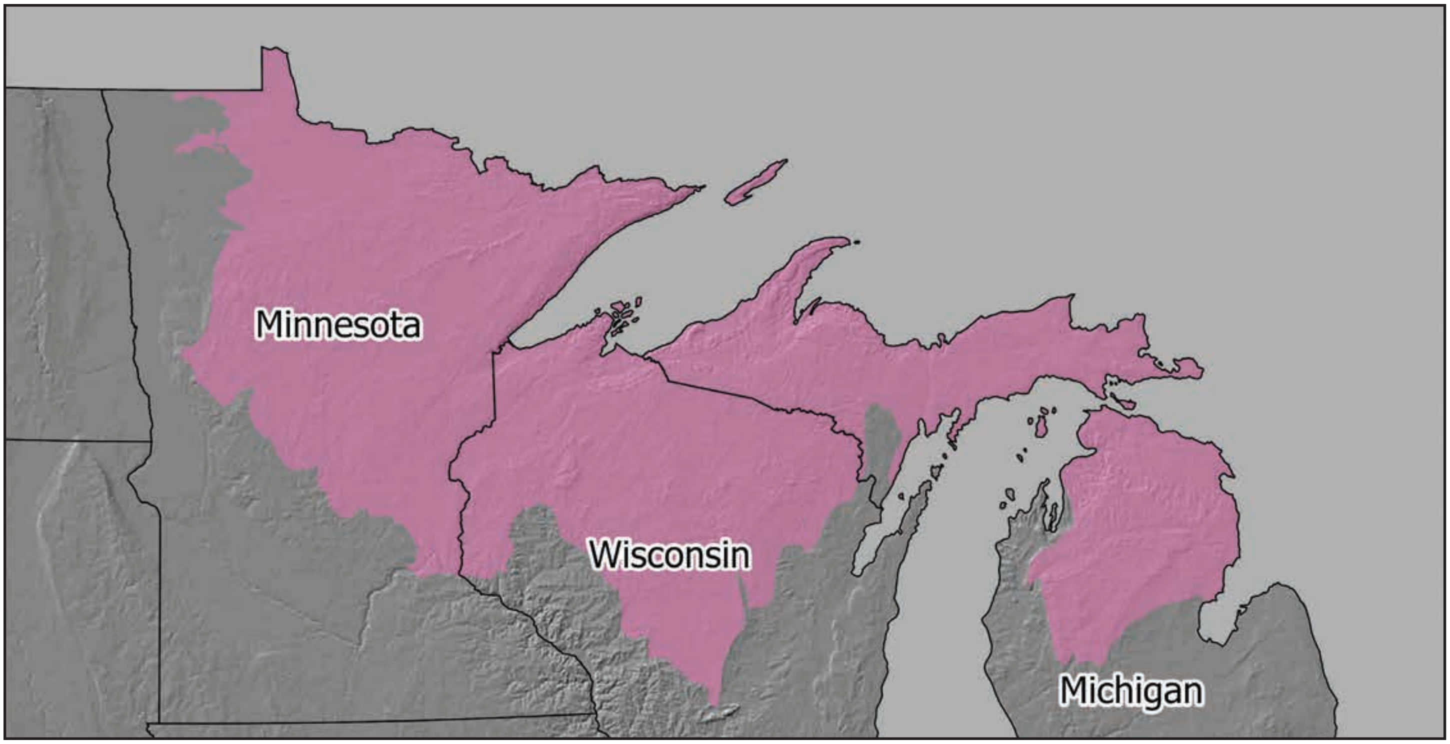

Figure K-1: Bordering Canada in the upper Midwest, Region K encompasses 259,390 square kilometers (100,150 square miles) across Minnesota, Wisconsin, and Michigan. Mean elevation is 365 meters (1,195 feet). Elevation ranges from 175 meters (575 feet) to 655 meters (2,150 feet).

K—Northern Lake States Forest and Forage Region

Land Resource Region K (fig. K-1) is the glaciated Precambrian crystalline bedrock region of northern Minnesota and Wisconsin that extends eastward and includes the glaciated Paleozoic sedimentary bedrock of Wisconsin and northern Michigan. Forests, lakes, wetlands, Histosols and Spodosols, and a frigid soil temperature regime characterize this region. Glacial lake deposits, undulating till plains and moraines, and short steep slopes on end moraines, drumlins, valley sidewalls, and lake escarpments comprise the topography and landforms. This region contains 13 major land resource areas. The extent of these MLRAs and their range in elevation are shown in table K-1.

Region K has a sharp boundary with Region F, to the west, along the Canadian border. The forests and Histosol wetlands on glacial till overlying crystalline bedrock (in Region K) change to the Mollisol cropland on lacustrine sediments of Pleistocene Lake Agassiz (in Region F). Region K has a gradual boundary with Region M, to the southwest. The forested Alfisols (in Region K) transition to the grassland Mollisols and a significant increase in cropland (in Region M). Region K has a readily apparent boundary with Region L, to the east. The abundant forests and Spodosols on noncalcareous drift (in Region K) change to the more abundant cropland on Alfisols and calcareous till (in Region L).

Climatically, Region K is one of the coldest and most snow-covered regions in the conterminous United States. The average annual temperature ranges from 38 to 47 degrees F (3 to 7 degrees C); the soil temperature regime is frigid. The mean freeze-free period ranges from 115 to 140 days, increasing southward. The average annual precipitation ranges from 26 to 33 inches (670 to 840 millimeters); soil moisture regimes are udic on the uplands and aquic on the topographic lowlands. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables K-2 and K-3.

Soils in the region are dominated by five orders (fig. 2, page 6). Alfisols formed in forests on calcareous glacial till. Inceptisols occur in neighboring forests to the east but also on coarse textured noncalcareous till in the Arrowhead region in northeastern Minnesota. Spodosols formed in the mixed coniferous and deciduous forest on noncalcareous till across northern Wisconsin and Michigan. Histosols associated with wetlands and Entisols associated with sandy alluvial, residual, and eolian areas are scattered throughout the region. Soil

Table K-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
57	27,955	10,795	350	1,150	390	1,300	420	1,380	460	1,510	610	2,000
88	30,020	11,590	310	1,020	330	1,090	370	1,220	400	1,340	560	1,840
89	9,470	3,655	220	720	270	890	300	990	330	1,100	440	1,460
90A	56,900	21,970	190	630	300	1,000	380	1,260	480	1,580	590	1,940
90B	13,145	5,075	240	810	320	1,060	370	1,230	440	1,460	580	1,910
91	11,855	4,580	180	600	270	880	300	990	360	1,190	460	1,520
92	6,935	2,675	170	580	190	650	270	890	360	1,180	530	1,760
93A	22,400	8,650	180	590	360	1,180	440	1,450	540	1,790	690	2,290
93B	18,165	7,015	170	580	220	720	410	1,340	510	1,680	610	2,010
94A	22,655	8,745	170	580	250	830	330	1,100	390	1,290	520	1,700
94B	25,020	9,660	170	560	190	620	230	780	330	1,100	490	1,610
94C	9,320	3,600	120	410	180	600	210	710	250	830	400	1,320
94D	5,555	2,145	430	1,420	460	1,530	490	1,610	510	1,680	560	1,860

Table K-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
57	3.5	38	3.9	39	4.4	40	5.1	41	6.4	43	115	128	140/140	149	155
88	2.8	37	3.3	38	3.7	39	4.5	40	4.9	41	90	120	130/130	140	145
89	6.1	43	6.5	44	6.9	44	7.4	45	7.8	46	135	138	147/145	152	155
90A	3.8	39	4.5	40	5.1	41	6.4	43	8.1	47	100	119	134/135	149	175
90B	4.7	40	5.2	41	6.1	43	6.7	44	7.3	45	125	129	143/140	149	160
91	4.3	40	5	41	5.9	43	7	45	8.1	47	115	119	143/140	157	175
92	4.2	39	4.6	40	5	41	5.5	42	6	43	105	117	123/125	136	165
93A	2.1	36	3	37	3.3	38	3.9	39	4.9	41	90	102	117/115	127	150
93B	2.6	37	4.1	39	4.6	40	5.6	42	6.2	43	95	107	122/120	139	165
94A	5.5	42	6.1	43	6.4	44	7.1	45	7.7	46	100	118	126/125	134	150
94B	4.3	40	4.9	41	5.4	42	5.9	43	6.7	44	95	115	125/125	142	170
94C	5.8	42	6.3	43	6.7	44	7.4	45	8	46	115	129	140/140	156	175
94D	4.1	39	4.3	40	4.5	40	4.7	41	5.2	41	115	119	126/125	129	135

carbonates are less common in this region than in neighboring regions to the west and south (fig. 5, page 9) because limestone is less common. Densic material, fragipans, and ortstein are root-restrictive features in some soils (figs. 9 and 11, pages 13 and 15).

Land use is dominated by forests, including woody wetlands, deciduous forest, mixed forest, herbaceous wetlands, and evergreen forest (fig. 8, page 12). Other land uses include grassland and pasture, developed open space, corn, and alfalfa (fig. K-2). Much of the forage and feed grain grown in the region is used on site by dairy and beef cattle industries. Other locally important crops include potatoes, edible beans, peas, berries, and fruit. Water erosion, especially on cropland, is a major resource concern. Wind erosion is a hazard in areas of silty and sandy soils. Soil wetness, fertility, and tilth and protection of water quality are additional resource concerns.

Table K-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
57	600	24	645	25	669/675	26/27	716	28	750	29
88	570	22	617	24	676/670	27/26	721	28	760	30
89	790	31	816	32	838/840	33/33	864	34	900	35
90A	660	26	711	28	789/780	31/31	827	33	910	36
90B	740	29	802	32	819/820	32/32	833	33	880	35
91	680	27	727	29	791/785	31/31	822	32	900	35
92	730	29	770	30	799/805	31/32	845	33	960	37
93A	660	26	691	27	732/745	29/29	815	32	960	38
93B	680	27	738	29	812/810	32/32	874	34	970	38
94A	700	28	748	29	823/815	32/32	872	34	920	36
94B	710	28	756	30	810/805	32/32	849	33	940	37
94C	720	28	746	29	779/780	31/31	814	32	880	34
94D	770	30	784	31	796/795	31/31	805	32	850	33

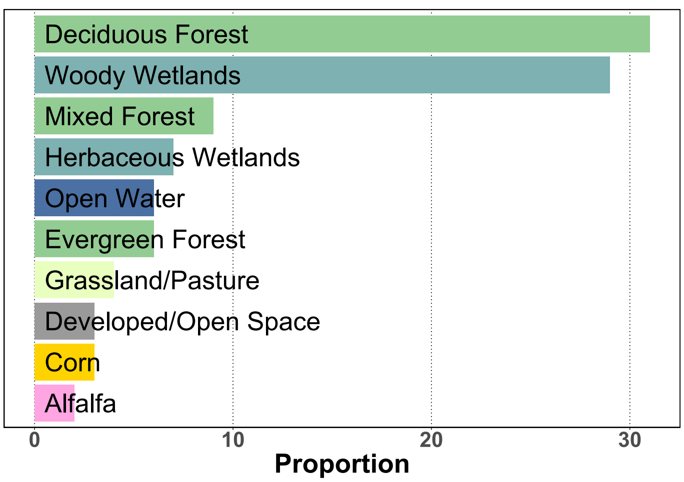

Figure K-2: Relative proportions (percentages) of land use in Land Resource Region K based on 2018 data from the National Agricultural Statistics Service.

57—Northern Minnesota Gray Drift

MLRA 57 (fig. 57-1) is characterized by a complex pattern of end moraines, ground moraines, outwash plains, drumlins, small isolated lake plains, and drainages associated with Wisconsin-age gray calcareous drift of the Des Moines and Wadena Lobes. This area is entirely in north-central Minnesota and makes up about 10,794 square miles (27,957 square kilometers).

MLRA 57 has a distinct boundary to the north and east with MLRA 88, which consists of silty and clayey lacustrine sediments and lake-modified glacial till sediments of glacial Lakes Agassiz, Aitkin, and Upham. The western and southwestern boundaries of MLRA 57 border MLRA 102A, which has rolling till plains with a prairie influence. The southern and southeastern boundaries border MLRA 90A, a glaciated region of sediments of the Rainy and Superior Lobes.

Physiography

This area is in the Western Lake section of the Central Lowland province of the Interior Plains. The landscape developed through a series of glaciations and subsequent retreating and wasting of the ice sheets. Lakes, ponds, and marshes are common. Elevation is about 985 to 1,640 feet (300 to 500 meters). On this choppy and complex landscape, relief typically is 15 to 50 feet (5 to 15 meters) within short distances. A portion of this area is on the Continental Divide.

Surface water in the northern and western parts of the area drains into the Red River, eventually entering Hudson Bay. The rest of the area is drained by the Mississippi River, southward into the Gulf of Mexico. The headwaters of the Mississippi

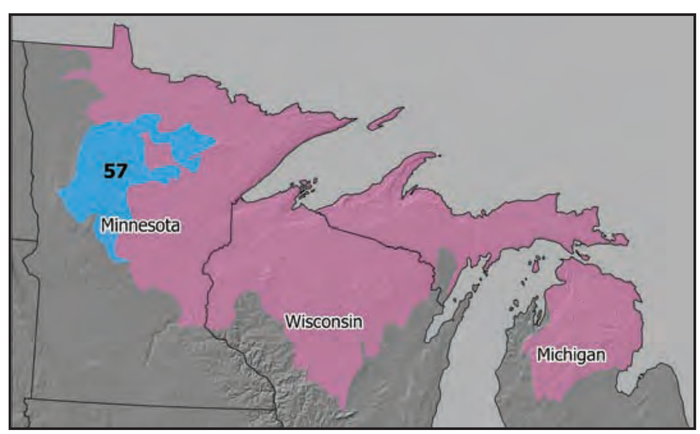

Figure 57-1: Location of MLRA 57, which covers 2,795,700 hectares (6,908,400 acres), within Region K.

River are in the northern part of the area. The Mississippi River and its tributaries drain most of the area.

Geology

This MLRA is covered by Late Wisconsin-age drift. The glacial deposits are from four major ice lobes—the Des Moines and Wadena Lobes to the north and west and the Rainy and Superior Lobes to the east. The thickness of the glacial till ranges from 300 to 600 feet (90 to 185 meters). In some areas these deposits are overlain by outwash or lacustrine sediments. Some depressional areas have an accumulation of organic matter. These organic deposits are more than 8 feet (2.5 meters) thick in some places.

Climate

The average annual precipitation is 24 to 29 inches (605 to 742 millimeters). About 65 percent of the annual precipitation falls as rain during the 5-month growing season (May through September) and about 18 percent falls as snow. The average annual temperature is 38 to 43 degrees F (3 to 6 degrees C). The freeze-free period averages 150 days and ranges from 120 to 175 days.

Water

This MLRA has abundant supplies of both surface and ground water that meet all of the current needs. The surface water generally is of good quality, and its use is not limited. Abundant supplies of good-quality ground water are in both surficial and buried drift aquifers throughout the area. Water from these aquifers is a calcium-magnesium-bicarbonate type and is hard. Nitrate concentrations can approach the harmful limit in the surficial drift aquifer. Glacial till generally caps the buried drift aquifer, which is thus more protected from contamination by surface activities than the surficial drift aquifer. The deeper aquifer, however, has very high levels of iron.

Soils

The dominant soil orders are Alfisols, Entisols, and Histosols. Some Mollisols are in the westernmost part of the area. The soils in the area have a frigid temperature regime, an aquic or udic moisture regime, and mixed or smectitic mineralogy. They are very deep and generally sandy to loamy. Their natural drainage class is related to landscape position.

The main soils and their series:

- Albaqualfs that formed in till on moraines (Auganaush series)
- Endoaqualfs that formed in till on moraines (Effie and Egglake series)
- Epiaqualfs that formed in till on drumlins and moraines (Nokay, Paddock, and Watab series)
- Glossudalfs that formed in till on moraines (Sol, Steamboat, and Suomi series)
- Haplohemists that formed in deep organic material on moraines and outwash plains (Mooselake and Rifle series)
- Haplosaprists that formed in deep organic material on moraines and outwash plains (Lupton and Seelyeville series); that formed in a thin layer of organic material over moraines and outwash plains (Cathro and Markey series)
- Hapludalfs that formed in glacial till on moraines (Beltrami, Mahkonce, Naytahwaush, Nebish, Snellman, Waukon, and Wykeham series); that formed in outwash on outwash plains and moraines (Sugarbush and Two Inlets series)
- Udipsamments that formed in outwash on moraines (Eagleview and Graycalm series)

Biological Resources

Ecological subsections in MLRA 57 include Chippewa Plains, Pine Moraines and Outwash Plains, and portions of the St. Louis Moraines (MDNR, 2003). Native vegetation was dominated by a mixture of deciduous trees and conifers. White pine and red pine grew on moraines, jack pine was dominant on outwash plains, and red oak, sugar maple, and basswood grew in sheltered areas near lakes. Forested lowlands were dominated by black spruce, tamarack, white cedar, and black ash. Wetlands that were not forested were dominated by sedge meadow communities. The western part of the MLRA was dominated by tall prairie grasses. Today most of this area is still forested. Mesic forests of sugar maple, basswood, paper birch, aspen, and northern red oak are widespread across fine textured soils on moraines and till plains. Jack pine and red pine are common on coarse textured soils in outwash areas. Sandy and gravelly deposits that cap many of the moraines in the western part of the MLRA support mixed forests of pine and boreal hardwood species, such as aspen and paper birch.

Major wildlife species include white-tailed deer, black bear, ruffed grouse, and sharp-tailed grouse. Because of its relatively unaltered landscape, this MLRA supports a high percentage of the rare plants and animals that occur in Minnesota. These species include the bald eagle and the eastern timber wolf.

Land Use

About 25 percent of this area is in farms (fig. 57-2). The farms generally are small and used mainly for forage and feed grain for livestock. Livestock operations are in scattered areas throughout the MLRA. Sunflowers, wheat, soybeans, and other cash crops are grown on some farms, mainly in the western part of the MLRA. Almost 60 percent of this area is forested. Part of the forestland is in State and national forests. Hardwood forest

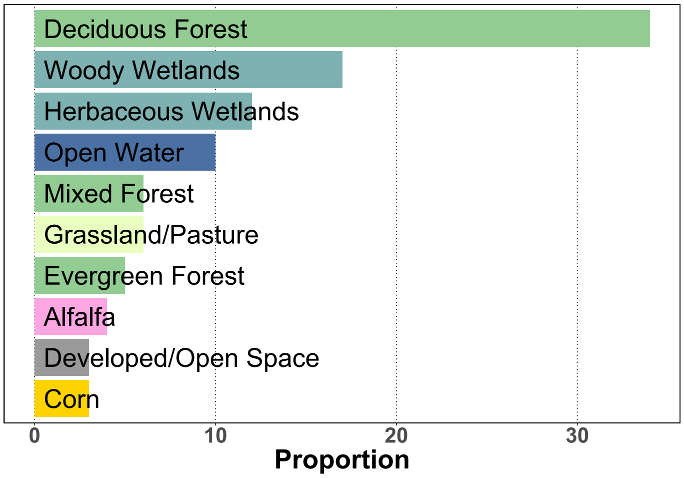

Figure 57-2: Relative proportions (percentages) of land use in MLRA 57.

types make up most of the area. Aspen is the dominant species. It is used in chipboard and pulp production. Softwood species (fir, pine, and spruce) are used for pulp. Because of the many lakes, ponds, and marshes in this area, water-based recreation and summer home development are significant economic enterprises.

The major resource concerns are poor soil drainage, which affects crop production; poor grazing management in areas of forestland and grassland; water erosion and wind erosion; and water quality. Conservation practices on cropland generally include crop residue management and conservation crop rotations, both of which help to control water erosion and wind erosion. Drainage ditches are used to improve drainage. Filter strips are installed along drainage ditches and streams to preserve water quality. Prescribed grazing systems are used to improve grazing management and remove livestock from forested areas. Exclusion from use as needed, forest stand improvement, riparian forest buffers, and proper establishment of trees and shrubs restore damaged forests and improve water quality. Field windbreaks reduce the hazard of wind erosion and improve crop production.

88—Northern Minnesota Glacial Lake Basins

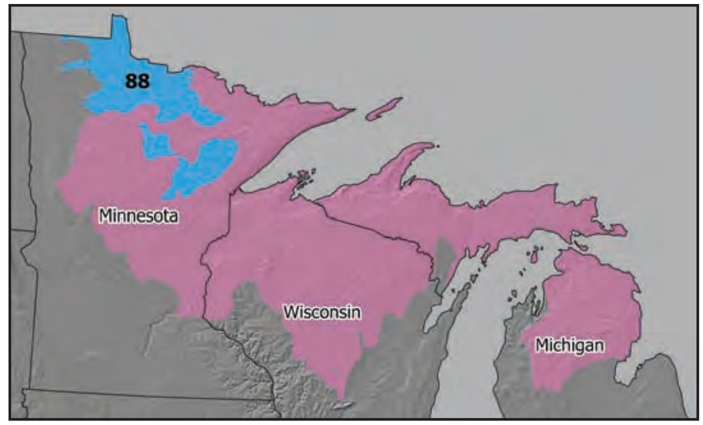

Figure 88-1: Location of MLRA 88, which covers 3,001,900 hectares (7,417,800 acres), within Region K.

MLRA 88 (fig. 88-1) consists of the lake beds of glacial Lakes Agassiz, Upham, and Aitkin. These vast glacial lake beds were formed by meltwaters associated with the last glaciation of the Wisconsin age. The large, flat, wet landscapes are filled with lacustrine lake sediments, wave-washed glacial till, and vast expanses of organic soils. This area is entirely in Minnesota and makes up about 11,590 square miles (30,019 square kilometers).

The western boundary of MLRA 88 with MLRA 56B is gradual. MLRA 56B is a portion of the Red River Valley that was formed by glacial Lake Agassiz and is dominantly prairie. The southern boundary of MLRA 88 with MLRA 57 consists of distinct moraines that formed from the glacial drift sediments of Late Wisconsin age. The eastern and southeastern boundaries are with portions of MLRAs 90A and 93A. These MLRAs are in a distinct glaciated region of sediments of the Rainy and Superior Lobes, and much of MLRA 93A is bedrock controlled.

Physiography

Most of this area is in the Western Lake section of the Central Lowland province of the Interior Plains. The eastern one-eighth of the area is in the Superior Upland province of the Laurentian Upland. The glacial lake plains of this MLRA have remnants of gravelly beaches, strandlines, deltas, and sandbars. The mostly level or nearly level plains are bordered by some gently sloping strandlines and rolling dune land. Elevation decreases gradually from 1,350 feet (410 meters) to 900 feet (275 meters) in the north.

Most of this area was inundated by glacial Lake Agassiz. The general slope and drainage are toward the north into the Rainy River and eventually into Hudson Bay. The Clearwater, Moose, Red Lake, and Roseau Rivers drain the southwestern part of the area and eventually flow into the Red River. The divide between the Rainy and Red River drainage basins lies in this area. The drainage of the glacial Lake Upham basin is to the east to Lake Superior. The St. Louis, Whiteface, Swan, and Savanna Rivers drain this basin. The drainage of the glacial Lake Aitkin basin is to the south by way of the Mississippi River. This MLRA includes numerous small lakes.

Geology

The surface of this area is covered mostly by silty and clayey lacustrine sediments and lake-modified glacial till. Much of the lake deposits are covered by bogs, swamps, and fens and other peatland vegetation. Crystalline metamorphic rocks underlie the glacial deposits.

Climate

The average annual precipitation is 23 to 30 inches (574 to 759 millimeters). About 68 percent of the annual precipitation falls as rain during the 5-month growing season (May through September), and about 20 percent falls as snow. The average annual temperature is 37 to 41 degrees F (3 to 5 degrees C). The freeze-free period averages about 135 days and ranges from 115 to 150 days.

Water

This area has abundant supplies of both surface and ground water that meet all of the current needs. The surface water generally is of good quality, and its use is not limited.

Abundant supplies of good-quality ground water are in both surficial and buried drift aquifers throughout this area. Water from these aquifers is a calcium-magnesium-bicarbonate type and hard. Nitrate concentrations can approach the harmful limit in the surficial drift aquifer. Glacial till generally caps the buried drift aquifer, which is thus more protected from contamination by surface activities than the surficial drift aquifer. The deeper aquifer, however, has very high levels of iron.

Ground water for domestic use is obtained from the Proterozoic metasedimentary aquifer in the southeastern part of this MLRA. This aquifer consists of argillite, slate, and metagraywacke and has calcium-magnesium-bicarbonate-type water that is hard. It has the best water quality of all the crystalline rock aquifers in Minnesota.

Soils

The MLRA has extensive areas of organic soils. Most of the organic soils in the Agassiz basin are slightly lower on the landscape than the surrounding mineral soils, whereas the large areas of organic soils in the Upham and Aitkin basins typically are slightly domed and slightly higher on the landscape than the surrounding mineral soils.

The dominant soil orders are Alfisols, Entisols, and Histosols. The soils in the area have a frigid temperature regime, an aquic or udic moisture regime, and mixed, smectitic, or isotic mineralogy. They are very deep, sandy to clayey, and dominantly somewhat poorly drained to very poorly drained.

The main soils and their series:

- Endoaqualfs that formed in water-modified till and glaciolacustrine sediments on lake plains (Effie, Chilgren, and Spooner series)
- Endoaquents that formed in glaciolacustrine sediments over glacial till on lake plains (Grygla series)
- Glossudalfs that formed in water-modified till and glaciolacustrine sediments on lake plains (Ashlake, Kooch, Suomi, and Taylor series)
- Haplohemists that formed in organic material over various glaciolacustrine sediments on lake plains (Daisybay, Greenwood, Rifle, and Tacoosh series)
- Haplosaprists that formed in organic material over various glaciolacustrine sediments on lake plains (Bullwinkle, Cathro, Lupton, Markey, Seelyeville, and Tawas series)
- Hapludalfs that formed in silty or clayey glaciolacustrine sediments (Baudette, Dalbo, and Littleswan series)
- Humaquepts that formed in a thin organic mantle over glaciolacustrine sediments (Leafriver series)
- Psammaquents that formed in sandy glaciolacustrine sediments (Cormant series)
- Sphagnofibrists that formed in sphagnum moss on raised bogs (Lobo and Waskish series)
- Udipsamments that formed in glaciolacustrine sediments on lake plains (Clearriver, Hiwood, Menahga, Redby, and Zimmerman series)

Biological Resources

Ecological subsections in MLRA 88 include Agassiz Lowlands, Littlefork Vermillion Uplands, Tamarack Lowlands, and the Rosy Lake Plain portion of the Chippewa Plains (MDNR, 2003). Native vegetation was dominated by a mixture of deciduous trees and conifers. Jack pine was dominant on sandy lake plains. Forested lowlands were dominated by black spruce, tamarack, white cedar, and black ash. Wetlands that were not forested were dominated by sedge meadow communities. Today, most of the area is still forested, but small areas of prairie occur in the western part of the MLRA. Much of the lake deposits are covered with peatland vegetation. The eastern edge of the MLRA is dominated by acid peatland communities such as black spruce bogs and poor swamp forest. The western edge consists of peatlands that are richer in minerals. Tamarack swamps, rich fens, and other rich peatland communities are common in that portion of the MLRA. Mesic and wet forests of aspen, paper birch, spruce, balsam fir, white cedar, and black ash are typical in the wave-washed glacial till areas of the lake basin. The low, sandy uplands that mark the recessional stages of glacial Lake Agassiz are characterized by fire-dependent species of jack pine or red pine.

Major wildlife species include white-tailed deer, black bear, ruffed grouse, and sharp-tailed grouse. Because of its relatively unaltered landscape, this area supports a high percentage of the rare plants and animals that occur in Minnesota. These species include the bald eagle and the eastern timber wolf.

Land Use

About 75 percent of this area is forested (fig. 88-2), dominantly by the aspen cover type. Hardwood and softwood species are harvested mostly for pulp. Most of the cropland is in the western part of the MLRA. The main crops are alfalfa, barley, oats, sunflowers, and wheat. A short growing season, excessive rainfall, and poor drainage can reduce yields in some years. Specialty crops, including bluegrass seed, foundation seed potatoes, and wild rice, are grown in some areas. Livestock operations are scattered throughout the MLRA. This MLRA has

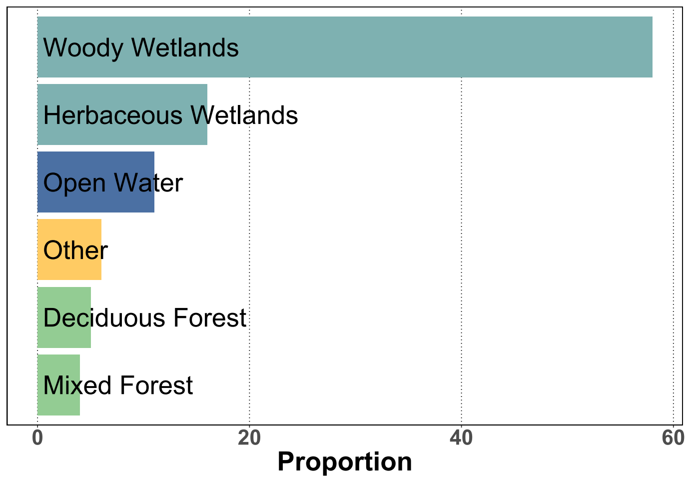

Figure 88-2: Relative proportions (percentages) of land use in MLRA 88.

two large, frequently used lakes: Leech Lake and Cass Lake. Water-based recreation and summer home development are significant economic enterprises.

The major resource concerns are excessive soil wetness, the short growing season, and surface compaction. Some sandy areas are subject to wind erosion. Important conservation practices on cropland include selection of crops that are tolerant of wetness and a short growing season. They also include timely tillage, which improves yields. Cover crops and minimum tillage can help to mitigate the effects of strong winds on sandy soils. Ditches have been used in an attempt to drain the many wet areas in the MLRA, but low gradients commonly prevent adequate removal of surface and subsurface water for cropping. Timely harvesting of trees can minimize compaction when soils are wet and can enhance the regeneration of tree species.

89—Wisconsin Central Sands

MLRA 89 (fig. 89-1) lies entirely in central Wisconsin and makes up about 3,656 square miles (9,470 square kilometers). It has deep deposits of sand and gravel that were formed by glacial Lake Wisconsin during the last glaciation. It largely consists of forests, wetlands, and irrigated agricultural land. Most of Wisconsin’s cranberries, potatoes, and vegetable crops are grown in this area.

To the west and south, MLRA 89 is bordered by MLRA 105 (in the Driftless Area), which is dominated by loess-covered, bedrock-controlled uplands. To the east and north, MLRA 89 is bordered by MLRAs 90B and 95, which are areas of loess-covered glacial till.

Physiography

This area is in the Wisconsin Driftless section of the Central Lowland province of the Interior Plains. It is an area of isolated buttes and mesas, valley trains, flood plains, and extensive

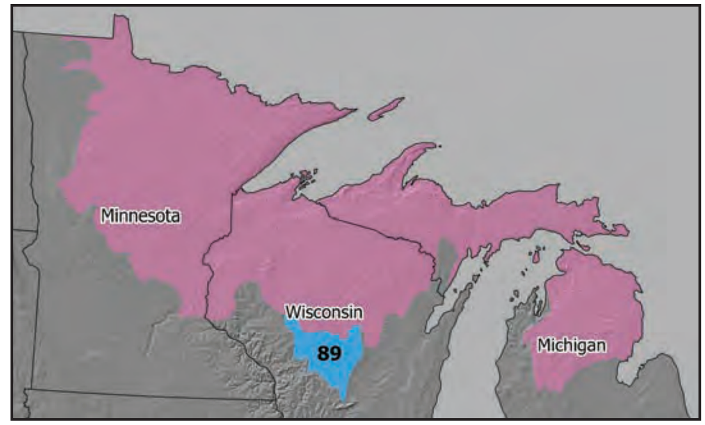

Figure 89-1: Location of MLRA 89, which covers 947,000 hectares (2,340,000 acres), within Region K.

wetlands. The southern and eastern parts of the area are on a large glacial lake and outwash plain. The northern and western parts are mostly on low hills and pediments. Elevation is 880 feet (270 meters) in the southern part of the area, in the village of Lyndon Station. It gradually increases to about 1,110 feet (340 meters) in the northeastern part of the area, in the city of Stevens Point. The maximum elevation, on Saddle Mound, in Jackson County, is about 1,400 feet (425 meters). The maximum local relief is about 400 feet (120 meters), but relief is considerably lower in most of the area.

Geology

This area is underlain dominantly by weak Cambrian sandstone and interbedded sandstone and shale formations, locally named the Wonewoc, Eau Claire, and Mount Simon Formations. Some areas are underlain by Precambrian metamorphic and igneous rocks. Some portions of this MLRA were most likely glaciated between about 25,000 and 2,400,000 years ago, and others probably were not glaciated. Although this part of Wisconsin is often referred to as the Driftless Area, it still has remnants of very old glacial drift as well as outwash and glacial lacustrine sand from the more recent Wisconsin glaciation. Glacial Lake Wisconsin covered more than 1,825 square miles (4,730 square kilometers), most of which lies in this MLRA.

Climate

The average annual precipitation is 31 to 35 inches (790 to 885 millimeters). Most of the rainfall comes from convective thunderstorms during the growing season. Snowfall generally occurs from October through April. The average annual temperature is 43 to 46 degrees F (6 to 8 degrees C).

Water

Ground water is used for most of the domestic, agricultural, municipal, and industrial needs in this area. The water comes from aquifers in unconsolidated sand and gravel deposits overlying Cambrian sandstone or from the sandstone itself. The water is generally of good quality and a calcium-magnesium-bicarbonate type that is moderately hard or hard. Sand and gravel deposits overlie Precambrian crystalline rocks in the northern part of this area. The water from these deposits has less total dissolved solids and is less hard than the water that lies over sandstone in the southern part of the area. Minor water use concerns are related to hardness and high concentrations of iron produced by reducing conditions in marshes and swamps. The regional flow of ground water is towards the Wisconsin River in the eastern part of the MLRA and towards the Black and Eau Claire Rivers in the western part.

Soils

The dominant soil order is Entisols. The soil temperature regime is dominantly mesic; it is frigid in low-lying depressions that are wet for long periods of time and in areas on the northern fringe of the MLRA. The soils in this MLRA have a udic or aquic moisture regime and dominantly mixed minerology (in the eastern part) or siliceous mineralogy (mainly in the western part). They are generally moderately deep to very deep, well drained to very poorly drained, and sandy to clayey. In much of the area, loess occurs in thin layers or does not occur at all. On some flood plains, silty alluvium is derived from the thicker mantles of loess on soils in adjacent MLRAs.

Hills and pediments, which are generally in the northern and western parts of this MLRA, are dominated by Haplorthods and Epiaquods, which formed dominantly in sandy and loamy residuum derived from interbedded sandstone and shale, and by Quartzipsamments, which formed in sandy slope alluvium, sandy residuum, and sandy pedisediment. The glacial lakes, outwash plains, and valley trains in the eastern and southern parts of the area are dominated by Udipsamments, Psammaquents, Hapludalfs, and Haplosaprists, all of which formed dominantly in outwash sand; lacustrine sand, silt, and clay; and organic material. The flood plains throughout the area are dominated by Udipsamments and Fluvaquents.

The main soil series:

- Dawsil series—Haplosaprists that formed in siliceous sandy alluvium on stream terraces and pediments
- Friendship series—Udipsamments that formed in sandy outwash on outwash plains
- Majik series—Quartzipsamments that formed in siliceous sandy alluvium on stream terraces
- Meehan series—Udipsamments that formed in sandy alluvium on stream terraces and outwash plains
- Merrillan series—Epiaquods that formed in loamy alluvium over sandy or clayey residuum from interbedded sandstone and shale on pediments
- Newson series—Psammaquents that formed in sandy alluvium on stream terraces and outwash plains
- Plainfield series—Udipsamments that formed in sandy outwash on outwash plains
- Ponycreek series—Psammaquents that formed in siliceous sandy alluvium on stream terraces and pediments
- Richford series—Hapludalfs that formed in sandy and loamy outwash on outwash plains
- Tarr series—Quartzipsamments that formed in siliceous sandy pedisediment over siliceous sandy residuum from sandstone on pediments

Biological Resources

This area is in the southern part of the conifer-hardwood forest, which includes xeric pine savannas and oak barrens. Jack pine, northern pin oak, black oak, and white oak are the dominant trees. The extensive wetlands in the area support red maple, aspen, paper birch, and speckled alder.

Major wildlife species include white-tailed deer, ruffed grouse, wild turkey, fox squirrel, gray squirrel, cottontail rabbits, ducks, and geese. Red fox, gray fox, coyote, muskrat, raccoon, and beaver are the main furbearers. Small populations of prairie chickens inhabit the area. Fishing is limited mostly to constructed impoundments and rivers. Local fish species include rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, yellow perch, and northern pike.

Land Use

Most of this MLRA is forestland (fig. 89-2). Lumber and pulp production are the forestry industries. The rest of the area is used mainly for cranberries, cash-grain crops, dairy farms, livestock grazing, irrigated vegetables, or Christmas trees. Most of the irrigated areas are used for potatoes, snap beans, peas, or sweet corn. Outdoor tourism, recreation, and wildlife management are important economic enterprises in this MLRA. Much of the area is covered by State, county, and local parks

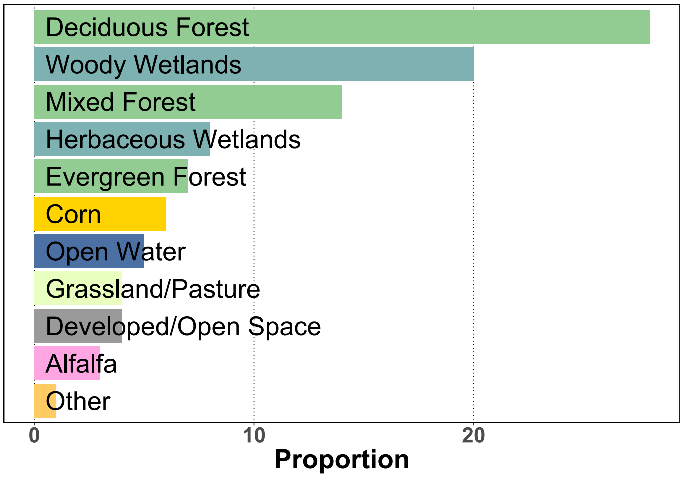

Figure 89-2: Relative proportions (percentages) of land use in MLRA 89.

and forests. Dams in two areas on the Wisconsin River formed Petenwell Flowage and Castle Rock Lake.

The major soil resource management concern is wind erosion. Maintenance of the content of soil organic matter and soil productivity and soil moisture management are additional concerns. The important conservation practices on cropland include systems of crop residue management, cover crops, windbreaks, vegetative wind barriers, stripcropping, and nutrient management.

90A—Wisconsin and Minnesota Thin Loess and Till

MLRA 90A (fig. 90A-1) is part of the recently glaciated till and outwash plains of central Minnesota and northern Wisconsin. The area was covered with loamy alluvium or loess after glaciation. It is in Wisconsin (56 percent), Minnesota (40 percent), and Michigan (4 percent). It makes up about 21,967 square miles (56,901 square kilometers).

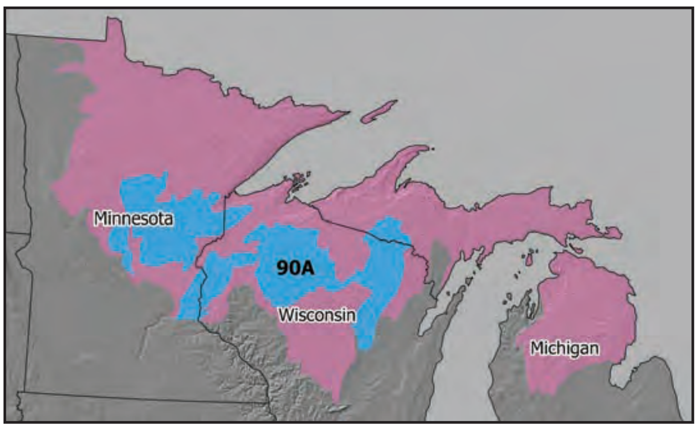

Figure 90A-1: Location of MLRA 90A, which covers 5,690,100 hectares (14,060,500 acres), within Region K.

This MLRA has distinct boundaries to the north where it borders tills of a dissimilar origin on the less morainic landscapes of MLRAs 88, 92, and 93A. The boundary to the west is where the MLRA transitions to the calcareous tills of the Des Moines Lobe, in MLRA 57. To the south, MLRA 90A borders MLRA 90B, which has older soils and better defined drainage patterns, and MLRA 91, which has the distinct lower landscape relief of an outwash channel.

Physiography

The part of this area in Minnesota is mostly in the Western Lake section of the Central Lowland province of the Interior Plains. Nearly all the parts in Wisconsin and Michigan are in the Superior Upland province of the Laurentian Upland. Four distinct lobes of the Laurentide Ice Sheet (Rainy, Superior, Chippewa, and Green Bay) played major roles in shaping the landscape in this area. The landscape is characterized by gently undulating to rolling, loess-mantled till plains, drumlin fields, and end moraines mixed with outwash plains associated with major glacial drainageways, swamps, bogs, and fens. In some areas lake plains and ice-walled lakes are significant. Steeper areas occur mostly as valley side slopes along flood plains and as escarpments along the margins of lakes.

Lakes, ponds, and marshes are common throughout the area, and streams generally have a dendritic pattern. The major rivers in this area are the Chippewa, St. Croix, Mississippi, and Wisconsin Rivers. Elevation ranges from 1,100 to 1,950 feet (335 to 595 meters). Local relief is mainly less than 10 feet to 20 feet (3 to 6 meters), but some major valleys and hills are 200 feet (60 meters) above the adjacent lowland.

Geology

Precambrian-age bedrock underlies most of the glacial deposits in this MLRA. The bedrock is a complex of folded and faulted igneous and metamorphic rocks. The bedrock terrain has been modified by glaciation and is covered in most areas by Pleistocene deposits and windblown silts. The glacial deposits form an almost continuous cover in most areas. The drift is several hundred feet thick in many areas. Loess covered the area shortly after the glacial ice melted.

Climate

The average annual precipitation is 26 to 36 inches (667 to 909 millimeters). The precipitation is fairly well distributed throughout the year but reaches a slight peak in spring. Rainfall commonly occurs as convective thunderstorms during the growing season. Snowfall generally occurs from October through April. The average annual temperature is 39 to 47 degrees F (4 to 8 degrees C). The freeze-free period averages about 145 days and ranges from 110 to 180 days.

Water

The moderate precipitation generally is adequate for crops and pasture, but in years with little or no precipitation, crops on sandy soils are damaged by a shortage of moisture. Drainage of most of the soils on wet lowlands is needed for good crop and forage production. Surface water and ground water are abundant and readily available. The sources of surface water are the many lakes and streams. This water is used mostly for recreational activities, partly for watering livestock, and occasionally for irrigation. Water quality is generally good. Landlocked lakes and lakes and streams that border bogs and swamps are more acid than other surface water in the area. Spring-fed lakes have the highest pH values. The water is very soft in most of the lakes, but it can be hard in the spring-fed lakes and in streams.

Ground water is abundant in deep glacial deposits in most of this area. It also occurs in sedimentary and volcanic rocks in the western part of the area. It is scarce where the layer of drift is thin. The water meets the domestic, agricultural, municipal, industrial, rural, and irrigation needs of the area. The content of dissolved solids in the ground water from all the various aquifers in this area is low, and the water generally is moderately hard or hard. The level of total dissolved solids in some of the water can be much higher because of a high content of limestone in some of the glacial deposits. Most of this area obtains ground water from unconsolidated glacial sand and gravel deposits on or very near the surface. Some wells tap the Cambrian sandstone in the southwestern part of the area, in Wisconsin.

In northwest Wisconsin (Ashland and Bayfield Counties) where there are no glacial deposits and in much of the part of this area in Minnesota, ground water from sedimentary and volcanic rock aquifers is used. This water is of very good quality; however, many soils have very porous layers that are poor filters of domestic waste and agricultural chemicals, so there is a risk of contamination from development and agriculture. Minor water concerns are hardness and, in some areas, high concentrations of iron. Yields of water from the glacial deposits vary.

Soils

The dominant soil orders are Alfisols, Entisols, Histosols, and Spodosols. The soils in the area have a frigid temperature regime, a udic or aquic moisture regime, and mixed mineralogy.

The main soils and their series:

Epiaqualfs that formed in a mantle of loamy alluvium overlying sandy loam or loamy sand till in depressions on moraines (Capitola and Wozny series)

Fluvaquents that formed in loamy alluvium on flood plains (Fordum series)

Glossaqualfs that formed in till mantled with silty material in swales (Cebana series)

Glossudalfs that formed in a thin, discontinuous silty mantle over firm or friable till (Amery, Brennyville, Freeon, Magnor, Milaca, and Mora series); that formed in outwash mantled with silty material (Antigo and Ossmer series); that formed in outwash mantled with loamy material (Rosholt and Oesterle series)

Haplorthods that formed in sandy loam or loamy sand till mantled with silty material (Chequamegon series); that formed entirely in till (Newot, Newood, Sarona, and Keweenaw series); that formed in outwash mantled with silty material on outwash plains (Stambaugh series); that formed in outwash mantled with loamy material on outwash plains (Padus and Pence series); that formed in sandy outwash on outwash plains (Vilas and Croswell series)

Haplosaprists that formed in organic deposits in basins and depressions (Lupton, Cathro, Loxley, and Beseman series)

Udipsamments that formed in sandy outwash on outwash plains and stream terraces (Grayling, Mahtomedi, and Friendship series)

Biological Resources

This area is in a conifer-hardwood forest. Sugar maple, basswood, yellow birch, white ash, red oak, white oak, aspen, eastern hemlock, red pine, and white pine are the dominant trees. Poorly drained soils support black ash, green ash, silver maple, red maple, swamp white oak, black spruce, tamarack, and speckled alder.

Major wildlife species include white-tailed deer, black bear, eastern gray wolf, ruffed grouse, sharp-tailed grouse, woodcock, fox squirrel, gray squirrel, snowshoe hare, ducks, and geese. Red fox, bobcat, coyote, muskrat, fisher, mink, otter, raccoon, and beaver are the main furbearers. A small herd of elk was released in this area, and the number of elk is increasing. State wildlife areas and substantial national and county forests provide wildlife habitat. Constructed impoundments, flowages, lakes, and rivers are used for fishing. Fish species include rainbow trout, brook trout, brown trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, musky, and northern pike.

Land Use

This area has a significant acreage of public and private forestland used to support the paper and lumber industry (fig. 90A-2). Sap collection from sugar maple and syrup production are important forestry enterprises. Agricultural enterprises include row crops, dairy farms, and beef operations. Crops include corn, soybeans, oats, wheat, and alfalfa. Tourism, recreation, and wildlife management are important. Hunting, fishing, snowmobiling, hiking, and skiing are popular activities

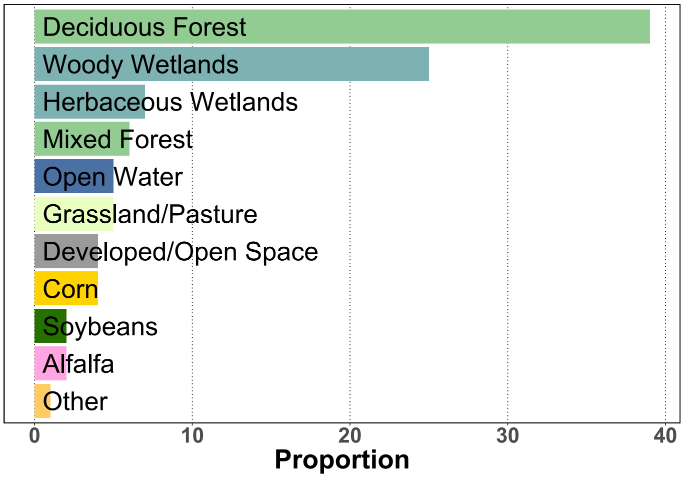

Figure 90A-2: Relative proportions (percentages) of land use in MLRA 90A.

because of the area's abundance of water, the many acres of national and county forests, and public hunting grounds.

The major soil resource concerns are water erosion, wetness, soil fertility, and tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems (especially no-till), contour farming, contour stripcropping, and grassed waterways. A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils.

90B—Central Wisconsin Thin Loess Dissected Till Plain

MLRA 90B (fig. 90B-1) lies entirely within Wisconsin and makes up about 5,076 square miles (13,147 square kilometers). This MLRA (formerly named "Wisconsin and Minnesota Thin Loess and Till, Southern Part") has gently undulating to rolling, slightly dissected till plains blanketed by thin loess and is used to produce cash and grain crops as well as forage for dairy cows.

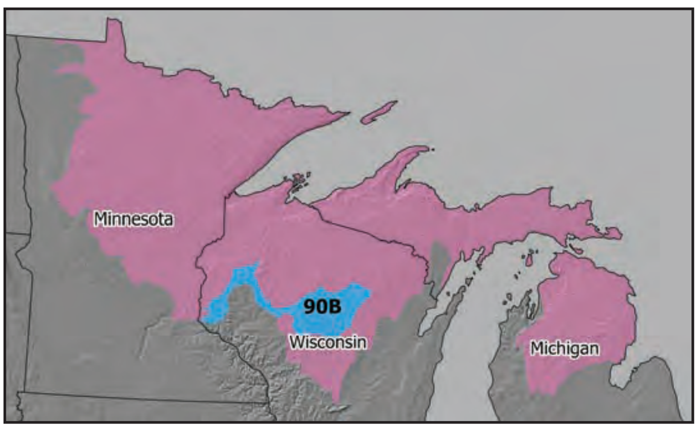

Figure 90B-1: Location of MLRA 90B, which covers 1,314,700 hectares (3,248,500 acres), within Region K.

This MLRA has distinct physiographic boundaries marking dissimilar landscapes. The changes in the landscape around MLRA 90B occur at the Late Wisconsin-age till plain and its terminal moraines from the Superior, Chippewa, and Langlade Lobes to the north and west (in MLRA 90A), the Late Wisconsin-age till plain and its terminal moraine from the Green Bay Lobe to the east (in MLRA 95), and sandy glacial Lake Wisconsin (in MLRA 89) and the loess-covered Wisconsin Driftless Area to the south (in MLRA 105).

Physiography

This area is part of the Wisconsin Driftless section of the Central Lowland province in the Interior Plains. It is characterized by dissected till plains, ground moraines, outwash plains, valley trains, glacial lakes, and sandstone and quartzite uplands. The steepest areas are adjacent to large river valleys. Natural lakes, bogs, swamps, flood plains, and depressions are extensive. Elevation ranges from about 815 feet (248 meters) along the Chippewa River near Lake Wissota to about 1,250 feet (380 meters) just north of Medford. Local relief is commonly 10 to 20 feet (3 to 6 meters) but can be more than 100 feet (30 meters) along the Wisconsin River.

Geology

This MLRA was most recently glaciated during a period that straddled the Early Wisconsin Ice Age (Early St. Croix and Early Chippewa phases) and other earlier glaciations (Baldwin, Dallas, Hamburg, and Nasonville phases). The glacial drift in this area was deposited around 35,000 to 790,000 years ago and is dominantly from a Superior basin origin with no carbonates. In places it may be underlain by older glacial drift deposited over 790,000 years ago that contains carbonates. Outwash is generally confined to the river valleys that previously carried glacial meltwater. Glacial lakes in this MLRA are distinctive landforms with smooth slopes and silty and clayey soils. The sandstone hills are dominantly weak Cambrian sandstones locally named the Tunnel City, Wonewoc, Eau Claire, and Mount Simon Formations. Most of the MLRA has a mantle of loess, which ranges from a few inches (50 millimeters) to more than 6.5 feet (2 meters) in thickness.

Climate

The average annual precipitation is 29 to 34 inches (747 to 871 millimeters). Most of the rainfall comes from convective thunderstorms during the growing season. The annual snowfall ranges from about 35 to 50 inches (90 to 125 centimeters). It generally occurs from October through April. The average annual temperature is 41 to 45 degrees F (5 to 7 degrees C). The freeze-free period averages about 160 days and ranges from 135 to 180 days.

Water

Most of this area relies on ground water for its main water supply while some is still dependent on surface water. Both surface water and ground water are abundant. Surface water occurs as ponds, lakes, streams, rivers, and flowages. It generally is of good quality, but it is mainly hard or very hard. It is used mainly for public supply, industry, power generation, recreation, fish habitat, sewage disposal, and livestock watering.

Ground water is used to meet some of the domestic, irrigation, and municipal needs in this MLRA. Most of the ground water in this area comes from unconsolidated sand and gravel aquifers in glacial deposits. The ground water from all the aquifers generally is moderately hard or hard.

Water in the Cambrian sandstone in western Wisconsin may have some high concentrations of iron, manganese, and sulfides that limit its use. Nitrates have been detected in most of the wells. The flow of the ground water generally is towards the local streams and rivers. The regional flow at depth is toward the Wisconsin River in the eastern part of the MLRA and towards the Chippewa and St. Croix Rivers in the western part.

Soils

The soil orders in this MLRA are dominantly Alfisols and, to a much lesser extent, Entisols and Histosols. The soil temperature regime is dominantly frigid; a few mesic areas are in the western part of the MLRA. The soils have udic or aquic moisture regimes. Mineralogy is dominantly mixed but is siliceous in a few areas in the western part of the MLRA. The soils generally are moderately deep to very deep, well drained to very poorly drained, and sandy to loamy. Thin to thick layers of loess are throughout the area and blanket the dissected till plain. Alluvium is sandy to silty.

Most of the soils on ground moraines are Glossudalfs. Most of the soils in glacial lakebeds that formed mainly in silty and clayey sediments are Glossudalfs and Hapludalfs. The soils on outwash plains and valley trains commonly are Glossudalfs or Hapludalfs that formed in silty or loamy alluvium over outwash or Udipsamments that formed entirely in outwash. Haplosaprists formed mostly in organic material underlain by outwash, till, alluvium, or lacustrine sediments. They are in bogs, swamps, and flood plains. The soils on flood plains throughout the area are primarily Dystrudepts and Fluvaquents that formed in loamy and sandy alluvium.

The main soil series:

- Almena series—Glossudalfs that formed in loess underlain by till on ground moraines
- Capitola series—Epiaqualfs that formed in silty alluvium underlain by dense till on moraines
- Fenwood series—Glossudalfs that formed in loess underlain by till or loamy residuum weathered from igneous and metamorphic bedrock on glaciated bedrock-controlled uplands
- Freeon series—Glossudalfs that formed in loess underlain by dense till on moraines
- Loyal series—Glossudalfs that formed in loess underlain by till on ground moraines
- Magnor series—Glossudalfs that formed in loess underlain by dense till on moraines
- Marshfield series—Epiaqualfs that formed in silty alluvium underlain by dense till on moraines
- Rietbrock series—Glossudalfs that formed in loess underlain by till or loamy residuum weathered from igneous and metamorphic bedrock on glaciated bedrock-controlled uplands
- Rosholt series—Glossudalfs that formed in loamy alluvium underlain by stratified sandy outwash on outwash plains, stream terraces, eskers, and kames
- Withee series—Glossudalfs that formed in loess underlain by till on ground moraines

Biological Resources

This area is in the southern part of the conifer-hardwood forest. Oak savanna, prairie, and lowland swamps also occur in the area. Sugar maple, basswood, yellow birch, white ash, red oak, white oak, aspen, eastern hemlock, red pine, and white pine are the dominant trees. Swampy areas support black ash, green ash, silver maple, red maple, swamp white oak, black spruce, tamarack, and speckled alder.

Major wildlife species include white-tailed deer, black bear, ruffed grouse, wild turkey, woodcock, fox squirrel, gray squirrel, cottontail rabbits, ducks, and geese. Red fox, bobcat, coyote, muskrat, mink, otter, raccoon, and beaver are the main furbearers. Grassy lowlands and old pastures provide scattered habitat for prairie chickens and gray partridge. The numerous State wildlife areas and the substantial acreage of county forestland provide wildlife habitat and opportunities for recreational hunting. Constructed impoundments, flowages, and rivers are used for fishing. Fish species include brown trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, yellow perch, and northern pike.

Land Use

Cropland and forestland are the major land uses in this area (fig. 90B-2). Lumber and pulp production is an important industry. Agricultural enterprises include row crops, dairy farms, and livestock operations. The major crops are corn, soybeans, oats, barley, and alfalfa. A small acreage is used for specialty crops, including sweet corn, potatoes, peas, snap beans, strawberries, apples, and ginseng. Tourism, recreation, and wildlife management are important. Damming of the Wisconsin River has formed Lake Dubay. Because of

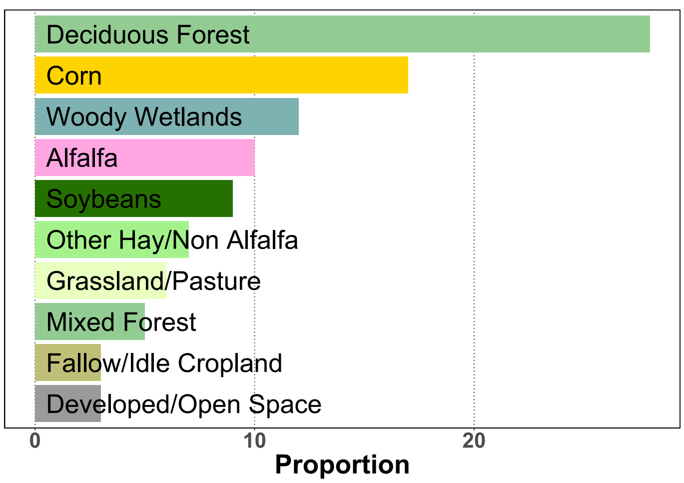

Figure 90B-2: Relative proportions (percentages) of land use in MLRA 90B.

the abundance of water and the many acres of county forest and public hunting grounds, hunting and fishing are popular activities.

The major soil resource concerns are water erosion, excessive soil wetness, soil fertility, and tilth. Conservation practices on cropland generally include crop rotations, cover crops, conservation tillage systems (especially no-till), contour farming, contour stripcropping, and grassed waterways. A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils.

91—Wisconsin and Minnesota Sandy Outwash

This area (fig. 91-1) is in Minnesota (53 percent) and Wisconsin (47 percent). It makes up about 4,578 square miles (11,857 square kilometers). Surficial deposits in this area formed during the Wisconsin glaciation and make up a series of large outwash plains (some of which are pitted or collapsed), dunes, lakes, swamps, bogs, and stream terraces.

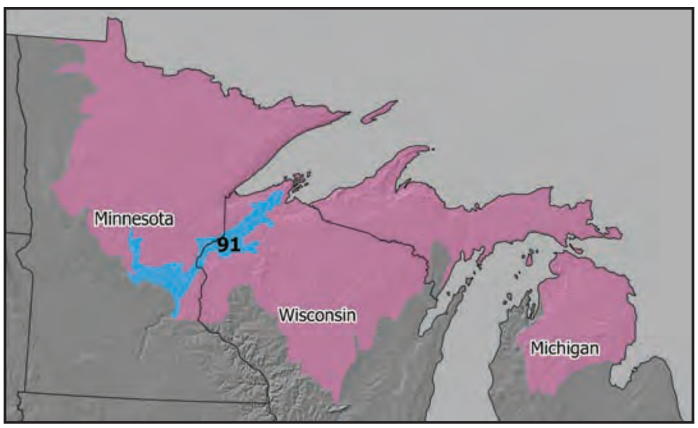

Figure 91-1: Location of MLRA 91, which covers 1,185,700 hectares (2,929,800 acres), within Region K.

MLRA 91 is surrounded by various till plains. To the east and west are the thin loess and Wisconsin-age till plains (in MLRA 90A). To the south are the Des Moines Lobe till plain prairies, savannas, and forests (in MLRA 103). To the north are the Superior clayey till lake plains (in MLRA 92).

Physiography

Most of the area is gently undulating to rolling. Some steep areas are on valley sidewalls or on escarpments along lake margins. Elevation ranges from 800 to 1,500 feet (245 to 455 meters). Local relief is mostly 10 to 20 feet (3 to 6 meters), but it as much as 80 feet (25 meters) in some areas.

Geology

Most of this MLRA consists of coarse textured outwash with a thin, discontinuous mantle of loamy material. The thickness of the outwash ranges from 3 feet (1 meter) to more than 300 feet (100 meters). Loamy glacial till underlies the outwash in many places. Organic material is in many of the larger basins and depressions. Recent loamy alluvium is on flood plains. Glacial till is in a few places along steep valley sidewalls. Precambrian and Cambrian sandstone underlies most of the glacial deposits.

Climate

The average annual precipitation is 27 to 35 inches (689 to 884 millimeters). Most of the precipitation falls as rain during the growing season (May through September). The average annual temperature is 40 to 46 degrees F (4 to 8 degrees C). The freeze-free period typically is 120 to 180 days. It is longest in the southern part of the MLRA and can be as short as 90 days in the northern part.

Water

Surface water is abundant and occurs in all parts of the MLRA. In years with normal precipitation, the amount is inadequate for crops and pasture on sandy soils. In years with little or no precipitation, crop yields are greatly reduced. Irrigation is widely used for high-value crops. Drainage of the wet lowland soils is needed for good crop production. The surface water that is sourced from lakes and streams is generally of good quality and suitable for almost all uses. Pollution of surface water is minimal because the area is relatively undeveloped and there is little municipal or industrial waste.

Ground water is abundant in unconsolidated sand and gravel in the surficial drift and buried drift aquifers throughout this MLRA. The deposits may be discontinuous in the buried drift, where lenses of sand and gravel are separated by lenses of till. The till helps to protect the buried drift aquifer from contamination by surface activities. The aquifers include the St. Peter and Prairie du Chien sandstone and dolomite, the Ironton-Galesville sandstone, and the Mount Simon-Hinckley sandstone. The St. Peter aquifer is not used much in this area because good aquifers occur above it.

Soils

The dominant soil orders in this MLRA are Mollisols, Histosols, Alfisols, Entisols, and Spodosols. The soils have a frigid temperature regime in the northern part of the area and a mesic temperature regime in the southern part. They have a udic or aquic moisture regime and mixed or isotic mineralogy.

The main soils and their series:

Argiudolls that formed in a mantle of loamy material over outwash on outwash plains (Dorset, Malardi, and Verndale series)

Endoaquods that formed in sandy outwash in depressions on outwash plains (Kinross and Au Gres series)
Fluvaquents that formed in sandy alluvium on flood plains (Totagatic series)
Haplorthods that formed on outwash plains and have a spodic horizon (Croswell, Rubicon, Vilas, and Sayner series)
Haplosaprists that formed in organic material in basins and depressions (Houghton, Markey, Seelyeville, Bowstring, Dawson, and Loxley series)
Hapludalfs that formed in sandy outwash or windblown sediments over lacustrine clay on old glacial lake plains (Karlsborg, Meenon, Perida, Dairyland, and Bigisland series)
Hapludolls that formed in a mantle of loamy material over outwash on outwash plains (Arvilla, Estherville, Hawick, Hubbard, Sandberg, Sparta, and Fairhaven series)
Psammaquents that formed in sandy outwash in depressions on outwash plains (Newson series)
Udipsamments that formed on outwash plains but have a thin loamy mantle or no loamy mantle (Cantlin, Graycalm, Grayling, Menahga, Mahtomedi, Grettum, Friendship, Winterfield, Wurtsmith, Zimmerman, Shawano, Crex, and Lino series)

Biological Resources

Historically, jack pine mixed with northern pin oak and bur oak grew on well drained soils on the outwash plains in this area. Barrens and oak savanna were common. Black spruce, tamarack, cedar, black ash, and sedges were prominent on poorly drained and very poorly drained soils.

Major wildlife species include white-tailed deer, black bear, ruffed grouse, and sharp-tailed grouse. Private and public forestland mixed with scattered cropland provides substantial wildlife habitat. The many lakes and rivers are used for fishing. Local species include rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, musky, and northern pike.

Land Use

The cropland in this MLRA is used mainly for feed grains and forage for livestock (fig. 91-2). Irrigation is common where corn, soybeans, potatoes, and canning crops, such as snap beans, peas, and corn, are grown. Droughtiness limits crop selection and yields in many areas without irrigation. Dairy and beef operations are common. The forestland in the area is used mainly for pulp and timber production. Recreational hunting and fishing are important activities in the MLRA, especially in the northern part, which is forested.

The major resource concerns are water quality, nutrient management, wetness, soil fertility, improperly managed grazing, and erosion. Conservation practices on cropland generally include cover crops, conservation crop rotations, crop residue management, and field windbreaks, all of which help to control erosion. Nutrient management and pest management are important because of water-quality concerns, especially on sandy soils and where irrigated vegetable crops are grown. Pasture and hayland planting and prescribed grazing improve pastures and grazing management. Forest stand improvement and forest trails and landings reduce the impact of timber management activities on water quality.

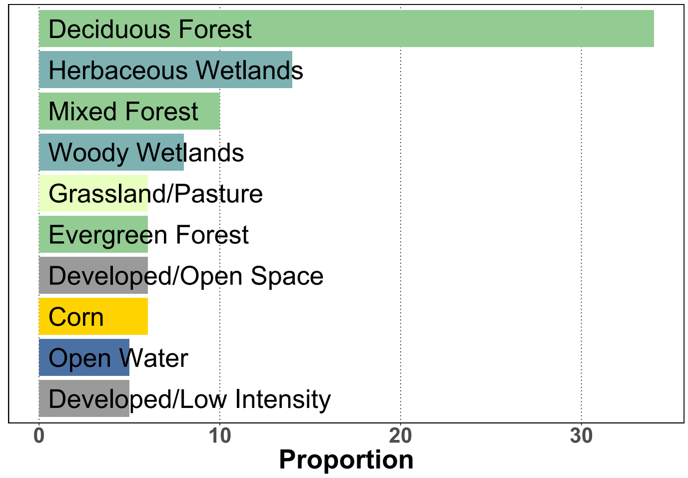

Figure 91-2: Relative proportions (percentages) of land use in MLRA 91.

92—Superior Lake Plain

MLRA 92 (fig. 92-1) consists of a clayey and silty till plain derived from glacial lake sediments that surround the shores of present-day Lake Superior. The area is used for forest products, recreation, and small-scale farming. It is in Wisconsin (54 percent), Michigan (39 percent), and Minnesota (7 percent). It makes up about 2,677 square miles (6,933 square kilometers).

MLRA 92 is bordered to the east, south, and west by MLRAs 90A, 91B, and 93B, respectively. The bordering areas are morainic landscapes with greater relief. Lake Superior is at the northern edge of MLRA 92.

Physiography

This area is in the Superior Upland province of the Laurentian Upland. Soils are Superior tills derived from sediments of glacial Lake Superior during the Wisconsin glacial period, and so they have both till and lacustrine features. The area is characterized by a till plain mixed with lake plains, lake terraces, beaches, flood plains, swamps, and marshes. Some rocky knobs, hills, and low mountains make up part of this nearly level lake plain. Elevation ranges from 580 to 1,600 feet (175 to 500 meters), increasing gradually from the lakeshore

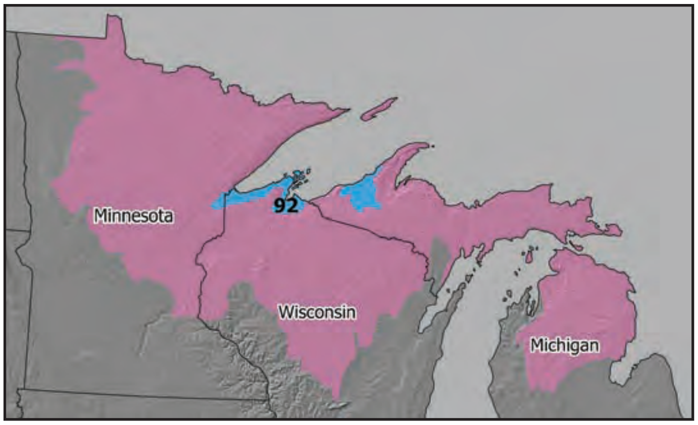

Figure 92-1: Location of MLRA 92, which covers 693,300 hectares (1,713,200 acres), within Region K.

inland. Local relief on the lake plain is only 3 to 6 feet (1 to 2 meters), but the adjoining hills and low mountains rise sharply from 85 feet (25 meters) to more than 330 feet (100 meters) above the plains.

Geology

This area has been glaciated, and most of the surface deposits are fine textured till derived from glacial lake sediments. The bedrock in the area is a mixture of Late Precambrian and Cambrian sandstones and shales and mafic igneous rocks. It is known as the Keweenawan Group in Wisconsin and Minnesota. Upper Precambrian basalts and gabbroic rocks, including the Duluth Complex, occur on the north shore in Minnesota. The bedrock units in Michigan are known as the Freda and Jacobsville Sandstones, Nonesuch Shale, the Portage Lake Volcanics, and the Copper Harbor Conglomerate.

Climate

The average annual precipitation is 29 to 37 inches (732 to 948 millimeters). It is lowest along the lakeshore and highest in inland areas. The maximum precipitation occurs as high-intensity, convective thunderstorms in summer. The lowest amount occurs in midwinter. Precipitation in winter occurs as snow. The average annual temperature is 40 to 43 degrees F (4 to 6 degrees C). The freeze-free period averages about 155 days and ranges from 125 to 190 days.

Water

Surface water provides almost all the freshwater used in this area. Precipitation is adequate for crops and pasture. Drainage of level areas of wet soils is needed for good growth of crops. The MLRA has few inland lakes, but much of the area has access to Lake Superior for water supply and recreation. Other water use in this area is for the wood and paper products industries. Iron ore, limestone, and dolomite are shipped from the Great Lakes harbors at Duluth, Minnesota, and Superior, Wisconsin, and some surface water is used in handling those materials. The surface water is of good quality. It is hard but suitable for most uses with little or no treatment.

Sources of ground water in this area include the isolated pockets of unconsolidated sand and gravel in the glacial drift and the aquifers of the Lake Superior sandstone and Precambrian lava flows. Water from these aquifers is moderately hard to very hard and is typically very low in total dissolved solids.

Soils

The dominant soils in this MLRA are Alfisols, Spodosols, Inceptisols, Entisols, and Histosols. The soils in the area have a frigid temperature regime, a udic or aquic moisture regime, and mixed or isotic mineralogy. The major soils formed in clayey to loamy till that had, in some areas, a sandy mantle. Some soils, primarily along the edges of the MLRA, have stratified silty and clayey lacustrine deposits. The soils in some areas along the shore of Lake Superior formed in organic material or sandy beach deposits.

The main soils and their series:

Epiaqualfs that formed in very deep clayey or loamy till in depressions on till plains (Bergland series)

Epiaquents that formed in clayey till mantled with sandy material in depressions on till plains (Wakeley series)

Epiaquepts that formed in very deep clayey or loamy till in depressions on till plains (Pickford series)

Eutrudepts that formed in a loamy till mantle over bedrock (Barto, Mesaba, and Greysolon series)

Glossaqualfs on till plains that formed in very deep clayey or loamy till (Cuttre and Badriver series); that formed in clayey till that is deep to loamy or sandy lacustrine deposits (Herbster series)

Glossudalfs on till plains that formed in very deep clayey or loamy till (Amnicon, Miskoaki, Odanah, Sanborg, Flintsteel, and Big Iron series); that formed in clayey till that is deep to loamy or sandy lacustrine deposits (Cornucopia and Portwing series)

Haplorthods that formed in clayey till mantled with loamy material on till plains and remnant beaches (Kellogg, Ashwabay, Ubly, Superior, and Manistee series); that formed in silty lacustrine deposits on lake plains and remnant beaches (Fence series); that formed in sandy beach, dune, or lacustrine deposits on remnant beaches and dunes (Vilas, Sultz, and Cublake series); that formed in clayey, loamy, and sandy deposits over sandstone bedrock in bedrock-controlled areas along Lake Superior (Brownstone series)

Haplosaprists that formed in organic deposits in inland swamps and in side-hill seep areas (Cathro, Lupton, and Tawas series)
Udifluvents that formed in silty alluvium on flood plains (Moquah series)
Udipsamments that formed in sandy alluvium on flood plains (Pelkie series)

Biological Resources

This area supports deciduous and evergreen trees. Boreal forests (aspen, white birch, balsam fir, white spruce, white pine, red pine, white cedar, and tamarack) and mixed deciduous and coniferous forests (hemlock, sugar maple, yellow birch, red pine, and white pine) are dominant. Swamp conifers and lowland brush commonly grow on the wetter soils.

Major wildlife species include black bear, white-tailed deer, coyote, snowshoe hare, timber wolf, ruffed grouse, tree squirrel, bald eagle, and Canada goose. Fish species include northern pike, perch, walleye, largemouth bass, smallmouth bass, brook trout, steelhead trout, and panfish.

Land Use

More than three-fourths of this area is forested, and about two-thirds is privately owned forestland used for timber production and recreation (fig. 92-2). About one-tenth of the MLRA is cropland used mainly for small grains and hay for dairy cattle and other livestock. Apples, blueberries, trefoil seed, and other specialty crops are important cash crops in some areas. Only a small part of the land is used for pasture.

The major soil resource concerns are water erosion, wetness, soil fertility, and tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems, and grassed waterways. Surface drainage systems are needed to remove surface water from wet areas.

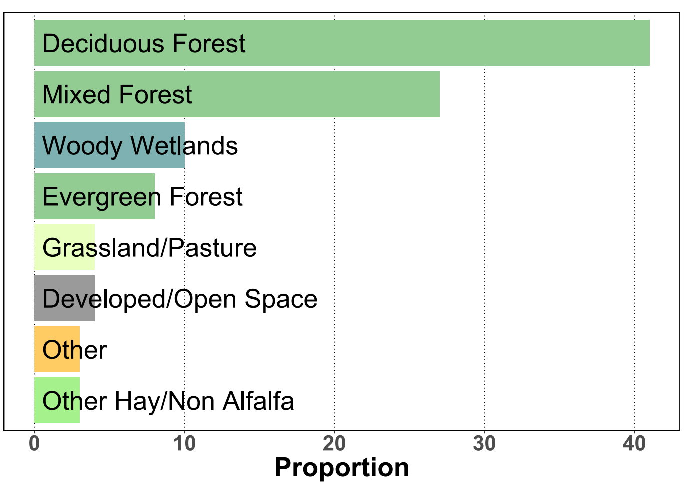

Figure 92-2: Relative proportions (percentages) of land use in MLRA 92.

93A—Superior and Rainy Stony and Rocky Till Plains and Moraines

MLRA 93A (fig. 93A-1) consists of till plains covered in stony, loamy mantle deposits over dense loamy till. Much of the area is bedrock controlled. The area is entirely in northeast Minnesota and makes up about 8,648 square miles (22,399 square kilometers). It is used for forest products, recreation, and iron ore mining.

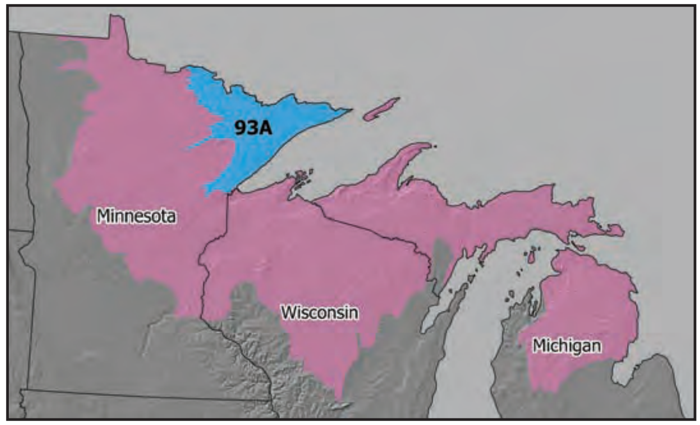

Figure 93A-1: Location of MLRA 93A, which covers 2,239,900 hectares (5,535,000 acres), within Region K.

The western boundary is with MLRAs 88 and 57, which are glacial lake basins and drift areas. The southern boundary is with MLRAs 90A (Superior tills) and 92 (Superior lake level tills), which do not have a bedrock-controlled landscape. Canada forms the northern boundary of MLRA 93A, and Lake Superior forms the southern and eastern boundaries.

Physiography

This area is in the Superior Upland province of the Laurentian Upland. It was glaciated by numerous advances of the Superior, Rainy, and Des Moines glacial lobes during the Wisconsin and Pre-Wisconsin glacial period. The western edge has deposits of glacial Lake Agassiz lacustrine material in the low-lying areas between high areas of till and bedrock. Most of the surfaces of this area are young, dominated by moraines, drumlin fields, small glacial lake plains, outwash plains, and bedrock-controlled uplands. Elevation ranges from 580 to 2,300 feet (180 to 700 meters). Eagle Mountain, at an elevation of 2,301 feet (701 meters), is the highest point in Minnesota. Closed depressions, lakes, ponds, and bogs are throughout the area. The several thousand lakes within the Boundary Waters Canoe Area Wilderness were formed by the scouring of the bedrock landscape by glacial ice. Local relief ranges from 10 to more than 100 feet (3 to 30 meters). It can be 600 feet (185 meters) or more in some areas adjacent to Lake Superior.

The surface drainage network in this area is immature. It is made up primarily of remnants of glacial meltwater channels. The major channels are occupied by the Vermilion, Whiteface, and St. Louis Rivers. Many small tributaries drain into Lake Superior from the uplands to the west, including the Lester, Baptism, and Temperance Rivers.

Geology

This area is covered by glacial till, drift, and outwash and by lake sediments, alluvium, and thin layers of loess. These deposits range from only a few inches to several hundred feet in thickness. Bedrock is on the surface or at a shallow depth in many areas. The bedrock formations in this area include Middle Precambrian graywacke and mudstone and their metamorphic equivalents, Upper Precambrian basalts, gabbroic rocks (including the Duluth Complex), and Lower Precambrian granitics, metabasalt, and graywacke. Iron ore is mined in this MLRA.

Climate

The average annual precipitation is 26 to 38 inches (672 to 958 millimeters). About 65 percent of the precipitation falls as rain during the growing season (May through September) and about 21 percent falls as snow. The average annual temperature is 36 to 41 degrees F (2 to 5 degrees C). The freeze-free period averages about 150 days and ranges from 120 to 175 days.

Water

The numerous and abundant lakes and rivers are water sources. The timber and mining industries are the main users of the surface water. This water is of very good quality and suitable for most uses.

Ground water occurs in joints, fractures, and bedding planes in the Precambrian crystalline rocks underlying most of this area and is hard. This aquifer may be the only source of ground water for domestic use and livestock in most of the area. Volcanic rocks along the shore of Lake Superior also contain ground water. The water in these basalt flows generally has a median level of total dissolved solids and is moderately hard. This aquifer provides water mostly for domestic use and livestock.

Soils

The dominant soil orders in this MLRA are Inceptisols and Histosols. The soils in the area have a frigid temperature regime, an aquic or udic moisture regime, and mixed or isotic mineralogy. They are shallow to very deep, excessively drained to very poorly drained, and sandy to clayey.

The main soils and their series:

- Dystrudepts that formed in a loamy till mantle over dense loamy till on bedrock-controlled uplands (Eveleth, Eaglesnest, and Babbitt series); that formed in a loamy till mantle with dense loamy till over bedrock (Conic, Isula, and Wahlsten series); that formed in a loamy mantle overlying gravelly outwash (Rollins series); that formed in loamy eolian or glaciofluvial deposits overlying gravelly outwash (Cloquet series)
- Epiaquepts that formed in a loamy till mantle with dense loamy till on till plains, moraines, and drumlins (Canosia series); that formed in a loamy till mantle with dense loamy till on drumlins and moraines (Nevens series)
- Eutrudepts that formed in a loamy till mantle with dense loamy till on till plains, moraines, and drumlins (Ahmeek, Normanna, and Hermantown series); that formed in a loamy till mantle with dense loamy till on drumlins and moraines (Toimi and Brimson series); that formed in a loamy mantle overlying gravelly outwash (Aldenlake and Pequaywan series); that formed in a loamy till mantle over bedrock on till plains and till-mantled bedrock uplands (Barto, Mesaba, and Greysolon series)
- Haplohemists that formed in hemic organic material in bogs (Rifle and Greenwood series); that formed in hemic organic material overlying loamy till on till plains, lake plains, outwash plains, and moraines (Tacoosh series)
- Haplosaprists that formed in sapric organic material overlying loamy till on moraines, outwash plains, stream terraces, and flood plains (Cathro series)
- Humaquepts that formed in organic material and a loamy till mantle with dense loamy till on moraines and drumlins (Twig series); that formed in a loamy till mantle with dense loamy till on moraines (Giese series); that formed in a loamy mantle overlying gravelly outwash (Hulligan series)
- Udorthents that formed in loamy till over bedrock on bedrock uplands (Quetico series)

Biological Resources

The soils on uplands in this area support natural stands of mixed northern hardwoods and pine. Sugar maple, oak, white ash, elm, yellow birch, white pine, jack pine, and red pine are the principal species. Lowland areas support both mixed hardwoods and conifers. Elm, soft maple, black ash, black spruce, tamarack, and northern white cedar are the major species.

Major wildlife species include white-tailed deer, black bear, red fox, raccoon, muskrat, cottontail rabbit, snowshoe hare, squirrel, ruffed grouse, woodcock, mallard, blue-winged teal, and wood duck. Lake Superior and other lakes, streams, and rivers are used for fishing. Fish species include lake trout, rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, and northern pike.

Land Use

Almost nine-tenths of this MLRA is forested (fig. 93A-2). A limited acreage of cropland is used for feed grains and hay. Much of the grain is fed to livestock on the farms where it is grown. The rest of the farmland in the area is about equally divided between pasture and farm woodlots. Recreation is an important land use, especially along the major streams and on sites bordering Lake Superior.

The major soil resource concerns are water erosion, soil wetness, soil fertility, and tilth. Conservation practices on cropland generally include select timber harvesting, crop rotations, and conservation tillage systems (especially no-till). A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils.

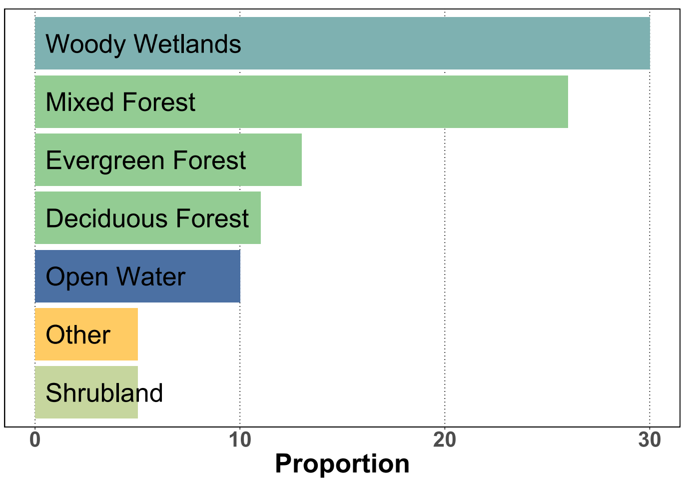

Figure 93A-2: Relative proportions (percentages) of land use in MLRA 93A.

93B—Superior Stony and Rocky Loamy Plains and Hills

MLRA 93B (fig. 93B-1) consists of a till plain covered by a thin layer of loamy eolian deposits. Much of this area is bedrock controlled with common rock outcrops. This MLRA is used for forest products and recreation. It is in Michigan (87 percent) and Wisconsin (13 percent). It makes up about 7,013 square miles (18,164 square kilometers).

Lake Superior forms most of the northern boundary of MLRA 93B. MLRA 92, which is a nearly level lake plain, also forms a distinct northern boundary in places. The southwestern part of MLRA 93B, where it joins MLRAs 90A, 91, and 94D, has a distinct boundary with the Winegar moraine, which designates the extent of the Ontonagon Lobe. The southeastern boundary, with MLRA 94B, is less obvious. MLRA 94B is roughly the extent of the Green Bay Lobe, which has more base-rich soil parent materials than MLRA 93B.

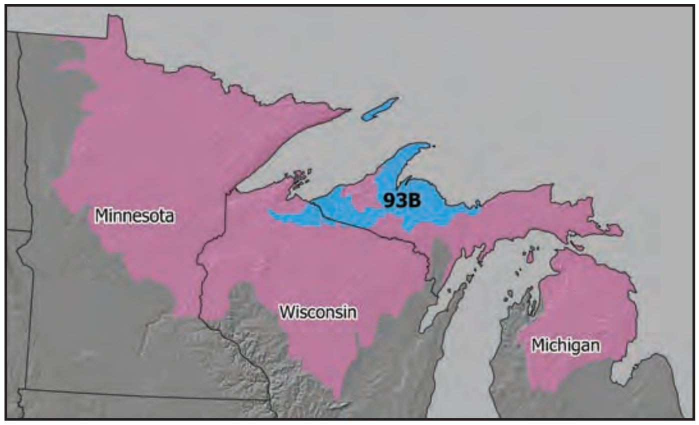

Figure 93B-1: Location of MLRA 93B, which covers 1,816,400 hectares (4,488,300 acres), within Region K.

Physiography

This area is almost entirely in the Superior Upland province of the Laurentian Upland. The eastern end of the area is in the Eastern Lake section of the Central Lowland province of the Interior Plains. This MLRA has many glacial landscape features and is dissected by numerous streams and rivers. It is characterized by a mixture of high-relief, bedrock-controlled moraines, end moraines, and ground moraines and nearly level areas of glaciofluvial deposits. Elevation generally ranges from 600 to 1,970 feet (185 to 600 meters). Mount Arvon, the highest point in Michigan, rises to an elevation of 1,979 feet (603 meters). The peaks of some bedrock-controlled moraines in the steeper areas rise more than 300 feet (90 meters) above the adjacent lowlands.

Numerous rivers drain this MLRA. Many of the rivers, such as the Escanaba, Paint, Michigamme, and Fence Rivers in Michigan, empty into Lake Michigan. The Chocolay, Sturgeon, Ontonagon, Montreal, and Presque Isle Rivers in Michigan drain into Lake Superior.

Geology

This area is underlain dominantly by Precambrian igneous or metamorphic bedrock that contains significant amounts of commercially valuable iron and copper. A smaller percentage of the area is underlain by Cambrian or Precambrian sandstone. The surface of the area is covered by glacial till derived from these bedrock types, glaciofluvial deposits with very diverse origins, and organic deposits.

Climate

The average annual precipitation ranges from 30 to 38 inches (760 to 965 millimeters) in most of this area. It is 26 to 30 inches (660 to 760 millimeters) just inland from Chequamegon Bay in Wisconsin and Keweenaw Bay in Michigan. About two-thirds of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Snow is common in winter. The average annual snowfall is more than 200 inches (510 centimeters) in areas adjacent to Lake Superior. The average annual temperature is 38 to 43 degrees F (3 to 6 degrees C). The freeze-free period averages about 140 days and ranges from 100 to 180 days. It is longest in areas adjacent to Lake Superior and shortest in inland areas that are farthest from the Great Lakes, in the part of the MLRA in Michigan.

Water

Lake Superior and the numerous inland lakes and streams are the sources of surface water in this MLRA. This water is of good quality and suitable for almost all uses. Ground water can be obtained from glacial deposits in most of this area, except for a large part of the northern half. The water is in sand and gravel outwash, in silty and sandy glacial lake sediments, and in buried sand and gravel lenses within the glacial till. The water is of good quality and suitable for almost all uses with minimal treatment. The water from some wells has very high levels of iron, especially in the southern half of the area.

A Precambrian sandstone aquifer is south and west of Keweenaw Bay, in the part of this area in Michigan. The aquifers of the Lake Superior sandstone and Precambrian lava flows occur in the southwestern part of this area, in Wisconsin. Water from these aquifers is very similar in quality to the water in the glacial deposits.

Soils

The dominant soil orders in this MLRA are Histosols and Spodosols. The soils in the area have a frigid temperature regime, an aquic or udic moisture regime, and mixed or isotic mineralogy. Most of the soils on till plains are Fragiorthods, Fragiaquods, or Haplorthods. They are shallow to very deep, well drained to somewhat poorly drained, and coarse-loamy or sandy. Most of the soils on outwash plains, lake plains, and dunes are Haplorthods and are excessively drained to somewhat poorly drained and clayey to sandy. Soils in depressions and drainageways are commonly Endoaquods or Haplosaprists and are poorly drained or very poorly drained.

The main soils and their series:

- Endoaquods that formed in sandy deposits on outwash plains (Au Gres series)
- Fragiaquods that formed in eolian deposits over till on ground and end moraines (Tula series)
- Fragiorthods that formed in till or loess over till on till plains and moraines (Gogebic, Munising, Champion, and Schweitzer series)
- Haplorthods that formed in loess over outwash on outwash plains, valley trains, and kames (Amasa, Sundog, Pence, Padus, and Channing series); that formed in sandy glacial deposits on outwash plains, valley trains, and moraines (Kalkaska, Karlin, Croswell, and Rubicon series); that formed in till or loess over till (Sarona series); that formed in till over igneous or metamorphic bedrock (Peshekee, Michigamme, Dishno, and Arcadian series); that formed in sandy eolian deposits on dunes and lake plains (Rousseau and Deer Park series)
- Haplosaprists that formed in organic material in depressions on lake plains, outwash plains, and till plains (Carbondale, Cathro, Lupton, Markey, and Tawas series)

Biological Resources

Uplands in this MLRA support natural stands of mixed northern hardwoods and pine. Sugar maple, oak, white ash, elm, yellow birch, white pine, jack pine, and red pine are the principal tree species. Lowland areas support both mixed hardwoods and conifers. Elm, soft maple, black ash, black spruce, tamarack, and northern white cedar are the major species.

Major wildlife species include white-tailed deer, black bear, grey wolf, coyote, red fox, raccoon, muskrat, cottontail rabbit, snowshoe hare, squirrel, ruffed grouse, woodcock, mallard, blue-winged teal, and wood duck. Lake Superior and other lakes, streams, and rivers are used for fishing. Fish species include lake trout, rainbow trout, brook trout, walleye, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, and northern pike.

Land Use

Almost nine-tenths of this MLRA is forested, and nearly four-fifths of the forestland is privately owned (fig. 93B-2). Feed grains and hay are the chief crops grown on the limited acreage used as cropland. Much of the grain is fed to dairy cattle and other livestock on the farms where it is grown. The rest of the farmland is about equally divided between pasture and farm woodlots. Recreation is an important land use, especially along the major streams and on sites bordering Lake Superior. Mining of copper and iron ore were significant in the past.

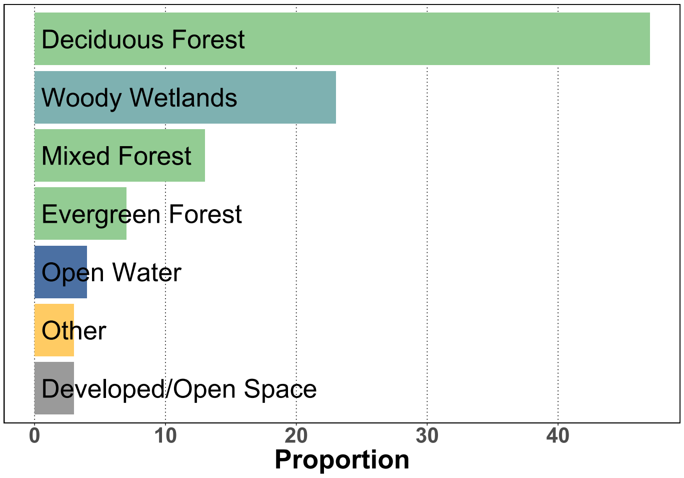

Figure 93B-2: Relative proportions (percentages) of land use in MLRA 93B.

The major soil resource concerns are water erosion, soil wetness, soil fertility, and tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems (especially no-till), contour farming, contour stripcropping, and grassed waterways. A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils.

94A—Northern Michigan Sandy Highlands

MLRA 94A (fig. 94A-1) is a relatively high plateau of sandy glacial drift, covered by northern hardwood forests and jack pine barrens and used mainly for forestry and recreation. This area is entirely in the northern part of the Lower Peninsula of Michigan. It makes up about 8,747 square miles (22,665 square kilometers). The MLRA is bordered by glaciolacustrine lowlands to the north and east (MLRA 94C) and by the warmer mesic soil temperature regime to the south (MLRAs 98 and 99) and west (MLRA 96).

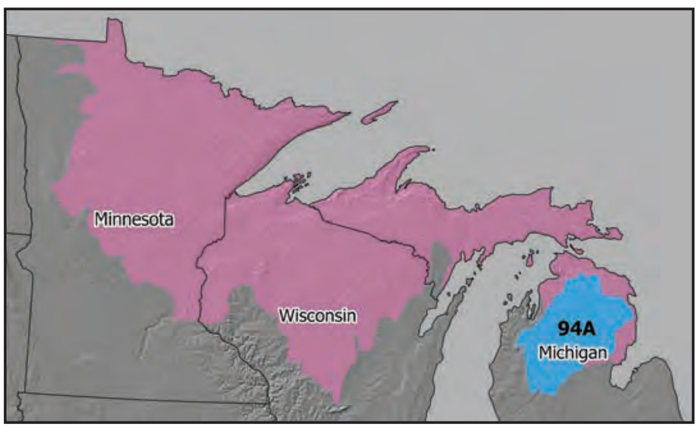

Figure 94A-1: Location of MLRA 94A, which covers 2,265,500 hectares (5,598,200 acres), within Region K.

Physiography

This area is in the Eastern Lake section of the Central Lowland province of the Interior Plains. It is dominated by outwash plains and moraines. Lake plains and till plains are scattered throughout the area. The terrain is steep on the moraines and flat on the outwash and lake plains. Elevation generally ranges from 740 to 1,420 feet (225 to 430 meters) with isolated areas as low as 610 feet (185 meters) or as high as 1,700 feet (520 meters). Local relief averages 45 feet (15 meters) and ranges to 615 feet (190 meters). The Au Sable, Manistee, Au Gres, and Pine Rivers are the major streams draining this MLRA.

Geology

This area is covered by some of the thickest glacial deposits in Michigan. The deposits consist of glacial till, outwash, and lake sediments and range from 200 to more than 1,000 feet (60 to more than 300 meters) in thickness. Bedrock consisting of Devonian limestone and dolomite with interbedded shale, chert, and anhydrite stringers is at various depths below the surface because of the curvature of the Michigan Basin.

Climate

The average annual precipitation is 28 to 36 inches (701 to 912 millimeters). Precipitation occurs as rain in summer and snow in winter and decreases from west to east. Mean annual snowfall ranges from 1.1 to 3.8 meters (45 to 150 inches). Moisture-enhanced winds over the Great Lakes are uplifted by the highlands, resulting in heavy snowfall in the northwest. The air dries out southeastward as it descends from the highlands.

The average annual temperature is 42 to 66 degrees F (6 to 8 degrees C). Temperatures generally decrease with elevation and latitude. Average 0 degrees C (32 degrees F) frost-free season ranges from 73 to 144 days. Average -2 degrees C (28 degrees F) freeze-free season is 106 to 172 days. Mean annual extreme minimum temperatures range from -33.3 to -23.1 degrees C (-28 to -10 degrees F); USDA hardiness zones range from 4a to 6a. Temperatures are coldest in the eastern interior frost pockets away from the Great Lakes.

Water

This MLRA has many high-quality, cold-water streams and lakes, which generally have a calcium-bicarbonate type of water but can have high levels of dissolved solids. The surface water is of good quality and suitable for almost all uses with minimal treatment.

Glacial deposits are the sole sources of ground water in this MLRA. The sedimentary rocks that underlie the glacial deposits are mostly shale and are not used as water sources. Of the glacial deposits, outwash and lakebed sands are the most productive aquifers. Calcium and bicarbonate are the principal dissolved substances in the ground water. The ground water is hard and can have high levels of iron. Nitrate contamination is related to land use practices, such as applications of fertilizer, manure management, and septic systems.

Soils

The dominant soils in this MLRA are Spodosols, Entisols, Alfisols, and Histosols. These soils have a frigid temperature regime and mixed mineralogy and are very deep. Spodosols and Entisols with a udic moisture regime formed in sandy glaciofluvial deposits in upland positions. Alfisols formed in sandy and loamy glacial drift or till in upland positions. These same soil orders occur lower on the landscape with an aquic soil moisture regime. Histosols formed in depressions that remain saturated year-round.

The main soil series:

- Blue Lake series—Haplorthods that formed in glacial drift on moraines and outwash plains
- Croswell series—Haplorthods that formed in glaciofluvial deposits on outwash plains, lake plains, and moraines
- Graycalm series—Udipsamments that formed in glaciofluvial deposits on moraines and outwash plains
- Grayling series—Udipsamments that formed in glaciofluvial deposits on outwash plains, moraines, and lake plains
- Kalkaska series—Haplorthods that formed in glacial drift on outwash plains and moraines
- Klacking series—Glossudalfs that formed in glacial drift on moraines and outwash plains
- Lupton series—Haplosaprists that formed in organic deposits in depressions on lake plains, moraines, and outwash plains
- Montcalm series—Hapludalfs that formed in glacial drift on moraines and outwash plains
- Rubicon series—Haplorthods that formed in glaciofluvial deposits on moraines, outwash plains, and lake plains
- Tawas series—Haplosaprists that formed in organic deposits over glacial drift in depressions on outwash plains, lake plains, and moraines

Biological Resources

Fire was historically infrequent in the western portion of the MLRA that is characterized by heavy snowfall. This area consisted mainly of mesophytic northern hardwood forests on loamy moraines or sandy drift with strong spodic soil development. Dominant trees included American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) with an important component of eastern hemlock (*Tsuga canadensis*) in sheltered uplands and areas adjacent to wetlands. Moist sites had a significant component of balsam fir (*Abies balsamea*) in the understory in the northern part of the MLRA. In contrast, the sandy interior outwash plains on the east side of the MLRA, outside the snowbelt, had frequent fire and little spodic soil development. These areas were dominated by xerophytic plant communities such as pine barrens. Dominant tree species included red pine (*Pinus resinosa*), jack pine (*Pinus banksiana*), and Hill's oak (*Quercus ellipsoidalis*). Canopy was often less than 60 percent, allowing for continuous cover of warm- and cool-season grasses and sedges, such as Pennsylvania sedge (*Carex pensylvanica*), little bluestem (*Schizachyrium scoparium*), and rough fescue (*Festuca altaica*).

White pine (*Pinus strobus*), red oak (*Quercus rubra*), and white oak (*Quercus alba*) dominated forests on a wide range of intermediate sites, although much of these forests were replaced by aspen (*Populus grandidentata* and *Populus tremuloides*) due to overharvesting or have a significant component of red maple (*Acer rubrum*) due to fire suppression. Wet mucky sites supported rich conifer swamp dominated by northern white cedar (*Thuja occidentalis*). Acid bog sites featured black spruce (*Picea mariana*) and leatherleaf (*Chamaedaphne calyculata*).

Wildlife species in the area include white-tailed deer, elk, black bear, coyote, bobcat, snowshoe hare, squirrels, ruffed grouse, woodcock, ducks, geese, songbirds, snakes, frogs, and turtles. Most of the global population of Kirtland's warbler nests in the jack pine barrens of this MLRA. Fish species include brook trout, northern pike, bass, yellow perch, bluegill, sunfish, and various introduced species of salmon and trout.

Land Use

About 70 percent of this area is forested, and about 15 percent is cropland or hayland (fig. 94A-2). About one-third of the MLRA is in small, privately owned holdings, and another one-third consists of national and State forests. The forests are used mainly for timber production and recreation. Dairy and beef operations are important enterprises in the area. Forage and feed grains for dairy cattle and other livestock are the principal crops. Wheat, oats, corn, potatoes, and hay also are grown.

The major soil resource concerns are wind erosion, water erosion, excessive soil wetness, soil moisture management, and maintenance of the fertility and productivity of the soils. Conservation practices on cropland generally include crop residue management systems (especially no-till and reduced-till), cover crops, wind barriers, stripcropping, and nutrient management.

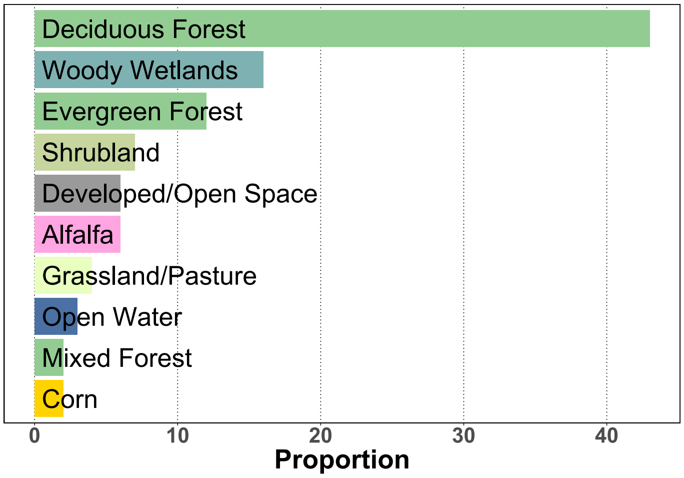

Figure 94A-2: Relative proportions (percentages) of land use in MLRA 94A.

94B—Michigan Eastern Upper Peninsula Sandy Glacial Deposits

MLRA 94B (fig. 94B-1) consists of Late Wisconsin-age (approximately 8,000 to 28,000 years ago) glacial deposits and landscape features that originated from the Michigamme and Green Bay Lobes of the Labrador Dome of the Laurentide Ice

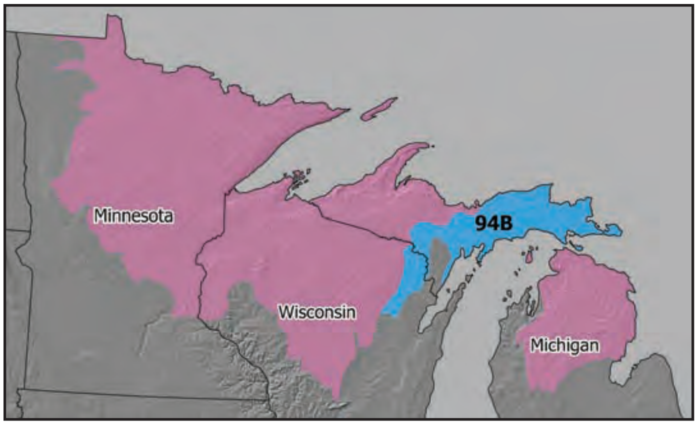

Figure 94B-1: Location of MLRA 94B, which covers 2,501,800 hectares (6,182,000 acres), within Region K.

Sheet. This area is in Michigan (84 percent) and Wisconsin (16 percent) and makes up about 9,659 square miles (25,018 square kilometers). Most of the area is in the part of Michigan known as the Upper Peninsula. Mackinac Island is included in the area. In the Michigan portion, most of the landforms are a product of the last stage of the Wisconsin glaciation known as the Greatlakean (formerly Valderan).

Soil parent materials are primarily glaciofluvial deposits and outwash, secondly till, and lastly organic and lacustrine materials. The soils in this MLRA are generally reddish, frigid, dominantly sandy (silty and clayey in localized areas), and generally higher in pH than soils in the surrounding MLRAs. They may contain carbonates at depth.

The boundaries to the west and south are distinct where they contact MLRAs 93B, 90A, and 95. The boundary between MLRAs 94B and 93B is based on the quantity of surficial bedrock and bedrock type (i.e., more Precambrian bedrock in MLRA 93B), greater quantities of calcium carbonates, and sandier soil textures (in MLRA 94B). A large portion of this boundary is based on a disintegration moraine that occupies a vast area of Iron and Marquette Counties, Michigan, and by a bedrock-controlled ground moraine in Alger County, Michigan. The boundary between MLRAs 94B and 90A is based on differences in climate, land use, and inherent soil properties. MLRA 94B contains soils with significantly greater quantities of calcium carbonate. The boundary between MLRAs 94B and 95 is based on differences in climate, land use (i.e., more agriculture and urbanization in MLRA 95), geomorphology, and soil types and properties. MLRA 95 is largely comprised of Alfisols and has fewer areas of Spodosols. The northern part of MLRA 95 is a distinct drumlin field, whereas the adjoining part of MLRA 94B is characterized by ground moraines and outwash plains. The northern boundary of MLRA 94B is with Lake Superior, a portion of the southern boundary is with Lake Michigan, and a portion of the southern boundary and the eastern boundary are with Lake Huron.

Physiography

Most of this MLRA is in the Eastern Lake section of the Central Lowland province of the Interior Plains. The western one-fifth is in the Superior Upland province of the Laurentian Upland. The area is relatively flat, compared to surrounding MLRAs, with an approximate change in elevation of about 317 meters (1,040 feet). The local relief is generally 8 meters (25 feet) or less, but some hills may rise more than 50 meters (165 feet) above the adjacent lowlands. This area has many glacial landscape features and is dissected by numerous streams and rivers, which are generally in a dendric pattern and may have waterfalls. Landscapes include outwash plains, till plains, and lake plains. The common landforms include pitted and non-pitted outwash plains, ground moraines, fluted ground moraines, recessional moraines, end moraines, lake plains, dune-capped lake plains, till-floored lake plains, and some kames (USDA-NRCS, 2006b).

Geology

This area is covered about equally with glacial deposits on outwash, till, and lacustrine deposits. The underlying bedrock is dominantly Silurian, Ordovician, or Cambrian sandstone or limestone bedrock types. Bedrock is quarried extensively for building materials, steelmaking, and agriculture. Some granitic rocks and metamorphosed sediments and volcanics underlie the western edge of the MLRA.

Climate

The climate of MLRA 94B is unique as it is largely influenced by the Great Lakes; areas that are closer to the Great Lakes are slightly warmer in winter and cooler in summer. The average annual precipitation is 28 to 37 inches (719 to 931 millimeters). About two-thirds of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Snow is common in winter. The average annual temperature is 40 to 44 degrees F (4 to 7 degrees C). The freeze-free period averages about 150 days and ranges from 120 to 180 days. It is longest in the southern end of the area and in a narrow belt along Lake Michigan.

Water

This area contains many small lakes, a few large lakes, and numerous perennial streams that are sources of good-quality surface water. Numerous rivers drain this MLRA. The Oconto, Peshtigo, and Menominee Rivers in Wisconsin and the Escanaba, Ford, Whitefish, and Manistique Rivers in Michigan empty into Lake Michigan. The Two Hearted, Sucker, and Tahquamenon Rivers in Michigan drain into Lake Superior, and the Munuscong, Carp, and Pine Rivers drain into Lake Huron. This MLRA has a significant percentage of wetlands. Ground water is abundant in the unconsolidated sand and gravel and lakebed sands in the glacial deposits that cover almost all of this area. No glacial deposits are used as aquifers in the far eastern tip of the area.

The highest yielding wells are in outwash deposits, but some domestic water also is pumped from glacial lake sediments and the till itself. This water is suitable for almost all uses with little or no treatment. Glacial deposits cover the bedrock aquifers in this area and help to protect them from contamination. Agricultural activities, municipal and industrial waste discharges, and road salts are the primary sources of contamination.

Three bedrock aquifers—Silurian-Devonian sediments, Cambrian-Ordovician sandstone and dolomite, and Precambrian sandstone—occur in the part of this MLRA in Michigan. The Cambrian-Ordovician sandstone extends south and west into the part of the area in Wisconsin. The water in the bedrock aquifers is similar in quality to the water in the glacial aquifers, but it has slightly more total dissolved solids. It tends to be fresher where the glacial aquifers are in contact with the bedrock aquifers and are recharging their water. Water from the bedrock aquifers is of good quality and suitable for almost all uses.

Soils

The dominant soil orders in this MLRA are Spodosols, Histosols, Entisols, and Alfisols. The soils in the area have a frigid temperature regime, an aquic or udic moisture regime, and mixed or isotic mineralogy. They are shallow to very deep, excessively drained to very poorly drained, and sandy to clayey. Shallow soils occur on or near bedrock outcrops; very poorly drained soils occur lower on the landscape on footslopes, in drainageways, and in depressions; and clayey soils generally occur on the lake plains. The soils with isotic mineralogy typically have high sand content and are on outwash plains. Aquic soils generally occur in drainageways, in depressions, and on footslopes.

The main soils and their series:

Glossudalfs that formed in loamy till over calcareous outwash on till plains, moraines, and drumlins (Perote series); that formed in sandy deposits over till on till plains, moraines, and drumlins (Rabe series)

Haplorthods that formed in sandy deposits on outwash plains, valley trains, and moraines (Kalkaska, Mancelona, Croswell, Au Gres, and Rubicon series); that formed in till or loess over till on ground moraines, end moraines, and drumlins (Trenary, Tilleda, Charlevoix, Greylock, and Shoepac series); that formed in sandy deposits over till or lacustrine deposits on ground moraines, end moraines, outwash plains, and lake plains (Menominee and Iosco series); that formed in till over limestone bedrock on ground moraines, glacial lake benches, bedrock benches, and terraces (Amadon and Longrie series); that formed in till over limestone, dolomite, or dolomitic sandstone on ground moraines and fluted ground moraines (Reade series); that formed in sandy deposits over igneous and metamorphic bedrock on ground moraines, end moraines, outwash plains, and stream terraces (Ishpeming series); that formed in sandy eolian deposits on dunes, lake plains, beach ridges, and outwash plains (Rousseau and Eastport series)

Haplosaprists that formed in organic material in depressions on lake plains, outwash plains, ground moraines, end moraines, and till plains (Carbondale, Cathro, Lupton, Markey, and Tawas series)

Hapludalfs that formed in loess over outwash on outwash plains, stream terraces, eskers, and kames (Nadeau series); that formed in till or loess on ground moraines, end moraines, and drumlins (Onaway and Emmet series)

Udipsamments that formed in sandy eolian deposits or sandy outwash on outwash plains, lake plains, moraines, and dunes (Shawano series); that formed in sandy outwash on outwash plains, valley trains, and moraines (Menahga series)

Biological Resources

The soils on uplands in this area support natural stands of mixed northern hardwoods and pine. Sugar maple, oak, white ash, elm, yellow birch, white pine, jack pine, red pine, and American beech are the principal tree species. The soils on lowlands support both mixed hardwoods and conifers. Elm, soft maple, black ash, black spruce, tamarack, and northern white cedar are the major species.

Major wildlife species include white-tailed deer, black bear, red fox, raccoon, muskrat, cottontail rabbit, snowshoe hare, squirrel, ruffed grouse, woodcock, mallard, blue-winged teal, grey wolves, coyote, common loon, and wood duck. Green Bay, Lake Michigan, Lake Huron, streams, inland lakes, and rivers are used for fishing. Fish species include lake trout, rainbow trout, brook trout, walleye, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, and northern pike.

Land Use

More than 80 percent of this MLRA is forested (fig. 94B-2), and about 80 percent of the forestland is privately owned. The part of the MLRA in Michigan is about 75 percent forestland and 25 percent cropland. Feed grains and hay are the principal crops. Much of the grain is fed to dairy cattle and other livestock on the farms where it is grown. Fruits and other specialty crops also are important. The rest of the land in farms is about equally divided between pasture and farm woodlots. Recreation is an important land use, especially along the major streams and on sites bordering Green Bay and Lake Michigan.

The major soil resource concerns are water erosion, excessive soil wetness, soil fertility, and tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems (especially no-till), contour

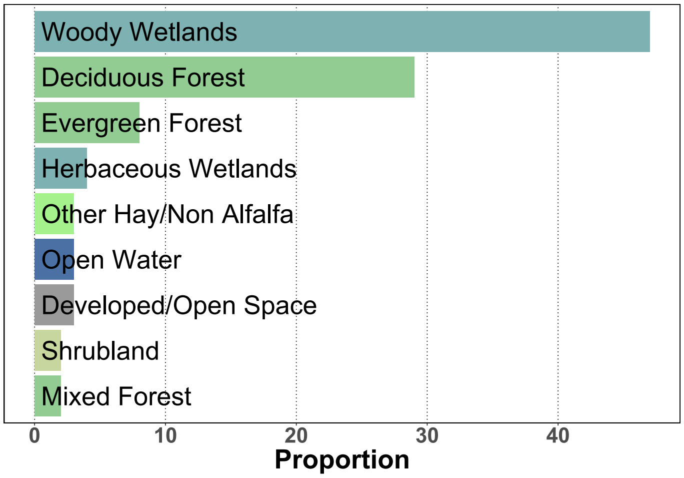

Figure 94B-2: Relative proportions (percentages) of land use in MLRA 94B.

farming, contour stripcropping, and grassed waterways. A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils.

94C—Northern Michigan Limestone Lake Plains

MLRA 94C (fig. 94C-1) consists of locally thin glacial drift over limestone on an ice-margin complex landscape adjacent to the Great Lakes. It is covered by northern hardwood forests and jack pine barrens and used mainly for forestry and recreation. This area is entirely in the northern part of the Lower Peninsula of Michigan and makes up about 3,598 square miles (9,319 square kilometers). It is bordered by Lakes Michigan and Huron to the north and east and by higher elevation outwash and moraines to the south and west (MLRA 94A). Warmer mesic soil temperature regimes near the shorelines of Lake Michigan and Lake Huron form relatively narrow boundaries with MLRAs 96 and 99, respectively.

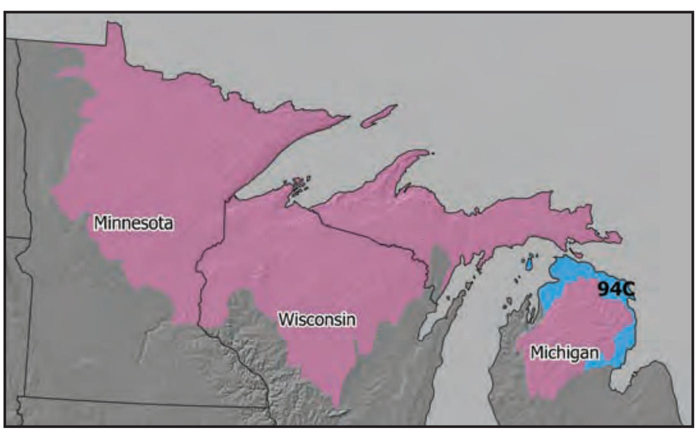

Figure 94C-1: Location of MLRA 94C, which covers 931,900 hectares (2,302,700 acres), within Region K.

Physiography

This area is in the Eastern Lake section of the Central Lowland province of the Interior Plains. It is dominated by lake plains, some of which are till-floored. Drumlins, moraines, and outwash plains are scattered throughout the area. The terrain includes flat outwash and lake plains and steep slopes in areas of moraines. Elevation generally ranges from 580 to 920 feet (175 to 280 meters) with isolated areas as high as 1,310 feet (400 meters). Local relief averages 25 feet (7 meters) and ranges to 260 feet (79 meters). The Cheboygan, Ocqueoc, and Thunder Bay Rivers are the major streams in the area.

Geology

This MLRA is covered with relatively shallow glacial deposits. Bedrock is generally at shallow depths and evident throughout the area. It consists of Devonian limestone and dolomite with interbedded shale, chert, and anhydrite stringers. Karst features are very common.

Climate

The average annual temperature is 42 to 46 degrees F (6 to 8 degrees F). Average 0 degrees C (32 degrees F) frost-free season ranges from 100 to 161 days. Average -2 degrees C (28 degrees F) freeze-free season is 137 to 188 days. Mean annual extreme minimum temperatures range from -31.6 to -23 degrees C (-25 to -9 degrees F); USDA hardiness zones range from 4b to 6a. Temperature extremes are greatest in the high-elevation interior and lowest along the Great Lakes shoreline.

The average annual precipitation is 29 to 34 inches (720 to 869 millimeters). The western one-third of the area is wetter than the eastern two-thirds. The precipitation occurs as rain during the growing season and snow in winter. Mean annual snowfall ranges from 1.3 to 2.4 meters (50 to 95 inches). Moisture-enhanced winds off the Great Lakes are usually from the northwest and therefore loose a substantial amount of moisture over intervening uplands before they reach this MLRA.

Water

This MLRA is surrounded by Lakes Michigan and Huron. It has many high-quality, cold-water streams and lakes, which generally have a calcium-bicarbonate type of water that can have high levels of dissolved solids. Ground water is abundant in the unconsolidated sand and gravel and lakebed sands in the glacial deposits that cover most of this area. The highest yielding wells are in outwash deposits within the drift, but some domestic water also is pumped from glacial lake sediments and the till itself. This water is hard and suitable for almost all uses with little or no treatment. Agricultural activities and road salts are the primary sources of potential contamination in the shallow glacial deposits. Silurian-Devonian sedimentary rocks underlie the glacial deposits. They are mostly shale and are not used as sources of water in this area. Dolomite and anhydrite are in the bedrock. There is potential for contamination reaching other bedrock aquifers through the solution cracks and openings in the limestone or dolomite bedrock.

Soils

The dominant soils in this MLRA are Spodosols, Entisols, Alfisols, and Histosols. These soils have a frigid temperature regime and mixed mineralogy and are very deep. The Spodosols and Entisols with a udic moisture regime formed in sandy glaciofluvial deposits in upland positions. The Alfisols formed in sandy and loamy glacial drift or till in upland positions. These same soil orders occur lower on the landscape with an aquic moisture regime. The Histosols formed in depressions that remain saturated year-round.

The main soil series:

- Au Gres series—Endoaquods that formed in glaciofluvial deposits on moraines, outwash plains, and lake plains
- Croswell series—Haplorthods that formed in glaciofluvial deposits on outwash plains, lake plains, and moraines
- Deford series—Psammaquents that formed in glaciofluvial deposits on outwash plains, lake plains, stream terraces, and deltas
- East Lake series—Haplorthods that formed in sandy and gravelly outwash on outwash plains, lake terraces, lake basins, deltas, and beach ridges
- Emmet series—Hapludalfs that formed in till on moraines and drumlins
- Grayling series—Udipsamments that formed in glaciofluvial deposits on outwash plains, moraines, and lake plains
- Kalkaska series—Haplorthods that formed in glacial drift on outwash plains and moraines
- Roscommon series—Psammaquents that formed in sandy material on lake plains and outwash plains
- Rubicon series—Haplorthods that formed in glaciofluvial deposits on moraines, outwash plains, and lake plains
- Tawas series—Haplosaprists that formed in organic deposits over glacial drift in depressions on outwash plains, lake plains, and moraines

Biological Resources

Upland sites are dominated by northern hardwoods such as sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), basswood (*Tilia americana*), and yellow birch (*Betula alleghaniensis*) with eastern hemlock (*Tsuga canadensis*). Some sandier sites support pine barrens dominated by jack pine (*Pinus banksiana*). Poorly drained sites support rich conifer swamps of northern white cedar (*Thuja occidentalis*). Sites with soils that are shallow to limestone bedrock and tills with a high content of carbonates near the surface support northern hardwoods with a significant component of northern white cedar. Near the cool, foggy coast, white spruce (*Picea glauca*), balsam fir (*Abies balsamea*), and striped maple (*Acer pensylvanicum*) are common. Limestone outcrops support the rare alvar community, which is an open wooded grassland with northern white cedar or common juniper (*Juniperus communis*). The alvars and limestone cobble shores near the Straits of Mackinac host several species of endemic plants, such as dwarf lake iris (*Iris lacustris*) and Houghton's goldenrod (*Solidago houghtonii*).

Wildlife species include white-tailed deer, elk, black bear, snowshoe hare, coyote, bobcat, squirrels, ruffed grouse, woodcock, ducks, geese, songbirds, snakes, frogs, and turtles. Fishing is common in the Great Lakes, numerous inland lakes, rivers, and streams. Fish species include lake trout, brook trout, northern pike, bass, yellow perch, bluegill, sunfish, and various introduced species of salmon and trout.

Land Use

About two-thirds of this MLRA is in small, privately owned holdings, and the other third consists of State forestland (fig. 94C-2). The forests are used mainly for timber production and recreation. Dairy and beef operations are important enterprises in the area. Forage and feed grain crops for dairy cattle and other livestock are the principal crops. Wheat, oats, corn, potatoes, and hay also are grown.

The major soil resource concerns are wind erosion, water erosion, excessive soil wetness, soil moisture management, and maintenance of the fertility and productivity of the soils. The important conservation practices on cropland are systems of crop residue management (such as no-till or reduced-till), cover crops, wind barriers, stripcropping, and nutrient management.

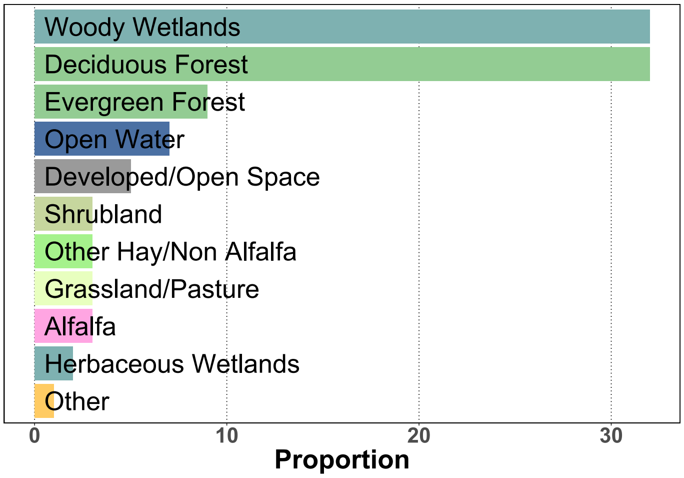

Figure 94C-2: Relative proportions (percentages) of land use in MLRA 94C.

94D—Northern Highland Sandy Pitted Outwash

MLRA 94D (fig. 94D-1) consists of an outwash plain with numerous ice-block depressions forming abundant lakes and wetlands. Thick glacial deposits are underlain by a dome of highly resistant igneous and metamorphic bedrock, the reason for the area's high elevation. This area is in Wisconsin (99 percent) and Michigan (1 percent). It makes up about 2,144 square miles (5,553 square kilometers). It is used primarily for forest products and recreational activities.

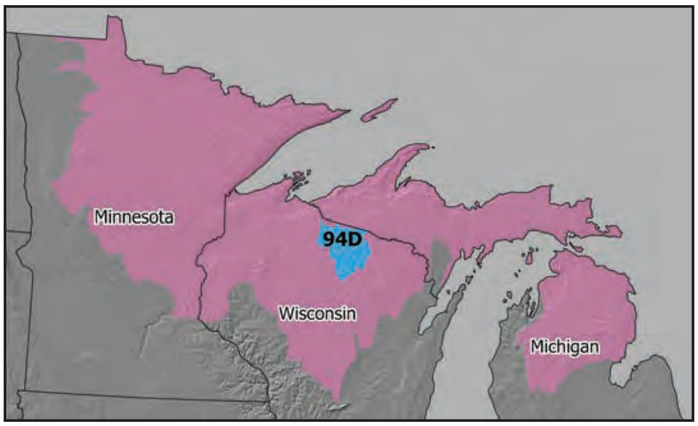

Figure 94D-1: Location of MLRA 94D, which covers 555,300 hectares (1,372,100 acres), within Region K.

This MLRA has a distinct physiographic boundary to the north with the Winegar Moraine (in MLRA 93B), which marks the extent of the Ontonagon Lobe. MLRA 94D is bordered by MLRA 90A to the south, east, and west. The southern boundary is distinct at the terminal moraines of the Wisconsin Valley and Langlade Lobes. The eastern boundary is distinct at the Langlade Lobe drumlin field. The western boundary is a gradual transition, where sandy glaciofluvial deposits commonly overlie the loamy glacial till deposits typical of MLRA 90A. While both MLRAs have many similarities overall, MLRA 94D is distinguished from MLRA 90A by its high concentration of lakes and peat bogs.

Physiography

This area is in the Superior Upland province of the Laurentian Upland. Three distinct glacial lobes of the Laurentide Ice Sheet (Wisconsin Valley, Langlade, and Ontonagon) have been important in shaping the landscape. The area is characterized by outwash plains (some of which are pitted or collapsed) and kame moraines intermixed with bogs and swamps and a few isolated drumlins. It has many lakes. The streams generally form a dendritic drainage pattern. Elevation ranges from about 1,500 feet (455 meters) to about 1,850 feet (565 meters). In much of the area, slopes are nearly level to gently rolling and local relief is only 10 to 20 feet (3 to 6 meters). Relief ranges from 20 to more than 330 feet (6 to more than 100 meters) on the moraines.

Geology

Precambrian-age bedrock underlies most of the glacial deposits in this MLRA. The bedrock is a complex of folded and faulted igneous and metamorphic rock that has been modified by glaciation. The bedrock is covered in most areas by Pleistocene deposits as much as 330 feet (100 meters) thick. Most of the Pleistocene sediment was deposited during the last part of the Wisconsin glaciation.

Climate

The average annual precipitation is 30 to 33 inches (772 to 840 millimeters). About two-thirds of the rainfall comes from convective thunderstorms during the growing season. Snowfall generally occurs from October through April. The average annual temperature is 39 to 41 degrees F (4 to 5 degrees C). The freeze-free period averages about 140 days and ranges from 125 to 155 days.

Water

Surface water and ground water are very abundant and readily available. The sources of surface water are the many lakes and streams. Water quality is generally good. Most of the lakes and streams are clear, but those that receive deposits of organic material from wetland vegetation are tinted brown from peat tannins. The surface water is used mostly for recreational activities. Extensive construction of cottages and houses along the lakes and streams may affect water quality.

This MLRA has three types of lakes—spring lakes, seepage lakes, and drainage lakes. Spring lakes seldom have an inlet, but they have an outlet with substantial flow. They are fed by ground water. Seepage lakes generally do not have an inlet or outlet but may have an intermittent outlet. The water level is maintained by the water table or a well sealed lake bottom. Drainage lakes have an outlet and at least one inlet. Their main water source is drainage from streams. Spring lakes have a high mineral content because they receive the greatest amount of ground water. Drainage lakes have a lower mineral content than spring lakes, and seepage lakes have a very low mineral content. Drainage lakes have the greatest range in pH. Water in the spring lakes has pH similar to that of the ground water. Seepage lakes commonly are acid, and some of the drainage lakes are alkaline.

Good-quality ground water comes from glacial deposits. Pollution of surface water is minimal because the area is relatively undeveloped and there is little municipal or industrial waste. Ground water meets domestic, agricultural, municipal, and industrial needs in this MLRA. Yields from glacial deposits vary. Supplies of ground water may be inadequate where glacial deposits are thin over crystalline bedrock. Generally, the fractured crystalline bedrock does not supply much water, although locally it provides a small amount for domestic uses.

Soils

The dominant soil orders are Spodosols and Histosols. The soils in the area have a frigid temperature regime, an aquic or udic moisture regime, and mixed mineralogy. Most of the soils on uplands, including outwash plains, moraines, and lake plains, are Haplorthods. These soils are very deep, excessively drained to somewhat poorly drained, and sandy or loamy. The soils on lowlands, in depressions and drainageways, are mostly Endoaquods or Haplosaprists. These soils are very deep, poorly drained or very poorly drained, and sandy, loamy, or mucky.

The main soils and their series:

- Endoaquods that formed in sandy outwash on outwash plains (Kinross and Au Gres series); that formed in loamy drift over sandy outwash on outwash plains (Wormet and Worcester series); that formed in sandy mudflow sediments on kame moraines (Pequaming series)
- Haplohemists that formed in hemic material in bogs (Greenwood series)
- Haplorthods that formed in sandy outwash on outwash plains, some of which are pitted or collapsed, or on kame moraines (Croswell, Rubicon, Vilas, Sayner, and Karlin series); that formed in loamy drift over sandy outwash on outwash plains, some of which are pitted or collapsed, or on kame moraines (Manitowish, Tipler, Pence, and Padus series); that formed in sandy mudflow sediments or till on kame moraines and drumlins (Keweenaw and Springstead series); that formed in loamy and silty glaciolacustrine sediments on lake plains (Annalake, Alcona, and Fence series)
- Haplosaprists that formed in sapric material in swamps (Markey, Carbondale, and Seelyeville series); that formed in sapric material in bogs (Dawson and Loxley series)

Biological Resources

This area supports conifer-hardwood forest. Sugar maple, yellow birch, white ash, red oak, aspen, paper birch, balsam fir, white spruce, eastern hemlock, red pine, white pine, and jack pine are the dominant trees. The poorly drained soils support black ash, green ash, red maple, black spruce, tamarack, and speckled alder.

Major wildlife species include white-tailed deer, black bear, eastern gray wolf, ruffed grouse, spruce grouse, woodcock, wild turkey, gray squirrel, red squirrel, snowshoe hare, porcupine, ducks, common loon, bald eagle, and geese. Red fox, bobcat, coyote, muskrat, fisher, mink, otter, raccoon, and beaver are the main furbearers. The many lakes and forests in this area provide substantial wildlife habitat. Fish species include rainbow trout, brook trout, walleye, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, muskellunge, and northern pike.

Land Use

Forests make up most of this area (fig. 94D-2). Timber and pulp production are important land uses. The paper industry is the largest manufacturer. Sap collection from sugar maple and syrup production are important forestry enterprises. Agriculture is a minor land use because of the sandy soils and the short growing season. Some corn silage, oats, and alfalfa hay are grown. Specialty crops include snap beans, potatoes, strawberries, and cranberries. Tourism, recreation, and wildlife management are important. The vast number of lakes and public forests provide year-round opportunities for recreation and tourism, especially recreational hunting, fishing, and hiking.

The major soil resource concerns are water erosion, excessive soil wetness, soil fertility, and tilth. Conservation practices on cropland generally include crop rotations, conservation tillage systems (especially no-till), contour farming, contour stripcropping, and grassed waterways. A combination of surface and subsurface drainage systems is needed in most areas of poorly drained soils. Conservation practices on forestland include forest stand improvement and forest trails and landings. These practices reduce the impact of timber management activities on water quality. Riparian forest buffers help to protect streams and rivers from timber harvesting activities, improve wildlife habitat, and protect water quality.

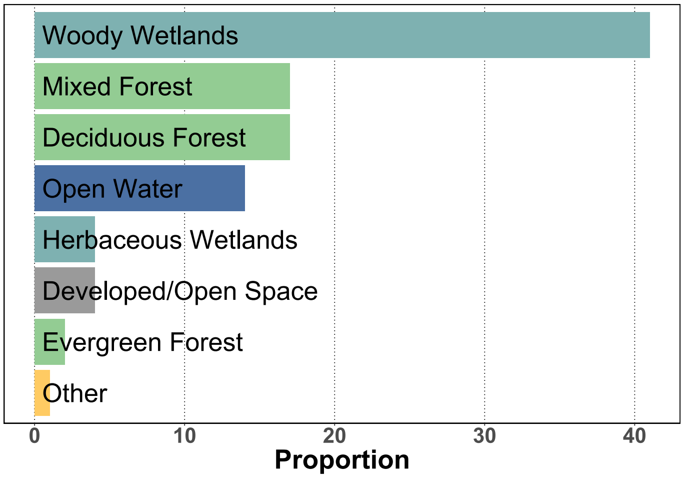

Figure 94D-2: Relative proportions (percentages) of land use in MLRA 94D.

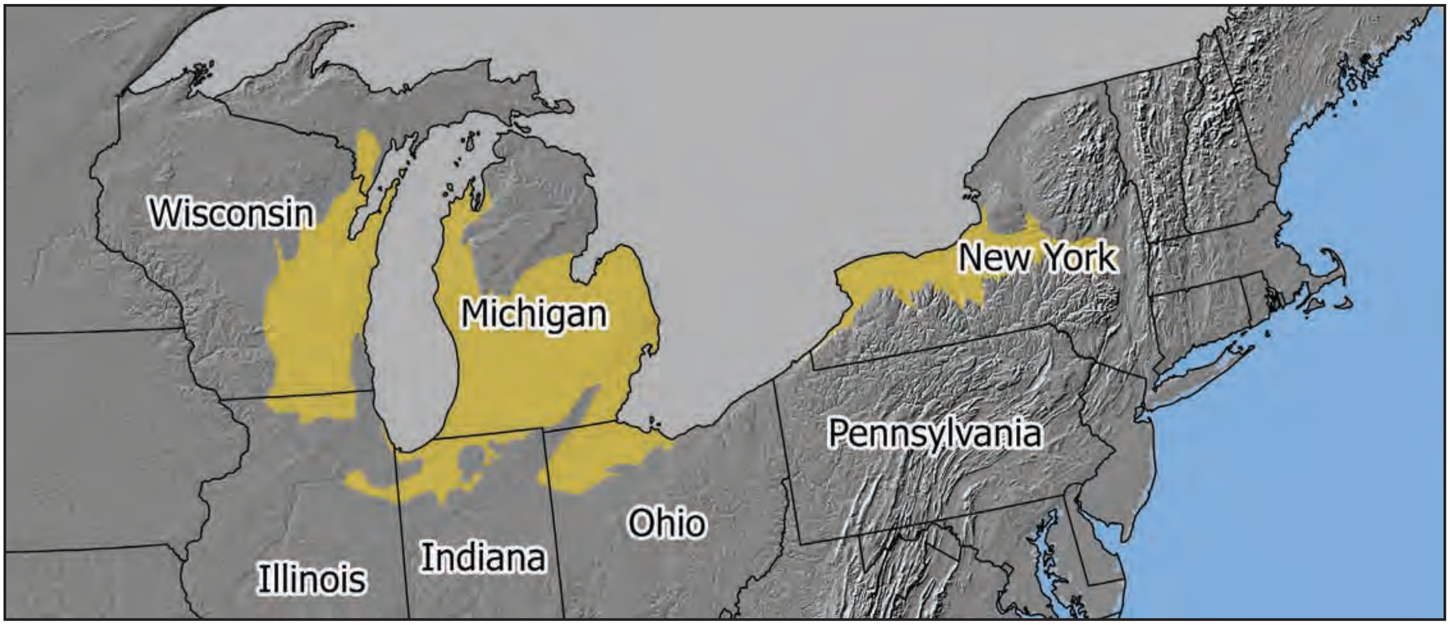

Figure L-1: Location and size of Land Resource Region L, which covers 167,645 square kilometers (64,725 square miles) across Wisconsin, Michigan, and New York.

L—Lake States Fruit, Truck Crop, and Dairy Region

Land Resource Region L (fig. L-1) is the calcareous glacial till region of the Great Lakes area. It is an area of cropland superimposed on glacial landforms that include remnant lake plains, till plains, outwash plains, moraines, drumlins, remnant beach ridges and shorelines, sand dunes, and stratified drift as eskers and kames. Region L occurs on both sides of Lake Michigan and extends into New York as a narrow strip between the Adirondack Mountains to the north and the Appalachian Plateau to the south. The glacial deposits overlie Paleozoic limestone, dolomite, sandstone, and shale. This region contains six major land resource areas. The extent of these MLRAs and their range in elevation are shown in table L-1.

Region L's boundary to the west with Regions K and M (fig. 1, page 5) separates the calcareous till and underlying limestone in Region L from the noncalcareous glacial till and underlying clastic and metamorphic bedrock in the other regions. Region L's southern boundary with Region M reflects a gradual change from Alfisols (Region L) to Mollisols that formed under former prairies (Region M). In addition, Region L's relict Pleistocene lake plains of Lake Erie and glacial Lake Chicago are a contrast to Region M's outwash plains and recessional moraines in Ohio, Illinois, and Indiana. Region L's boundary to the north (in Michigan) with Region K is the readily discernable change from cropland on Alfisols on calcareous till (Region L) to forests on Spodosols on noncalcareous till (Region K). In New York, Region L is bordered by forests on noncalcareous till in areas of Spodosols (to the north) in the Adirondack Mountains and by wooded areas on Inceptisols (to the south) in the Catskill Mountains, both of which occur in Region R.

Climatically, the average annual precipitation is 33 to 39 inches (839 to 1,002 millimeters). Due to the amount of precipitation, the soil moisture regime is udic on the uplands and aquic in the topographically lower areas. The average annual temperature is 46 to 49 degrees F (7.7 to 9.4 degrees C), producing the mesic soil temperature regime. Snowfall is common in winter. The average freeze-free period is 145 to 170 days; it is longest in narrow belts adjacent to the Great Lakes. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables L-2 and L-3.

Soils in the region are dominated by Alfisols, which reflect the high base status of the sediments combined with the native broadleaf deciduous forests. They include much smaller areas of sandy Entisols and Spodosols on scattered remnant shorelines and moraines, Inceptisols in clayey till and lake sediments, Mollisols in low wet areas, and Histosols in bogs (fig. 2, page 6). Carbonates are common in soils of this region, especially where glacial till is underlain by limestone (fig. 5, page 9). Restrictive zones occur as densic material (fig. 9, page 13) in

Table L-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
95	44,690	17,255	160	530	210	690	250	840	300	990	480	1,580
96	10,380	4,010	170	570	190	620	230	770	280	920	370	1,230
97	8,980	3,470	160	520	180	600	200	660	240	780	310	1,030
98	43,370	16,745	110	370	210	690	260	850	300	990	390	1,270
99	34,085	13,160	90	300	180	590	210	680	230	770	270	890
101	26,130	10,090	30	120	110	370	190	620	390	1,270	700	2,300

Table L-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
95	5.1	41	6.6	44	7.7	46	8.6	47	9.2	48	115	145	156/155	168	185
96	6.8	44	7.4	45	7.7	46	8	46	8.7	48	125	134	141/145	156	185
97	8	46	8.6	48	9.1	48	10.2	50	10.8	52	135	155	162/165	187	210
98	7.2	45	8.3	47	8.9	48	9.9	50	10.3	50	135	156	164/165	172	185
99	7.4	45	8	46	9.4	49	10.1	50	10.4	51	140	159	172/170	185	215
101	5.7	42	7.3	45	8.7	48	9.3	49	9.8	50	130	152	166/165	180	195

Table L-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
95	700	28	779	31	839/840	33/33	904	36	950	37
96	770	30	811	32	875/870	34/34	898	35	950	37
97	840	33	899	35	948/950	37/37	1,004	40	1,030	40
98	800	32	825	32	910/910	36/36	997	39	1,040	41
99	720	29	805	32	852/855	34/34	917	36	970	38
101	790	31	855	34	1,002/995	39/39	1,126	44	1,470	58

many soil profiles and as ortstein and fragipans (fig. 11, page 15) in a few areas. Argillic horizons are common in the region and are a distinctive feature in New York (fig. 12, page 16).

Land use includes a significant amount of agriculture for the production of corn, soybeans, pasture, and alfalfa (fig. 8, page 12). It is also dominated by deciduous forest with substantial areas of woody wetlands, developed areas, and open water (fig. L-2). Production of beans, sugar beets, and fruits (especially sour cherries) is important in a narrow belt adjacent to the Great Lakes, and wine grapes are grown in the Finger Lakes area. Resource concerns include controlling pollution from sediment and pesticides, reducing excess wetness on cropland, conserving soil moisture in droughty soils, improving soil fertility and tilth, and preserving water quality, wetlands, habitat for fish and wildlife, and prime farmland.

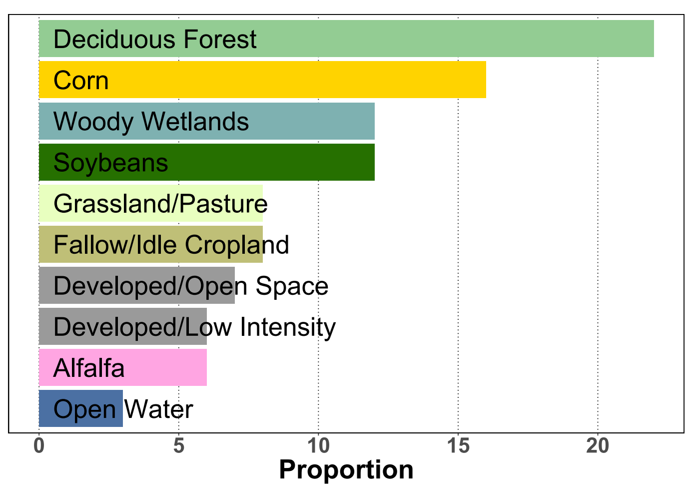

Figure L-2: Relative proportions (percentages) of land use in LRR L.

95—Eastern Wisconsin, Northern Illinois, and Upper Michigan Drift Plain

This MLRA (fig. 95-1) is characterized by nearly level to rolling till plains, outwash plains, drumlin fields, and glacial lake plains. It is used to produce cash crops, feed grain, and livestock. It includes the shorelines of Lake Winnebago and Lake Michigan. This area is in Wisconsin (85 percent), Illinois (10 percent), and Michigan (5 percent). It makes up about 17,255 square miles (44,690 square kilometers).

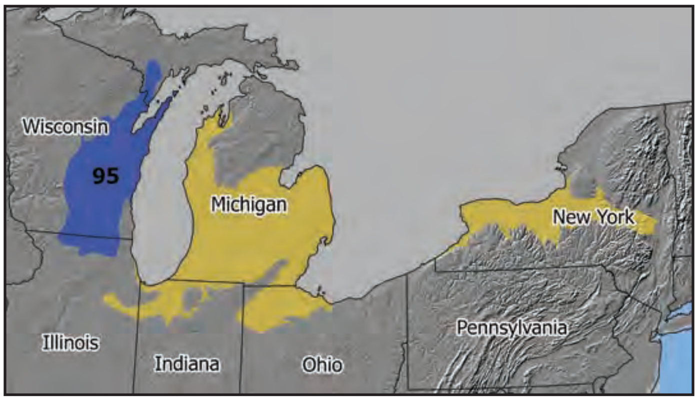

Figure 95-1: Location of MLRA 95, which covers 4,469,000 hectares (11,043,100 acres), within Region L.

MLRA 95 has a distinct boundary based on physiography with MLRAs 89 (Wisconsin Central Sands), 105 (Upper Mississippi Bedrock Controlled Uplands and Valleys), and 110 (Northern Illinois and Indiana Heavy Till Plain). It has a less apparent boundary with MLRAs 90A, 94B, and 108. The boundary with MLRAs 90A (Wisconsin and Minnesota Thin Loess and Till) and 94B (Michigan Eastern Upper Peninsula Sandy Glacial Deposits) is based on the boundary between the mesic and frigid soil temperature regimes. The boundary with MLRA 108 (Illinois and Iowa Deep Loess and Drift) is based on the thickness of loess, outwash, and till deposits over bedrock and the texture of the till.

Physiography

This area is in the Central Lowland province of the Interior Plains. Most of the area is in the Eastern Lake section. A narrow strip along the southwestern edge of the area is in the Wisconsin Driftless section. The southwestern quarter is in the Till Plains section. The nearly level to rolling till plains, glacial lake plains, and outwash plains are mixed with drumlin fields, ground moraines, end moraines, flood plains, lake terraces, beaches, dunes, swamps, and marshes. Most of the southern part of this area has belts of morainic hills and ridges and nearly level outwash terraces. Drumlins are prominent features in the central part of the area. Glaciokarst topography occurs in the east-central parts of the area influenced by underlying Niagara Dolomite. Lakes and streams are numerous, and streams generally form a dendritic drainage pattern. Elevation ranges from 530 to 1,580 feet (160 to 480 meters). Local relief is mainly 25 feet (8 meters), but the moraines, drumlins, and bedrock escarpments rise 80 to 330 feet (25 to 100 meters) above the adjacent valleys.

Major rivers in the MLRA include the Menominee River, which empties into Lake Michigan. The Rock and Wisconsin Rivers flow through this MLRA and eventually empty into the Mississippi River. The Fox River flows through Lake Winnebago, the largest lake in Wisconsin, and empties into Green Bay of Lake Michigan.

Geology

This MLRA is mostly covered with glacial drift of Wisconsin age. Some of the higher areas are moraines that appear as arc-shaped ridges representing the retreat of the ice from south to north. Most of the bedrock in the area consists of Silurian, Ordovician, and Cambrian sandstone, limestone, and dolomite. Some igneous and metamorphic rocks underlie the northwestern edge of the area. Devonian limestone and shale occur at the far eastern edge in the Milwaukee area.

Climate

The annual precipitation ranges from 28 to 37 inches (700 to 950 millimeters) with a mean of 33 inches (840 millimeters). The annual temperature ranges from 41 to 48 degrees F (5.1 to 9.2 degrees C) with a mean of 46 degrees F (7.7 degrees C). The freeze-free period ranges from 115 to 185 days with a mean of 155 days. It decreases in length from south to north and from the shore of Lake Michigan inland. Lake Michigan helps to moderate the climate of the area.

Water

The moderate precipitation generally is adequate for crops and pasture, but in some years yields on sandy soils are greatly reduced by drought. Drainage of poorly drained soils is needed for good crop and forage production. Lakes and streams are additional sources of water. Ground water is abundant in bedrock aquifers and in unconsolidated sand and gravel deposits that occur throughout the MLRA and are covered mainly by glacial drift and in some areas by clayey drift.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, Histosols, Mollisols, and Spodosols. The soils in the area dominantly have a mesic or frigid temperature regime, an aquic or udic moisture regime, and mixed mineralogy. They are very deep, excessively drained to very poorly drained, and sandy to clayey. Areas of Spodosols and soils with a frigid soil temperature regime occur in the northern part of the MLRA.

The main soils and their series:

Argiudolls that formed in loess over till on moraines and drumlins (Hochheim series); that formed in loess and outwash or sandy loam till on outwash plains, stream terraces, and till plains (Plano series); that formed in till and have a frigid soil temperature regime, on ground moraines (Solona series)

Endoaquolls that formed in glaciofluvial sediments on till plains, outwash plains, and stream terraces (Pella series)

Haplorthods that formed in glaciofluvial deposits over till or lacustrine deposits and have a frigid soil temperature regime, on moraines, outwash plains, and lake plains (Menominee series)

Haplosaprists that formed in herbaceous organic materials in depressions and drainageways (Houghton series) and that have a frigid soil temperature regime (Lupton series)

Hapludalfs that formed in loess over outwash on outwash plains, stream terraces, valley trains, kames, and moraines (Fox series); that formed in till or loess over till (Kewaunee series) and have a frigid soil temperature regime (Onaway series) on moraines and drumlins

Udipsamments that formed in sandy drift (Plainfield series) on outwash plains and moraines

Biological Resources

The northern part of this MLRA supports natural stands of mixed northern hardwoods and pine. Sugar maple, oak, white ash, elm, yellow birch, white pine, red pine, and American beech are the principal species. Low-lying areas support both mixed hardwoods and conifers. Elm, soft maple, black ash, and northern white cedar are the major species. Brush and sedge meadows also occur in the low-lying areas.

The southern part of this MLRA supports hardwoods and prairie vegetation. Uplands support natural stands of oak, sugar maple, and hickory, and natural prairie vegetation is characterized by little bluestem and big bluestem. Many of the prairies have scattered oak and hickory trees. Low-lying areas support sedge and grass meadows and mixed stands of hardwoods and conifers. Elm, ash, eastern cottonwood, soft maple, and white cedar are the major species in the low-lying areas.

Major wildlife species include white-tailed deer, black bear, red fox, raccoon, beaver, otter, muskrat, cottontail rabbit, squirrel, turkey, pheasant, woodcock, ducks, and geese. Fish species include rainbow trout, brook trout, walleye pike, largemouth bass, smallmouth bass, bluegill, black crappie, yellow perch, musky, and northern pike.

Land Use

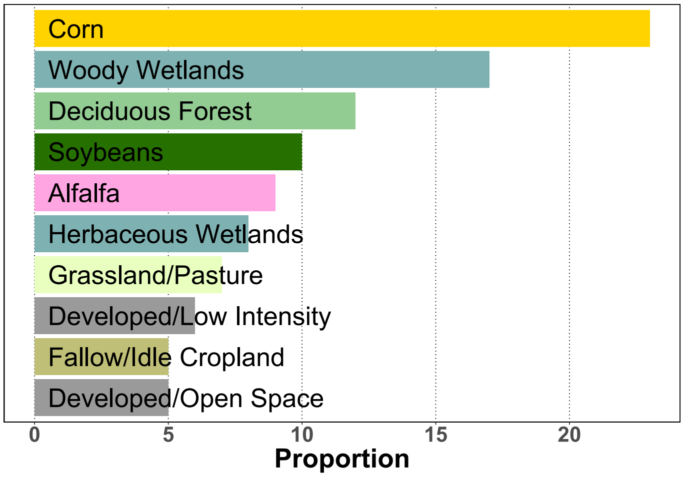

Figure 95-2: Relative proportions (percentages) of land use in MLRA 95.

Most of this MLRA is in farms (fig. 95-2). The area is dominantly used as cropland or pasture. Agricultural uses include the production of dairy cattle and other livestock, forage, hay, feed grains, sweet corn, snap beans, canning peas, potatoes, soybeans, winter wheat, barley, and fruit. Much of the hay, feed grain, and forage is fed to dairy cattle and other livestock on the farms where the feed is grown, but cash-grain farming also is important.

The rest of the land is used for tame pasture, farm woodlots, and urban development. Some of the better farmland is increasingly used for urban development. Recreation is an important land use, especially along the major streams and shoreline of Lake Michigan. The Door County area, the peninsula northeast of Green Bay, is a popular resort area.

The major soil resource concerns are water erosion, soil health, quality of surface and ground water, excessive soil wetness, and restoration of wetland wildlife habitat. Conservation practices on cropland generally include conservation tillage systems (especially mulch-till, no-till, and strip-till), cover crops, crop rotations, and nutrient and pest management. Other practices include grassed waterways, grade-stabilization structures, surface and subsurface drainage systems, filter strips, protection of streambanks and shorelines, and management of wetland wildlife habitat. Stormwater management helps to reduce ponding and flooding and improves water quality in urbanized areas.

96—Northwestern Michigan Fruit Belt

MLRA 96 (fig. 96-1) consists of glacial drift adjacent to the Great Lakes that is covered by northern hardwood forests and pine-oak barrens and commonly used for orchards and vineyards. This area is entirely in the northwestern portion of the Lower Peninsula of Michigan and makes up about 4,008 square miles (10,381 square kilometers). The MLRA is bordered by Lake Michigan to the north and west, by colder, frigid soil temperature regimes to the east (MLRAs 94A and 94C), and by a change in forest vegetation to the south (MLRAs 97 and 98) where summers are warmer.

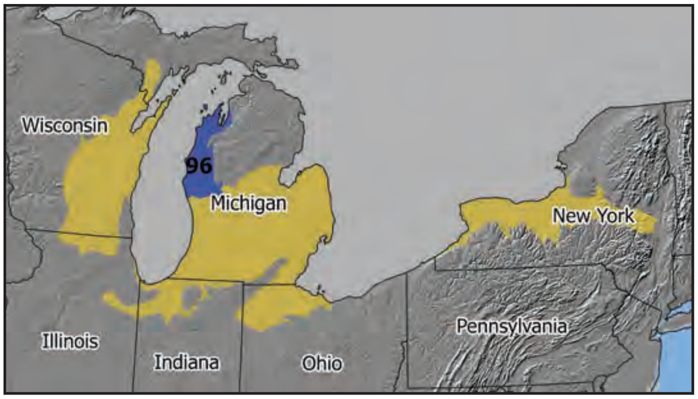

Figure 96-1: Location of MLRA 96, which covers 1,038,100 hectares (2,565,100 acres), within Region L.

Physiography

This MLRA is in the Eastern Lake section of the Central Lowland province of the Interior Plains. It is in the glaciated areas of northern Michigan and is dominated by outwash plains and moraines. Lake plains, till plains, and sand dunes are scattered throughout the area. The terrain is steep on moraines and beach ridges and flat on outwash plains and lake plains. Elevation generally ranges from 580 to 1,000 feet (175 to 305 meters) with isolated areas of more than 1,215 feet (370 meters). Local relief averages 35 feet (11 meters) in the south and 65 feet (20 meters) in the north and ranges to 520 feet (158 meters) at Empire Bluff in Sleeping Bear Dunes National Lakeshore. Much of the area rises sharply from the lakeshore to the adjoining hilltops.

The Manistee River is the longest river in this area. Its trout fishery is maintained by constant inflow of cool ground water. The Jordan, Boardman, Betsie, Pine, Pere, and Marquette Rivers also occur in this MLRA.

Geology

Nearly all of this MLRA has glacially modified topography. Bedrock in the area is the Traverse Group and the Dundee Limestone. These Silurian-Devonian rocks are mostly limestone and dolomite with some interbedded shale, chert, and anhydrite stringers. These units are at various depths below the surface because of the curvature of the Michigan Basin. A few bedrock exposures are on the western shore of the MLRA, where the outer edges of the basin rise. This MLRA also has several areas of sand dunes near the Lake Michigan shoreline.

Climate

The average annual temperature is 44 to 48 degrees F (7 to 9 degrees C). The average annual precipitation is 31 to 37 inches (770 to 943 millimeters). Prevailing winds pick up moisture from the Great Lakes in the form of lake-effect rain and snow showers during fall and winter and in the form of fog during spring and summer. Thunderstorm intensity is reduced by temperature inversions over the lakes during spring and early summer, when lake water cools the air flowing over it. Mean annual snowfall ranges from 1.6 to 3.6 meters (60 to 140 inches).

Average 0 degrees C (32 degrees F) frost-free season ranges from 108 to 161 days. Average -2 degrees C (28 degrees F) freeze-free season is 141 to 194 days, increasing in length from north to south and decreasing in length from the lakeshore inland. Mean annual extreme minimum temperatures range from -29 to -18.9 degrees C (-20 to -2 degrees F); USDA hardiness zones range from 4b to 6b.

Water

In years with normal precipitation, soil moisture is adequate for crops. In years with little or no precipitation, yields are reduced, especially on the sandy soils and where bedrock is at a shallow depth. Lake Michigan and high-quality, cold-water streams and lakes in the area are sources of surface water. The surface water is suitable for almost all uses with little or no treatment. Streams and lakes generally have a calcium-bicarbonate type of water but can have high levels of dissolved solids.

Ground water is abundant in areas of deep, sandy and loamy drift. These deposits consist of outwash, lake sediments, and till. Wells in the outwash yield the most water, and wells in the till yield the least. The ground water is of good quality and hard. Calcium and bicarbonate are the principal dissolved substances in the ground water. The median concentration of iron is below the secondary standard for drinking water, but some wells exceed this standard. Nitrate contamination is related to land use practices. Fertilizer, manure, and septic systems are the primary sources of nitrates in the ground water.

A Silurian-Devonian aquifer occurs along the lakeshore in this area. The quality of the water in this aquifer is very similar to that of the water in the overlying glacial deposits. This aquifer is generally below the glacial drift aquifers, so it is little used in this area. Other sedimentary rocks that underlie the glacial deposits are mostly shale and are not used as sources of water.

Soils

The dominant soils in this MLRA are Spodosols, Entisols, Alfisols, and Histosols. The soils in the area have a mesic temperature regime, an aquic or udic moisture regime, and dominantly mixed mineralogy. They are very deep and excessively drained to very poorly drained. The Histosols formed in depressions that remain saturated year-round.

The main soil series:

Adrian series—Haplosaprists that formed in organic material over glacial drift in depressions on outwash plains, lake plains, and moraines

Benona series—Haplorthods that formed in glacial drift on moraines, outwash plains, and lake plains

Benzonia series—Haplorthods that formed in glacial drift on outwash plains, moraines, and lake plains
Coloma series—Udipsamments that formed in glacial drift on moraines, outwash plains, and glacial deltas
Covert series—Haplorthods that formed in glacial drift on moraines, outwash plains, and lake plains
Grattan series—Haplorthods that formed in glacial drift on lake plains, outwash plains, and moraines
Houghton series—Haplosaprists that formed in organic material in depressions and drainageways on lake plains, outwash plains, and moraines
Kaleva series—Haplorthods that formed in glacial drift on outwash plains, lake plains, and moraines
Metea series—Hapludalfs that formed in sandy deposits over glacial till on moraines and till plains
Pipestone series—Endoaquods that formed in outwash on outwash plains and lake plains
Plainfield series—Udipsamments that formed in glacial drift on outwash plains and moraines
Spinks series—Hapludalfs that formed in glacial drift on moraines, till plains, outwash plains, and lake plains

Biological Resources

Most upland sites are dominated by northern hardwoods such as sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), basswood (*Tilia americana*), and yellow birch (*Betula alleghaniensis*) with eastern hemlock (*Tsuga canadensis*). Sandy outwash plains in the south, away from the lake, are historically prone to fire. They support a mosaic of forests and barrens with white pine (*Pinus strobus*), white oak (*Quercus alba*), and black oak (*Quercus velutina*) and open areas of warm-season grasses, such as big bluestem (*Andropogon gerardii*), and forbs, such as wild lupine (*Lupinus perennis*). Depressions support rich conifer swamps of northern white cedar (*Thuja occidentalis*). Flood plains support silver maple (*Acer saccharinum*) and green ash (*Fraxinus pennsylvanica*). The relatively mild, lake-moderated climate allows more southern hardwoods, such as blackgum (*Nyssa sylvatica*), sassafras (*Sassafras albidum*), and flowering dogwood (*Cornus florida*), to extend north into this MLRA; the species are absent from other MLRAs at the same latitude. The coastal sand dunes and coastal plain marshes provide habitat for several rare plants.

Wildlife species include white-tailed deer, black bear, coyote, snowshoe hare, squirrels, ruffed grouse, woodcock, ducks, geese, songbirds, snakes, frogs, and turtles. Fish species include lake trout, brook trout, northern pike, bass, yellow perch, bluegill, sunfish, and various introduced species of salmon and trout.

Land Use

About two-thirds of this area is in small, privately owned holdings, and one-third consists mostly of State forests (fig. 96-2). The forests are used mainly for timber production and recreation. The production of orchard crops and other crops and dairy and beef operations are important enterprises in the area. Forage and feed grains for dairy and other livestock are the principal crops. Asparagus, wheat, oats, corn, and hay are commonly grown in the area. Orchard products include sweet and tart cherries, apples, plums, and peaches.

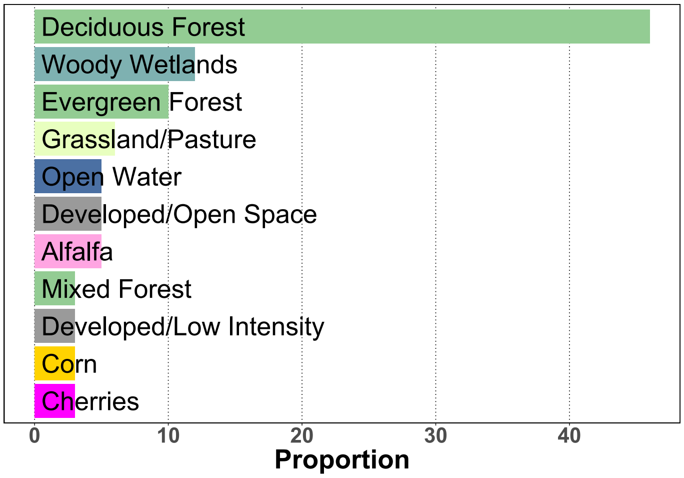

Figure 96-2: Relative proportions (percentages) of land use in MLRA 96.

The major soil resource concerns are wind erosion, water erosion, wetness, soil moisture management, and maintenance of the fertility and productivity of the soils. Conservation practices on cropland generally include crop residue management systems, such as no-till or reduced-till.

97—Southwestern Michigan Fruit and Vegetable Crop Belt

MLRA 97 (fig. 97-1) consists of sandy glaciolacustrine plains and lake-influenced till adjacent to the Great Lakes. It is covered by beech-maple forests and pine-oak barrens and is commonly used for orchards and vineyards. This area wraps around the southern end of Lake Michigan and occurs in Michigan (84 percent), Indiana (13 percent), and Illinois (3 percent). It makes up about 3,468 square miles (8,982 square kilometers). The MLRA is bordered by Lake Michigan to the west, by a change in forest vegetation to the north, where summers are cooler, and by outwash plains and a climate less influenced by Lake Michigan to the south and east.

Physiography

This area is in the Eastern Lake section of the Central Lowland province of the Interior Plains. It consists of a nearly level glacial drift plain and scattered areas of gently rolling to strongly rolling hills (moraines). Elevation generally ranges from 580 to 820 feet (175 to 250 meters) with isolated areas as

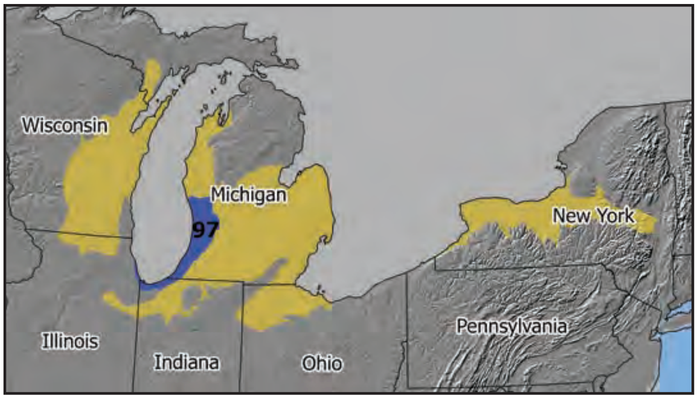

Figure 97-1: Location of MLRA 97, which covers 898,200 hectares (2,219,500 acres), within Region L.

high as 1,035 feet (315 meters). Local relief averages 30 feet (9 meters) and ranges to 235 feet (72 meters). The highest relief is among coastal sand dunes. The southern portion of the area has less relief, averaging only 15 feet (4 meters). Tributaries to the Grand River and the Kalamazoo River are in the northern part of the area. Another Michigan river that drains into Lake Michigan in this area is the St. Joseph River. The Des Plaines River drains much of Chicago. It becomes the Illinois River just southwest of this area.

Geology

The surface of this area is covered mainly with deposits of glacial drift. Most of the drift consists of till, but there are some deposits of unconsolidated sand and gravel outwash. Some lake sediments are near the shoreline of Lake Michigan. The bedrock beneath the glacial deposits consists primarily of limestone and dolomite in the parts of this MLRA in Illinois and Indiana and sandstone and shale in the part in Michigan. Abandoned limestone and dolomite quarries in the Chicago area are now used to store urban runoff during storms.

Climate

The average annual precipitation is 34 to 40 inches (854 to 1,021 millimeters). Mean annual snowfall ranges from 0.9 meter to 2.4 meters (35 to 95 inches). Summer precipitation is generally less near the lake than inland due to temperature inversions. Snowfall is generally less near the lake than inland due to the warmer temperatures and lack of orographic uplift before inland areas. A sharp reduction in lake-effect snowfall occurs where Lake Michigan is not frequently upwind, near the Indiana-Michigan State line.

The average annual temperature is 46 to 51 degrees F (8 to 11 degrees C). In general, summer temperatures decrease northward and immediately adjacent to the lake. Winter temperatures decrease northward and inland, with southern inland locations ranging colder than northernmost lakeshore sites. Average 0 degrees C (32 degrees F) frost-free season ranges from 130 to 177 days. Average -2 degrees C (28 degrees F) freeze-free season is 157 to 200 days. Mean annual extreme minimum temperatures range from -25.4 to -18.4 degrees C (-14 to -1 degrees F); USDA hardiness zones range from 5b to 6b. The longest growing seasons and mildest temperature extremes are near Lake Michigan.

Water

In years with normal precipitation, soil moisture is adequate for crops, but in years with little or no precipitation, yields are reduced. Most of the fine textured soils require artificial drainage to ensure that tillage is not delayed in spring and fall. Wet areas need to be drained for good crop production. Lake Michigan is the source of municipal and industrial water for the Chicago area. The surface water is suitable for almost all uses, but it is very hard and requires some treatment.

The glacial deposits in this area yield some ground water for domestic, municipal, and industrial uses. The highest yielding wells are in the outwash deposits within the drift, but some domestic water also is pumped from glacial lake sediments and from the till itself. This water is suitable for almost all uses with little or no treatment. The glacial drift covering the bedrock aquifers in this area helps to protect the aquifers from surface contamination. Agricultural activities, municipal and industrial waste discharges, road salts, brine disposal from oil well exploration and production, and pumping-induced movement of deeper, more saline water into the aquifers are the primary sources of contamination.

Two bedrock aquifers occur in this area—the shallow dolomite in northeastern Illinois and the Marshall Formation (sandstone) in the northeastern part of the MLRA. The water quality in the Marshall aquifer is similar to that in the glacial aquifers. Total dissolved solids in the water in the shallow dolomite can exceed the recommended level for drinking water. The median iron concentration exceeds the national secondary standard, an esthetics standard, for drinking water. The ground water from the shallow dolomite is very hard and requires treatment before it is used.

Soils

The dominant soils in this MLRA are Alfisols, Entisols, Spodosols, and Mollisols. The soils in the area have a mesic temperature regime, an aquic or udic moisture regime, and dominantly mixed mineralogy. They are very deep and excessively drained to very poorly drained. The Spodosols and Entisols with a udic moisture regime formed in upland positions where parent material was sandy glaciofluvial or glaciolacustrine deposits. The Alfisols formed in upland positions where parent material was sandy and loamy glacial drift or till. These same soil orders as well as the Mollisols occur lower on the landscape with an aquic soil moisture regime.

The main soil series:

Blount series—Epiaqualfs that formed in dense glacial till on till plains
Capac series—Glossudalfs that formed in glacial till on moraines and till plains
Chelsea series—Udipsamments that formed in eolian deposits on dunes
Coloma series—Udipsamments that formed in glacial drift on moraines and outwash plains
Houghton series—Haplosaprists that formed in organic material in depressions and drainageways on lake plains, outwash plains, and moraines
Oakville series—Udipsamments that formed in eolian deposits on dunes and beach ridges
Oshtemo series—Hapludalfs that formed in outwash on outwash plains and moraines
Pipestone series—Endoaquods that formed in outwash on outwash plains and lake plains
Plainfield series—Udipsamments that formed in glacial drift on outwash plains and moraines
Riddles series—Hapludalfs that formed in glacial till on till plains and moraines
Spinks series—Hapludalfs that formed in glacial drift on moraines, till plains, outwash plains, and lake plains
Thetford series—Hapludalfs that formed in till or outwash on moraines, outwash plains, or lake plains

Biological Resources

The northern lake plain supports deciduous hardwoods, such as sugar maple (*Acer saccharum*) and American beech (*Fagus grandifolia*), and conifers, such as eastern hemlock (*Tsuga canadensis*) and eastern white pine (*Pinus strobus*). Sandy lake plains with deeper water tables are more vulnerable to fire and drought and support black oak (*Quercus velutina*), white oak (*Quercus alba*), and white pine barrens with several prairie species. Loamy moraines inland of the lake plain support a diversity of deciduous hardwoods, including sugar maple, American beech, basswood (*Tilia americana*), black cherry (*Prunus serotina*), and tuliptree (*Liriodendron tulipifera*). Wet acidic sandy depressions support unique herbaceous species with an affinity to the Atlantic coastal plain. The Lake Michigan sand dunes and beaches support beachgrass (*Ammophila breviligulata*), sea rocket (*Cakile edentula*), and the endemic Pitcher's thistle (*Cirsium pitcheri*). South of the Michigan border, the higher summer temperatures, reduced lake-effect snowfall, and higher fire frequency favor the prairies and oak savannas and woodlands instead of closed forest.

Major wildlife species include white-tailed deer, coyote, red fox, opossum, muskrat, mink, cottontail, woodchuck, squirrels, red-tailed hawk, wild turkey, introduced pheasant, ruffed grouse, woodcock, kingfisher, bobwhite quail, herons, sandhill crane, Canada goose, ducks, songbirds, snakes, frogs, and turtles. Fish species include sunfish, perch, bass, northern pike, walleye, catfish, sucker, carp, and various introduced species of salmon and trout.

Land Use

More than three-fifths of this MLRA is in farms (fig. 97-2). Slightly more than half of the acreage in farms is cropland. Fruits, especially peaches and grapes, are grown extensively near the shore of Lake Michigan. Many other fruits and vegetables also are grown. Forage and feed grains for dairy cattle and other livestock are important crops. Some areas are used as permanent pasture, but most of the farmland that is not cultivated is in woodlots. A large part of the area that is not in farms is in State forests and parks. Nearly 30 percent of the MLRA is used for urban development.

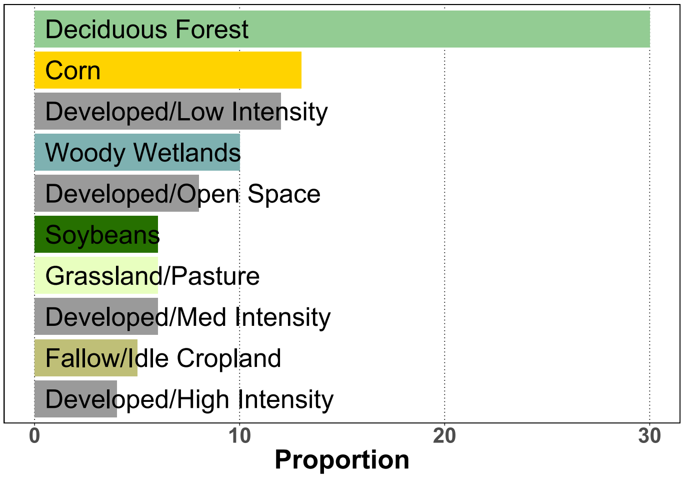

Figure 97-2: Relative proportions (percentages) of land use in MLRA 97.

The major soil resource concerns are wind erosion, water erosion, wetness, soil moisture management, and maintenance of the fertility and productivity of the soils. Conservation practices on cropland generally include crop residue management systems, such as no-till or reduced-till.

98—Southern Michigan and Northern Indiana Drift Plains

MLRA 98 (fig. 98-1) consists of fine-loamy till and sandy and gravelly outwash plains inland from the Great Lakes. It is covered by beech-maple forests and oak savannas and is commonly used to produce corn and soybeans. This area is in Michigan (79 percent), Indiana (17 percent), and Illinois (4 percent). It makes up about 16,746 square miles (43,372 square kilometers). It is bordered by a frigid soil temperature regime and a change in forest vegetation to the north (MLRA 94A), by the Lake Michigan moraine and an increased lake-influenced climate to the west (MLRAs 96 and 97), by a glaciolacustrine

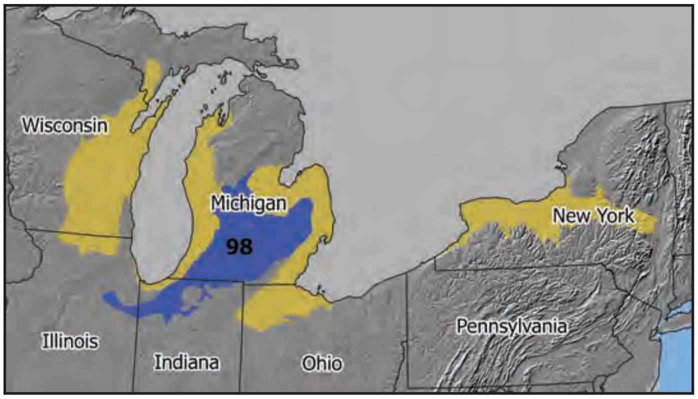

Figure 98-1: Location of MLRA 98, which covers 4,337,200 hectares (10,717,300 acres), within Region L.

plain to the east (MLRA 99), and by a break from outwash and a climate with warmer summer temperatures to the south (MLRAs 110, 111B, and 111C).

Physiography

This area is in the Eastern Lake section of the Central Lowland province of the Interior Plains. It is a broad glaciated plain that is deeply mantled by till and outwash. The landscape in the northern half of the MLRA is a large till plain. Landscapes in the southern half are dominated by outwash plains. Much of the area is nearly level to gently rolling. Elevation generally ranges from 640 to 1,050 feet (195 to 320 meters) but is more than 1,280 feet (390 meters) on some hills. Local relief averages 30 feet (9 meters) and ranges to 245 feet (74 meters).

The Flat, White, Rogue, and Pere Marquette Rivers are in the northwestern part of the MLRA. Most of the rivers in this area are short because of their proximity to the Great Lakes east and west.

Geology

The surface of this MLRA is covered with glacial drift deposits that are 100 to 500 feet (30 to 150 meters) thick in most areas. In a few places in the central part of the MLRA, the deposits are less than 10 feet (3 meters) thick. At the northern edge of the area, the drift is more than 600 feet (185 meters) thick. Most of the drift consists of till, but there are significant deposits of unconsolidated sand and gravel outwash throughout the area. Some lake sediments are in the northwest corner of the MLRA, near the shoreline of Lake Michigan. The bedrock beneath the glacial deposits in this area is deformed in the shape of a basin. The center of this basin is in the north-central part of the MLRA. Jurassic-age shale (red beds) and Pennsylvanian-age sandstone are in the center of the basin, and Mississippian-age sandstone and shale beds form the outer rings of the basin.

Climate

The MLRA is divided into northern and southern zones with the boundary occurring around the Indiana-Michigan State line. The northern, more forested portion of the area has mean July temperatures ranging from 20.4 to 23 degrees C (69 to 73 degrees F). Mean January temperatures range from -6.5 to -3.7 degrees C (20 to 25 degrees F). Average 0 degrees C (32 degrees F) frost-free season ranges from 127 to 175 days. Average -2 degrees C (28 degrees F) freeze-free season is 155 to 199 days. Mean annual extreme minimum temperatures range from -26.6 to -20.8 degrees C (-16 to -5 degrees F); USDA hardiness zones range from 5a to 6a. Mean annual precipitation ranges from 799 to 1,033 millimeters (31 to 41 inches). Mean annual snowfall ranges from 0.6 meter to 2.2 meters (25 to 85 inches).

The southern, prairie-dominated portion of the MLRA has mean July temperatures ranging from 22.4 to 23.4 degrees C (72 to 74 degrees F). Mean January temperatures range from -4.8 to -3.8 degrees C (23 to 25 degrees F). Average 0 degrees C (32 degrees F) frost-free season ranges from 152 to 176 days. Average -2 degrees C (28 degrees F) freeze-free season is 176 to 191 days. Mean annual extreme minimum temperatures range from -25.7 to -22.5 degrees C (-14 to -8 degrees F); USDA hardiness zones range from 5b to 6a. Mean annual precipitation ranges from 949 to 1,037 millimeters (37 to 41 inches). Mean annual snowfall ranges from 0.5 meter to 1.7 meters (20 to 65 inches).

Water

In much of the MLRA, the moderate precipitation is adequate for crops, but conserving moisture in the coarse textured soils is a major management concern. Many small and medium-size lakes and many perennial streams are sources of good-quality surface water. Municipalities, public water suppliers, and industry in the western part of the MLRA obtain surface water from Lake Michigan. The surface water in this area is very hard and requires softening prior to most uses.

Ground water is abundant in the deep glacial drift. The highest yielding wells are in the outwash deposits within the drift, but some domestic water also is pumped from glacial lake sediments and from the till itself. This water is suitable for almost all uses with little or no treatment. The glacial drift covering the bedrock aquifers helps to protect the aquifers from contamination. Agricultural activities, municipal and industrial waste discharges, road salts, brine disposal from oil well exploration and production, and pumping-induced movement of deeper, more saline water into the aquifers are the primary sources of contamination.

Two bedrock aquifers, the Saginaw and Marshall Formations, occur in this area. The Saginaw Formation is a sandstone unit with some interbedded shale. The Marshall Formation is sandstone. Both aquifers are Mississippian in age. The water quality in the Marshall aquifer is similar to that in the glacial aquifers. Water in the Saginaw Formation commonly contains levels of iron that exceed the national secondary standard, an esthetics standard, for drinking water. This water is the hardest water in all of the aquifers in Michigan, and it requires treatment prior to use. The water in these bedrock aquifers tends to be fresher where the glacial aquifers contact them and recharge their water.

Soils

The dominant soil orders in this MLRA are Alfisols, Mollisols, Entisols, and Histosols. The soils in the area dominantly have a mesic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. They are very deep, well drained to very poorly drained, and loamy or sandy. The Alfisols with a udic moisture regime formed in upland positions where parent material was sandy and loamy glacial drift or till. The Mollisols occur lower on the landscape and have an aquic moisture regime. The Entisols formed in upland positions where parent material was sandy drift or outwash. The Histosols formed in depressions that remain saturated year-round.

The main soil series:

Boyer series—Hapludalfs that formed in glacial drift over sandy and gravelly outwash on outwash plains and moraines

Capac series—Glossudalfs that formed in till on moraines and till plains

Coloma series—Udipsamments that formed in glacial drift on moraines and outwash plains

Conover series—Hapludalfs that formed in dense till on moraines and till plains

Gilford series—Endoaquolls that formed in outwash on outwash plains

Houghton series—Haplosaprists that formed in organic material in depressions and drainageways on lake plains, outwash plains, and moraines

Kalamazoo series—Hapludalfs that formed in loess-influenced outwash over sandy and gravelly outwash on outwash plains and moraines

Marlette series—Glossudalfs that formed in till on moraines and till plains

Maumee series—Endoaquolls that formed in sandy outwash on outwash plains and lake plains

Oshtemo series—Hapludalfs that formed in loess-influenced outwash over sandy and gravelly outwash on outwash plains and moraines

Plainfield series—Udipsamments that formed in glacial drift on outwash plains and moraines

Sebewa series—Argiaquolls that formed in loamy outwash and underlying gravelly and sandy outwash on outwash plains, valley trains, and stream terraces

Spinks series—Hapludalfs that formed in glacial drift on moraines, till plains, and outwash plains

Biological Resources

Well drained to somewhat poorly drained sites on till plains in the north part of the MLRA support extensive forests of American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), red oak (*Quercus rubra*), shagbark hickory (*Carya ovata*), bitternut hickory (*Carya cordiformis*), and basswood (*Tilia americana*). Flood plains support silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), and hackberry (*Celtis occidentalis*). Coarse moraines along the northern fringe support forests of white pine (*Pinus strobus*) and white oak (*Quercus alba*), with swamps of northern white cedar (*Thuja occidentalis*) in depressions. Loamy outwash plains in the south support extensive oak-hickory forests, oak savanna, and tallgrass prairie due the higher fire frequency, while areas south into the Kankakee River drainage substrates of eolian sand support black oak (*Quercus velutina*) barrens in a matrix of wet prairie.

Major wildlife species include white-tailed deer, coyote, red fox, opossum, muskrat, mink, cottontail, groundhog, squirrels, red-tailed hawk, wild turkey, introduced pheasant, ruffed grouse, woodcock, kingfisher, bobwhite quail, herons, sandhill crane, Canada goose, ducks, songbirds, snakes, frogs, and turtles. Fish species include sunfish, perch, bass, trout, northern pike, walleye, catfish, sucker, carp, and various introduced species of salmon and trout.

Land Use

More than three-fourths of this MLRA is in farms (fig. 98-2). The rest is used mainly for urban development. Much of the farmland is in small woodlots. A small acreage is in State forests and parks. Nearly one-half of the area is cropland. Corn, other feed grains, and hay for dairy cattle and other livestock are the major crops. Soft winter wheat and dry beans are important cash crops, and fruits and vegetables are grown

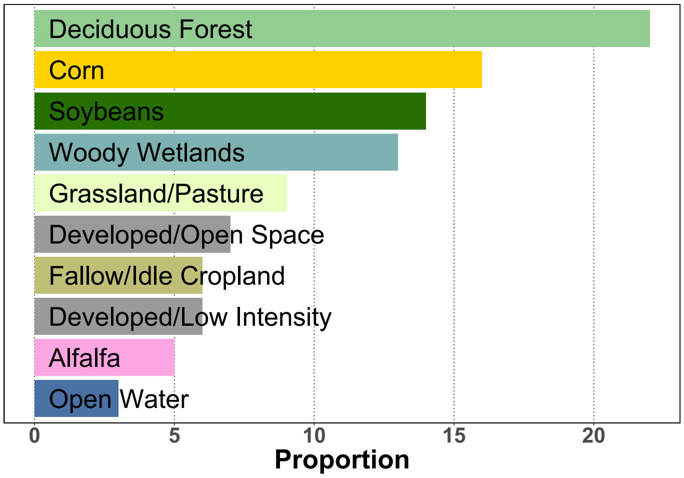

Figure 98-2: Relative proportions (percentages) of land use in MLRA 98.

in many places where the soils and markets are favorable. Less than one-tenth of the area is permanent pasture.

The major resource concerns are controlling the pollution resulting from the movement of sediment and pesticides by water and wind, reducing excess soil wetness on cropland, conserving soil moisture in droughty soils, improving soil fertility and tilth, and preserving water quality, wetlands, and prime farmland. Conservation practices on cropland generally include grassed waterways, conservation and field borders, pest and nutrient management, windbreaks, stripcropping, crop residue management, cover crops, conservation tillage, diversions, grade-stabilization structures, and waste management.

99—Erie-Huron Lake Plain

MLRA 99 (fig. 99-1) consists of glaciolacustrine plains adjacent to the Great Lakes. It is covered by beech-maple forests and lake plain oak savannas and is commonly used for the production of corn, soybeans, and sugar beets. This area is in Michigan (64 percent), Ohio (35 percent), and Indiana (1 percent). It makes up about 13,161 square miles (34,087 square kilometers). It is bordered by Lakes Huron and Erie and connecting waterways to the east, by higher glacial till and outwash to the south and west (MLRAs 98 and 111B), by a cooler frigid soil temperature regime and a change in forest vegetation to the north (MLRAs 94A and 94C), and by glaciated plateaus along Lake Erie (MLRA 139).

Physiography

This area is in the Eastern Lake section of the Central Lowland province of the Interior Plains. It is a nearly level glacial lake plain with a few scattered ridges of sandy soils that represent past shorelines and moraines. Elevation ranges from 570 to 815 feet (175 to 250 meters), increasing gradually from the lakeshore inland. Isolated areas are as high as 900 feet (275 meters). Local relief averages 10 feet (3 meters) and ranges to 110 feet (34 meters).

The part of this MLRA in Ohio was probably a swamp prior to the introduction of drainage by early settlers. Remnant marshes are near the Lake Erie shore. The Maumee and Sandusky Rivers are in the part of this area in Ohio. The Saginaw, Clinton, and Huron Rivers empty into the Great Lakes in the part of the area in Michigan.

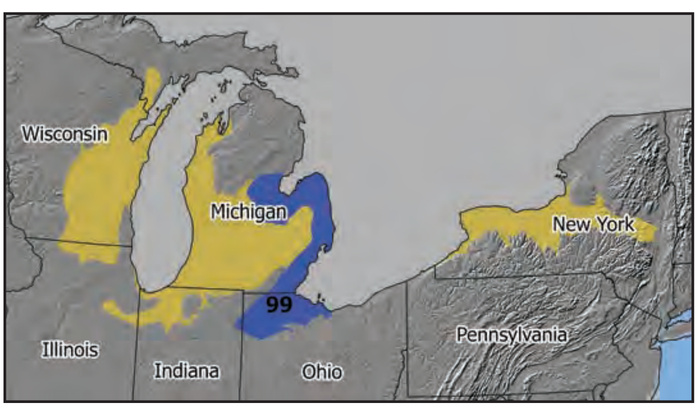

Figure 99-1: Location of MLRA 99, which covers 3,408,700 hectares (8,423,000 acres), within Region L.

Geology

The southern half of this MLRA is covered with glacial deposits of till, lake sediments, and outwash from the Wisconsin and older glacial periods. The area also has some low moraines. Mississippian- to Silurian-age shale, limestone, and dolomite rocks are at the surface in the northern half of this MLRA, along the shores of Lake Erie and Lake Huron in Michigan. These rocks underlie the glacial deposits in the southern half.

Climate

The average annual temperature is 45 to 51 degrees F (7 to 11 degrees C). The northern fringe and the “thumb area” have the coolest temperatures, while the urban heat island around Detroit adds to the warmth of the southern half of the MLRA. Average 0 degrees C (32 degrees F) frost-free season ranges from 125 to 196 days. Average -2 degrees C (28 degrees F) freeze-free season is 155 to 216 days. Mean annual extreme minimum temperatures range from -24.5 to -18.8 degrees C (-12 to -2 degrees F); USDA hardiness zones range from 5b to 6b. The average annual precipitation is 29 to 38 inches (725 to 964 millimeters). It is wettest from north to south. Mean annual snowfall ranges from 0.7 meter to 1.5 meters (25 to 55 inches), with most of the area except the “thumb area” unaffected by lake-effect precipitation.

Water

In most years the moderate precipitation provides enough water for crops. Many of the soils require artificial drainage before they can be used for crops, and even the better drained soils require some drainage to ensure that tillage is not delayed in spring and fall. The Great Lakes supply water for large cities, are major transportation arteries, and are used for recreation. Surface water is abundant in this MLRA and of good quality. It is suitable for almost all uses with little treatment, except in reaches downstream from municipal or industrial waste discharge points.

The abundant ground water in this MLRA is not used extensively because of the availability of good-quality surface water. It meets most domestic and some municipal drinking water needs in the area. The water type is typically calcium-bicarbonate. Where the level of total dissolved solids is higher, the water type changes to sodium-sulfate. All of the ground water is hard or very hard. Sources include unconsolidated sand

and gravel deposits in the glacial till and glacial outwash in the southeastern part of the area. Some water also can be obtained from sands in the lake deposits. Around Saginaw (Michigan) and northwest Ohio, ground water is available in bedrock units, from the Saginaw Formation and from older carbonate rocks, respectively.

Soils

The dominant soil orders are Alfisols, Inceptisols, and Mollisols. The soils in the area have a mesic temperature regime, a dominantly aquic moisture regime, and mixed or illitic mineralogy. They are very deep, generally somewhat poorly drained to very poorly drained, and loamy or clayey. The Alfisols and Mollisols formed in reworked till on low-relief till plain landscapes that were modified by glacial lakes. The Inceptisols formed in glaciolacustrine deposits on the same landscapes. Sandy nearshore and beach ridge deposits on the glacial lake plain historically were mapped as Spodosols.

The main soil series:

- Blount series—Epiaqualfs that formed in dense till on wave-worked till plains and in relict nearshore zones
- Conover series—Hapludalfs that formed in dense till on moraines and till plains
- Hoytville series—Epiaqualfs that formed in dense till on wave-worked till plains and water-laid moraines
- Latty series—Endoaquepts that formed in glaciolacustrine sediments on lake plains
- Lenawee series—Epiaquepts that formed in lacustrine deposits on lake plains and in depressions on moraines
- Londo series—Glossaqualfs that formed in till on wave-worked till plains and water-laid moraines
- Nappanee series—Epiaqualfs that formed in dense till on wave-worked till plains and till-floored lake plains
- Parkhill series—Epiaquepts that formed in dense till on wave-worked till plains and water-laid moraines
- Paulding series—Epiaquepts that formed in dense lacustrine material on lake plains and till-floored lake plains
- Pipestone series—Endoaquods that formed in sandy drift on lake plains, beach ridges, and wave-worked till plains
- Selfridge series—Hapludalfs that formed in sandy drift over loamy till on moraines and wave-worked till plains
- Shebeon series—Epiaqualfs that formed in dense till on wave-worked till plains and water-laid moraines
- Tappan series—Epiaquolls that formed in dense till on wave-worked till plains and water-laid moraines
- Toledo series—Endoaquepts that formed in glaciolacustrine sediments on lake plains

Biological Resources

Broad, flat, somewhat poorly drained lake plains contain American beech (*Fagus grandifolia*) and sugar maple (*Acer saccharum*) flatwoods with extensive swamps of silver maple (*Acer saccharinum*), green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), pin oak (*Quercus palustris*), and swamp white oak (*Quercus bicolor*). Sandy ridges and thin sand flats contain lake plain prairies and savannas with an overstory of bur oak (*Quercus macrocarpa*). In the northern half of the MLRA, sandy areas are dominated more by conifers, such as eastern white pine (*Pinus strobus*) and eastern hemlock (*Tsuga canadensis*).

Major wildlife species include raccoon, white-tailed deer, rabbit, squirrels, introduced pheasant, bobwhite quail, songbirds, snakes, frogs, and turtles. Fish species include sunfish, perch, bass, northern pike, walleye, catfish, sucker, and carp.

Land Use

Nearly three-fourths of this MLRA is in farms (fig. 99-2). About three-fifths of the farmland is cropland. The rest of the farmland is mostly in small farm woodlots, but some is used for permanent pasture or other purposes. Cash crops are important. Corn, winter wheat, soybeans, and hay are the major crops. Sugar beets and canning crops also are important. Some fruit and truck crops are grown on the coarse textured soils. Dairying is an important enterprise on some farms near the larger cities. Almost one-fifth of the area is used for urban development.

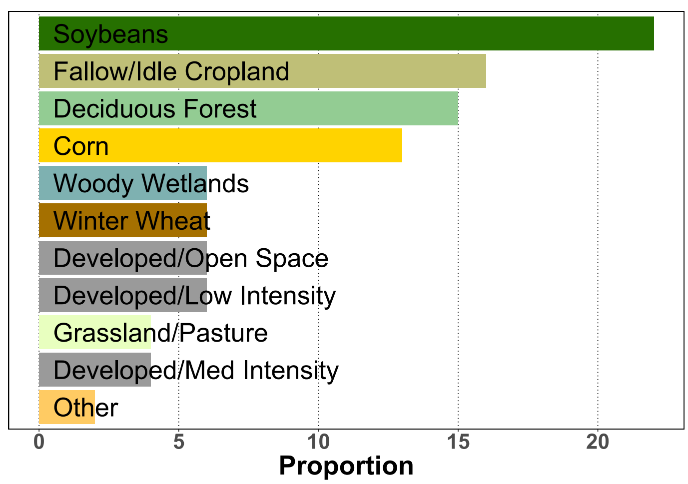

Figure 99-2: Relative proportions (percentages) of land use in MLRA 99.

The major resource concerns are seasonal wetness; maintenance of the content of organic matter and productivity of the soils; water erosion and wind erosion; excessive sediment, nutrients, and pesticides in surface water; nutrients and pesticides in ground water; and the loss of habitat for fish and wildlife. The conservation practices important in addressing these resource concerns generally include surface and subsurface drainage systems, conservation crop rotations, crop residue management, filter strips, riparian forest buffers, nutrient management, pest management, protection of streambanks and shorelines, agrichemical containment facilities, and management of upland and wetland wildlife habitat.

101—Ontario-Erie Plain and Finger Lakes Region

MLRA 101 (fig. 101-1) is entirely within New York and makes up about 10,089 square miles (26,131 square kilometers). It consists of a broad lowland that includes the Ontario lowland, the Lake Erie lake plain, low-lying to rolling areas associated with several of the larger Finger Lakes, and the Mohawk Valley. It is underlain by relatively thick Wisconsin tills, outwash, and lacustrine deposits. This MLRA is used extensively for agriculture and forestry but also has several large cities, which serve as major urban and industrial centers.

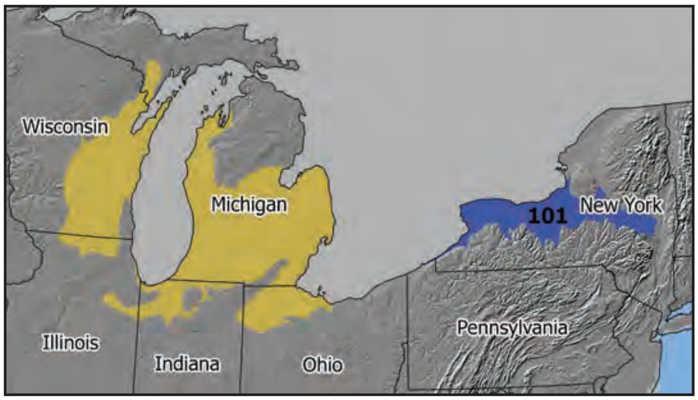

Figure 101-1: Location of MLRA 101, which covers 2,613,100 hectares (6,457,100 acres), within Region L.

The northeastern boundary of MLRA 101 is distinct where it contacts the physiographically dissimilar Tug Hill Plateau (MLRA 141) and Adirondack Mountain region (in MLRA 143), which are dominated by frigid soil temperatures and Spodosols. The southern boundary is gradual as the glacial tills with higher carbonate content grade to the more acid tills of the Glaciated Alleghany Plateau (in MLRA 140). The eastern boundary, with MLRA 144A in the mid-Hudson Valley, is relatively diffuse. The northwestern boundary consists of Lakes Erie and Ontario and the Niagara River.

Physiography

Most of this MLRA is in the Eastern Lake section of the Central Lowland province of the Interior Plains. The southeast quarter of the area is in the Southern New York section of the Appalachian Plateaus province of the Appalachian Highlands, and the northeast corner is in the Mohawk section of the same province and division. Most of the MLRA is a nearly level to rolling plain. Low remnant beach ridges are commonly interspersed with a relatively level lake plain in the northern part. Drumlins (long, narrow, steep-sided, cigar-shaped hills) are prominent in an east-west belt in the center of the area. The Finger Lakes region consists of a gently sloping to rolling till plain.

Elevation is roughly 330 to 1,310 feet (100 to 400 meters), increasing gradually from the shores of Lake Ontario and Lake Oneida to the Allegheny Plateau, the southern border of the area. Local relief is mostly 10 feet (3 meters), but the larger drumlins and many valley sides rise 80 to 330 feet (25 to 100 meters) above the adjacent lowlands or valley floors.

Geology

The bedrock underlying this area consists of alternating beds of limestone, dolomite, and calcareous sandstone and shale of Ordovician, Silurian, and Devonian age. Most of the surface is covered with calcareous till, lake-laid silts and clays, and sandy or gravelly outwash. The texture of the lake sediments is silt loam, silty clay, or fine or very fine sand. Ancient beaches, developed at different lake levels, form ridges along the shoreline of Lakes Erie and Ontario. Stratified drift (eskers and kames) and calcareous glacial outwash deposits are in many valleys. Drumlin fields are scattered throughout most of the Ontario lowland, with a particularly large field stretching from just east of Rochester to Oswego (New York) along Lake Ontario, and then south to the Finger Lakes.

Climate

The average annual precipitation is 31 to 57 inches (799 to 1,457 millimeters). The precipitation is evenly distributed throughout the year. Most of the rainfall occurs during high-intensity, convective thunderstorms in summer. Heavy snowfall is common in winter. The average annual temperature is 42 to 50 degrees F (6 to 10 degrees C). The freeze-free period averages 155 days and ranges from 100 to 190 days.

Water

In most years the precipitation is adequate for crops, except for those on coarse textured soils. Irrigation water for high-value fruit and vegetable crops is obtained from wells or the Great Lakes. The wetter soils require drainage before they can be used for crops, and even the better drained soils benefit from drainage. Many of the larger cities obtain water from the Great Lakes. Some surface water is suitable for almost all uses with little or no treatment.

Ground water is used on a mainly local basis because of the abundance of surface water. The ground water also is abundant and meets the domestic, industrial, and municipal needs for parts of the MLRA. All of the aquifers are fairly shallow and subject to contamination from agriculture and urban and industrial wastes. A sandstone aquifer is used in the northeastern part of the area. It has very hard water and the highest levels of chloride of all the aquifers in this area, which are still well below the drinking water standard.

A carbonate aquifer occurs all along the southern half of this MLRA. It has naturally occurring saline zones, which have evaporate deposits. This aquifer produces the hardest water in New York and requires treatment prior to use.

Lake sediments and valley fill deposits of glacial outwash and stratified drift in this area have good-quality ground water. This water has low levels of total dissolved solids but is very hard and requires softening prior to use.

Soils

The dominant soil orders are Alfisols and Inceptisols. The dominant suborders are Udalfs and Udepts. The soils in the area have a mesic temperature regime, a udic and aquic moisture regime, and mixed mineralogy. They are shallow to very deep, excessively drained to very poorly drained, and sandy to clayey.

The main soil series:

Appleton series—Endoaqualfs that formed in brown loamy calcareous dense till on till plains

Aurora series—Hapludalfs that formed in brown, moderately deep, loamy calcareous till over limestone or shale on till plains

Canadaigua series—Endoaquepts that formed in brown calcareous silts and clays on lacustrine plains

Cazenovia series—Hapludalfs that formed in red loamy calcareous till and reworked lacustrine deposits on till plains

Galen series—Hapludalfs that formed in brown loamy and sandy outwash on deltas and lacustrine plains

Hamlin series—Eutrudepts that formed in silty neutral alluvium

Hilton series—Hapludalfs that formed in red loamy calcareous dense till on till plains

Honeoye series—Hapludalfs that formed in brown loamy calcareous dense till on till plains

Lairdsville series—Hapludalfs that formed in red, moderately deep, clayey calcareous till over shale on till plains

Lamson series—Endoaquepts that formed in brown loamy and sandy outwash on deltas and lacustrine plains

Niagara series—Endoaqualfs that formed in brown calcareous silts and clays on lacustrine plains

Palmyra series—Hapludalfs that formed in brown loamy calcareous outwash on outwash plains

Schoharie series—Hapludalfs that formed in red calcareous fine-family clays on lacustrine plains

Teel series—Eutrudepts that formed in silty neutral alluvium

Wampsville series—Hapludalfs that formed in red loamy calcareous outwash on outwash plains

Biological Resources

This area supports forest vegetation, particularly hardwoods. The potential forest types are elm-ash-red maple and beech-birch-sugar maple in varying proportions. Other species associated with these types include basswood (*Tilia americana*), eastern hemlock (*Tsuga canadensis*), eastern white pine (*Pinus strobus*), black cherry (*Prunus serotina*), and some species of upland oak (*Quercus*). Northern white cedar (*Thuja occidentalis*), red maple (*Acer rubrum*), black ash (*Fraxinus nigra*), and aspen (*Populus grandidentata* and *Populus tremuloides*) grow on the wet soils. Cattails (*Typha* spp.) and mosses (*Bryophyta*) grow on the organic soils and on other extremely wet sites. Major wildlife species in this area include white-tailed deer, cottontail, gray squirrel, pheasant, woodcock, and ruffed grouse.

Land Use

Most of this MLRA is in farms (fig. 101-2). About one-third of the acreage is cropland, which is used mainly for hay, corn, and small grains associated with dairy operations. Cash crops, including canning and truck crops, wheat, and dry beans, also are grown. Orchard crops are important locally, particularly near Lake Ontario. Vineyards are common near some of the Finger Lakes. About one-third of the area is forestland, mostly in farm woodlots. About 15 percent of the area is used for urban development, which is expanding around the larger cities, such as Buffalo, Rochester, and Syracuse. The Great Lakes provide transportation and are used extensively for recreation. The Finger Lakes also are used for recreation.

The major soil resource concerns are sheet and rill erosion, the sedimentation caused by stormwater runoff, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include crop residue management; conservation tillage; winter cover crops; nutrient management, including manure management; and pesticide management. Excluding livestock from wetlands and watercourses and developing rotational grazing systems help to control erosion and protect water quality. Conservation practices important to community development include critical area treatment and urban stormwater management.

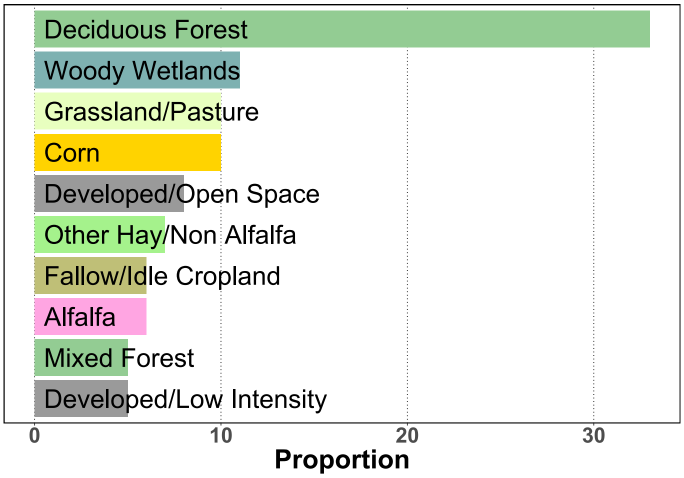

Figure 101-2: Relative proportions (percentages) of land use in MLRA 101.

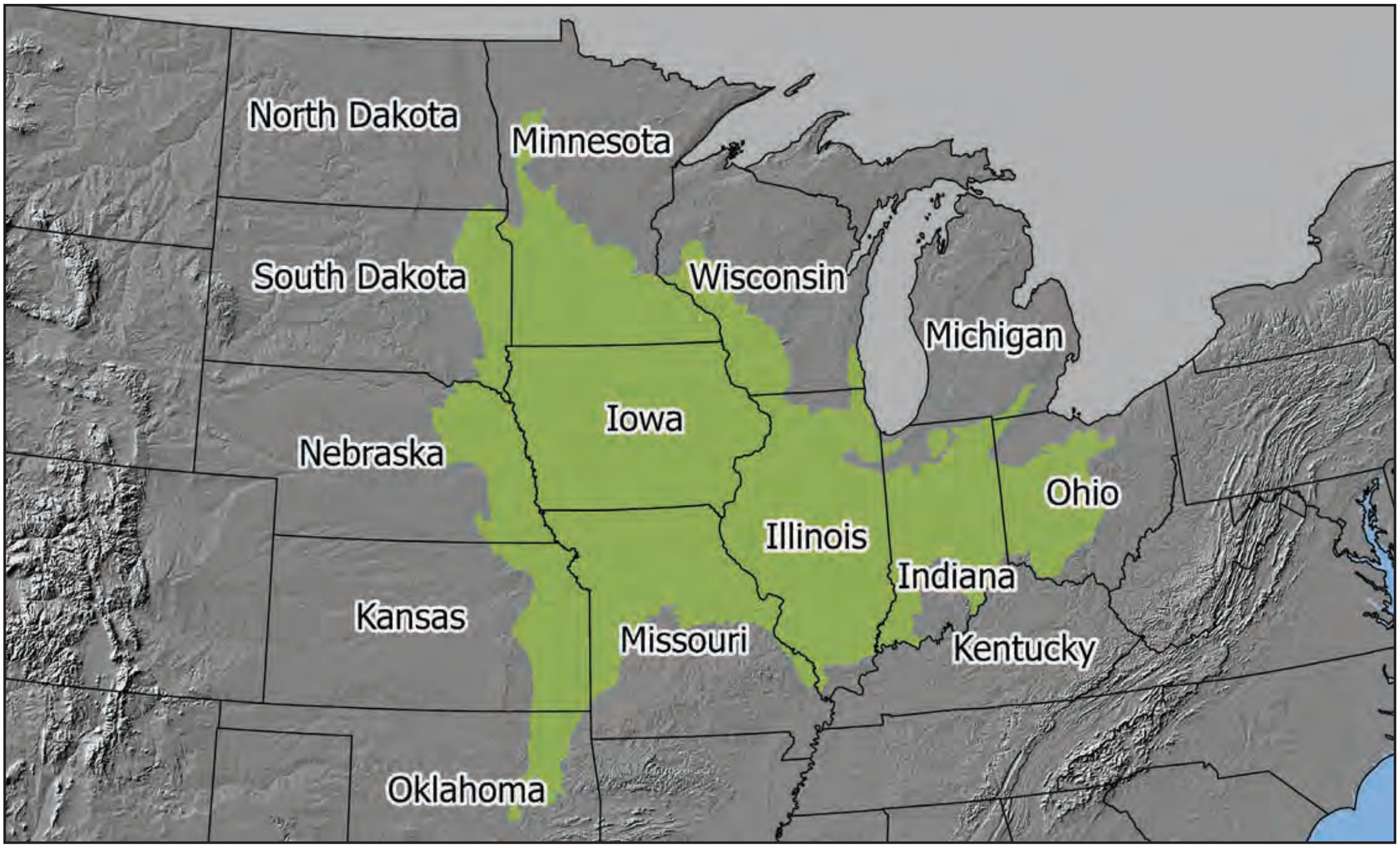

Figure M-1: Location and size of Land Resource Region M, which covers 731,180 square kilometers (282,310 square miles) from Ohio to the Great Plains and from Minnesota to Oklahoma.

M—Central Feed Grains and Livestock Region

Land Resource Region M (fig. M-1) is the highly productive cropland region of the Midwest. This region was covered multiple times by Pleistocene glaciers that deposited drift over Paleozoic limestone, sandstone, and shale bedrock. The thickest glacial drift buries pre-existing valleys while the thinnest buries hills. The oldest drift is the most dissected. It occurs as Pre-Illinoian-age till in eastern Nebraska and Kansas, southern Iowa, and northern Missouri. The youngest drift is the least dissected till of Wisconsin age that retains recognizable glacial landforms of lake plains, outwash plains, drumlin fields, ground moraines, end moraines, recessional moraines, lake terraces, remnant beaches, and till plains. Loess blankets most of the drift in the western half of Region M, becoming thinner and finer away from the source areas of the Missouri and Mississippi River flood plains and the Nebraska Sand Hills. Superimposed on this physical landscape are native tallgrass prairies and their associated Mollisols in the western portion of the region. The prairies grade to deciduous forests and their associated Alfisols eastward and southward. Numerous perennial streams provide ample supplies of surface and ground water. This region contains 17 major land resource areas. The extent of these MLRAs and their range in elevations are shown in table M-1.

Region M's boundaries to the west with Regions F, G, and H (fig. 1, page 5) mark the approximate boundary between the udic and the udic ustic soil moisture regimes as well as the gradual transition to the drier Great Plains at higher elevations. Region M's southern boundary with Region N, except where MLRA 112 extends into Oklahoma, is the southernmost extent of Pleistocene glaciation. Its northern boundary marks a decrease in cropland and increase in forest as the area transitions to the more freshly glaciated topography and frigid temperature regime of Region L and the crystalline bedrock of Region K.

The soils in Region L are primarily Mollisols and Alfisols (fig. 2, page 6). The region's western boundary marks the change from Udolls to Ustolls (westward). Farther east, in Indiana and Ohio, areas of Udolls become progressively wetter and transition to Aquolls. The Alfisols formed under forest vegetation and, like the Mollisols, are productive cropland soils. Most of the Alfisols are Udalfs, with the notable exceptions of the Aqualfs of southern Illinois and other wet soils of Indiana and Ohio. Inceptisols occur on severely eroded landforms and

Table M-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
102A	25,095	9,690	260	860	310	1,030	360	1,190	410	1,360	540	1,790
102B	5,670	2,190	340	1,120	370	1,240	440	1,450	530	1,730	570	1,870
102C	28,945	11,175	320	1,040	380	1,250	470	1,540	560	1,840	660	2,190
102D	20,375	7,865	350	1,150	480	1,580	530	1,760	570	1,890	650	2,130
103	71,800	27,720	200	680	300	980	340	1,120	410	1,350	540	1,790
104	30,175	11,650	160	540	260	850	310	1,030	380	1,260	430	1,430
105	51,845	20,020	160	540	220	740	300	990	360	1,190	520	1,710
106	28,705	11,080	210	710	290	960	360	1,180	430	1,410	530	1,740
107	53,525	20,665	170	570	230	780	350	1,150	430	1,420	560	1,840
108	85,390	32,970	80	270	190	620	225	740	340	1,090	470	1,520
109	41,975	16,205	150	490	210	700	270	880	320	1,050	380	1,270
110	20,125	7,770	110	380	190	620	210	690	230	770	300	980
111	88,820	34,295	80	280	220	710	265	875	330	1,070	480	1,550
112	54,090	20,885	30	120	210	670	270	880	340	1,090	470	1,540
113	32,780	12,655	70	240	130	420	165	545	260	840	310	1,020
114	26,905	10,390	90	310	140	460	190	620	290	960	410	1,340
115	64,965	25,085	20	90	130	420	175	580	230	740	320	1,030

Table M-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
102A	4	39	5	41	6.1	43	6.6	44	7.1	45	135	146	151/150	156	160
102B	6.6	44	7.1	45	7.9	46	8.7	48	9.5	49	145	150	155/155	159	160
102C	6.6	44	7.6	46	9.2	49	9.8	50	10.6	51	145	152	159/160	164	175
102D	5.4	42	6	43	6.4	44	7	45	7.2	45	135	145	149/150	154	160
103	6.3	43	6.9	44	7.4	45	9	48	10.3	50	150	155	159/160	164	180
104	6.8	44	7.1	45	8.1	47	8.9	48	10	50	145	155	160/160	166	185
105	5.8	42	6.9	44	7.7	46	8.6	47	9.8	50	130	147	157/155	166	185
106	9.8	50	10.6	51	11.4	52	12.6	55	13.3	56	165	171	177/180	198	210
107	6.7	44	8.1	47	9.9	50	12.4	54	13.4	56	145	157	168/175	195	210
108	8.3	47	9.2	49	10.5	51	11.9	53	14.2	58	155	168	182/180	189	210
109	9.9	50	10.2	50	11	52	11.8	53	12.4	54	165	172	186/185	190	205
110	8	46	8.8	48	10.1	50	10.7	51	11.2	52	155	171	178/180	184	210
111	8.9	48	9.8	50	10.5	51	11.4	53	12.9	55	155	172	177/180	188	205
112	11.9	53	12.8	55	13.6	57	15.7	60	16.4	62	190	199	204/205	222	245
113	10.7	51	11.8	53	12.5	55	13.3	56	13.7	57	180	190	197/195	202	205
114	11.8	53	12.4	54	13	55	13.4	56	13.6	56	185	189	198/200	206	215
115	8.6	48	10.8	51	12.3	54	13.5	56	14.3	58	150	181	194/195	206	220

on older river terraces. Entisols are mainly on river flood plains. Carbonates are common in soils of this region, especially where glacial till is underlain by limestone, as in Indiana and Ohio (fig. 5, page 9). Restrictive zones occur in many soil profiles in Region M mainly as densic material, an abrupt textural change, lithic bedrock, paralithic bedrock (fig. 9, page 13) and, in a few areas, fragipans, natric horizons, and sulfuric horizons (fig. 11, page 15). Argillic horizons are common in the region except in soils on the youngest glacial and fluvial landforms (fig. 12, page 16). Region M has some of the highest amounts of

Table M-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
102A	580	23	609	24	645/650	25/26	703	28	780	30
102B	630	25	653	26	669/670	26/26	685	27	710	28
102C	620	24	680	27	712/715	28/28	761	30	790	31
102D	550	22	590	23	637/640	25/25	691	27	740	29
103	610	24	724	28	803/800	32/31	888	35	930	37
104	780	31	856	34	899/895	35/35	935	37	990	39
105	800	32	837	33	880/880	35/35	922	36	980	39
106	730	29	770	30	837/855	33/34	971	38	1,040	41
107	700	28	736	29	842/870	33/34	1,052	41	1,120	44
108	850	34	903	36	941/975	37/38	1,116	44	1,200	47
109	900	36	939	37	980/985	39/39	1,040	41	1,100	43
110	830	33	895	35	955/950	38/37	992	39	1,030	40
111	870	34	951	37	1,006/1,010	40/40	1,078	42	1,160	46
112	900	36	992	39	1,092/1,080	43/43	1,149	45	1,190	47
113	970	39	1,028	40	1,082/1,080	43/43	1,142	45	1,230	48
114	990	39	1,013	40	1,048/1,060	41/42	1,114	44	1,190	47
115	880	35	950	37	1,046/1,050	41/41	1,163	46	1,250	49

organic carbon accumulation in the conterminous United States (fig. 14, page 18).

Climatically, the region has abundant precipitation, averaging 25 to 43 inches (637 to 1,092 millimeters) annually. The soil moisture regimes are udic and aquic across the entire region. Average annual temperature is 43 to 57 degrees F (6.1 to 13.6 degrees C), increasing southward, and the average freeze-free period is 150 to 205 days. The soil temperature regime is mesic, except for small areas in the north that extend into the frigid regime and small areas in the south that extend into the thermic regime. Snowfall is common in winter in the northern parts of the region. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables M-2 and M-3.

Land use is primarily industrial agriculture. Because of the favorable climate and arable soils, Region M produces most of the corn and soybeans in the United States (fig. 8, page 12). Pasture, forests, and developed land are comparatively minor land uses (fig. M-2). The major soil resource concerns are water erosion, wind erosion, wetness, maintenance of soil organic matter, and soil productivity. Wind erosion is a hazard in some northern areas with lighter textured soils. Protecting wildlife habitat and preserving the quality of surface and ground water are additional concerns in many areas. The lower reaches of the large rivers have poor-quality water primarily because of sediment, nutrient, and pesticide pollution from agricultural runoff.

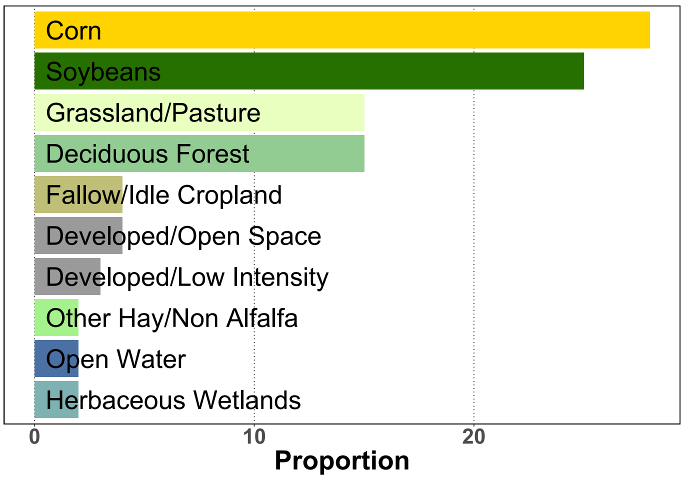

Figure M-2: Relative proportions (percentages) of land use in LRR M.

102A—Rolling Till Prairie

MLRA 102A (fig. 102A-1) is in Minnesota (87 percent), South Dakota (12 percent), and North Dakota (1 percent). It makes up about 9,689 square miles (25,093 square kilometers). This area is comprised of tallgrass prairies and glaciated landscapes of loamy calcareous till and glaciolacustrine and glacifluvial deposits. It has many ponds, lakes, and marshes; rolling topography; and ill-defined drainages. The most prominent landscapes include the Big Stone, Alexandria, and

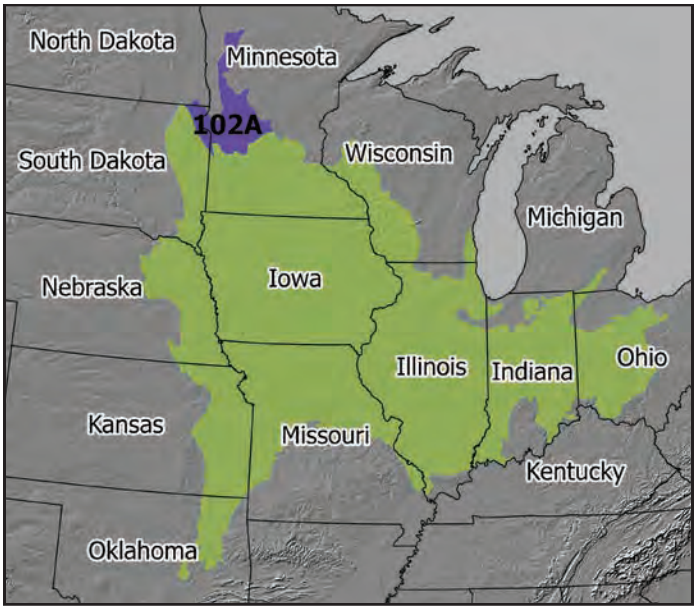

Figure 102A-1: Location of MLRA 102A, which covers 2,509,300 hectares (6,200,600 acres), within Region M.

Altamont Moraines, which are a series of prominent stagnation features near ice margins formed during the retreat of the Wadena and Des Moines Lobes of the Wisconsin continental ice sheet. A shallow pro-glacial lake (glacial Lake Benson) formed beyond the margin of the Big Stone Moraine in the southern reaches of MLRA 102A and is bisected by Minnesota River Valley alluvium.

This MLRA is bordered to the southwest by the Prairie Coteau (MLRA 102D), which is one of the more prominent landforms in North America. MLRA 102D has deranged drainage and significant amounts of range and pastureland, and its resource concerns are associated with moisture deficit. MLRA 102A is bordered to the north and east by Northern Minnesota Gray Drift (MLRA 57), which represents landscapes of similar age. MLRA 57 has soils that formed under deciduous and mixed forest. Glacial Lake Agassiz and associated lacustrine sediments are dominant in a prairie ecosystem in the Red River Valley (in MLRA 56A) to the northwest of MLRA 102A, in aspen parkland (MLRA 56B) to the north, and in a forested ecosystem (MLRA 88) to the northeast. The Coteau des Prairies splits the last continental ice sheet into the Des Moines Lobe (to the east) and James Lobe (to the west). The southern boundary of MLRA 102A is the break to a mesic soil temperature regime (MLRA 103).

Physiography

Most of this area is in the Western Lake section of the Central Lowland province of the Interior Plains. This MLRA has nearly level to rolling topography with many temporary and seasonal wetlands associated with depressions and shallow relict glacial lakes. Elevation generally ranges from 860 to 1,790 feet (260 to 540 meters).

Geology

Prominent landscapes in this area are evidence of Wisconsin glaciation and include moraines, till plains, outwash plains, lake plains, and river valleys. The MLRA is dominated by till-covered moraines, including undulating disintegration moraines with many depressions. The steepest slopes are on escarpments adjacent to some of the larger tributaries and along moraines. Small outwash plains are adjacent to the watercourses. Shallow lacustrine deposits are most common in the southeast part of the area along the Traverse Gap and Lake Agassiz basins. Much of this MLRA has 30 to 200 meters of glacial sediments over Archean and Cretaceous metasedimentary bedrock.

Climate

The average annual precipitation is 23 to 30 inches (580 to 780 millimeters). At least half of the precipitation falls during the growing season. Rainfall typically occurs during high-intensity, convective thunderstorms in summer. Precipitation in winter occurs as snow. The average annual temperature is 39 to 45 degrees F (4 to 7 degrees C). The freeze-free period averages about 150 days and ranges from 135 to 160 days.

Water

Precipitation is the principal source of moisture for crops. Small ponds and shallow wells are the principal sources of water for livestock. Many temporary and seasonally ponded wetlands occur in shallow depressions. Both surface water and ground water are used for some irrigation. Many natural glacial lakes are in the northern part of the area, and many of the larger ones are used for recreation. The water in the lakes and larger streams is generally suitable for all uses. The quality of the water in the smaller streams is generally poor.

Shallow wells in glacial outwash deposits, primarily sand and gravel, provide water for livestock, domestic use, and irrigation. Ground water also is available in deep wells in the Precambrian bedrock or the Dakota sandstone. These aquifers are seldom used in this area because of the abundance of shallow glacial deposits and surface water.

Soils

The dominant soil order is Mollisols. The MLRA has a dominantly frigid soil temperature regime; a mesic soil temperature regime is at its southern border. The soils have an aquic or udic moisture regime and mixed mineralogy. They generally are very deep and well drained to very poorly drained. The parent materials are dominantly coarse-loamy till to clayey till, with smaller amounts of outwash, glaciolacustrine deposits, glaciofluvial deposits, eolian deposits, alluvium, and, to a lesser extent, loess and organic materials.

The main soils and their series:

- Argiaquolls that formed in colluvial and alluvial sediments in swales and depressions on till plains (Parnell series)
- Calciaquolls that formed in fine-loamy over sandy alluvium or outwash sediments (Marysland series)
- Calciudolls that formed in fine-loamy till on undulating ground moraines on till plains (Buse and Balaton series)
- Endoaquolls that formed in silty water-sorted sediments in swales and depressions on till plains (Quam series); that formed in silty alluvium on flood plains (Lamoure series)
- Hapludolls that formed in fine-loamy till on uplands on till plains (Barnes, Formdale, and Hokan series); that formed in moderately coarse textured glacial outwash on till plains (Arvilla and Fordville series)

Biological Resources

This area supports true prairie vegetation characterized by big bluestem, little bluestem, porcupinegrass, and green needlegrass. Needle and thread and prairie dropseed are important species on the steeper soils. Prairie cordgrass commonly grows in wet areas.

Major wildlife species include white-tailed deer, beaver, muskrat, mink, pheasant, gray partridge, giant Canada goose, mallard, blue-winged teal, wood duck, northern shoveler, pintail, ruddy duck, widgeon, redhead, canvasback, chestnut-collared longspur, marbled godwit, and upland plover. Fish species include walleye, northern pike, yellow perch, black crappie, white crappie, white bass, catfish, black bullhead, bluegill, carp, white sucker, buffalo, redhorse, and bait minnow.

Land Use

Most of this MLRA is in farms, and about two-thirds of this is used for crops grown for sale or livestock feed (fig. 102A-2). The principal crops are corn, soybeans, alfalfa, spring wheat, and oats. Wooded areas generally occur as narrow bands along streams and rivers or as shelterbelts around farmsteads. Recreational hunting and fishing are important land uses around the many natural lakes in the northern part of the MLRA.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, soil wetness, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management, especially no-till or other conservation tillage systems that conserve moisture and contribute to soil quality. Other practices include terraces, vegetative wind barriers, grassed waterways, and nutrient management.

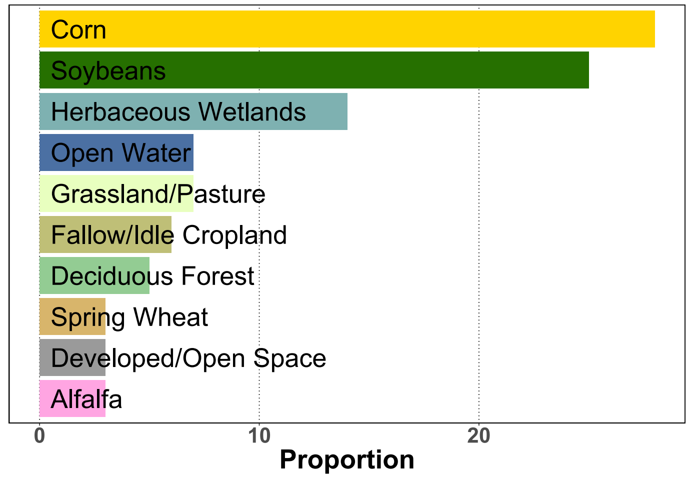

Figure 102A-2: Relative proportions (percentages) of land use in MLRA 102A.

102B—Till Plains

MLRA 102B (fig. 102B-1) is characterized by glaciated, nearly level to hilly till plains. It is entirely in South Dakota and covers about 2,189 square miles (5,670 square kilometers). It is in the southwestern quarter of the Coteau de Prairies, a high plateau of thick glacial deposits that formed during repeated glaciations. Most of the MLRA consists of till that formed from local rocks ground up by the ice and is very rich in clay and silt. Soils of the area dominantly formed in till or shallow loess over till parent materials.

The eastern boundary of MLRA 102B is the deeper loess of the southeastern quarter of the Coteau de Prairies (in MLRA

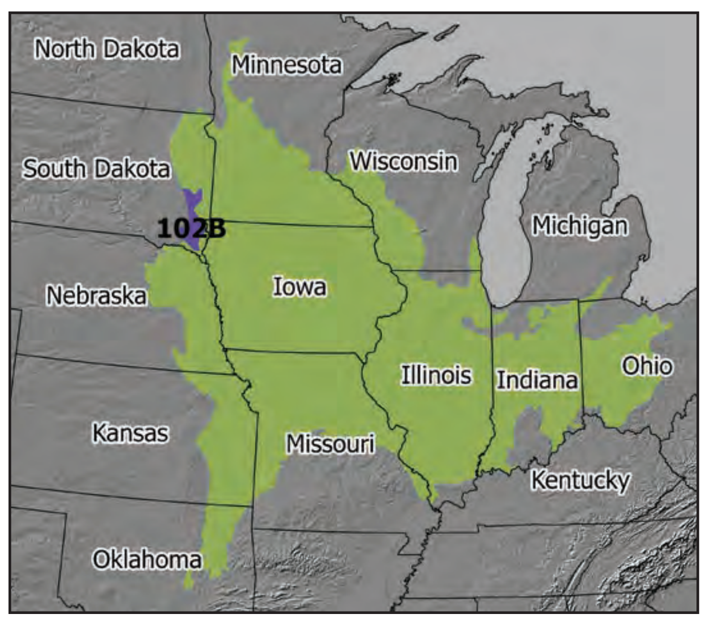

Figure 102B-1: Location of MLRA 102B, which covers 567,000 hectares (1,401,100 acres), within Region M.

102C). The southern boundary is alluvium of the Missouri River Valley (in MLRA 102C). The northern and western boundaries, with MLRAs 102A and 55C, are where older glacial drift of the plateau meets the younger glacial material from the Des Moines and James Lobes of the last Wisconsin-age glaciation.

Physiography

This area is in the Western Lake section of the Central Lowland province of the Interior Plains. The most recent glacial activity was between 12,000 and 14,000 years ago during the Pleistocene Epoch. The height of the plateau split this glacial advance into the Des Moines Lobe to the east and the James Lobe to the west, further increasing the elevation difference between the plateau and surrounding areas.

Elevation ranges from 1,115 feet (340 meters) on the edge of the bottom land along the Missouri River in the southern part of the MLRA to 1,903 feet (580 meters) in central Lake County. The Vermillion River is just outside the western boundary of the MLRA, and the Big Sioux River is just outside the eastern boundary. The drainage is poorly integrated except for the main rivers and streams.

Geology

The major landforms are stagnation moraines, end moraines, glacial outwash terraces, and flood plains. The area is dominated by glacial drift-covered moraines. The stagnation moraines generally are nearly level to gently rolling and have many depressions and ill-defined drainageways. The steeper slopes are on end moraines and on breaks adjacent to some of the larger tributaries. Small outwash areas are adjacent to the minor moraines. The dominant parent materials are silty glacial drift, glacial till, glacial outwash, and alluvium (Flint, 1955).

Climate

The average annual precipitation is 25 to 28 inches (580 to 780 millimeters). Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Winter precipitation typically occurs as snow. Annual snowfall is 23 to 46 inches (60 to 120 centimeters). The average annual temperature is 44 to 49 degrees F (7 to 9 degrees C). The freeze-free period averages about 155 days and ranges from 145 to 160 days.

Water

Precipitation is the principal source of moisture for crops but it may be inadequate for maximum crop production in some years. Surface water is not plentiful in the southern half of the MLRA; pothole lakes are more prominent in the northern half.

A limited supply of ground water is in the glacial drift and alluvial aquifers near the surface. These aquifers, typically consisting of unconsolidated sand and gravel, provide fresh or saline water that is hard because of high levels of calcium, magnesium, and sulphates. The ground water is used primarily for domestic purposes and livestock, but there is limited irrigation development where the water supply is most abundant. Many private wells test positive for high levels of nitrate plus nitrite since these elements are not tightly held by the soil. Most of this contamination occurs because the wells are located downslope from septic tank absorption fields, feedlots, barnyards, or fertilizer storage areas.

Soils

The dominant soil order is Mollisols. These soils have deep, dark, relatively fertile topsoil that typically formed under and supported grass vegetation. The soils in the area dominantly have a mesic temperature regime, an ustic moisture regime that borders on udic, and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and silty, loamy, or clayey.

The main soils and their series:

- Argialbolls that formed in alluvial depressions (Tetonka series)
- Argiaquolls that formed in alluvium in wet drainageways (Chancellor series); that formed in alluvial depressions (Worthing series)
- Calciaquolls that formed in silty drift or glacial till in areas with upward water movement (Wakonda and Davison series)
- Calciustolls that formed in till on the steeper slopes of moraines (Ethan series)
- Haplustolls that formed in silty drift (Wentworth and Trent series); that formed in silty drift over glacial till (Egan and Viborg series); that formed in glacial till (Clarno series); that formed in stream alluvium (Bon, Davis, and Roxbury series); that formed in lacustrine sediments (Huntimer series)

Biological Resources

This MLRA is in the western part of the tallgrass prairie. Big bluestem, little bluestem, Indiangrass, porcupinegrass, and green needlegrass are the dominant species in the native plant communities. Needle and thread and prairie dropseed are important species in the steeper areas. Cattails, prairie cordgrass, bulrush, and reed canarygrass commonly grow in wet areas.

Major wildlife species include white-tailed deer, red fox, coyote, white-tailed jackrabbit, pheasant, gray partridge, ducks, and geese. The rivers and pothole lakes common to the northern half of the MLRA are used for fishing. Fish species include walleye (yellow pike), smallmouth bass, bluegill, yellow perch, northern pike, carp, channel catfish, and black bullhead.

Land Use

Most of the area is used for farming, about 71 percent of which is used to grow crops, primarily corn, soybeans, alfalfa, and oats (fig. 102B-2). Wooded areas generally occur as narrow bands along streams and rivers or as shelterbelts around farmsteads. Irrigation systems are used on droughty soils where water supplies are available. Urban development is expanding around some of the larger towns.

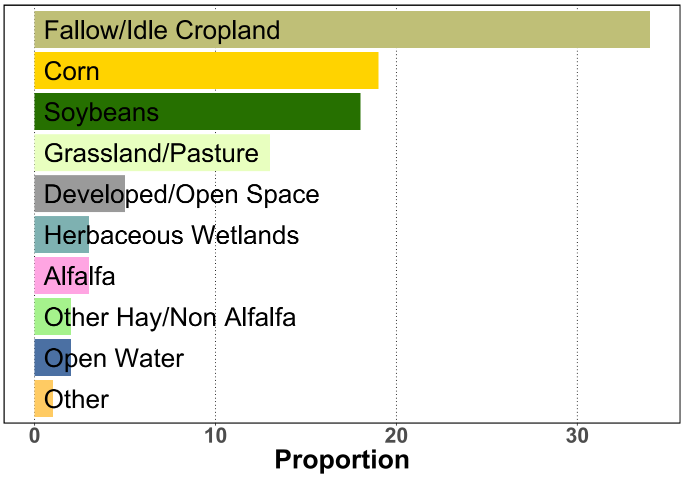

Figure 102B-2: Relative proportions (percentages) of land use in MLRA 102B.

The major soil resource concerns are wind and water erosion, maintenance of organic matter content and productivity of the soils, wetness, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management, especially no-till or conservation tillage systems that conserve moisture and contribute to soil quality. Other practices include terraces, vegetative wind barriers, grassed waterways, and nutrient management.

102C—Loess Uplands

MLRA 102C (fig. 102C-1) is in northeast Nebraska (78 percent), southeast South Dakota (14 percent), northwest Iowa (5 percent), and southwest Minnesota (3 percent). It covers about 11,176 square miles (28,945 square kilometers). The area consists of rolling hills covered in deep loess and supports natural prairie vegetation.

MLRA 102C is bordered to the east by the side slopes of the Missouri River and the deep loess soils (MLRA 107A) that occur in the wetter udic soil moisture regime. It is bordered to the south by loess soils that are similar but have a wetter soil moisture regime (MLRA 106) or a drier soil moisture regime (MLRA 71). It is bordered to the west by till- and loess-covered soils (MLRA 102B) and the Nebraska Sand Hills, which have

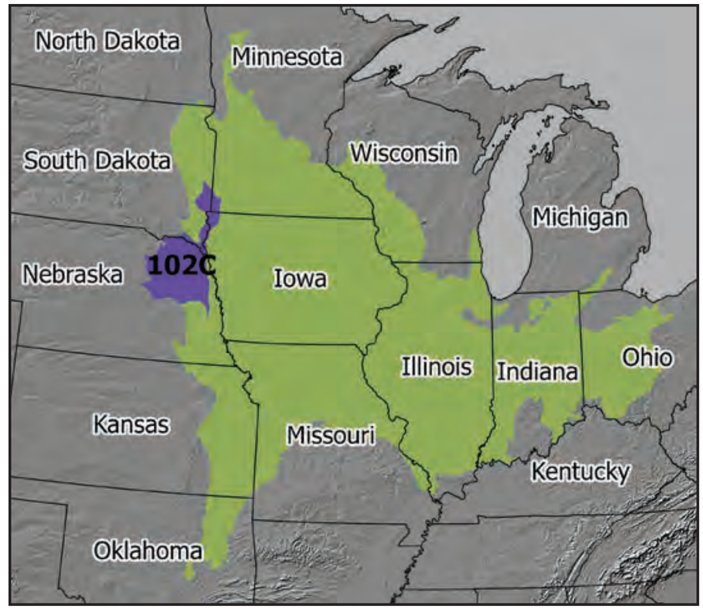

Figure 102C-1: Location of MLRA 102C, which covers 2,894,500 hectares (7,152,400 acres), within Region M.

a drier soil moisture regime and sandy soils. It is bordered to the north by the Missouri River Valley and, across the river, by glacial till soils (MLRA 55C) in an area that was covered in ice during the last glacial advance. MLRA 102C is also bordered to the north by the Coteau de Prairies, a high plateau that was unaffected by the last glacial advance.

Physiography

Most of this area is in the Dissected Till Plains section of the Central Lowland province of the Interior Plains. The southwestern third is in the High Plains section of the Great Plains province of the Interior Plains. This MLRA has broad, undulating to rolling ridgetops and hilly to steep valley sides. The valleys are generally narrow, but broad flood plains and terraces are along the major rivers and large tributaries. Elevation ranges from 1,017 to 2,231 feet (310 to 680 meters), increasing from southeast to northwest. Local relief is commonly 5 to 30 feet (2 to 9 meters).

The Big Sioux River forms the boundary between Iowa and South Dakota and joins the Missouri River in this area. The Missouri River and the Elkhorn River, a major tributary to the Platte River in Nebraska, also occur in this area.

Geology

The loess began as rocks that were ground into “glacial flour” by advancing ice sheets. When temperatures warmed, the ice began to melt, producing enormous amounts of water that deposited this sediment as huge mud flats. When the mud flats dried, the sediments were picked up and carried by strong westerly winds and redeposited over a wide area (USDI-USGS, 1999). This process was repeated over thousands of years, creating the thick loess landscapes of MLRA 102C. Initially, the loess deposition was more uniform and flatter, but over time, erosion dissected the loess to create the rolling hills of today.

The loess that covers most of the MLRA is pale brown or light grayish brown and calcareous. It is mainly of Peorian age, which is the most recent period of loess deposition. It ranges from 6 to 65 feet (2 to 20 meters) in thickness. Deposits of glacial till underlie the loess in most of the MLRA but generally are below the typical depths of soil investigations. The underlying till can be more than 200 feet thick (61 meters). There are some minor areas where no glacial deposits occur (loess or till) and bedrock is at or near the surface. Some principal stream valleys are filled with deposits of Pleistocene sand and gravel. The glacial till is underlain by Pleistocene sand and gravel in some buried bedrock valleys, but it typically rests directly on bedrock throughout most of the area. This underlying bedrock layer is typically Dakota sandstone, a bedrock formation of Cretaceous age, but the southeastern part of the area has rocks of Pennsylvanian age at or near the surface. The Dakota sandstone is exposed in areas along the eastern boundary as the landscape begins cutting down toward the Missouri River but is progressively more deeply buried moving east to west.

Climate

The average annual precipitation is 25 to 31 inches (629 to 785 millimeters). Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. The maximum precipitation occurs from midspring to early autumn. Precipitation in winter occurs as snow. The annual snowfall ranges from about 24 inches (61 centimeters) in the southern part of the area to 34 inches (86 centimeters) in the northern part. The average annual temperature is 44 to 51 degrees F (7 to 11 degrees C). The freeze-free period averages about 165 days and ranges from 150 to 190 days, increasing in length from northwest to southeast.

Water

Precipitation is the principal source of moisture for crops, but it is inadequate for maximum crop production in some years. The water in the Missouri River is of very good quality and suitable for most uses with minimal treatment. Sediment, nutrients, and pesticides from agricultural activities impair the other major rivers in this area, but the surface water is still used for livestock, irrigation, public supply, and industry in some parts.

Ground water is obtained from shallow alluvial and glacial meltwater deposits of unconsolidated sand and gravel throughout much of the area. It is typically very hard and has high amounts of calcium and magnesium. The glacial till is a poor source of ground water because yields to wells are small to negligible and the water is commonly highly mineralized. Locally, thick deposits of Pleistocene sand and gravel yield moderate or moderately large supplies of good-quality water to wells. The ground water is used for domestic purposes, livestock, irrigation, public supply, and industry.

The Cretaceous-age Dakota sandstone is at a shallow or moderate depth in the eastern part of this area. It is tapped by many domestic and livestock wells. Not many irrigation wells tap this aquifer, but several communities in eastern Nebraska obtain their public supplies from it. Locally, the Dakota sandstone has beds of gravel at its base. Moderately large yields can be obtained from these beds. Water quality varies in this bedrock aquifer, depending on whether the aquifer is recharged locally, whether it has been leached of salts, and whether the water within the aquifer has been there a long time. Calcium is the principal cation in the ground water where the Dakota sandstone is recharged locally or where it has been leached. Sodium is the dominant cation in the poorer quality water where no local recharge occurs, where salts in the aquifer have not been leached, or where water has been in the aquifer for a long time. The water from the Dakota sandstone aquifer is very hard. Other bedrock formations in the area are generally poor sources of water.

Soils

The dominant soil order is Mollisols. These soils have deep, dark, relatively fertile topsoil that typically formed under and once supported grass vegetation. The soils in the area dominantly have a mesic temperature regime, an ustic moisture regime bordering on udic, and mixed or smectitic mineralogy. They are shallow to very deep, moderately well drained to somewhat excessively drained, and silty, loamy, or clayey.

The main soils and their series:

- Endoaquolls that formed in alluvium on flood plains (Colo, Gibbon, and Zook series)
- Fluvaquents that formed in alluvium on the Missouri River flood plain (Albaton series)
- Haplustolls that formed in loess on uplands (Belfore, Moody, and Nora series); that formed in loess over outwash on uplands (Dempster and Graceville series); that formed in colluvium and alluvium on footslopes (Alcester and Hord series); that formed in eolian deposits on uplands (Flandreau, Grovena, and Thurman series)
- Udifluvents that formed in alluvium on the Missouri River flood plain (Blake and Grable series)
- Ustorthents that formed in loess on steep uplands (Crofton series)

Biological Resources

This area supports natural prairie vegetation. Little bluestem, big bluestem, switchgrass, western wheatgrass, and sideoats grama characterize the vegetation on silty and loamy soils. Porcupinegrass, green needlegrass, and western wheatgrass characterize the vegetation on clayey soils on uplands.

Major wildlife species include white-tailed deer, coyote, raccoon, pheasant, bobwhite quail, mourning dove, and meadowlark. Fish species include smallmouth bass, bluegill, channel catfish, and black bullhead.

Land Use

Nearly all this MLRA is farmed, about 74 percent of which is cropland (fig. 102C-2). Corn and soybeans are the main crops, but feed grains and hay crops are also widely grown. About 20 percent of the area is irrigated; the remainder relies on precipitation for crop growth. The hilly and steep slopes that border the drainageways support native grasses and shrubs used for grazing.

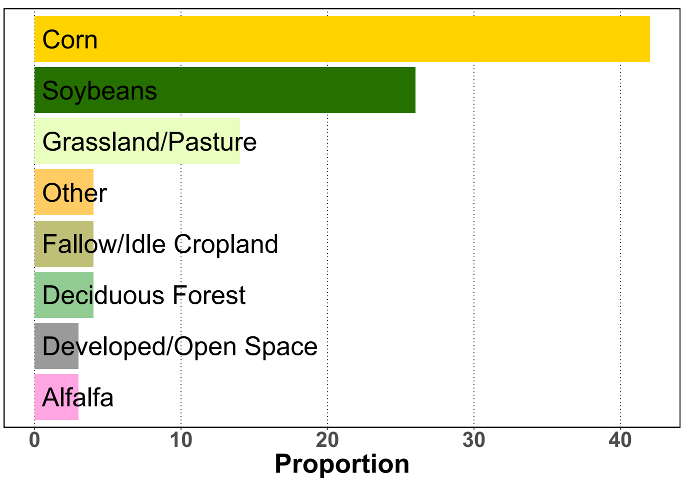

Figure 102C-2: Relative proportions (percentages) of land use in MLRA 102C.

The major soil resource concerns are wind and water erosion and maintenance of the organic matter content, tilth, and moisture of soils. Soils that formed in loess are highly susceptible to wind and water erosion. Pasture and rangeland are subject to wind erosion and water erosion when the plant cover is depleted by overgrazing.

Conservation practices on cropland generally include the use of high-residue crops in the cropping system, systems of crop residue management (such as no-till and mulch-till), level terraces, contour farming, contour stripcropping, irrigation water management, and nutrient management. Conservation practices on pasture and rangeland generally include fences and proper grazing management.

102D—Prairie Coteau

MLRA 102D (fig. 102D-1) is in South Dakota (77 percent), Minnesota (22 percent), and North Dakota (less than 1 percent). It makes up about 7,867 square miles (20,375 square kilometers). The area mostly consists of nearly level to undulating till plains with potholes and moraines and is part of the Prairie Pothole Region.

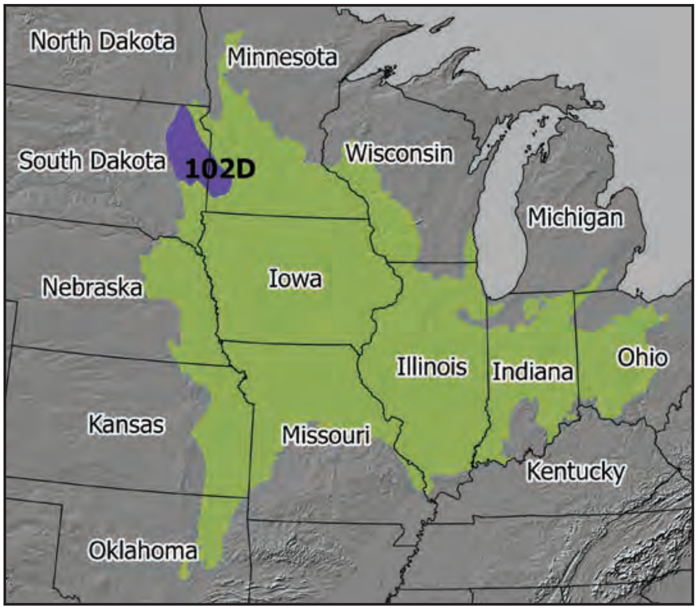

Figure 102D-1: Location of MLRA 102D, which covers 2,037,500 hectares (5,034,700 acres), within Region M.

The area east-northeast of MLRA 102D consists of nearly level to rolling topography with many depressions and ill-defined drainages and was developed by the continental ice sheet of the Des Moines Lobe. The area to the east was also developed by the Des Moines Lobe. It is covered with glacial till and outwash with overlying recent alluvium and has a break to the mesic soil temperature regime. The area south of MLRA 102D is mostly loess covered, consisting of silty material deposited by wind, and has a break to the mesic soil temperature regime. The area to the west was developed by the continental ice sheet of the James Lobe and has a level to rolling topography and a break to the mesic soil temperature regime. To the northwest is MLRA 55D, which is characterized by glacial lacustrine deposits of glacial Lake Dakota.

Physiography

Three-fourths of this MLRA is in the Western Lake section of the Central Lowland province of the Interior Plains. The southwest quarter is in the Missouri Plateau, glaciated, section of the Great Plains province of the Interior Plains. The center of the Prairie Coteau, in northeastern South Dakota, is the Dissected Till Plains section of the Central Lowland province. Elevation ranges from 1,150 to 2,130 feet (350 to 650 meters).

Geology

This MLRA consists of nearly level to rolling topography that has many depressions and ill-defined drainages. Prairie pothole lakes and ponds are common. The steeper slopes occur on the sides of drainages and on breaks adjacent to some of the larger tributaries.

The Prairie Coteau is one of the most prominent landforms in North America. The northern tip of this wedge-shaped highland is in North Dakota. Isolated highs on the Prairie Coteau, in northeastern South Dakota, are at an elevation of more than 2,000 feet (610 meters). This high area splits the last continental ice sheet into the Des Moines and James Lobes.

Climate

The average annual precipitation is 22 to 29 inches (559 to 734 millimeters). Half or more of the precipitation falls during the growing season. Rainfall typically occurs during high-intensity, convective thunderstorms in summer. In the western part of the MLRA, rainfall is less abundant and not always adequate for full maturation of crops. Precipitation in winter is typically snow. The average annual temperature is 42 to 45 degrees F (6 to 7 degrees C). The freeze-free period averages 155 days and ranges from 140 to 175 days.

Water

Precipitation is the principal source of moisture for crops but in some years is inadequate for maximum crop production. Small ponds and shallow wells are the principal sources of water for livestock. Both surface water and ground water are used for irrigation. Many natural glacial lakes are in the northern part of the area, and many of the larger ones are used for recreation. The water in the lakes and larger streams is generally suitable for all uses. The quality of the water in the smaller streams is generally poor. The water is slightly saline at low flows.

Shallow wells in glacial outwash deposits, primarily sand and gravel, provide water for livestock, domestic use, and irrigation. Ground water also is available in deep wells in the Precambrian bedrock or in the Dakota sandstone. These aquifers are seldom used in this area because of the abundance of shallow glacial deposits and surface water.

Soils

The dominant soil order in this MLRA is Mollisols. The soils in the area dominantly have a frigid temperature regime, an aquic or udic moisture regime, and mixed mineralogy. They generally are very deep, well drained to very poorly drained, and loamy. The parent materials are dominantly fine-loamy till to clayey material, with smaller amounts of outwash, glaciofluvial deposits, eolian deposits, alluvium, and, to a lesser extent, loess and organic materials.

The main soils and their series:

- Argialbolls that formed in alluvium in depressions (Tonka series)
- Argiaquolls that formed in alluvium in depressions (Parnell series); that formed in alluvium in drainageways on till plains (Badger series)
- Argiudolls that formed in fine-loamy till on till plains (Aastad and Forman series)
- Calciaquolls that formed in alluvium on flood plains (Marysland and Mortiz series); that formed in fine-loamy till on till plains (Hamerly and Vallers series); that formed in silty sediments on till plains (Cubden and McKranz series)
- Calciudolls that formed in fine-loamy till on moraines (Buse series)
- Endoaquolls that formed in alluvium on flood plains (Lamoure and Rauville series); that formed in alluvium in depressions (Southam series)
- Hapludolls that formed in fine-loamy till on till plains (Barnes and Svea series); that formed in silty sediments on till plains (Kranzburg, Poinsett, and Waubay series); that formed in coarse-loamy eolian deposits (Egeland and Embden series); that formed in sandy eolian deposits (Maddock series); that formed in glaciofluvial deposits on till plains and moraines (Arvilla, Fordville, Renshaw, and Sioux series); that formed in colluvial-alluvial sediments on till plains (Darnen series); that formed in alluvium on flood plains (LaDelle and La Prairie series)

Biological Resources

The ecological subsections in MLRA 102D include the Prairie Coteau, Prairie Coteau Escarpment, and Big Sioux Basin (US EPA, 2013). This area supports true prairie vegetation characterized by big bluestem, little bluestem, porcupinegrass, and green needlegrass. Needle and thread and prairie dropseed are important species in the steeper areas. Prairie cordgrass commonly grows in wet areas.

Major wildlife species include white-tailed deer, beaver, muskrat, mink, pheasant, gray partridge, giant Canada goose, mallard, blue-winged teal, wood duck, northern shoveler, pintail, ruddy duck, widgeon, redhead, canvasback, chestnut-collared longspur, marbled godwit, and upland plover. Fish species include walleye, northern pike, yellow perch, black crappie, white crappie, white bass, catfish, black bullhead, bluegill, carp, white sucker, buffalo, redhorse, and bait minnow.

Land Use

Most of this area is in farms (fig. 102D-2), and the crops are grown for sale or livestock feed. The principal crops are corn, soybeans, alfalfa, spring wheat, and oats. Wooded areas generally occur as narrow bands along streams and rivers or as shelterbelts around farmsteads. Recreational hunting and fishing are important land uses in areas of the many natural lakes.

The major soil resource concerns are wind and water erosion, maintenance of the organic matter content and productivity of the soils, soil wetness, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management, especially no-till

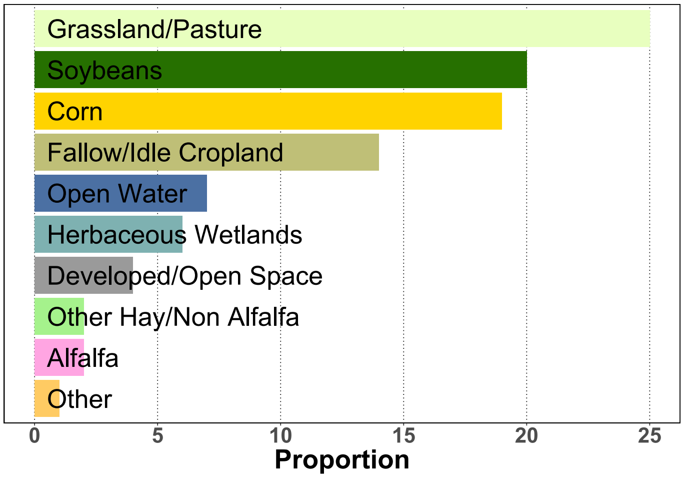

Figure 102D-2: Relative proportions (percentages) of land use in MLRA 102D.

or other conservation tillage systems that conserve moisture and contribute to soil quality. Other practices include terraces, vegetative wind barriers, grassed waterways, and nutrient management.

103—Central Iowa and Minnesota Till Prairies

MLRA 103 (fig. 103-1) is in Minnesota (56 percent) and Iowa (44 percent). It makes up about 27,722 square miles (71,800 square kilometers). It is an expansive and agriculturally important region located between south-central Minnesota

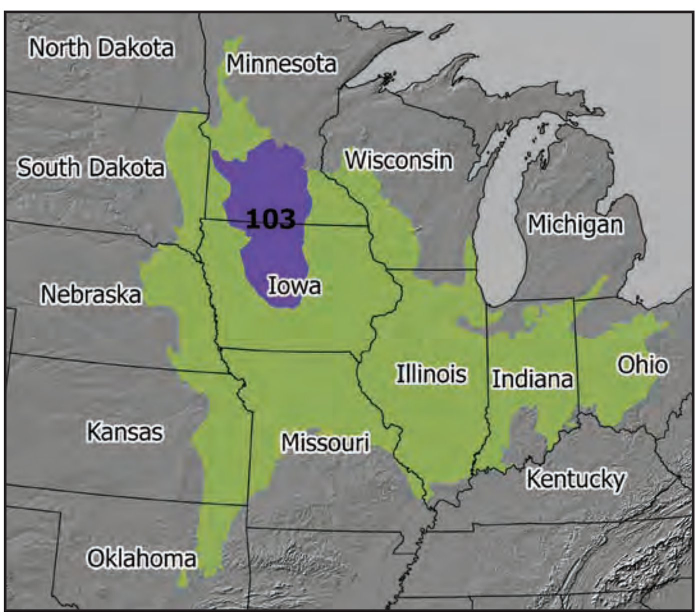

Figure 103-1: Location of MLRA 103, which covers 7,180,000 hectares (17,742,100 acres), within Region M.

and north-central Iowa. The surficial deposits formed during the Wisconsin glaciation and make up a series of low-relief till plains, end moraines, disintegration moraines, and glacial lakes of the Des Moines Lobe. Because the area is geologically young, natural drainage has not been well developed and, as a result, nearly half of the land area is made up of hydric soils. The MLRA is ecologically diverse with forest (the Big Woods) in the northeast, savanna around the perimeter of the Big Woods and along large drains and rivers, and prairie covering the rest of the MLRA. Soil parent material is largely deep fine-loamy till overlain with less extensive deposits of outwash, lacustrine, and alluvial material.

The north-central and northwestern boundaries of MLRA 103 are breaks to the frigid soil temperature regime. There is a large outwash plain along the northeastern boundary (MLRA 91). The eastern boundary is the break between the Wisconsin-age Des Moines Lobe and the older Pre-Illinoian till (MLRA 104). The western, southwestern, and southern boundaries and part of the southeastern boundary are breaks to much older landscapes that have been covered by loess deposits and are underlain by Pre-Illinoian till (MLRAs 107 and 108).

Physiography

This area has mostly low relief. Local elevation differences are mainly less than 10 feet to 20 feet (3 to 6 meters), but some of the major river flood plains are 165 feet (50 meters) or more below the adjoining uplands. Elevation ranges from 689 to 1,837 feet (210 to 560 meters). Natural lakes, marshes, and potholes occur throughout the area.

Geology

This area is covered with glacial till, outwash, and glacial lake deposits, all of which were deposited within the last 20,000 years. More recent alluvium consisting of clay, silt, sand, and gravel fills the bottoms of most of the major river valleys. There is a north-to-south gradient for the sand, silt, and clay content of the glacial till, and subtle differences can be attributed to several advance stages of the Des Moines Lobe (Olivia, Algona, Altamont, and Bemis moraines). At the farthest extent of the Des Moines Lobe (Bemis terminal moraine), the glacial till becomes coarse-loamy. South of the Iowa-Minnesota State line, the Des Moines Lobe overrode a Peoria loess deposit (IA DNR, 1996) causing the silt portion of the fine-earth fraction to be higher and resulting in an improved drainage. Paleozoic bedrock sediments, primarily shale, limestone, and dolomite, underlie the glacial deposits in most of the MLRA. Some Precambrian Sioux Quartzite is exposed on the western edge of the area, in southwestern Minnesota (Ojakangas and Matsch, 1982; IA DNR, 1996).

Climate

The average annual precipitation is 24 to 37 inches (619 to 929 millimeters). The average annual air temperature is 43 to 50 degrees F (6 to 10 degrees C). The freeze-free period averages 155 days and ranges from 140 to 180 days.

Water

During most years natural precipitation is adequate for crops, and most of the region has tile drainage to remove surplus surface water. The abundant surface water may be degraded by nonpoint sources of sediment, nutrients, and pesticides in runoff from agricultural land. Agricultural yields may be reduced during occasional drought years, but in general irrigation is almost never used. The few places where irrigation is used are on coarse textured soils with high hydraulic conductivity. Rivers and lakes are common in the area, with the highest concentration of lakes in the northeasternmost part.

Several unconsolidated and bedrock aquifers occur in the area. Most of the ground water that is pumped (mostly for home or municipal use) is from the surficial aquifer (buried channels, glacial drift, and alluvium) or the Ordovician and Cambrian sandstone and dolomite in the Jordan, or Prairie du Chien-Jordan, aquifer.

Soils

The dominant soil orders are Mollisols and, to a lesser extent, Alfisols, Histosols, and Inceptisols. The soils in the area have a mesic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. Most landscapes have soil morphologies that are closely reflective of three major ecological groups—forests, savannas, and prairies.

The main soils and their series in forests:

- Alfisols that formed in fine-loamy till on till plains and moraines (Lester, Angus, Dundas, and Hayden series); that formed in a mantle of lacustrine sorted materials on disintegration moraines (Kilkenny and Lerdal series)
- Mollisols that formed in slope alluvium and fine-loamy till and have thick surface horizons because of deposition (Le Sueur, Cordova, and Delft series)

The main soils and their series on savannas:

- Mollisols that formed in fine-loamy till and slope alluvium on till plains (Reedslake, Cokato, and Forestcity series)

The main soils and their series on prairies:

- Calcic Hapludolls that formed in fine-loamy till on till plains in the extreme northwestern part of the MLRA (Amiret and Ves series)
- Hapludolls that formed in outwash, commonly near rivers and streams (Estherville and Hawick series)
- Mollisols that formed in fine-loamy till or shallow-water lacustrine deposits and slope wash over till on till plains (Clarion, Nicollet, Webster, Canisteo, Glencoe, Okoboji, and Terril series)
- Mollisols that formed in lacustrine or lacustrine-mantled till on lake plains (Waldorf, Collinwood, Bode, and Kossuth series)

The main soils and their series in other ecological groups:

- Haplosaprists that formed in herbaceous and coprogenic organic materials (Muskego, Houghton, and Klossner series), in areas throughout the MLRA but mostly concentrated in the extreme northeast
- Lithic Hapludolls that are influenced by bedrock (Copaston series), commonly near down-cut rivers and drains
- Mollisols that formed in alluvial materials on flood plains (Spillville, Colo, and Coland series)

Biological Resources

MLRA 103 is a continental-scale transition from hardwood forests in the Northeast to the shortgrass prairie of the Dakotas, Nebraska, and areas further south and west. Nearly all the MLRA was plowed for agriculture and otherwise influenced by European settlement, so very little of the natural condition remains. Most of the central, southern, and western parts of the MLRA have dominant species in the reference state that reflect tallgrass prairie. Little bluestem, porcupinegrass, and sideoats grama grow on the drier parts of the landscape. Leadplant, Indiangrass, big bluestem, and prairie dropseed occupy the sloping portions of the landscape. The wetter areas include sedges, switchgrass, bluejoint, prairie cordgrass, broadleaf cattail, and river bulrush. In the savanna regions, the understory is largely the same as it is on the prairies but the woody vegetation tends to be fire-tolerant species, such as bur oak and aspen. The dominant species in the northeastern Big Woods include sugar maple, northern red oak, basswood, and elm.

Major wildlife species include white-tailed deer, fox, beaver, muskrat, rabbit, squirrel, mink, Canada goose, pheasant, and gray partridge. The most common fish species in the area are walleye, northern pike, largemouth bass, bluegill, crappie, yellow perch, and sunfish.

Land Use

Nearly all this area is farmed, and about four-fifths is cropland (fig. 103-2). The proportion of cropland is highest in the southern part. Corn, soybeans, and other feed grains are the major crops. Some of the cropland is used for hay. Dairy farming is a more common enterprise in the northern, and especially northeastern, part of the MLRA than in the southern part. Less than one-tenth of the area is used for urban development. Many natural lakes occur in this area, and numerous bogs, swales, and circular depressions indicate sites of previously ponded water. Much of the area is currently drained by tile and ditching.

The major resource concerns are water erosion, depletion of soil organic matter, excess surface and subsurface water

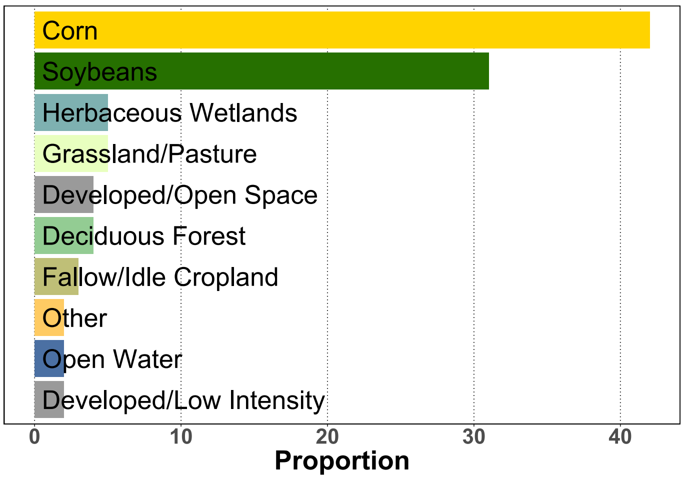

Figure 103-2: Relative proportions (percentages) of land use in MLRA 103.

(in terms of agricultural production), and poor water quality. Conservation practices on cropland generally include systems of crop residue management (especially no-till, strip-till, and mulch-till), cover crops, surface and subsurface drainage systems, nutrient and pest management, grassed waterways, buffer strips, and development of wildlife habitat.

104—Eastern Iowa and Minnesota Till Prairies

This MLRA (fig. 104-1) is a nearly level to undulating till plain with long slopes and common karst topography. It is used to produce cash crops, feed grain, hay, and livestock. This area is in Iowa (80 percent) and Minnesota (20 percent). It makes up about 11,650 square miles (30,173 square kilometers).

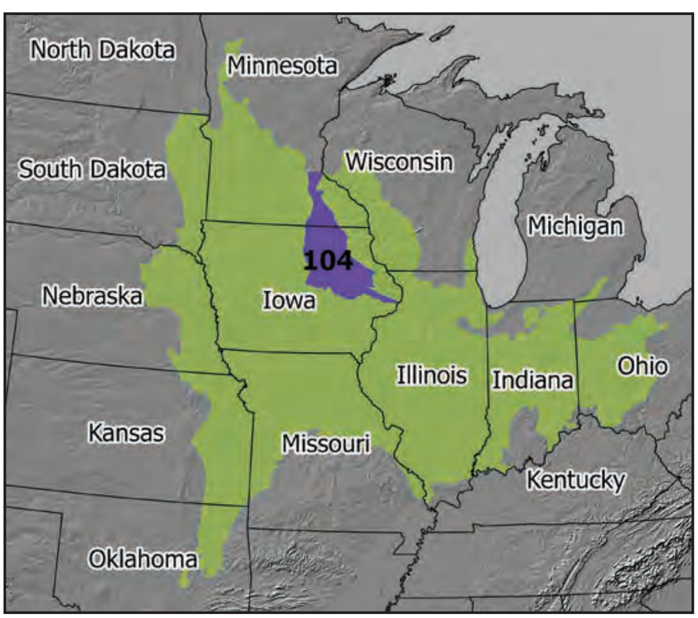

Figure 104-1: Location of MLRA 104, which covers 3,017,300 hectares (7,455,900 acres), within Region M.

MLRA 104 has a distinct boundary based on physiography with MLRAs 103 (Central Iowa and Minnesota Till Prairies), 105 (Upper Mississippi River Bedrock Controlled Uplands and Valleys), 108 (Illinois and Iowa Deep Loess and Drift), and 115 (Central Mississippi Valley Wooded Slopes). It has a less apparent boundary based on the boundary between the mesic and frigid soil temperature regimes with MLRA 90A (Wisconsin and Minnesota Thin Loess and Till).

Physiography

This area is in the Central Lowland province of the Interior Plains. Most of the area is in the Dissected Till Plains section of the province, but parts along the western edge are in the Western Lake section. The natural drainage network is well established and dendritic, resulting in few lakes and ponds. Elevation ranges from 540 to 1,430 feet (160 to 430 meters). Local relief is 10 to 20 feet (3 to 6 meters). The Cedar River flows through this MLRA.

Geology

This area is covered with till and outwash deposits of Pre-Illinoian age. Recent alluvium consisting of clay, silt, sand, and gravel fills the major river valleys. Paleozoic bedrock, primarily shale and limestone, underlies most of the area. Because of a shallow depth to limestone, much of the area has karst topography. Some limestone units containing fossils are exposed in road cuts in the northeast corner of the area and along the major rivers in the part of the area in Iowa.

Climate

The annual precipitation ranges from 31 to 39 inches (780 to 990 millimeters) with a mean of 35 inches (895 millimeters). The annual temperature ranges from 44 to 50 degrees F (6.8 to 10 degrees C) with a mean of 47 degrees F (8.1 degrees C). The freeze-free period ranges from 145 to 185 days with a mean of 160 days.

Water

Precipitation is generally adequate for crops, but in years when the precipitation is below normal, yields are reduced. Many of the wet soils require artificial drainage for good growth of the field crops common to the area. Much of the area is drained by tile. Extensive drainage ditches provide outlets for the tile drains. Water is generally abundant in the many rivers. Most of the ground water used in this area is pumped from either a surficial aquifer (buried channels, glacial drift, and alluvium) or the Ordovician and Cambrian sandstone and dolomite in the Jordan aquifer.

Soils

The dominant soil orders in this MLRA are Mollisols and, to a lesser extent, Alfisols. The soils in the area dominantly have a mesic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. They generally are very deep, well drained to very poorly drained, and silty or loamy.

The main soils and their series:

- Argiudolls that formed in loess over till on till plains (Dinsdale series); that formed in loess on uplands and stream terraces (Tama series)
- Endoaquolls that formed in outwash or sediments over till (Clyde and Tripoli series); that formed in loess over till on till plains (Maxfield series); that formed in alluvium on flood plains (Colo series)
- Hapludalfs that formed in sediments over till on till plains (Bassett series)
- Hapludolls that formed in sediments over till (Floyd, Kenyon, and Readlyn series) and loess over till (Klinger series) on till plains

Biological Resources

This area primarily supports prairie vegetation on the uplands. Big bluestem, Indiangrass, and prairie dropseed are dominant grasses on the well drained soils in rolling areas. Oak trees sporadically occur across these prairies. Switchgrass, prairie cordgrass, and bluejoint are better adapted to the somewhat poorly drained soils. Sedges, rushes, bulrushes, and cattails are common on poorly drained and very poorly drained soils. Little bluestem, porcupinegrass, and prairie sandreed are indicators of dry, sandy, and gravelly sites. Forbs, such as prairie clovers, phlox, sunflowers, blazing stars, and prairie coneflowers, grow on the more productive soils. Roundhead lespedeza, bluejacket, and flowering spurge grow on droughty soils. Loosestrife, swamp milkweed, meadow-rue, and iris grow on wet soils. The larger river valleys support forests dominated by silver maple, American elm, eastern cottonwood, green ash, and common hackberry.

Major wildlife species include white-tailed deer, beaver, otter, muskrat, squirrel, mink, pheasant, gray partridge, great blue heron, American egret, mallard, and teal. Fish species in the area include smallmouth bass, catfish, northern pike, black bullhead, bluegill, sunfish, and rough fish.

Land Use

Most of this area is in farms (fig. 104-2). Corn, soybeans, other feed grains, and hay are the principal crops. Raising and feeding hogs and beef cattle and dairying are important enterprises. The forestland is mainly on steep valley sides and in low-lying areas on flood plains.

The major resource concerns are water erosion, soil health, excess surface and subsurface water, and water quality. Conservation practices on cropland generally include conservation tillage systems (especially no-till, strip-till, and mulch-till), cover crops, and nutrient and pest management. Other practices include surface and subsurface drainage systems, grassed waterways, terraces, manure management, planting for pasture and hayland, and grade-stabilization structures.

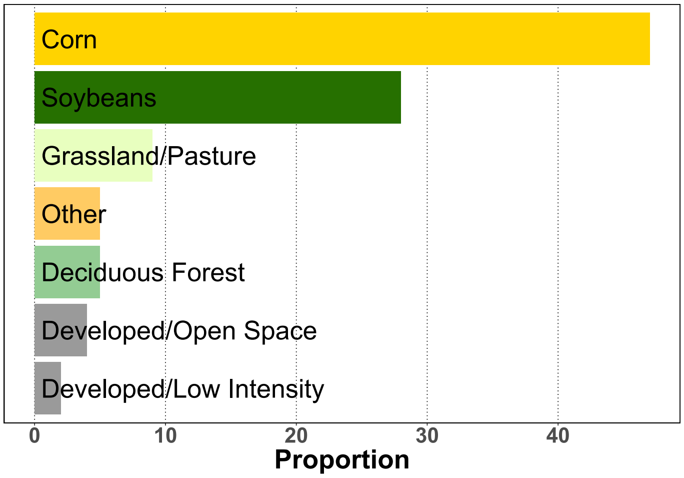

Figure 104-2: Relative proportions (percentages) of land use in MLRA 104.

105—Upper Mississippi River Bedrock Controlled Uplands and Valleys

MLRA 105 (fig. 105-1) is in Wisconsin (58 percent), Iowa (20 percent), Minnesota (18 percent), and Illinois (4 percent). It makes up about 20,018 square miles (51,847 square kilometers). This MLRA is in the Driftless Area and was not glaciated

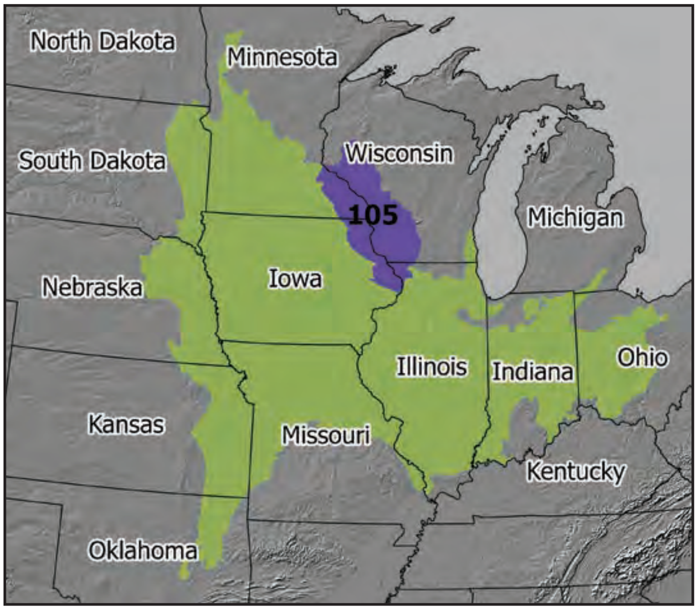

Figure 105-1: Location of MLRA 105, which covers 5,184,700 hectares (12,811,600 acres), within Region M.

during the last ice age. It is the incised portion of the Paleozoic plateau that has no glacial drift. In this MLRA, gently sloping to rolling farmed summits with steep wooded colluvial valley walls join alluvial valleys and flood plains. Geologic erosion and deep incision of the Upper Mississippi River and its tributaries into Paleozoic bedrock upland created areas of high relief. Large glacial meltwater terraces occur along the major rivers. Stream valleys are deep, narrow, and V-shaped. Some karst features, such as sinkholes and caves, have formed where carbonate rocks are near the surface. The downcutting into the Cambrian sandstone aquitard provides the area with spring-fed and cold-water trout streams.

MLRA 105 boundaries are defined by Pre-Illinoian-age to Early Wisconsin-age glaciation to the north (MLRA 90A), a gradation of the Iowan Erosion Surface to the southwest (MLRA 104), the Illinoian till plain to the southeast (MLRA 108), glacial Lake Wisconsin to the northeast (MLRA 89), and the Green Bay Lobe of the Wisconsin-age glaciation to the east (MLRA 95).

Physiography

This area is in the Wisconsin Driftless section of the Central Lowland province of the Interior Plains. The boundaries of the Driftless Area are marked by smoothed glacial till landscapes on all sides except to the east. To the east, in the southwestern part of Wisconsin's Central Plain, is a portion of the Driftless Area that lacks evidence of glaciation but was altered by glacial meltwaters that formed glacial Lake Wisconsin. This area has isolated hills, bluffs, and pinnacles that are eroded Cambrian bedrock remnants of the Paleozoic plateau. Ecologically, the flora and fauna of the Driftless Area are more closely related to those of the Great Lakes region than those of the broader Midwest and Central Plains regions.

Geology

The surficial bedrock of the Driftless Area is composed of mostly Paleozoic dolomite, limestone, sandstone, and shale along with a very small percentage of quartzite. The bedrock is horizontally bedded and dips slightly southwest from the Wisconsin Arch. The Paleozoic bedrock upland dominates the Driftless Area, but occurrences of Pre-Illinoian till are patchy west of the Mississippi River. Cambrian sandstone is exposed in the northern part of the area on narrow summits and lower nose slopes and lies beneath Ordovician colluvial sediments. Prairie du Chien dolomite with small remnants of St. Peter Sandstone make up the cap rock in the north-central part. In the southern part of the area, the younger (Ordovician-age) dolomite of Galena to Platteville units is the cap rock. Loess blankets the Driftless Area. It was deposited by the prevailing winds and has varying thickness dependent on distance from its source. Typically, the loess surface layer is silt loam and was deposited during the last glacial maximum along the corridor of the Mississippi River. The erosion pattern of tight gullies typically occurs within a mile of the Mississippi River.

Climate

The average annual precipitation in most of this MLRA is 32 to 38 inches (801 to 973 millimeters). Two-thirds or more of the precipitation falls during the freeze-free period. Most of the rainfall occurs during high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 42 to 50 degrees F (6 to 10 degrees C). The freeze-free period averages about 175 days and ranges from 145 to 205 days.

Water

In most years the moderate precipitation is adequate for crops and forage, but in years with little or no precipitation, yields are reduced on soils that are shallow over bedrock. The many springs, streams, and farm ponds are additional sources of surface water. The surface water is abundant and generally of good quality. Poor water quality in stream reaches is primarily the result of nonpoint sources of sediment, nutrients, and pesticides from agricultural land or wastewater discharges downstream from the larger cities.

Ground water is abundant in glacial outwash deposits in most of the river valleys in this area. This water is moderately hard or hard but generally of very good quality. The supply of ground water varies in the uplands. The sandstone and dolomite layers in the Jordan and Prairie du Chien aquifers usually provide adequate yields to wells. The water from these aquifers is suitable for all uses.

Soils

The dominant soil order in this MLRA is Alfisols. The soils in the area dominantly have a mesic temperature regime, a udic moisture regime, and mixed mineralogy. They generally are moderately deep to very deep, well drained or moderately well drained, and loamy. Soil parent materials are loess, residuum or pedisediment, alluvium, slope alluvium, and colluvium.

The main soil series:

- Dorerton series—Hapludalfs that formed in a mix of loess and erosional sediment over loamy-skeletal material from dolomite
- Downs series—Hapludalfs that formed in loess on bedrock-controlled uplands
- Dubuque series—Hapludalfs that formed in loess over thin pedisediment and residuum weathered from limestone
- Fayette series—Hapludalfs that formed in loess on bedrock-controlled uplands
- Mt. Carroll series—Hapludalfs that formed in loess on bedrock-controlled uplands

Newglarus series—Hapludalfs that formed in loess, clayey pedisediment, and loamy residuum from dolomite
Norden series—Hapludalfs that formed in loess and loamy residuum weathered from glauconitic sandstone
Palsgrove series—Hapludalfs that formed in loess and residuum weathered from limestone
Seaton series—Hapludalfs that formed in loess on bedrock-controlled uplands along major river valleys
Tama series—Argiudolls that formed in loess

Biological Resources

The soils on uplands support native hardwoods. Oak, hickory, and sugar maple are the dominant species. Big bluestem, little bluestem, and scattered oak trees grow on some sites. The soils on lowlands support mixed hardwoods, mainly elm, cottonwood, river birch, ash, silver maple, and willow. Sedge and grass meadows and scattered trees grow on some of the wetter lowlands. Goat prairies occur on the very steep southwest aspects. The small, isolated ecosystem called algific talus slopes also occurs in this region. Native vegetation that impacted soils was tallgrass prairie and bur oak savanna on ridgetops and southwest-facing slopes, sugar maple-basswood-oak forests on moister slopes, sugar maple-basswood forests on north-facing slopes, sedge meadows along the rivers, and mesic prairies on terraces.

Major wildlife species include white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, fisher, otter, mink, cottontail, fox squirrel, gray squirrel, red squirrel, Canada goose, sandhill crane, bald eagle, red-shouldered hawk, goshawk, peregrine falcon, osprey, Cooper's hawk, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, hooded merganser, pileated woodpecker, and red-bellied woodpecker.

Land Use

Nearly all this MLRA is farmed (fig. 105-2). About one-half of the farmland is cropland, and 15 percent is permanent pasture. Cash crops, such as corn and soybeans, and feed grains and forage crops for dairy cattle and other livestock are the principal crops. About one-fourth of the MLRA, mainly the more sloping parts, consists of woodlots used for commercial timber production or recreation, such as hunting. The Mississippi River and its major tributaries provide opportunities for recreation. The abundant spring-fed cold-water streams provide great trout habitat. This area is known for its apple orchards, and its use for grape production is increasing.

The major resource concerns are water erosion, depletion of soil organic matter, and poor water quality. Conservation practices on cropland generally include systems of crop residue management (especially no-till, strip-till, and mulch-till), cover crops, nutrient and pest management, contour stripcropping, grassed waterways, terraces, manure management, planting of pasture and hayland, tree planting, and grade-stabilization structures.

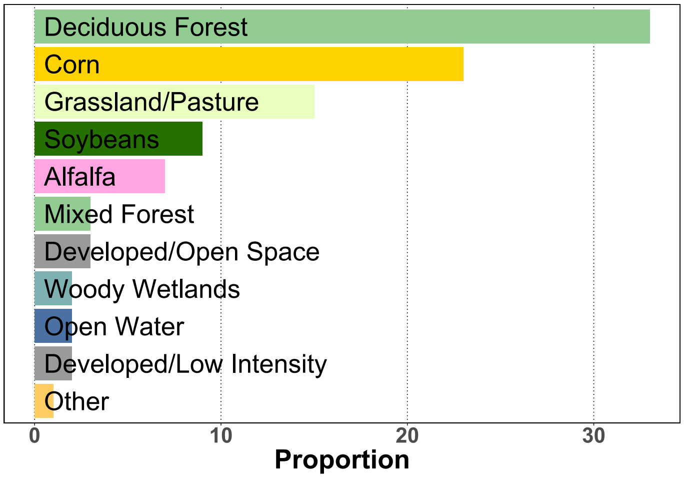

Figure 105-2: Relative proportions (percentages) of land use in MLRA 105.

106—Nebraska and Kansas Loess-Drift Hills

This MLRA (fig. 106-1) consists of loess over glacial till in nearly level to strongly sloping areas with short slopes. It is used to produce cash crops, feed grain, hay, and livestock. It is in Nebraska (51 percent) and Kansas (49 percent). It makes up about 11,082 square miles (28,703 square kilometers).

MLRA 106 has a distinct boundary based on physiography with MLRAs 71 (Central Nebraska Loess Hills), 102C (Loess Uplands), 107 (Iowa and Missouri Deep Loess Hills), and 112 (Cherokee Prairies). It has a less apparent boundary with MLRAs 75 (Central Loess Plains) and 76 (Bluestem Hills).

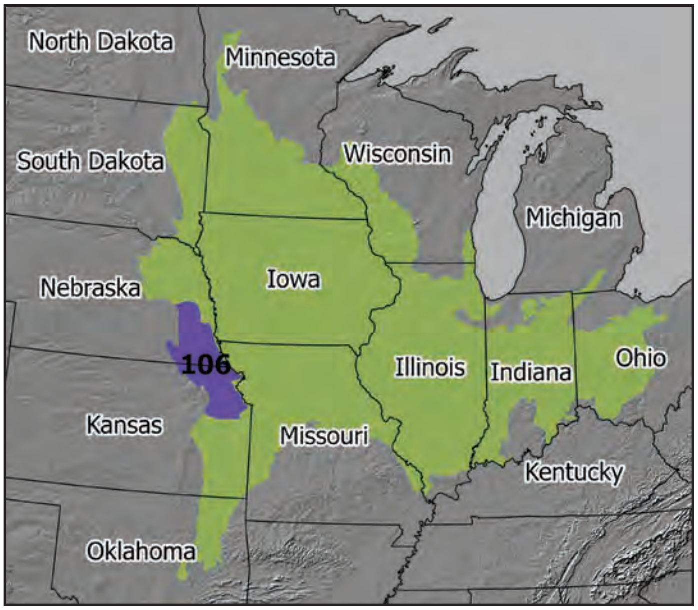

Figure 106-1: Location of MLRA 106, which covers 2,870,300 hectares (7,092,700 acres), within Region M.

Physiography

This area is almost entirely in the Dissected Till Plains section of the Central Lowland province of the Interior Plains. The southern tip is in the Osage Plains section of the same province and division. This area consists of a dissected glacial drift plain and broad and smooth ridgetops. Stream valleys are bordered by relatively narrow bands of hilly and steep slopes. Valley floors are typically narrow, except along the larger rivers and their primary tributaries. Elevation ranges from 710 to 1,740 feet (210 to 530 meters), increasing from east to west. Local relief is mainly 10 to 20 feet (3 to 6 meters), but some of the larger valley floors are 80 to 160 feet (25 to 50 meters) or more below the level of the adjacent uplands.

The Little Nemaha River and the North Fork of the Big Nemaha River flow through this MLRA and into the Missouri River, which is just east of the part of this area in Nebraska. The Big Blue River flows through Beatrice, Nebraska, and into the part of this area in Kansas. Salt and Wahoo Creeks flow through Lincoln and Wahoo, Nebraska, and into the Platte River in the northern part of the area. The Big Blue joins the Black Vermillion River at Tuttle Creek Lake in the southern end of the MLRA, in Kansas. The Soldier and Delaware Rivers also are in the part of the MLRA in Kansas.

Geology

Loess covers the surface of almost all of the uplands in this MLRA. Glacial drift underlies the loess. Deposits of alluvial clay, silt, sand, and gravel are in all of the stream and river valleys. The alluvial deposits can be extensive in the major river valleys. Paleozoic sandstone, shale, and limestone units are exposed in a few road cuts and in the walls of valleys along the major streams on the east side of the area, near the bluffs along the Missouri River. This MLRA has limestone and shale (clay) quarries.

Climate

The average annual precipitation in most of this area is 29 to 41 inches (730 to 1,040 millimeters), increasing from northwest to southeast. About three-fourths of the precipitation falls during high-intensity, convective thunderstorms from late spring through early autumn. The scant precipitation in winter occurs mainly as snow. The average annual temperature is 50 to 56 degrees F (10 to 13 degrees C). The freeze-free period averages about 180 days and ranges from 165 to 210 days.

Water

Precipitation is generally adequate for crops, but in years with little or no precipitation, yields are reduced. The supply of both surface and ground water is limited. Small areas along some of the perennial streams are irrigated. Small ponds and reservoirs are important sources of water for livestock. The surface water is generally of good quality, but it typically is not used for drinking because of the variability of the supply. Many streams flow only in direct response to rainfall.

Shallow wells in glacial drift and in alluvium in stream valleys supply water for domestic and livestock needs on most farms. This water primarily contains calcium, magnesium, and bicarbonate and is very hard. The level of total dissolved solids varies considerably in the water in the glacial drift. In some areas deep wells in glacial drift provide very hard water. Many communities and households obtain water from the Dakota Formation. This water is very hard. The public water supply for Lincoln, Nebraska, is pumped from alluvium along the Platte River, almost 30 miles east of the city.

Soils

The dominant soil orders in this MLRA are Mollisols, Alfisols, and Entisols. The soils in the area dominantly have a mesic temperature regime, a udic moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained or moderately well drained, and loamy or clayey.

The main soils and their series:

- Argiudolls that formed in loess on uplands (Aksarben and Wymore series); that formed in till on uplands (Burchard, Morrill, Pawnee, and Shelby series); that formed in colluvium and residuum on uplands (Martin series)
- Hapludalfs that formed in loess on uplands and stream terraces (Yutan and Otoe series); that formed in till on uplands (Malmo series)
- Hapludolls that formed in alluvium on flood plains (Kennebec series); that formed in colluvium on footslopes and alluvial fans (Judson series); that formed in loess on uplands (Marshall series)
- Udifluvents that formed in alluvium on flood plains (Nodaway series)
- Udorthents that formed in till on uplands (Steinauer series)

Biological Resources

This area supports grassland vegetation characterized by mid and tall grasses. Big bluestem, little bluestem, switchgrass, Indiangrass, porcupinegrass, and sideoats grama are the dominant species on silty soils in the uplands. Clayey soils in the uplands support a similar plant community but have a higher percentage of switchgrass and some wildrye. Green ash, hackberry, oak, boxelder, black walnut, and maple trees grow along streams and intermittent drainageways. Major wildlife species include white-tailed deer, raccoon, opossum, tree squirrel, pheasant, bobwhite quail, and mourning dove.

Land Use

Nearly all of this area is farmland, about two-thirds of which is cropland (fig. 106-2). The cropland is more extensive on the less sloping soils that formed in loess than on other soils. Corn

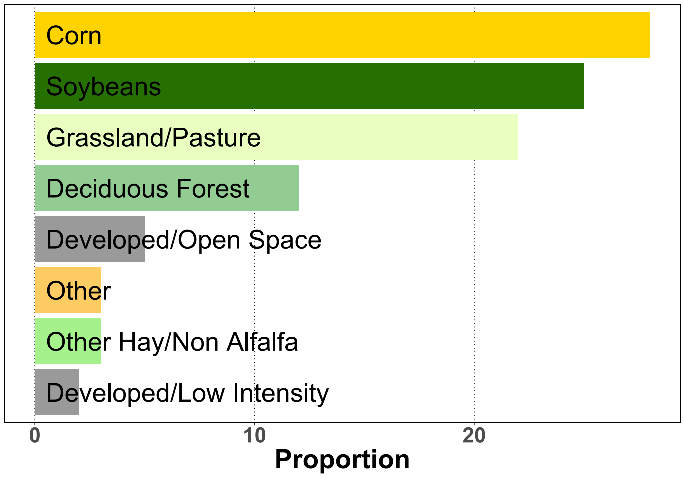

Figure 106-2: Relative proportions (percentages) of land use in MLRA 106.

and soybeans are important cash crops, but grain sorghum and alfalfa and other hay crops are grown on a large percentage of the area. Most of the grain and hay is fed to livestock on the farms where it is grown. About one-fourth of the area is used as pasture or range. Pastures of native grasses are more extensive on the strongly sloping to steep soils that formed in glacial till than on other soils. Pastures of introduced grasses and legumes are on the more productive soils, and native grasses are common on the more sloping, shallow soils. Native woodland is confined to narrow bands bordering drainageways and streams and to some nearly level, wet soils on bottom land.

The major soil resource concerns are water erosion and maintenance of the content of soil organic matter. The resource concerns on pasture and rangeland are plant productivity, health, and vigor; noxious and invasive plants; and inadequate wildlife habitat. Conservation practices on cropland generally include the use of high-residue crops in the cropping system, systems of crop residue management (such as no-till, strip-till, and mulch-till), gradient terraces and grassed waterways, underground outlets, contour farming, conservation crop rotations, and nutrient and pest management. Conservation practices on rangeland and pasture generally include prescribed grazing, brush management, management of upland wildlife habitat, and proper distribution of watering facilities.

107—Iowa and Missouri Deep Loess Hills

This MLRA (fig. 107-1) is a loess-covered, rolling to hilly till plain that has undergone extensive geologic erosion and dissection. It is used to produce cash crops, feed grain, and livestock. This area is in Iowa (57 percent), Missouri (29 percent), Nebraska (9 percent), Kansas (3 percent), and Minnesota (2 percent). It makes up about 20,666 square miles (53,526 square kilometers).

MLRA 107 has a distinct boundary based on physiography with MLRAs 102D (Prairie Coteau), 103 (Central Iowa and

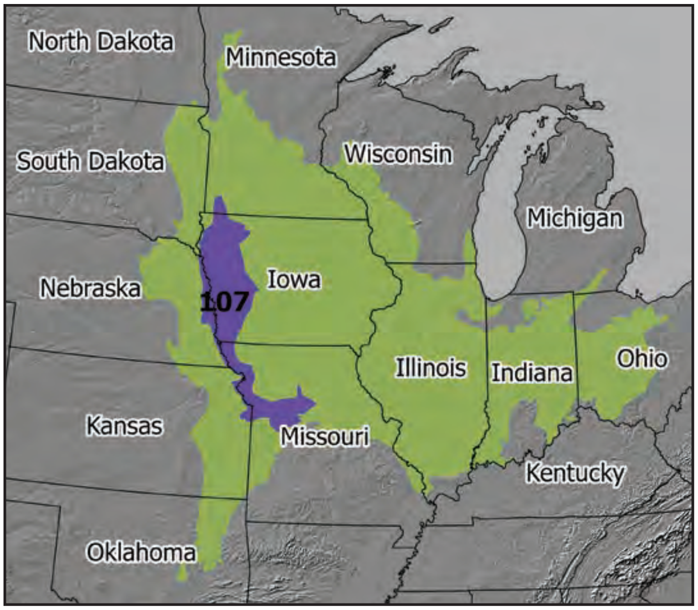

Figure 107-1: Location of MLRA 107, which covers 5,352,600 hectares (13,226,500 acres), within Region M.

Minnesota Till Prairies), and 115 (Central Mississippi Valley Wooded Slopes). It has a less apparent boundary with MLRAs 102C, 106, 108, 109, and 112. The boundary with MLRA 102C (Loess Uplands) is based on the boundary between the udic and ustic soil moisture regimes. The boundary with MLRA 106 (Nebraska and Kansas Loess-Drift Hills) is based on loess thickness and texture. The boundary with MLRA 108 (Illinois and Iowa Deep Loess and Drift) is based on loess thickness. The boundary with MLRA 109 (Iowa and Missouri Heavy Till Plain) is based on clay content of the till. The boundary with MLRA 112 (Cherokee Prairies) is based on the boundary between the mesic and thermic soil temperature regimes.

Physiography

This area is almost entirely in the Dissected Till Plains section of the Central Lowland province of the Interior Plains. The farthest northeastern part in Iowa and Minnesota is in the Western Lake section of the same province and division, and the farthest southern part in Missouri is in the Osage Plains section. The MLRA has mostly rolling to hilly slopes with some nearly level to undulating, broad ridgetops and some steep slopes on valley sides. Nearly level, broad valley floors are along a few large rivers. The natural drainage network is well established and dendritic, resulting in few lakes and ponds. Elevation ranges from 570 feet (170 meters) where the Missouri River exits the area to 1,840 feet (560 meters) on the highest ridges. Local relief is mainly 10 to 100 feet (3 to 30 meters), but valley floors can be 80 to 300 feet (25 to 90 meters) below the adjacent uplands. Some upland flats and valley floors have local relief of only 3 to 6 feet (1 to 2 meters). The Missouri River flows through this MLRA.

Geology

Most of the area is overlain by loess deposits that reach a thickness of 65 to 200 feet (20 to 60 meters) in the Loess Hills and a thinness of about 4 feet (1 meter) on hillslopes in the northern part of the area. The loess is underlain mostly by Pre-Illinoian-age till that has undergone extensive erosion and dissection. In the Loess Hills, Holocene cycles of erosion and deposition have produced deeply incised gullies and fine grained alluvial deposits. In some eastern parts of the MLRA, the loess is underlain by Wisconsin-age till. The Quaternary overburden ranges from 150 to 450 feet (45 to 135 meters) in thickness throughout most of the MLRA, but it is generally less than 150 feet (45 meters) thick in the southeastern part. The glacial materials are underlain by Pennsylvanian and Cretaceous bedrock consisting of shale, mudstone, and sandstone.

Climate

The annual precipitation ranges from 28 to 44 inches (700 to 1,120 millimeters) with a mean of 34 inches (870 millimeters). The average annual temperature ranges from 44 to 56 degrees F (6.7 to 13.4 degrees C) with a mean of 50 degrees F (9.9 degrees C). The freeze-free period ranges from 145 to 210 days with a mean of 175 days.

Water

Precipitation is the principal source of moisture for crops. Much of the northern part of this area is drained by tile. Extensive drainage ditches provide outlets for tile drains. The Missouri River provides most of the municipal and industrial water for the major cities. Other streams and rivers provide some surface water for livestock, irrigation, and public supplies. The principal sources of ground water are glacial drift aquifers, alluvial aquifers along the major streams, buried valley aquifers, the Cretaceous-age Dakota sandstone, and the Ordovician and Cambrian sandstone and dolomite in the Jordan aquifer.

Soils

The dominant soil orders in this MLRA are Mollisols and, to a lesser extent, Alfisols, Inceptisols, and Entisols. The soils in the area dominantly have a mesic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. They generally are very deep, well drained to poorly drained, and silty.

The main soils and their series:

- Endoaquolls that formed in alluvium on flood plains and in upland drainageways (Colo series)
- Eutrudepts that formed in loess on till plains, loess hills, and stream terraces (taxadjuncts of Exira, Galva, Marshall, and Monona series as a result of accelerated erosion)
- Hapludalfs that formed in loess on till plains and bluffs bordering the Missouri River (Knox series)
- Hapludolls that formed in loess on till plains, loess hills, and stream terraces (Exira, Galva, Marshall, Monona, and Primghar series); that formed in colluvium or alluvium on upland drainageways and alluvial fans (Judson and Napier series)
- Udifluvents that formed in alluvium on flood plains (Nodaway series)
- Udorthents that formed in calcareous loess on till plains and stream terraces (Ida series)

Biological Resources

Prairies in this MLRA support tall grasses on moist soils on uplands and mid and short grasses on dry, sandy, or gravelly soils and on steep slopes of the Loess Hills. Within the prairies, grama, muhly, and wheatgrass commonly grow beside the more familiar little bluestem, big bluestem, Indiangrass, and prairie dropseed. The wooded areas on uplands commonly consist of bur oak, chinquapin oak, white oak, northern red oak, black oak, bitternut hickory, shagbark hickory, American basswood, and black walnut. The wooded areas on flood plains commonly consist of eastern cottonwood, American elm, green ash, silver maple, and willow. The wildlife species on the prairies include Great Plains toad, bobcat, rattlesnake, regal fritillary, and prairie skink.

Land Use

Most of this area is in farms and used mainly for producing corn, soybeans, other feed grains, hay, and livestock (fig. 107-2). The forestland in the area is mainly on steep valley sides and in low-lying areas on flood plains. The major resource concerns are water erosion, soil health, and water quality. Many of the wet soils require artificial drainage for good growth of crops. Conservation practices on cropland generally include conservation tillage systems (especially no-till, strip-till, and mulch-till), cover crops, and nutrient and pest management. Other practices include subsurface drainage systems, grassed waterways, terraces, manure management, planting of pasture and hayland, and grade-stabilization structures.

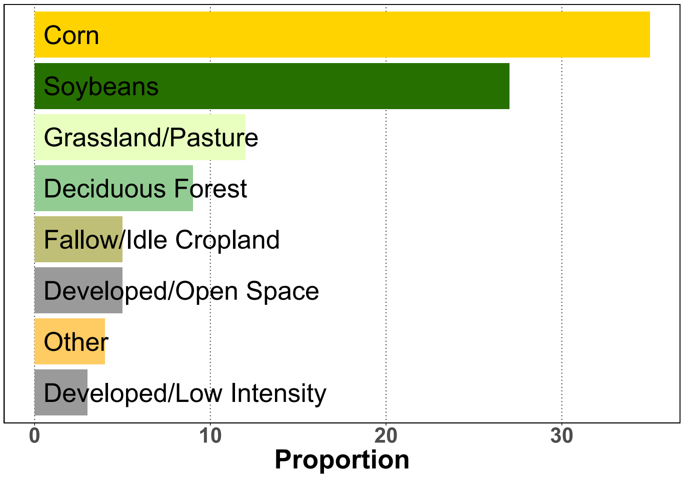

Figure 107-2: Relative proportions (percentages) of land use in MLRA 107.

108—Illinois and Iowa Deep Loess and Drift

This MLRA (fig. 108-1) is a loess-covered, nearly level to hilly till plain. It is used extensively to produce cash crops. It is in Illinois (58 percent), Iowa (38 percent), Missouri (3 percent), and Indiana (1 percent) in two separate areas. It makes up about 32,967 square miles (85,389 square kilometers).

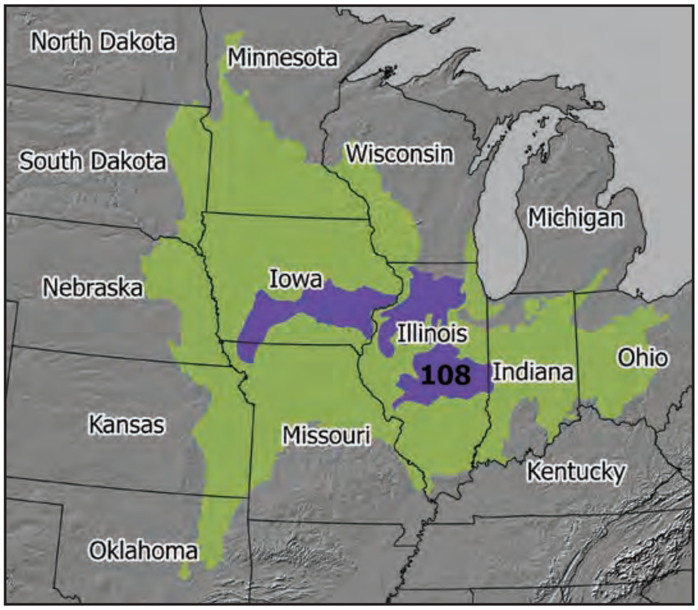

Figure 108-1: Location of MLRA 108, which covers 8,538,900 hectares (21,099,900 acres), within Region M.

MLRA 108 has a distinct boundary based on physiography with MLRAs 103 (Central Iowa and Minnesota Till Prairies), 104 (Eastern Iowa and Minnesota Till Prairies), 105 (Upper Mississippi River Bedrock Controlled Uplands and Valleys), 111 (Indiana and Ohio Till Plain), 113 (Central Claypan Areas), 114 (Southern Illinois and Indiana Thin Loess and Till Plain), and 115 (Central Mississippi Valley Wooded Slopes).

MLRA 108 has a less apparent boundary with MLRAs 95, 107, 109, and 110. The boundary with MLRA 95 (Eastern Wisconsin, Northern Illinois, and Upper Michigan Drift Plain) is based on thickness of the loess, outwash, and till deposits over bedrock and the texture of the till. The boundary with MLRA 107 (Iowa and Missouri Deep Loess Hills) is based on thickness of the loess. The boundary with MLRA 109 (Iowa and Missouri Heavy Till Plain) is based on clay content of the till. The boundary with MLRA 110 (Northern Illinois and Indiana Heavy Till Plain) is based on clay content of the glacial deposits.

Physiography

This MLRA is in the Central Lowland province of the Interior Plains. The eastern half of this area (the part in Illinois) is in the Till Plains section and has a lower stream density than the western half of the MLRA (the part in Iowa and Missouri) that is in the Dissected Till Plains section.

End moraines are numerous in the far eastern part of this area in Illinois and generally form elongated ridges trending from northwest to southeast. Slopes are mostly nearly level to undulating on broad ground moraines but are steeper on the end moraines and on valley sides along major streams. In the western part of this MLRA in Illinois, the till plains are more rolling and stream terraces are adjacent to broad flood plains in some places. Steeper slopes are on valley sides along major streams. In the far western part of the MLRA (the part in Iowa and Missouri), the slopes are mostly rolling to hilly on the dissected till plain. Some broad ridgetops are nearly level to undulating, and valley sides along major streams are steep. Major rivers that flow through this MLRA include the Cedar, Des Moines, Illinois, and Mississippi Rivers.

Elevation ranges from 270 feet (80 meters) in the lowest valleys to about 1,520 feet (470 meters) on the highest ridges. Valley floors can be 80 to 200 feet (25 to 60 meters) below the adjacent uplands. Local relief is typically 3 to 10 feet (1 to 3 meters) in the eastern part of this MLRA and 10 to 20 feet (3 to 6 meters) in the western part. Valley floors and some upland flats have local relief of only 3 to 6 feet (1 to 2 meters).

Geology

The eastern half of the MLRA is underlain mostly by Pennsylvanian shale, siltstone, and limestone with Ordovician and Silurian limestone in the extreme northern part. Coal beds occur mostly east of the Illinois River. Glacial drift covers the entire MLRA, except for some areas along the major streams where underlying bedrock is exposed. The glacial drift is Wisconsin or Illinoian in age in the eastern half of the area and consists of distinct till units as well as sorted, stratified outwash. The entire MLRA has been covered by a layer of Peoria Loess. In a few areas the loess directly overlies bedrock.

The western half of the MLRA is underlain by dense, Pre-Illinoian-age till that has undergone extensive erosion and dissection. The till surface is covered by a mantle of Peoria Loess on the hillslopes and by Holocene alluvium (DeForest Formation) in the river valleys. The till is generally less than 150 feet (45 meters) thick in the southern and western parts of the area and ranges from 150 to 350 feet in thickness (45 to 105 meters) in the rest of the area. It is underlain mostly by Pennsylvanian and Mississippian bedrock consisting mainly of limestone, shale, and mudstone. The bedrock includes Devonian and Silurian dolomite in the northeastern part of the area.

Climate

The annual precipitation ranges from 34 to 47 inches (850 to 1,200 millimeters) with a mean of 38 inches (975 millimeters). The annual temperature ranges from 47 to 58 degrees F (8.3 to 14.2 degrees C) with a mean of 51 degrees (10.5 degrees C).

The freeze-free period ranges from 155 to 210 days with a mean of 180 days.

Water

In most years the moderate precipitation is adequate for crops. Many of the wet soils require artificial drainage for good growth of field crops commonly produced in the area. Numerous large rivers provide surface water for livestock, irrigation, industry, and public supplies. The Coralville Reservoir provides municipal and industrial water to areas along the Iowa River. Some water for livestock is stored in small ponds and reservoirs. The principal sources of ground water are glacial drift aquifers, sand and gravel aquifers, buried channel aquifers, alluvial aquifers along the major streams, and Paleozoic bedrock.

Soils

The dominant soil orders in this MLRA are Mollisols and, to a lesser extent, Alfisols. The soils in the area have a mesic temperature regime, an aquic or udic moisture regime, and dominantly mixed mineralogy. They generally are very deep, poorly drained to well drained, and silty, loamy, or clayey.

The main soils and their series:

- Argiudolls that formed in till (Shelby series) and loess over till (Flanagan series) on till plains; that formed in loess on uplands, hills, and stream terraces (Ipava, Osco, Sharpsburg, and Tama series)
- Endoaquolls that formed in alluvium on flood plains, low stream terraces, and upland drainageways (Colo series); that formed in loess over outwash (Drummer series) and in loess (Sable series) on outwash plains, stream terraces, and till plains
- Hapludalfs that formed in loess on till plains and stream terraces (Ladoga series)

Biological Resources

This MLRA originally supported prairie vegetation with hardwood forests on scattered upland sites. The areas of tall prairie grasses are characterized by big bluestem, Indiangrass, prairie dropseed, and switchgrass. White oak, bur oak, black oak, hickory, white ash, American basswood, sugar maple, and black walnut grow on the better drained soils. Silver maple, black willow, eastern cottonwood, American elm, green ash, and American sycamore grow on the flood plains.

Major wildlife species include white-tailed deer, coyote, turkey, red fox, beaver, raccoon, skunk, muskrat, opossum, cottontail rabbit, fox squirrel, Canada goose, red-tailed hawk, northern harrier, great horned owl, blue heron, wood duck, mallard duck, redheaded woodpecker, quail, leopard frog, and rattlesnake. Fishing is limited mostly to rivers and constructed impoundments. Fish species in the area include largemouth bass, carp, catfish, bluegill, crappie, and sunfish.

Land Use

Most of this area is in farms and mainly used to produce corn and soybeans (fig. 108-2). Other feed grains, silage, hay, and pasture are grown for the livestock produced in the area. Some small grains, such as winter wheat and oats, also are grown. Grasslands support introduced and native grasses. Some of the better farmland is increasingly used for urban development. A few areas on broad stream terraces and outwash plains are irrigated and used for high-value specialty crops. The forested areas in this MLRA are mainly on steep valley sides and in low-lying areas on flood plains. Although limited in acreage, surface-mined areas and active underground coal-mining areas are in the part of this MLRA in Illinois.

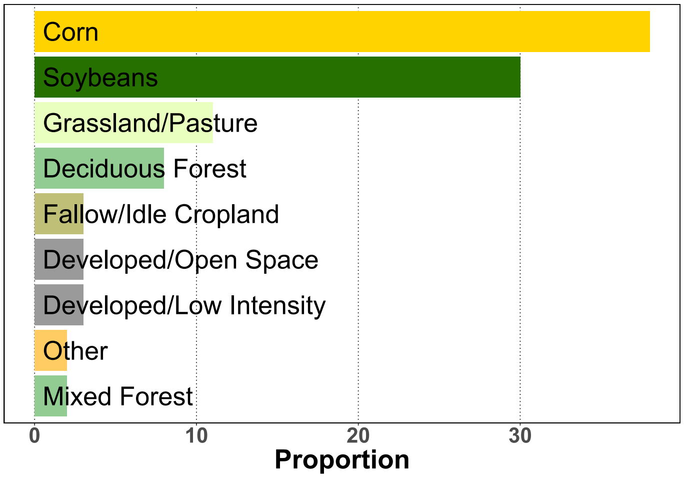

Figure 108-2: Relative proportions (percentages) of land use in MLRA 108.

The major resource concerns are wind erosion, water erosion, soil health, and water quality. Conservation practices on cropland generally include conservation tillage systems (especially no-till, strip-till, and mulch-till), cover crops, and nutrient and pest management. Other practices include windbreaks, vegetative wind barriers, surface and subsurface drainage systems, grassed waterways, terraces, manure management, planting of pasture and hayland, and grade-stabilization structures.

109—Iowa and Missouri Heavy Till Plain

This MLRA (fig. 109-1) is characterized by loess-covered, rolling hills of clayey till. It is used to produce cash crops, feed grain, and livestock. This area is in Iowa (35 percent) and Missouri (65 percent). It makes up about 16,207 square miles (41,975 square kilometers).

MLRA 109 has a distinct boundary based on physiography with MLRAs 113 (Central Claypan Areas) and 115 (Central Mississippi Valley Wooded Slopes). It has a less apparent

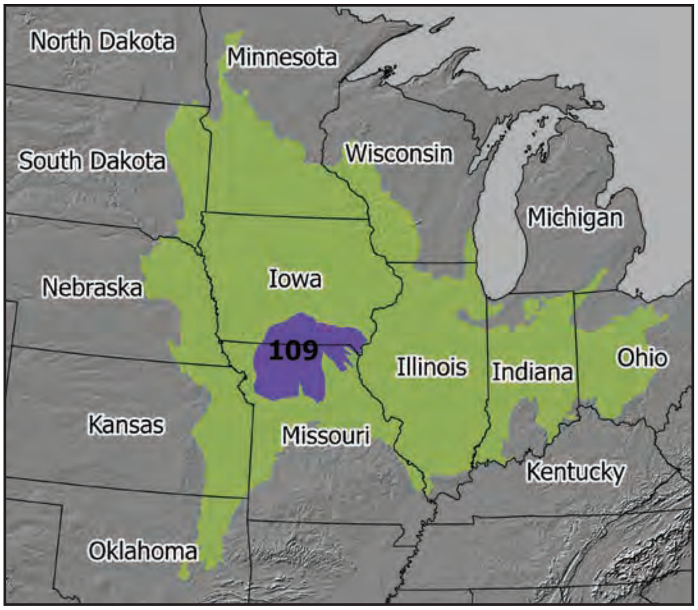

Figure 109-1: Location of MLRA 109, which covers 4,197,500 hectares (10,372,300 acres), within Region M.

boundary based on clay content of the till with MLRAs 107 (Iowa and Missouri Deep Loess Hills) and 108 (Illinois and Iowa Deep Loess and Drift).

Physiography

This MLRA is in the Dissected Till Plains section of the Central Lowland province of the Interior Plains. It is an area of rolling hills interspersed with uniformly level upland divides and level flood plains. Dendritic drainage patterns characterize the area. The northeastern part of the MLRA consists of flat, tablelike uplands with steep or hilly land only near the margins of river valleys. Other parts of the MLRA are more dissected, have less extensive upland divides, and consist mostly of hillslopes. Nearly level, broad valley floors are along a few large rivers. Elevation ranges from 490 feet (150 meters) in the lowest valleys to 1,270 feet (380 meters) on the highest ridges. Local relief is mainly 10 to 20 feet (3 to 6 meters), but valley floors can be 80 to 160 feet (25 to 50 meters) below the adjacent uplands. Some upland flats and valley floors have local relief of only 3 to 6 feet (1 to 2 meters).

The Des Moines River, a major tributary of the Mississippi River, flows through the northeast corner of this area. The Chariton and Grand Rivers, tributaries to the Missouri River, flow through the central portion.

Geology

Loess covers most of the uplands. The loess is underlain by Illinoian-age or Pre-Illinoian-age till that has a high content of clay. Most upland soils have a paleosol that formed in till but some have a paleosol that formed in the lower part of the loess above the till or in the pedisediment. Alluvial clay, silt, sand, and gravel deposits are in the river valleys. These deposits can be extensive in the major river valleys. Mississippian shale and limestone bedrock lie beneath the glacial and alluvial deposits.

Climate

The annual precipitation ranges from 36 to 43 inches (900 to 1,100 millimeters) with a mean of 39 inches (985 millimeters). The annual temperature ranges from 50 to 54 degrees F (9.9 to 12.4 degrees C) with a mean of 52 degrees F (11 degrees C). The freeze-free period ranges from 165 to 205 days with a mean of 185 days.

Water

In most years the well distributed, moderate precipitation provides enough water for crops. The many small perennial streams and a few large streams are additional sources of water. Many communities rely on surface water for their supply of drinking water. Because the streamflow fluctuates widely and frequently, storage is required to maintain any public supplies. The principal sources of ground water are glacial drift aquifers and alluvial aquifers along the larger rivers.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Mollisols. The soils in the area have a mesic temperature regime, an aquic or udic moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and loamy or clayey.

The main soils and their series:

- Argiudolls that formed in till (Shelby series) and loess over pedisediment over till (Lagonda and Lamoni series) on till plains; that formed in loess on divides and interfluves (Grundy series)
- Endoaquolls that formed in alluvium on flood plains and stream terraces (Zook series)
- Hapludalfs that formed in till (Gara and Lindley series) and loess or pedisediment over till (Armstrong and Keswick series) on till plains
- Udifluvents that formed in alluvium on flood plains and upland drainageways (Nodaway series)

Biological Resources

The western portion of this MLRA supports tallgrass prairie vegetation. Big bluestem, Indiangrass, little bluestem, and switchgrass are the dominant grass species, while blazing star, coneflower, aster, and goldenrod are common prairie wildflowers. The eastern portion supports woodlands and forests dominated by oak and hickory with an understory of white ash, eastern hop hornbeam, Ohio buckeye, and hawthorn. The flood plains support forest vegetation, mainly American elm, eastern cottonwood, silver maple, and common hackberry and have American sycamore, green ash, and other hardwood species scattered throughout. Most of the native grasses have been removed by cultivation and overgrazing. Naturalized bluegrass is prevalent in uncultivated areas.

Major wildlife species include white-tailed deer, raccoon, skunk, opossum, muskrat, cottontail rabbit, mink, squirrel, and quail. Fish species in the area include bullhead, carp, bass, bluegill, and catfish.

Land Use

Most of this MLRA is in farms (fig. 109-2). Corn, soybeans, other feed grains, and hay are the principal crops. About one-third of the area supports introduced and native grasses. Beef cattle and swine are important sources of income on many farms. The forested areas are mainly on steep valley sides and in low-lying areas on flood plains.

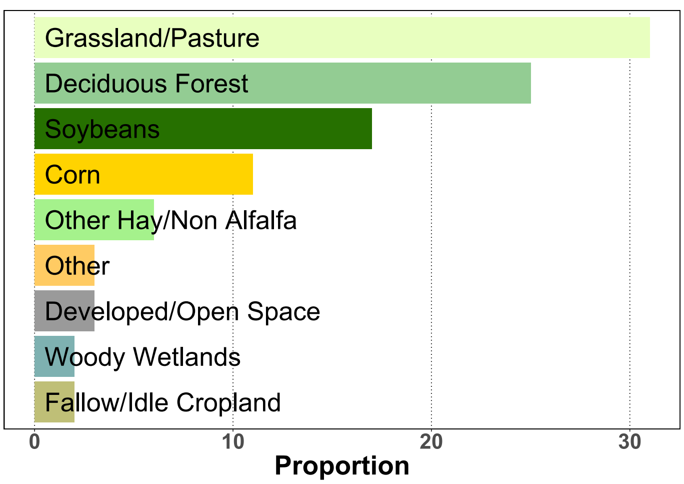

Figure 109-2: Relative proportions (percentages) of land use in MLRA 109.

The major resource concerns are water erosion, soil health, and water quality. Conservation practices on cropland generally include conservation tillage systems (especially no-till, strip-till, and mulch-till), cover crops, and nutrient and pest management. Other practices include grassed waterways, terraces, manure management, planting of pasture and hayland, and grade-stabilization structures.

110—Northern Illinois and Indiana Heavy Till Plain

This MLRA (fig. 110-1) is characterized by nearly level to gently undulating till plains and glacial lake plains covered with clayey till and glaciolacustrine deposits. It is used to produce cash crops or for urban development. This area is in Illinois (82 percent), Wisconsin (10 percent), and Indiana (8 percent). It makes up about 7,770 square miles (20,124 square kilometers).

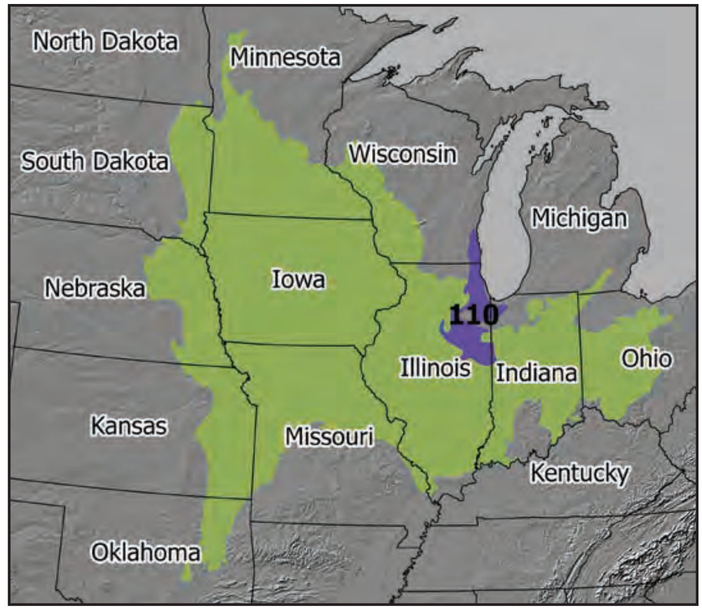

Figure 110-1: Location of MLRA 110, which covers 2,012,400 hectares (4,972,600 acres), within Region M.

MLRA 110 has a distinct boundary based on physiography with MLRA 95 (Eastern Wisconsin, Northern Illinois, and Upper Michigan Drift Plain). It has a less apparent boundary with MLRAs 97, 108, and 111. The boundary with MLRAs 108 (Illinois and Iowa Deep Loess and Drift) and 111 (Indiana and Ohio Till Plain) is based on clay content of the glacial deposits. The boundary with MLRA 97 (Southwestern Michigan Fruit and Vegetable Crop Belt) is based on sand content of the glacial deposits.

Physiography

The northern half of this area is in the Eastern Lake section of the Central Lowland province of the Interior Plains. The southern half is in the Till Plains section of the same province and division. The area is a nearly level to gently undulating glaciated plain from the Wisconsin glacial period. It has relatively low relief on broad ground moraines and glacial lake plains and more rolling topography along the major river valleys and on end moraines. The area’s numerous end and recessional moraines generally form elongated ridges trending from northwest to southeast. Elevation ranges from 380 to 980 feet (110 to 300 meters), increasing gradually from Lake Michigan south. Streams have cut shallow valleys on much of the plain. Local relief is typically 10 to 25 feet (3 to 8 meters). The Des Plaines, Illinois, Kankakee, and Vermilion Rivers flow through the MLRA.

Geology

The surface of this area is covered by glacial drift of Wisconsin age. Till, outwash, lacustrine deposits, loess or other silty material, and organic deposits are common. Silurian dolomite and limestone bedrock lie beneath the glacial drift.

Climate

The annual precipitation ranges from 33 to 40 inches (830 to 1,030 millimeters) with a mean of 37 inches (950 millimeters). The annual temperature ranges from 46 to 52 degrees F (8 to 11.2 degrees C) with a mean of 50 degrees F (10.1 degrees C). The freeze-free period ranges from 155 to 210 days with a mean of 180 days. It is longest in a narrow belt along Lake Michigan.

Water

In most years the favorably distributed, moderate precipitation is adequate for crops. Ground water is the primary source of the municipal water supply, except in the Chicago, Gary, and Milwaukee areas, where water is taken directly from Lake Michigan. Abundant ground water in shallow glacial outwash deposits (unconsolidated sand and gravel) meets the domestic and municipal needs in much of the MLRA. Some irrigation water is pumped from areas underlain by extensive outwash deposits. Isolated lenses of sand and gravel buried in the glacial till also provide some ground water throughout the area. Fractured limestone and dolomite bedrock beneath the glacial drift is also a source of ground water.

Soils

The dominant soil orders are Mollisols and, to a lesser extent, Alfisols and Entisols. The soils in the area have a mesic temperature regime, an aquic or udic moisture regime, and mixed or illitic mineralogy. They generally are very deep, very poorly drained to moderately well drained, and silty, loamy, or clayey.

The main soils and their series:

- Argiudolls that formed in loess over till (Elliott series) or in till or lacustrine deposits (Swygert series) on till plains
- Endoaquolls that formed in lacustrine deposits on glacial lake plains (Milford series); that formed in colluvium or lacustrine deposits over till on till plains (Ashkum and Bryce series); that formed in loess over outwash on till plains and outwash plains (Drummer series); that formed in outwash on outwash plains or lake plains (Selma series)
- Hapludalfs that formed in loess over till on till plains (Markham and Ozaukee series)
- Udorthents that formed in human-altered and human-transported materials in urban areas (Anthroportic Udorthents)

Biological Resources

When this area was settled, about 60 percent of the total acreage supported tallgrass prairie vegetation dominated by big bluestem, Indiangrass, little bluestem, and prairie dropseed. Currently, cattails, bulrushes, and sedges grow on organic soils in marshes. A few bogs support tamarack, pitcherplant, sundew, cranberry, leatherleaf, winterberry, and bog birch. Major wildlife species include white-tailed deer, coyote, fox, beaver, raccoon, and Canada goose.

Land Use

Most of this area is in farms, but about 30 percent is used for urban development (fig. 110-2). Urban agriculture is locally important. Some land formerly used for crops is rapidly becoming urbanized. Farmed areas are used mainly to produce corn and soybeans. Other feed grains and hay are grown to support the local livestock industry. The forested areas are mainly on steep valley sides, in low-lying areas on flood plains, and on ridges formed by moraines.

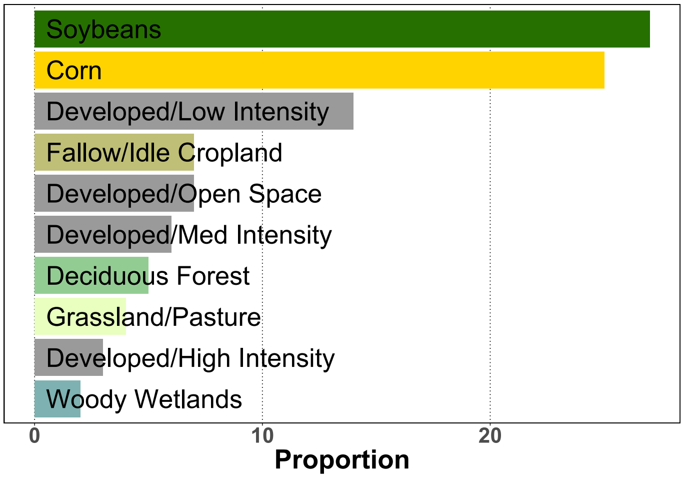

Figure 110-2: Relative proportions (percentages) of land use in MLRA 110.

The major resource concerns are water erosion, soil health, excessive soil wetness, flooding, surface water quality, and protection and restoration of wetland wildlife habitat. Conservation practices on cropland generally include conservation tillage systems (such as mulch-till, no-till, and strip-till), cover crops, crop rotations, and nutrient and pest management. Other practices include maintenance of tile drainage systems, grassed waterways, grade-stabilization structures, filter strips, and wildlife habitat management. Stormwater management helps to reduce ponding and flooding and improve water quality in urbanized areas.

111—Indiana and Ohio Till Plain

This MLRA (fig. 111-1) is a nearly level to undulating till plain with numerous recessional moraines. It is used to produce cash crops, feed grain, and hay for livestock. This area is in Indiana (53 percent), Ohio (44 percent), Michigan (2 percent), and Illinois (1 percent). It makes up about 34,294 square miles (88,821 square kilometers).

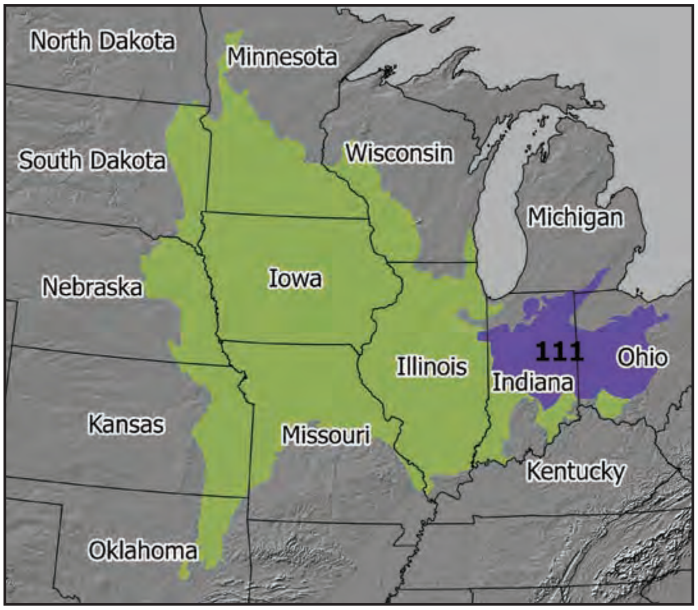

Figure 111-1: Location of MLRA 111, which covers 8,882,100 hectares (21,948,000 acres), within Region M.

MLRA 111 has a distinct boundary based on physiography with MLRAs 99 (Erie-Huron Lake Plain), 120C (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northeastern Part), 121 (Kentucky Bluegrass), and 124 (Western Allegheny Plateau).

MLRA 111 has a less apparent boundary with MLRAs 98, 108, 110, 114, and 139. The boundary with MLRA 98 (Southern Michigan and Northern Indiana Drift Plains) is based on sand content of the glacial deposits. The boundary with MLRA 108 (Illinois and Iowa Deep Loess and Drift) is based on thickness of the loess and density of the till. The boundary with MLRA 110 (Northern Illinois and Indiana Heavy Till Plain) is based on clay content of the glacial deposits. The boundary with MLRA 114 (Southern Illinois and Indiana Thin Loess and Till Plain) is based on thickness of the loess and age of the till. The boundary with MLRA 139 (Lake Erie Glaciated Plateau) is based on lime content of the till.

Areas of MLRA 114 that are too small to delineate at the publication scale are included in MLRA 111. These areas occur in the far eastern part in Ohio and along the southern boundary of MLRA 111 in Illinois, Indiana, and Ohio.

Physiography

This area is mostly in the Till Plains section of the Central Lowland province of the Interior Plains. Northern parts of this area are in the Eastern Lake section of the same province and division. The entire MLRA is glaciated and dominated by broad, nearly level to undulating ground moraines broken in places by kames, outwash plains, glacial lake plains, loess hills, stream terraces, flood plains, end moraines, and recessional moraines. In many places river valleys occur at the leading edge of the end moraines and recessional moraines. Some places along the large streams have steep slopes. Narrow, shallow valleys are common along the large rivers, and some places that parallel the major rivers and streams have deposits of sand. Elevation ranges from 280 to 1,550 feet (80 to 480 meters), increasing gradually from west to east. Relief is mainly a few meters, but some hills rise as much as 100 feet (30 meters) above the adjoining plains. Major rivers that flow through this area include the Huron, Sandusky, Tippecanoe, and Wabash Rivers.

Geology

Surface deposits in this area include Wisconsin-age till and glaciolacustrine deposits and outwash from Wisconsin and older glacial periods. A mantle of Peoria Loess covers much of the area. The loess is commonly less than 40 inches (1 meter) in thickness. Paleozoic shale, siltstone, sandstone, limestone, and dolostone bedrock lie beneath the glacial deposits.

Climate

The annual precipitation ranges from 34 to 46 inches (870 to 1,160 millimeters) with a mean of 40 inches (1,010 millimeters). The annual temperature ranges from 48 to 55 degrees F (8.9 to 12.9 degrees C) with a mean of 51 degrees F (10.5 degrees C). The freeze-free period ranges from 155 to 205 days with a mean of 180 days.

Water

In most years the moderate precipitation provides enough water for crops, but in some years yields are reduced by drought. Many of the wet soils require artificial drainage before they can be used for crops. Reservoirs on major rivers and their tributaries provide water for public, municipal, and industrial supplies and for cooling thermoelectric power plants. A few lakes and some of the reservoirs are also used for recreation.

The principal sources of ground water are shallow glaciofluvial deposits (unconsolidated sand and gravel along streams and in glacial channels), isolated lenses of sand and gravel buried in the glacial till, a glacial outwash aquifer (a sand and gravel deposit in northern Indiana and in Michigan), and fractured limestone and dolomite bedrock beneath the glacial drift.

Soils

The dominant soil orders in this MLRA are Alfisols and, to a lesser extent, Inceptisols and Mollisols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or illitic mineralogy. They are very deep, very poorly drained to well drained, and silty, loamy, or clayey.

The main soils and their series:

- Argiaquolls that formed in loess over till on till plains (Treaty series); that formed in till on till plains and lake plains (Pewamo series)
- Endoaquepts that formed in alluvium on flood plains (Shoals series)
- Epiaqualfs that formed in till (Bennington and Blount series) and in loess over till (Crosby and Fincastle series) on till plains
- Hapludalfs that formed in till (Miami and Miamian series) and in loess over till (Celina and Glynwood series) on till plains

Biological Resources

This area mostly supports hardwoods, but broad, nearly level uplands in the northwestern part of the area support prairie vegetation. Pin oak, swamp white oak, blackgum, American sycamore, green ash, silver maple, and eastern cottonwood grow on the wetter soils. White oak, northern red oak, black walnut, tuliptree, shagbark hickory, sugar maple, and white ash are major species on the better drained soils.

Major wildlife species include white-tailed deer, red fox, gray squirrel, raccoon, opossum, cottontail rabbit, quail, ducks, turkey, dove, and geese. Fishing is limited mostly to rivers, streams, and constructed impoundments. Fish species in the area include largemouth bass, smallmouth bass, flathead catfish, bullhead catfish, bluegill, and crappie.

Land Use

Most of this MLRA is in farms and mainly used to produce corn, soybeans, other feed grains, and hay for livestock (fig. 111-2). Dairying is an important enterprise near the cities. Truck and canning crops are grown extensively where the soils and markets are favorable. Some small areas along the major rivers are irrigated. There are small acreages of permanent pasture and farm woodlots. The forested areas are mainly on steep valley sides and in low-lying areas on flood plains. The pressure of urban expansion is high around the major towns and cities in the area.

The major resource concerns are water erosion, soil health, excessive soil wetness, the quality of surface and ground water, and loss of wildlife habitat. Conservation practices on cropland generally include conservation tillage systems (especially mulch-till, no-till, and strip-till), cover crops, crop rotations, and nutrient and pest management. Other practices include surface and subsurface drainage systems, filter strips, and wildlife habitat management. Stormwater management helps to reduce ponding and flooding and improve water quality in urbanized areas.

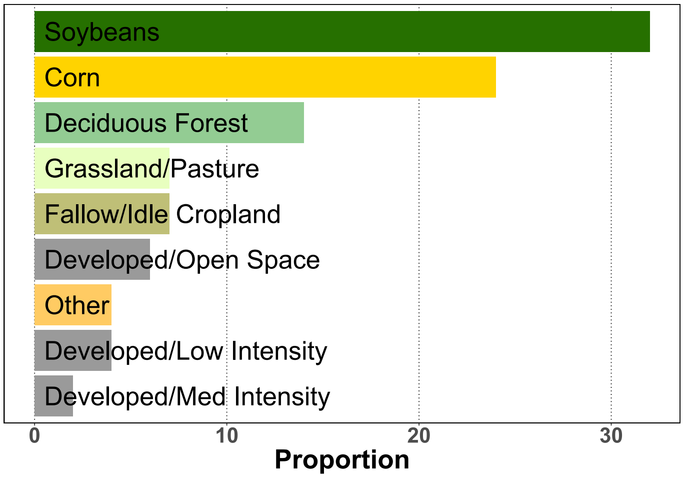

Figure 111-2: Relative proportions (percentages) of land use in MLRA 111.

112—Cherokee Prairies

MLRA 112 (fig. 112-1) is a gently undulating to rolling dissected plain covered by residuum, colluvium, and alluvium with low local relief. It is used for grassland and cropland. This area is in Kansas (48 percent), Oklahoma (29 percent), and Missouri (23 percent). It makes up about 20,885 square miles (54,092 square kilometers).

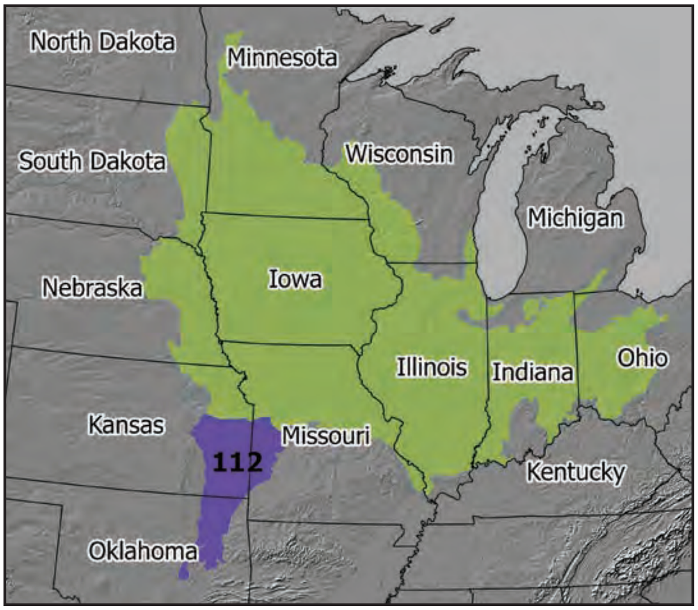

Figure 112-1: Location of MLRA 112, which covers 5,409,200 hectares (13,366,300 acres), within Region M.

MLRA 112 has a distinct boundary based on physiography with MLRAs 76 (Bluestem Hills), 84A (North Cross Timbers), 116A (Ozark Highland), 117 (Boston Mountains), 118A (Arkansas Valley and Ridges, Eastern Part), and 118B (Arkansas Valley and Ridges, Western Part). MLRA 112 has a less apparent boundary based on the boundary between the mesic and thermic soil temperature regimes with MLRAs 106 (Nebraska and Kansas Loess-Drift Hills), 107 (Iowa and Missouri Deep Loess Hills), and 116B (Springfield Plain). Its boundary with MLRA 116B is also based on geology.

Physiography

This area is in the Osage Plains section of the Central Lowland province of the Interior Plains. Elevation ranges from 120 to 1,540 feet (30 to 470 meters). Although the area is thoroughly dissected, local relief typically is only 3 to 10 feet (1 to 3 meters) and major valleys generally are less than 8 feet (25 meters) below the adjacent uplands.

The Little Osage, Verdigris, and South Grand Rivers flow though this area. The Harry Truman Reservoir, the westernmost lake in the recreational area called Lake of the Ozarks, is in the part of this area in Missouri. The John Redmond Reservoir, a major reservoir on the Neosho River, is in the part in Kansas.

Geology

Most of this MLRA is underlain by Permian, Pennsylvanian, and Mississippian sandstone, shale, and limestone bedrock. The northern part of the area has a thin mantle of loess.

Climate

The annual precipitation ranges from 36 to 48 inches (900 to 1,230 millimeters) with a mean of 43 inches (1,080 millimeters). The annual temperature ranges from 53 to 62 degrees F (11.9 to 16.5 degrees C) with a mean of 57 degrees F (13.6 degrees C). The freeze-free period ranges from 190 to 245 days with a mean of 205 days.

Water

In many years the moderate precipitation is adequate for crops and pasture, but in some years summer droughts reduce crop yields. Small ponds and reservoirs on individual farms are important sources of water for livestock. Low river flow during dry periods is a major limitation affecting use of the water. Large reservoirs have been constructed to augment river flow. They provide water for industrial use and public supplies. Water from the John Redmond Reservoir on the Neosho River is piped to a nuclear power plant for use in evaporative cooling.

In much of the area, shallow wells are the principal sources of water for livestock and domestic use. Other sources of ground water are alluvial aquifers in the southern end of this area in Oklahoma and deep wells, especially in the dolomite and minor sandstone layers in the Ozark aquifer, in western Missouri.

Soils

The dominant soil orders are Mollisols and, to a lesser extent, Alfisols and Vertisols. The soils in the MLRA dominantly have a thermic soil temperature regime, an aquic or udic soil moisture regime, and mixed, smectitic, or siliceous mineralogy. They generally are moderately deep to very deep, well drained to poorly drained, and loamy, silty, or clayey.

The main soils and their series:

- Albaqualfs that formed in old alluvium or residuum on interfluves, divides, and paleoterraces (Parsons series)
- Argiaquolls that formed in sediments on interfluves, divides, and paleoterraces (Woodson series)
- Argiudolls that formed in residuum (Bates, Dennis, Eram, and Wagstaff series) and in colluvium mixed with residuum (Summit series) on interfluves and hillslopes; that formed in loess or old alluvial sediments on plains and paleoterraces (Kenoma series)
- Epiaquerts that formed in clayey alluvium on flood plains (Osage series)
- Hapludolls that formed in alluvium on flood plains (Verdigris series); that formed in colluvium or residuum on interfluves and hillslopes on plains (Zaar series)

Biological Resources

The western part of this area generally supports tall prairie grasses. Big bluestem, little bluestem, Indiangrass, and switchgrass are the main species. The eastern part of the area and the valleys in the western part support hardwoods, mainly northern red oak, white oak, and shagbark hickory. Islands of tall prairie grasses are common.

Major wildlife species include white-tailed deer, cottontail rabbit, fox squirrel, bobwhite quail, and mourning dove. Fish species in the area include bass, bluegill, crappie, carp, channel catfish, black bullhead, and flathead catfish.

Land Use

This MLRA is mostly rangeland, hayland, and pasture (fig. 112-2). The cropland is used to produce winter wheat, soybeans, corn, grain sorghum, and other feed grains. More than two-fifths of the area supports pasture grasses and legumes. The forested areas are mainly on steep valley sides and in low-lying areas on flood plains.

The major resource concerns on cropland are water erosion, soil health, surface compaction, and low soil pH. The major resource concerns on pasture and rangeland are plant productivity, health, and vigor and noxious and invasive plants. Conservation practices on cropland generally include the use of high-residue crops in the cropping system, conservation tillage

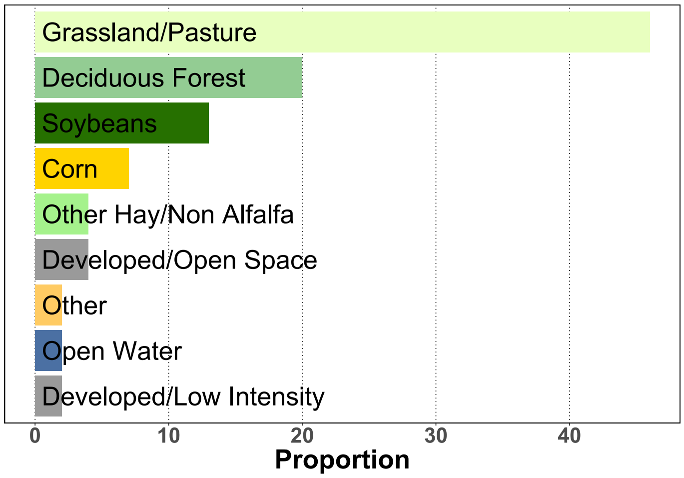

Figure 112-2: Relative proportions (percentages) of land use in MLRA 112.

systems (such as no-till, strip-till, and mulch-till), a combination of gradient terraces and grassed waterways, contour farming, crop rotations, and nutrient and pest management. Conservation practices on rangeland generally include prescribed grazing, brush management, and proper distribution of watering facilities.

113—Central Claypan Areas

MLRA 113 (fig. 113-1) is a loess-covered, nearly level to undulating till plain of Illinoian age or older. It is used to produce cash crops, feed grain, hay, and livestock. The soils have a high clay content in the subsoil or in the underlying paleosol in till. This MLRA is in Illinois (69 percent) and Missouri (31 percent) in two separate areas. It makes up about 12,656 square miles (32,778 square kilometers).

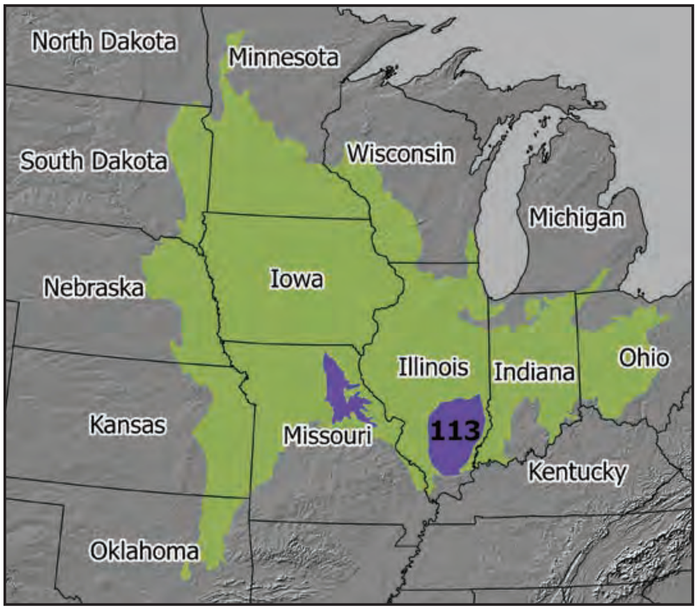

Figure 113-1: Location of MLRA 113, which covers 3,277,800 hectares (8,099,500 acres), within Region M.

MLRA 113 has a distinct boundary based on physiography with MLRAs 108 (Illinois and Iowa Deep Loess and Drift), 109 (Iowa and Missouri Heavy Till Plain), 115 (Central Mississippi Valley Wooded Slopes), and 120A (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part). It has a less apparent boundary based on thickness of the loess with MLRA 114 (Southern Illinois and Indiana Thin Loess and Till Plain).

Physiography

The part of this area in Illinois is in the Till Plains section of the Central Lowland province of the Interior Plains. The part in Missouri is in the Dissected Till Plains section. River valleys are shallow and generally narrow. Elevation ranges from 240 to 1,020 feet (70 to 310 meters), increasing gradually from south to north in both States. Local relief on broad, flat till plains and flood plains is mainly 5 to 10 feet (1.5 to 3 meters). Carlyle Lake, a major reservoir on the Kaskaskia River, is in the part of this area in Illinois. Mark Twain Lake, a major reservoir on the Salt River, is in the part in Missouri.

Geology

The eastern part of this MLRA is covered by Peoria Loess, which is underlain by Illinoian-age till. The western part has a mantle of Peoria Loess or Pre-Wisconsin-age loess overlying Nebraskan-age and Kansan-age till. The till in this MLRA generally has a high content of clay and commonly contains remnants of a paleosol. Pennsylvanian limestone and shale bedrock lie beneath the till.

Climate

The annual precipitation ranges from 39 to 48 inches (970 to 1,230 millimeters) with a mean of 43 inches (1,080 millimeters). The annual temperature ranges from 51 to 57 degrees F (10.7 to 13.7 degrees C) with a mean of 55 degrees F (12.5 degrees C). The freeze-free period ranges from 180 to 205 days with a mean of 195 days.

Water

In most years the moderate precipitation is adequate for crops. Most of the soils are somewhat poorly drained or poorly drained, and the presence of claypans reduces the effectiveness of artificial drainage. Reservoirs have been built on some of the larger rivers to provide drinking water and water for industries. The surface water also is used for cooling thermoelectric plants and in mineral extraction. Small to moderate quantities of ground water are available in this area. Sources of ground water are glacial drift in the part of this area in Missouri and Pennsylvanian-Mississippian bedrock in the part in Illinois.

Soils

The dominant soil order in this MLRA is Alfisols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and loamy, silty, or clayey. Although limited in extent, some soils have a natric horizon in the part of the MLRA in Illinois.

The main soils and their series:

- Albaqualfs that formed in loess over pedisediment over till on till plains (Cisne and Putnam series)
- Epiaqualfs that formed in loess over pedisediment over till (Bluford and Mexico series) and in loess over till (Leonard series) on till plains
- Fragiudalfs that formed in loess over pedisediment over till on till plains (Ava series)
- Hapludalfs that formed in till (Hickory series) and in loess over pedisediment over till (Armstrong, Hoyleton, and Keswick series) on till plains

Biological Resources

When this MLRA was settled, most of the level soils on uplands supported tall prairie grasses, mainly big bluestem, Indiangrass, prairie dropseed, and switchgrass. Currently, forests of post oak, swamp white oak, blackjack oak, and pin oak grow on poorly drained soils. White oak, shingle oak, black oak, hickory, white ash, basswood, sugar maple, elm, and walnut grow on the better drained soils. Silver maple, willow, eastern cottonwood, American sycamore, elm, pin oak, white oak, hickory, and ash grow on flood plains.

Major wildlife species include white-tailed deer, coyote, turkey, and bobwhite quail. Fish species include carp, catfish, largemouth bass, bluegill, crappie, and sunfish.

Land Use

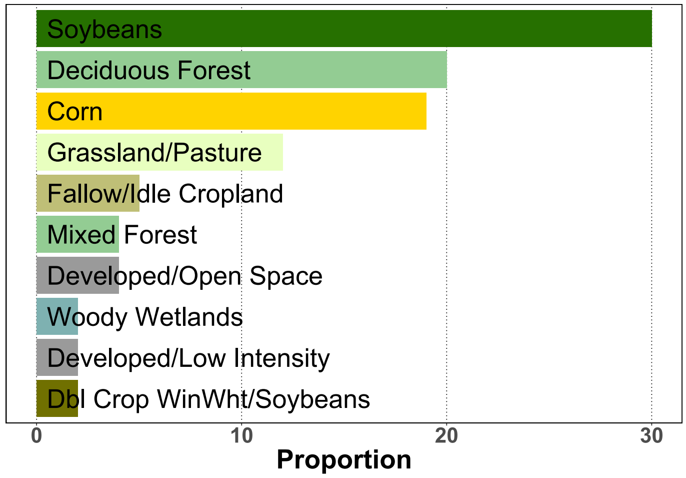

Figure 113-2: Relative proportions (percentages) of land use in MLRA 113.

Most of this MLRA is in farms (fig. 113-2). Corn, soybeans, other feed grains, and hay for cattle and other livestock are the principal crops. The grassland supports introduced and native grasses. The forested areas are mainly on steep valley sides and in low-lying areas on flood plains.

The major soil resource concerns are water erosion, soil health, excessive soil wetness, flooding, and a limited available water capacity. Conservation practices on cropland generally include conservation tillage systems, cover crops, and nutrient and pest management. Other practices include surface and subsurface drainage systems and filter strips.

114—Southern Illinois and Indiana Thin Loess and Till Plain

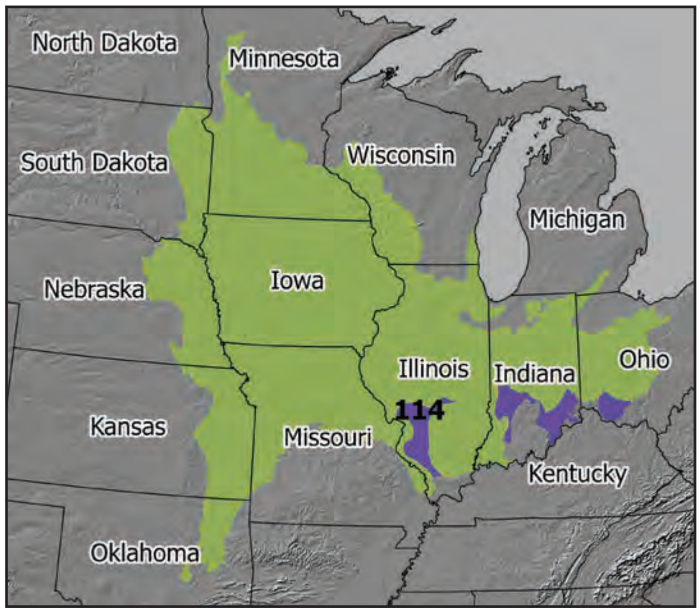

Figure 114-1: Location of MLRA 114, which covers 2,690,400 hectares (6,648,000 acres), within Region M.

This MLRA (fig. 114-1) is a loess-covered till plain with broad, nearly level summits and steeper slopes in areas dissected by tributaries of the Ohio and Mississippi Rivers. It is used to produce cash crops, feed grain, and livestock. This MLRA is in Indiana (47 percent), Illinois (38 percent), and Ohio (15 percent) in four separate areas. It makes up about 10,388 square miles (26,904 square kilometers).

MLRA 114 has a distinct boundary based on physiography with MLRAs 108 (Illinois and Iowa Deep Loess and Drift), 115 (Central Mississippi Valley Wooded Slopes), 120A (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part), 120B (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northwestern Part), 120C (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northeastern Part), 121 (Kentucky Bluegrass), and 124 (Western Alleghany Plateau).

MLRA 114 has a less apparent boundary with MLRAs 111 and 113. The boundary with MLRA 111 (Indiana and Ohio Till Plain) is based on thickness of the loess and age of the till. The boundary with MLRA 113 (Central Claypan Areas) is based on thickness of the loess.

Physiography

This area is in the Till Plains section of the Central Lowland province of the Interior Plains. Well defined valleys with broad flood plains and numerous stream terraces are along the major streams and rivers. The flood plains along the smaller streams are narrow. Broad summits are nearly level or gently sloping. Steep slopes are along rivers and streams. Elevation ranges from 310 feet (90 meters) on the southernmost flood plains to 1,340 feet (410 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters) but can be 50 to 100 feet (15 to 30 meters) along drainageways and streams.

The Little Miami River flows through the part of this MLRA in Ohio. The Ohio River flows along the southernmost boundary in some parts of this area in Ohio. The Kaskaskia River flows through the part of this area in Illinois. Tributaries to the Mississippi and Ohio Rivers drain this MLRA.

Geology

This area is covered dominantly by loess and Illinoian-age till or outwash. Most of the loess is Late Wisconsin-age Peoria Loess. In some places the Peoria Loess in underlain by Early Wisconsin-age Roxana Silt or by sandier or grittier loess. The loess ranges from 3 to 7 feet (1 or 2 meters) in thickness on stable summits and does not occur on some of the steeper slopes. The underlying Illinoian-age till and outwash commonly contain a paleosol. Meltwater outwash and lacustrine and alluvial deposits are on some of the stream terraces along the major tributaries. The till and outwash are underlain by several bedrock systems. Mississippian and Pennsylvanian bedrock occurs mostly in the western part of the MLRA. Ordovician, Silurian, and Devonian bedrock occurs mostly in the central part. Bedrock outcrops are common on the bluffs along the large rivers and their major tributaries. They also are evident at the base of steep slopes along minor streams and drainageways.

Climate

The average annual precipitation ranges from 39 to 47 inches (990 to 1,190 millimeters) with a mean of 42 inches (1,060 millimeters). The annual temperature ranges from 53 to 56 degrees F (11.8 to 13.6 degrees C) with a mean of 55 degrees F (13 degrees C). The freeze-free period ranges from 185 to 215 days with a mean of 200 days.

Water

In most years the supply of moisture is adequate for crop production, except on sandy soils. In some years, yields are reduced by drought. The many springs, farm ponds, and streams are sources of surface water. Some water for livestock is stored in small ponds and reservoirs. The larger rivers and reservoirs provide water for industrial and municipal uses and some limited irrigation and for cooling thermoelectric power plants. A few large streams are used mostly for recreation. The surface water is suitable for most uses.

The primary sources of ground water are deposits of unconsolidated sand and gravel along major rivers. Away from the river valley deposits, the sources of ground water are fractured bedrock and isolated lenses of sand and gravel buried in older glacial till.

Soils

The dominant soil orders are Alfisols and Entisols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They are deep or very deep, poorly drained to well drained, and loamy, silty, or clayey. Although limited in extent, some soils have a natric horizon in the part of the MLRA in Illinois.

The main soils and their series:

- Albaqualfs that formed in loess or loess over pedisediment on till plains (Marine series)
- Endoaqualfs that formed in loess or loess over pedisediment on till plains (Oconee series)
- Fluvaquents that formed in alluvium on flood plains (Wakeland series)
- Fragiudalfs that formed in loess over pedisediment over till (Cincinnati series) and loess over till (Rossmoyne series) on till plains
- Glossaqualfs that formed in loess over till on till plains (Avonburg, Clermont, and Cobbsfork series)
- Hapludalfs that formed in till (Hickory series) and loess over pedisediment (Homen series) on till plains

Biological Resources

The soils on uplands support natural hardwoods. Oak, hickory, beech, and sugar maple are the dominant species. Native grasses grow in some scattered areas between the trees. The soils in low-lying areas support mixed forest vegetation. Pin oak, shingle oak, sweetgum, and black oak are the dominant species on the wetter sites. White oak, black oak, northern red oak, hickory, yellow-poplar, ash, sugar maple, and black walnut grow on the better drained sites. Honeylocust is dominant on soils that formed in shaly limestone residuum. Silver maple, eastern cottonwood, American sycamore, pin oak, elm, and sweetgum grow along rivers and streams. Black walnut is abundant on very deep, well drained soils on some small flood plains. Sedge and grass meadows and scattered trees are on some low-lying sites.

Major wildlife species include white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, turkey vulture, turkey, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, and bobwhite quail.

Land Use

Most of this MLRA is in farms and used to produce corn, soybeans, and livestock (fig. 114-2). Some small grains, including winter wheat, oats, and grain sorghum, also are grown. A small acreage is used for specialty crops, such as popcorn and apple orchards. The grassland supports introduced and native grasses. The forested areas are mainly on steep valley sides and in low-lying parts of flood plains. Surface coal mines make up a small acreage.

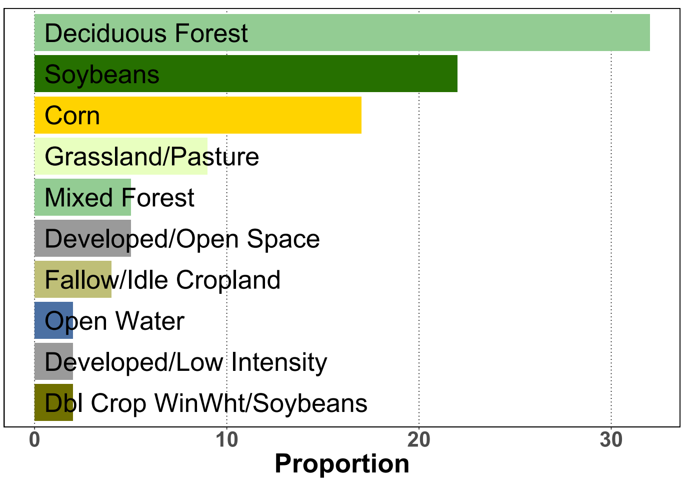

Figure 114-2: Relative proportions (percentages) of land use in MLRA 114.

The major soil resource concerns are wind erosion, water erosion, soil health, flooding, excessive soil wetness, and a limited available water capacity. Conservation practices on cropland generally include conservation tillage systems, cover crops, and nutrient and pest management. Other practices include surface and subsurface drainage systems, filter strips, and soil moisture management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important for timber production.

115—Central Mississippi Valley Wooded Slopes

This MLRA (fig. 115-1) is characterized by deeply dissected, loess-covered hills bordering well defined valleys of the Illinois, Mississippi, Missouri, Ohio, and Wabash Rivers and their tributaries. It is used to produce cash crops and livestock. About one-third of the area is forested, mostly on the steeper slopes. This area is in Illinois (50 percent), Missouri (36 percent), Indiana (13 percent), and Iowa (1 percent) in two separate

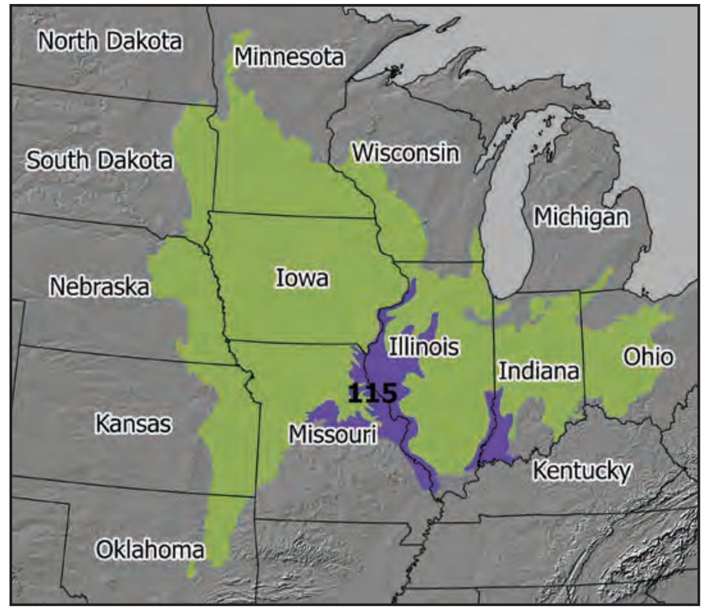

Figure 115-1: Location of MLRA 115, which covers 6,496,700 hectares (16,053,600 acres), within Region M.

areas. It makes up about 25,084 square miles (64,967 square kilometers).

MLRA 115 has a distinct boundary based on physiography with MLRAs 104 (Eastern Iowa and Minnesota Till Prairies), 105 (Upper Mississippi River Bedrock Controlled Uplands and Valleys), 107 (Iowa and Missouri Deep Loess Hills), 108 (Illinois and Iowa Deep Loess and Drift), 109 (Iowa and Missouri Heavy Till Plain), 113 (Central Claypan Areas), 114 (Southern Illinois and Indiana Thin Loess and Till Plain), and 116A (Ozark Highland).

MLRA 115 has a less apparent boundary with MLRAs 120A, 120B, 131A, and 134. The boundary with MLRAs 120A (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part) and 120B (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northwestern Part) is based on thickness of loess. The boundary with MLRAs 131A (Southern Mississippi River Alluvium) and 134 (Southern Mississippi Valley Loess) is based on the boundary between the mesic and thermic soil temperature regimes.

Physiography

Most of this area is in the Till Plains section and the Dissected Till Plains section of the Central Lowland province of the Interior Plains. The Springfield-Salem plateaus section of the Ozarks Plateaus province of the Interior Highlands occurs along the Missouri River and the Mississippi River south of the confluence with the Missouri River. The nearly level to very steep uplands are dissected by both large and small tributaries of the Illinois, Mississippi, Missouri, Ohio, and Wabash Rivers. The Ohio River flows along the southernmost boundary of this area in Indiana. Well defined valleys with broad flood plains and numerous stream terraces are along the major streams and rivers. The flood plains along the smaller streams are narrow. Broad summits are nearly level to undulating. Karst topography is common in some parts along the Missouri and Mississippi Rivers and their tributaries. Well developed karst areas have hundreds of sinkholes, caves, springs, and losing streams. In the St. Louis area, many of the karst features have been obliterated by urban development.

Elevation ranges from 90 feet (20 meters) on the southernmost flood plains to 1,030 feet (320 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters) but can be 50 to 150 feet (15 to 45 meters) in the steep, deeply dissected hills bordering rivers and streams. The bluffs along the major rivers are generally 200 to 350 feet (60 to 105 meters) above the valley floor.

Geology

The uplands in this MLRA are covered almost entirely with Peoria Loess. The loess can be more than 7 feet (2 meters) thick on stable summits. On the steeper slopes, it is thin or does not occur. In Illinois, the loess is underlain mostly by Illinoian-age till that commonly contains a paleosol. Pre-Illinoian-age till is in parts of this MLRA in Iowa and Missouri and to a minor extent in the western part of Illinois. Wisconsin-age outwash, alluvial deposits, and sandy eolian material are on some of the stream terraces and on dunes along the major tributaries. The loess and glacial deposits are underlain by several bedrock systems. Pennsylvanian and Mississippian bedrock are the most extensive. To a lesser extent are Silurian, Devonian, Cretaceous, and Ordovician bedrock. Karst areas have formed where limestone is near the surface, mostly in the southern part of the MLRA along the Mississippi River and some of its major tributaries. Bedrock outcrops are common on the bluffs along the Mississippi, Ohio, and Wabash Rivers and their major tributaries and at the base of some steep slopes along minor streams and drainageways.

Climate

The annual precipitation ranges from 35 to 49 inches (880 to 1,250 millimeters) with a mean of 41 inches (1,050 millimeters). The annual temperature ranges from 48 to 58 degrees F (8.6 to 14.3 degrees C) with a mean of 54 degrees F (12.3 degrees C). The freeze-free period ranges from 150 to 220 days with a mean of 195 days.

Water

In most years the supply of moisture is adequate for crop production, but in some years yields on sandy soils are reduced by drought. Surface water is abundant in this MLRA. Water for livestock is stored in small ponds and reservoirs. The larger rivers provide water for public supply, industrial and municipal use, and some limited irrigation. The Mississippi, Missouri, and Ohio Rivers are major transportation arteries. These rivers and their major tributaries also are used for recreation. Although most areas along the Mississippi, Missouri, and Ohio Rivers are protected by a levee system, flooding remains a major concern.

Abundant ground water occurs in deposits of unconsolidated sand and gravel along the larger rivers throughout this area. These aquifers provide water for domestic use, livestock, municipal and industrial needs, and some limited irrigation. Away from the river valley deposits, the sources of ground water are fractured bedrock and, to a lesser extent, isolated lenses of sand and gravel buried in older glacial till or glacial drift aquifers.

Soils

The dominant soil orders are Alfisols and, to a lesser extent, Entisols and Mollisols. The soils in the area have a mesic soil temperature regime, an aquic or udic soil moisture regime, and mixed or smectitic mineralogy. They are shallow to very deep, excessively drained to poorly drained, and loamy, silty, or clayey.

The main soils and their series:

- Argiudolls that formed in loess on interfluves (Ipava series)
- Fluvaquents that formed in alluvium on flood plains (Wakeland series)
- Fragiudalfs that formed in loess on hills (Hosmer series)
- Hapludalfs that formed in loess on hills, benches, and high stream terraces (Fayette, Menfro, Rozetta, and Winfield series); that formed in till (Hickory series) and loess over pedisediment over till (Keswick series) on till plains
- Paleudalfs that formed in colluvium and residuum on hills (Goss series)

Biological Resources

The soils on uplands in this area support natural hardwoods. Oak, hickory, and sugar maple are the dominant species. Big bluestem, little bluestem, and scattered oak and eastern redcedar grow on some sites. The soils on flood plains support mixed forest vegetation, mainly American elm, eastern cottonwood, river birch, green ash, silver maple, sweetgum, American sycamore, pin oak, pecan, and willow. Sedge and grass meadows and scattered trees are on some low-lying sites.

Major wildlife species include white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, cottontail rabbit, fox squirrel, gray squirrel, Canada goose, bald eagle, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, ring-necked pheasant, and bobwhite quail.

Land Use

Most of this area is in farms and mainly used to produce corn, soybeans, and livestock (fig. 115-2). Some small grains,

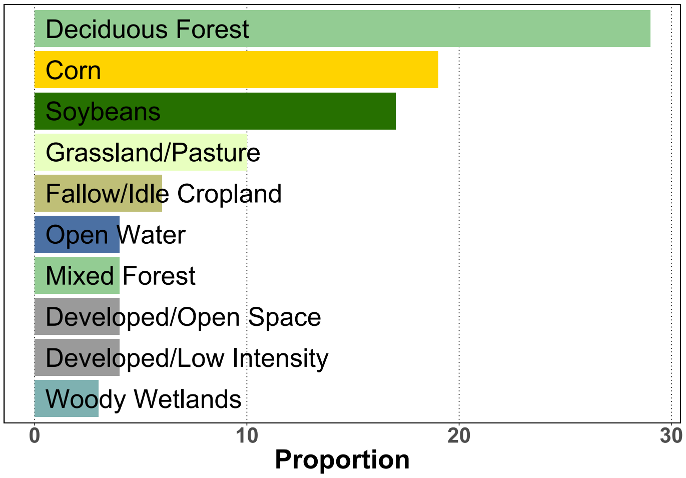

Figure 115-2: Relative proportions (percentages) of land use in MLRA 115.

such as winter wheat, grain sorghum, and oats, also are grown. Some areas on broad stream terraces and outwash plains are irrigated. A small acreage is used for specialty crops, such as watermelons, pumpkins, vegetables, and apple and peach orchards. The grassland supports introduced and native grasses. About one-third of the MLRA is forested. The forested areas are mainly on steep valley sides and in low-lying areas on flood plains. Urban development is expanding around some of the larger towns and cities. Surface coal mines make up a small percentage of this MLRA.

The major soil resource concerns are wind erosion, water erosion, soil health, flooding, excessive soil wetness, a limited available water capacity, and surface water quality. Conservation practices on cropland generally include conservation tillage systems (especially no-till), cover crops, and nutrient and pest management. Other practices include surface and subsurface drainage systems, windbreaks, and vegetative wind barriers. Woodland management practices, such as grazing exclusion and timber stand improvement, are important for timber production. Stormwater management helps to reduce ponding and flooding and improve water quality in urbanized areas.

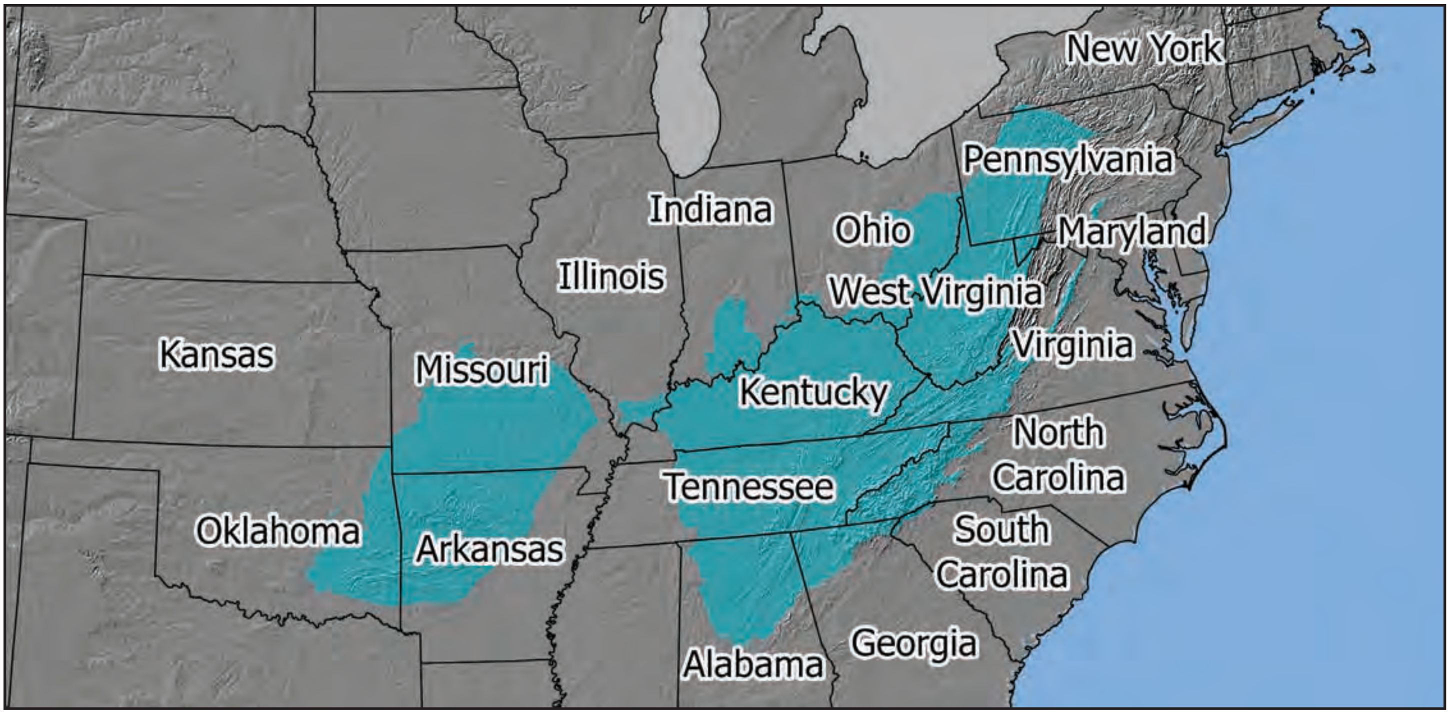

Figure N-1: Location and size of Land Resource Region N, which covers 613,492 square kilometers (236,870 square miles). It extends from its northern boundary with glacial drift in Pennsylvania, southward to its contact with the coastal plain in Alabama, and westward beneath the coastal plain, until it emerges as highland in Missouri, Arkansas, and Oklahoma.

N—East and Central Farming and Forest Region

Land Resource Region N (fig. N-1) is the Paleozoic bedrock region higher in elevation than the neighboring glacial drift area to the north, the igneous-metamorphic piedmont to the southeast, and the unconsolidated coastal plain sediments to the south. It extends west from the metasedimentary rocks of the Blue Ridge across the folded and thrust-faulted sedimentary rocks of the Valley and Ridge, the undeformed clastic rocks of the Appalachian Plateaus, the limestones of the Interior Low Plateaus of middle Tennessee and Kentucky, and the Ouachita province and Ozark Plateaus of Arkansas and Missouri.

The Blue Ridge consists of rugged mountains. The Valley and Ridge is characterized by long, linear, forested ridges and valleys with cropland. The Appalachian Plateaus, which stretch from central Pennsylvania to northern Georgia, consist of dissected plateaus and rugged bands of mainly forested mountains and high hills underlain by shale, sandstone, coal, and some limestone. The Interior Low Plateaus are gently rolling on level-bedded limestone. The Ouachita province has folded and thrust-faulted bedrock similar to the Valley and Ridge. The dissected landscape of the Ozark Plateaus is underlain by limestone, sandstone, shale, and small areas of igneous bedrock. Region N contains 21 major land resource areas. The extent of these MLRAs and their range in elevations are shown in table N-1.

Region N's boundary with Region M to the west (fig. 1, page 5) is a readily recognizable change in parent material, elevation, and landforms. Its boundaries with Regions M and R to the north are the least recognizable, marked by the extent of glaciation. Its boundary with Region S to the south demarks the transition from a predominance of valleys to a predominance of ridges (i.e., the Valley and Ridge of the south transitions to the Valley and Ridge of the north).

Climatically, the region has an udic soil moisture regime with aquic conditions confined to topographic low areas. The mean annual precipitation in most of the region is 42 to 57 inches (1,060 to 1,445 millimeters), but the southern, high-elevation parts of the Blue Ridge may receive as much as 119 inches (3,025 millimeters). The mean annual air temperature in most of the region is 52 to 61 degrees F (11 to 16 degrees C). The mean freeze-free period generally ranges from 175 to 230 days, but it is considerably shorter in the high-elevation areas in North Carolina, Virginia, and West Virginia. The mean annual air temperature and the length of the freeze-free period increase from north to south and with decreasing elevation. Mean annual temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables N-2 and N-3.

Table N-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
116A	85,855	33,150	60	200	170	560	280	920	380	1,260	670	2,210
116B	14,200	5,480	180	610	260	870	340	1,120	420	1,400	520	1,720
116C	4,100	1,585	110	360	190	630	270	880	360	1,180	540	1,770
117	17,170	6,630	50	170	170	570	360	1,200	560	1,860	780	2,570
118A	17,055	6,585	30	100	90	310	150	500	230	760	830	2,740
118B	7,600	2,935	150	510	180	610	220	720	260	860	340	1,120
119	30,950	11,950	40	130	140	460	230	750	370	1,210	810	2,670
120A	23,440	9,050	20	80	110	370	140	480	200	680	320	1,060
120B	6,220	2,400	110	360	130	430	170	580	230	760	300	990
120C	2,550	986	110	390	170	560	220	730	260	880	320	1,050
121	26,660	10,295	110	370	180	590	240	810	280	940	440	1,440
122	54,480	21,035	40	140	150	490	220	730	300	1,010	610	2,000
123	15,305	5,910	20	90	160	530	220	730	290	960	630	2,080
124	32,510	12,555	140	470	220	720	290	970	380	1,260	630	2,080
125	55,825	21,555	150	520	270	900	420	1,380	630	2,090	1,280	4,210
126	45,345	17,505	150	500	210	710	300	1,000	380	1,260	590	1,950
127	49,395	19,070	160	540	440	1,450	610	2,000	910	2,990	1,480	4,860
128	57,655	22,260	40	150	170	560	290	950	680	2,240	1,430	4,710
129	20,500	7,915	30	120	130	430	210	710	380	1,260	710	2,330
130A	5,370	2,075	60	200	230	750	430	1,410	790	2,590	1,280	4,200
130B	41,320	15,955	200	650	410	1,370	740	2,430	1,120	3,690	2,030	6,670

Table N-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
116A	12.2	54	12.8	55	13.3	56	14.8	59	15.9	61	155	187	194/195	208	235
116B	12.5	54	13	55	13.3	56	14.2	57	15.2	59	180	189	196/195	203	215
116C	12.6	55	12.7	55	12.9	55	13.2	56	13.6	56	175	180	186/185	192	205
117	13	55	14.1	57	14.6	58	15.7	60	16.4	62	195	204	213/215	223	240
118A	13.9	57	15.6	60	16.1	61	16.3	61	16.8	62	200	216	222/225	233	255
118B	15.6	60	16.1	61	16.4	61	16.5	62	16.8	62	215	226	230/230	235	245
119	14.2	58	15.7	60	16.1	61	16.6	62	17.6	64	195	210	222/225	234	260
120A	13	55	13.4	56	13.9	57	14.4	58	15.3	59	175	195	203/200	207	220
120B	11.6	53	12.2	54	12.6	55	13.4	56	13.7	57	175	185	192/195	204	210
120C	11.2	52	11.6	53	12	54	12.7	55	14.3	58	175	182	191/190	201	210
121	11.6	53	12.4	54	12.8	55	13.3	56	14.4	58	175	188	200/200	203	210
122	11.3	52	13.3	56	14.2	58	14.8	59	16.1	61	175	194	199/200	208	220
123	13.4	56	14.3	58	14.5	58	14.8	59	15.5	60	190	196	199/200	205	220
124	8.2	47	9.6	49	10.8	51	12.4	54	13.2	56	145	162	175/175	188	210
125	9.6	49	11.9	53	12.9	55	13.6	56	16	61	160	179	192/190	203	230
126	8.6	48	10.4	51	11.2	52	12.4	54	13	55	150	169	176/175	187	205
127	6.2	43	7.1	45	8.5	47	10.6	51	12.6	55	115	136	156/155	173	200
128	8	46	11.5	53	14.6	58	16.4	61	17.7	64	140	174	202/200	219	285
129	13.5	56	14.6	58	15.8	60	16.9	62	17.4	63	185	204	215/215	222	235
130A	8.2	47	10.2	50	11.6	53	13.1	56	13.5	56	150	173	190/190	204	225
130B	7.8	46	10.6	51	12.5	54	14.4	58	16.2	61	135	163	181/185	205	230

Table N-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
116A	1,060	42	1,114	44	1,163/1,165	46/46	1,217	48	1,300	51
116B	1,090	43	1,120	44	1,150/1,150	45/45	1,170	46	1,230	48
116C	1,110	44	1,139	45	1,177/1,175	46/46	1,195	47	1,250	49
117	1,100	44	1,200	47	1,287/1,285	51/51	1,367	54	1,540	60
118A	1,140	45	1,184	47	1,257/1,250	50/49	1,294	51	1,480	58
118B	1,030	41	1,069	42	1,112/1,115	44/44	1,153	45	1,220	48
119	1,090	43	1,235	49	1,354/1,355	53/53	1,463	58	1,760	69
120A	1,120	44	1,164	46	1,222/1,220	48/48	1,280	50	1,310	52
120B	1,160	46	1,183	47	1,201/1,200	47/47	1,214	48	1,250	49
120C	1,130	45	1,152	45	1,175/1,170	46/46	1,187	47	1,200	47
121	1,010	40	1,074	42	1,145/1,140	45/45	1,185	47	1,250	49
122	1,110	44	1,195	47	1,291/1,310	51/52	1,439	57	1,560	61
123	1,220	48	1,290	51	1,356/1,365	53/54	1,451	57	1,520	59
124	950	38	1,003	39	1,039/1,060	41/42	1,153	45	1,280	50
125	1,050	41	1,124	44	1,237/1,270	49/50	1,481	58	1,940	76
126	920	37	1,002	39	1,083/1,090	43/43	1,194	47	1,340	53
127	900	36	1,048	41	1,155/1,180	45/46	1,359	53	1,800	71
128	910	36	1,064	42	1,307/1,265	51/50	1,421	56	1,600	63
129	1,290	51	1,379	54	1,443/1,445	57/57	1,503	59	1,740	68
130A	980	39	1,041	41	1,170/1,195	46/47	1,373	54	1,680	66
130B	920	36	1,104	43	1,372/1,400	54/55	1,748	69	2,540	100

The soils are dominantly Ultisols characterized by low-base (i.e., comparatively less calcium, magnesium, potassium, and sodium) forest soils with argillic horizons. A striking boundary between the Ultisols in Region N (which is non-glaciated) and the Inceptisols in Region R (which is glaciated) occurs in northern Pennsylvania (fig. 2, page 6). The highly weathered Ultisols in Region N formed primarily in residuum and colluvium and testify to the great age of the geomorphic surfaces in this unglaciated region. Inceptisols and Alfisols are also extensive. Inceptisols occur on flood plains, in colluvium along very steep slopes, in large areas of shale and sandstone residuum on the Appalachian Plateau, and in colluvium weathered from igneous and metamorphic rocks in the high mountains of the Blue Ridge. Alfisols formed in loess of the Ozark and Interior Low Plateaus but are most prominently associated with shallow limestone, as Hapludalfs with minor areas of Mollisols. The soils in Region N have a thermic, mesic, or frigid temperature regime, depending on latitude and elevation, and a udic moisture regime.

Carbonates are uncommon in soils of this region except in northern Kentucky near the boundary with the calcareous till of Region M and in the flood-plain soils of the Arkansas River that originate in drier climates where carbonates are common (fig. 5, page 9). Restrictive zones occur in many soil profiles as lithic and paralithic bedrock (fig. 9, page 13) as well as fragipans (fig. 11, page 15). Argillic horizons occur throughout Region N except in soils on the very steep slopes where Inceptisols are common and on younger fluvial landforms (figs. 2 and 12). High amounts of soil organic carbon occur in the Appalachian Mountains (fig. 14, page 18).

Land use in the region is dominated by deciduous forest (fig. N-2), but coniferous forests dominate the highest elevations. Forestry is an important industry. Oak, yellow-poplar, and pine are the main trees harvested. Grassland,

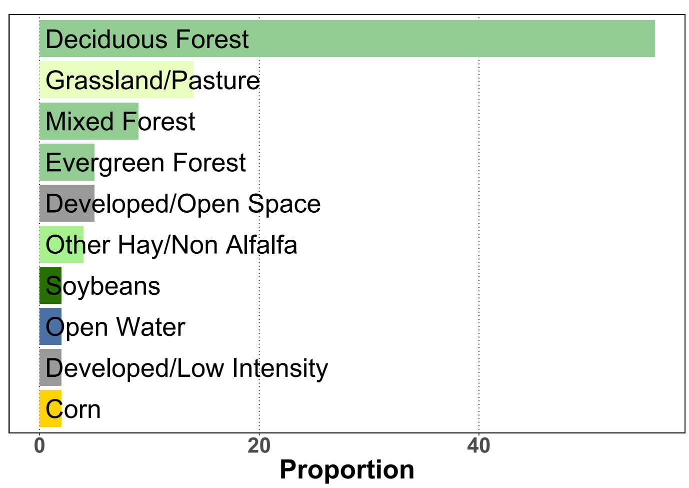

Figure N-2: Relative proportions (percentages) of land use in LRR N.

pasture, and hayland also make up much of this region. Because of the diverse topography and climate, the region has a wide range of natural ecosystems and land use (fig. 8, page 12). The major management concerns in areas of forestland are the erosion caused by harvest practices and maintenance of forest productivity. The concerns on cropland include maintenance of soil productivity, erosion control, and prevention of ground water contamination.

116A—Ozark Highland

MLRA 116A (fig. 116A-1) consists mainly of a deeply dissected plateau typically underlain by limestone, dolostone, and shale bedrock. A prevalence of soluble carbonate rock results in karst topography, which leads to the formation of springs, caves, sinkholes, and valleys. This MLRA is in southern Missouri (72 percent), northern Arkansas (23 percent), and northeastern Oklahoma (5 percent). It makes up about 33,150 square miles (85,857 square kilometers).

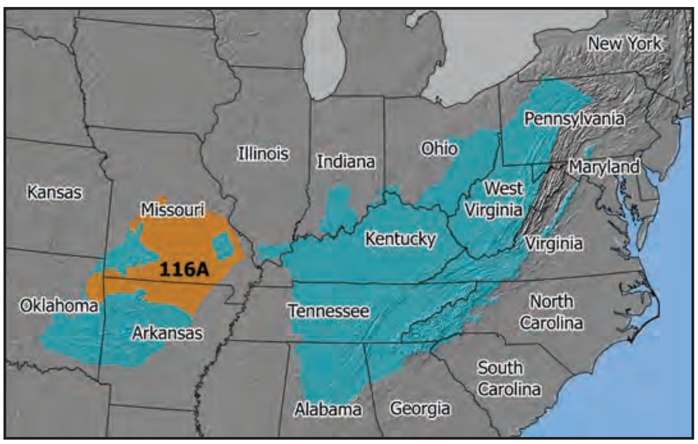

Figure 116A-1: Location of MLRA 116A, which covers 8,585,700 hectares (21,215,600 acres), within Region N.

MLRA 116A has a distinct boundary based on physiography with MLRAs 112 (Cherokee Prairies), 115 (Central Mississippi Valley Wooded Slopes), 116C (St. Francois Knobs and Basins), 117 (Boston Mountains), and 131A (Southern Mississippi River Alluvium). MLRA 112 is less dissected than MLRA 116A, its soils have a lower rock content, and it occurs along the boundary between the mesic and thermic soil temperature regimes. MLRA 115B is deeply dissected with higher relief. MLRA 116C has igneous rocks consisting primarily of granites with intruded rhyolites. MLRA 117 is characteristically deeply dissected with higher relief and hardwood forests. MLRA 131A has low relief and alluvial deposits.

MLRA 116A has a less apparent boundary with MLRA 116B (Springfield Plain). MLRA 116B has comparatively little dissection and low relief.

Physiography

This area is in the Springfield-Salem plateaus section of the Ozark Plateaus province of the Interior Highlands. The landscape ranges from highly dissected, steeply sloping wooded hills and narrow, gravelly valleys in the central and southern parts of the area to gently rolling prairie-like uplands in the northern part. Soluble carbonate rocks are the reason for a well-developed karst topography in the southern part of the area. This topography includes sinkholes, caves, dry valleys, box valleys, and large springs.

Elevation ranges from about 300 feet (90 meters) on the southeast edge of the Ozark escarpment to about 1,600 feet (490 meters) on the western side of the area. Relief is generally 200 to 800 feet (60 to 245 meters). It is highest in the southwestern part of the area. The geologic strata generally are horizontally bedded but there is a slight dip to the west and south away from the apex of the Ozark Uplift in southeast Missouri. The major rivers in this area are the Osage, Gasconade, Current, Black, James, White, and Buffalo Rivers. Streamflow is highest in winter and spring.

Geology

This MLRA has a variety of geologic formations. Most of the bedrock consists of sedimentary rocks, including Ordovician-age dolostone and sandstone, Lower Mississippian-age limestone and dolostone, and Pennsylvanian-age sandstone and shale. Remnants of an ancient loess deposit ranging from a few inches to several feet in thickness are on the nearly level upland divides. The loess is thickest in the northern and eastern parts of the area. Most of the exposed bedrock consists of limestone and dolostone formations that have thick layers of chert bedrock or chert fragments. The chert generally occurs in long, wavy beds less than 1 foot thick. In some places, however, it occurs in massive layers more than 6 feet (2 meters) thick. Several old and inactive geologic faults are in the MLRA.

Climate

The average annual precipitation in almost all of this MLRA is 38 to 45 inches (965 to 1,145 millimeters). It is as high as 49 inches (1,245 millimeters) in some small areas along the extreme southeast and south edges of the area. About 57 percent of the annual precipitation falls during the 6 warmest months of the year. Snow falls nearly every winter, but snow cover lasts for only a few days. The annual snowfall averages about 12 inches (305 millimeters). The average annual temperature is about 53 to 60 degrees F (12 to 16 degrees C). The lower temperatures occur at the higher elevations in the western part of the MLRA. The freeze-free period averages 210 days and ranges from 175 to 245 days. It is shortest at the higher elevations along the western edge of the MLRA. The longer freeze-free periods occur at the lower elevations.

Water

In most years precipitation is adequate for most agricultural uses, but summer droughts of sufficient severity and duration to reduce production are common. Streams, ponds, springs, and lakes provide surface water for livestock. Karst areas are common in much of the southern part of the MLRA, and many stretches of headwater streams in this part of the MLRA are dry or losing streams. This water flows to underground systems and surfaces elsewhere as springs. Springs are numerous, and spring flow is a major contributor to the base flow of many streams. The major springs are Big, Blanchard, Greer, Alley, Mammoth, and Round Springs. Large reservoirs in the MLRA provide hydroelectric power, flood control, and opportunities for recreation.

Ground water is abundant. The primary source is the Ozark aquifer in Missouri and Arkansas. This aquifer consists of consolidated dolomite with some minor beds of sandstone. It is about 1,000 feet below the ground surface in western Missouri. It provides good-quality water for public supply, irrigation, municipal and industrial uses, and domestic use. Water in the Ozark aquifer is hard or very hard but does not have high levels of iron. Because of the karst topography, contaminated water from surface activities has created some local water-quality problems in this bedrock aquifer. Hazardous waste, landfills, municipal and industrial wastewater, and agricultural activities have caused some bacteria and nitrate contamination.

The Roubidoux and Keokuk-Reeds Spring aquifers are in this MLRA. They occur only in a few counties in the northeast corner of Oklahoma. These aquifers are the only source of water for rural landowners and small communities in this part of the MLRA. The water is generally of good quality and suitable for most uses. Chloride, sulfate, and fluoride levels, however, exceed the national drinking water standards in some areas.

Soils

Most of the soils are Alfisols or Ultisols. The soils in the area formed in material weathered from cherty limestone. Most of the northern and eastern parts of the MLRA are partly covered with a thin mantle of loess. Physical and chemical weathering has caused the cherty limestone to disintegrate into its least soluble components, which are chert and clay. The chert remains in the form of angular fragments or wavy horizontal beds interstratified with layers of clay. Downslope movement by gravitational creep and overland waterflow has altered the cherty material in the upper part of some soils. In general, the soils are shallow to very deep, moderately well drained to excessively drained, and medium textured to fine textured. The soil temperature regime is mesic bordering on thermic, the soil moisture regime is udic, and mineralogy is mixed or siliceous.

The main soils and their series:

Fragiudalfs on nearly level to moderately sloping upland divides (Viraton series)

Fragiudults on nearly level to moderately sloping upland divides (Scholten series)

Hapludalfs on moderately sloping to steep side slopes in the uplands (Gatewood series)

Hapludults on moderately sloping to steep side slopes in the uplands (Bendavis series)

Mollisols in glades (Moko series)

Paleudalfs on nearly level to moderately sloping upland divides (Gepp series); on moderately sloping to steep side slopes in the uplands (Alred and Goss series)

Paleudults on moderately sloping to steep side slopes in the uplands (Clarksville and Poynor series)

Biological Resources

Oak, hickory, and shortleaf pine are the major tree species in the forested areas of this MLRA. Eastern redcedar is a common invader in glades and abandoned fields. Most of the less sloping areas have been cleared and planted to cool-season grasses. Fescue is the dominant introduced grass species. Glade openings support warm-season grasses, primarily big bluestem, Indiangrass, little bluestem, and dropseeds. Savanna restoration projects are underway in the national and State forests and parks. Major game species include white-tailed deer, eastern cottontail, raccoon, wood duck, wild turkey, smallmouth bass, and largemouth bass.

Land Use

The public lands in this area are used for timber production and recreational activities (fig. 116A-2). Most of the private lands are in farms and ranches. Forage and grain are grown for beef, dairy cattle, and other livestock. Raising cattle, both beef and dairy, is one of the major industries. Poultry production is important in the southwestern part of the MLRA. Specialized farming includes vineyards and small orchards. The areas along the Interstate 44 corridor and near the large lakes have

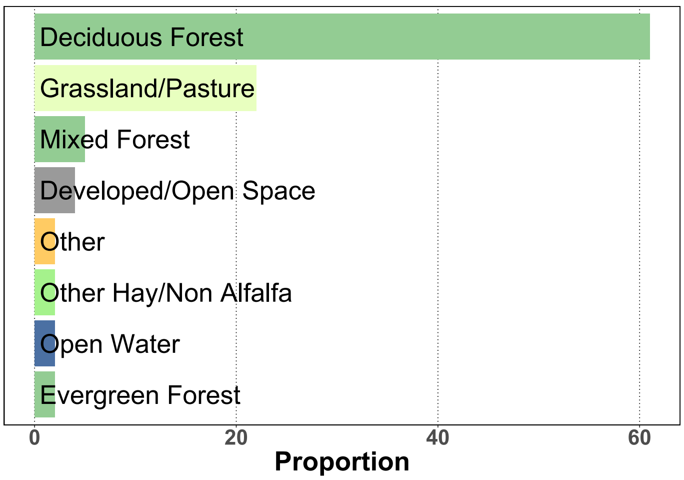

Figure 116A-2: Relative proportions (percentages) of land use in MLRA 116A.

a growing service industry oriented to recreation and tourism. Commercial and residential growth occurs mainly around large lakes, major highways, and the Branson area.

The major resource concerns are the quality of both surface and subsurface water; forest and grassland productivity, health, and vigor; and streambank erosion. The important conservation practices are forest stand improvement, prescribed grazing, development of springs, riparian forest buffers, nutrient management, and exclusion from use as needed.

116B—Springfield Plain

This MLRA (fig. 116B-1) is dominantly in southwest Missouri (90 percent) and extends for a short distance into the northeast corner of Oklahoma (9 percent) and southeast Kansas (1 percent). It makes up about 5,482 square miles (14,200 square kilometers). It is a smooth plain consisting of Mississippian-age limestone that is slightly dissected along streams. A prevalence of soluble carbonate rock results in karst topography, which leads to the formation of springs, caves, sinkholes, and valleys.

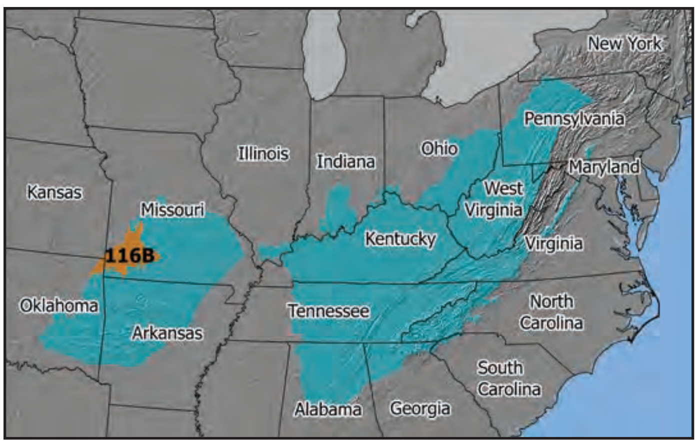

Figure 116B-1: Location of MLRA 116B, which covers 1,420,000 hectares (3,508,700 acres), within Region N.

MLRA 116B has an indistinct boundary with MLRA 112 (Cherokee Prairies) that is based on the boundary between the mesic and thermic soil temperature regimes and different geologies (Pennsylvanian versus Mississippian). It also has an indistinct boundary with MLRA 116A (Ozark Highland), an area that is more dissected than MLRA 116B and has greater relief.

Physiography

This area is in the Springfield-Salem plateaus section of the Ozark Plateaus province of the Interior Highlands. It is in the western part of the Ozark Uplift, which is commonly referred to as the Springfield Plateau. It is primarily a smooth plain that is slightly dissected along streams. The plain is underlain by carbonate rocks, which result in well developed karst features in several places and also numerous caves and springs. Elevation is about 1,000 feet (305 meters) in the northern part of the MLRA and increases to more than 1,700 feet (520 meters) on the eastern escarpment. Relief is generally less than 150 feet (45 meters) but is as much as 250 feet (75 meters) along the eastern boundary of the MLRA, where the prominent Burlington Escarpment rises above the adjacent Ozark Highlands.

Because the MLRA is at a relatively high elevation, it contains the headwaters and upper reaches of streams that drain into adjacent regions. The area includes the Sac River, which flows north into the Osage River; the James River and Finley Creek, which flow south into the White River; and Shoal Creek and the Spring River, which drain most of the western part of the area westward into the Neosho River. Stockton Lake is a large multipurpose reservoir on the Sac River. Lake McDaniel and Lake Springfield provide water for the city of Springfield.

Geology

Sedimentary rocks ranging from Mississippian-age limestone to Pennsylvanian-age sandstone and shale underlie this area. A layer of loess that is generally about 6 inches or less in thickness covers most of the area. Erosion has removed much of the original loess. On the nearly level upland divides, however, remnants of the loess are 1 to 2 feet (0.3 to 0.7 meter) thick. Most of the exposed bedrock consists of limestone formations that have thick layers of chert bedrock or chert fragments. The chert generally occurs in long, wavy beds less than 1 foot thick. In some areas, however, it occurs in massive layers more than 6 feet (2 meters) thick. Although the bedrock strata appear to lie horizontally, there is a regional dip to the west. The direction of the dip is influenced mainly by the Ozark Uplift. The apex of the uplift is in southeast Missouri, and the bedrock dips away from the uplift. Historic lead and zinc mines in the southwestern part of the MLRA have altered large areas. Tripoli, a chert powder used for polishing and for manufacturing paint and paper, is mined in Newton County, Missouri. High-calcium limestone is quarried, mostly near Springfield and Joplin, Missouri.

Climate

The average annual precipitation is 41 to 45 inches (1,040 to 1,145 millimeters). About 57 percent of the annual precipitation falls during the 6 warmest months of the year. Snow falls nearly every winter, but snow cover lasts for only a few days. The annual snowfall averages about 12 inches (305 millimeters). The average annual temperature is about 55 to 58 degrees F (13 to 15 degrees C). The lower temperatures occur at the higher elevations. The freeze-free period averages 210 days and ranges from 195 to 225 days. It is shortest at the higher elevations.

Water

In most years the precipitation is adequate for crops and pasture, but summer droughts of sufficient severity and duration to reduce crop yields are common. Streams, ponds, springs, and lakes provide surface water for most livestock. Springs are numerous, and spring flow is a major contributor to the base flow of many streams. The few large reservoirs provide flood control, opportunities for recreation, and part of the water supply for large cities, such as Springfield, Missouri. The surface water is generally of good quality and suitable for most uses.

Ground water is very abundant in this area. The primary source is the Ozark aquifer in Missouri. This aquifer consists of consolidated dolomite with some minor beds of sandstone. It is about 1,000 feet below the ground surface in western Missouri. It provides good-quality water for public supply, irrigation, municipal and industrial uses, and domestic use. Water in the Ozark aquifer is hard or very hard but does not have high levels of iron. Because of the karst topography, contaminated water from surface activities has created some local water-quality problems in this bedrock aquifer. Hazardous waste from abandoned lead and zinc mines, landfills, municipal and industrial wastewater, and agricultural activities have caused some contamination by heavy metals, bacteria, and nitrates.

The Roubidoux and Keokuk-Reeds Spring aquifers are in this area. They occur only in a few counties in the northeast corner of Oklahoma. They are the only sources of water for rural landowners and small communities in this part of the MLRA. The water generally is of good quality and suitable for most uses. Chloride, sulfate, and fluoride levels, however, exceed the national drinking water standards in some areas.

Soils

Most of the soils are Alfisols, Ultisols, or Mollisols. The soils in the area formed in material weathered from cherty limestone. This material is partly covered with a thin mantle of loess. Physical and chemical weathering has caused the cherty limestone to disintegrate into its least soluble components, which are chert and clay. The chert remains in the form of angular fragments or wavy horizontal beds interstratified between layers of clay. Downslope movement by gravitational creep and overland waterflow has altered the cherty material in the upper part of some soils. In general, the soils are moderately deep to very deep, moderately well drained or well drained, and medium textured to fine textured. The soil temperature regime is typically mesic and extends slightly into thermic. The soil moisture regime is udic. Mineralogy generally is mixed or siliceous, but some soils have a high content of kaolinite.

The main soils and their series:

Fragiudalfs on nearly level to moderately sloping upland divides (Creldon, Hoberg, and Keeno series)

Fragiudults on nearly level to moderately sloping upland divides (Tonti series)

Hapludolls on terraces and the adjacent flood plains (Cedargap series)

Hapludults on gently sloping to moderately sloping side slopes in the uplands (Cliquot series)

Paleudalfs on moderately sloping to steep side slopes in the uplands (Goss and Rueter series)

Paleudults on moderately sloping to steep side slopes in the uplands (Clarksville and Noark series)

Biological Resources

This MLRA is a transitional area between the oak-hickory forests to the east and south and the bluestem prairie to the west and north. The vegetation prior to settlement consisted mostly of prairie grasses with timber along streams. The major native grass species are big bluestem, little bluestem, Indiangrass, and switchgrass. Most of the area is cleared and used for pasture or cropland, but forests remain in the steepest areas. Fescue is the dominant introduced grass species.

Major wildlife species in the area include white-tailed deer, eastern cottontail, raccoon, wood duck, wild turkey, smallmouth bass, and largemouth bass. Several prairie species, such as black-tailed jackrabbits and prairie chickens, inhabit small areas of the original tallgrass prairie.

Land Use

Farms and ranches make up most of this area (fig. 116B-2). Forage and grain are grown for beef, dairy cattle, and other livestock. The poultry business and cattle production are the major industries. The area around Springfield is the leading dairy area in Missouri. Soybeans, winter wheat, and hay are the major cash crops grown in the MLRA. The loss of prime farmland and farmland of statewide importance to urban development is a concern, especially in the Springfield and Joplin areas.

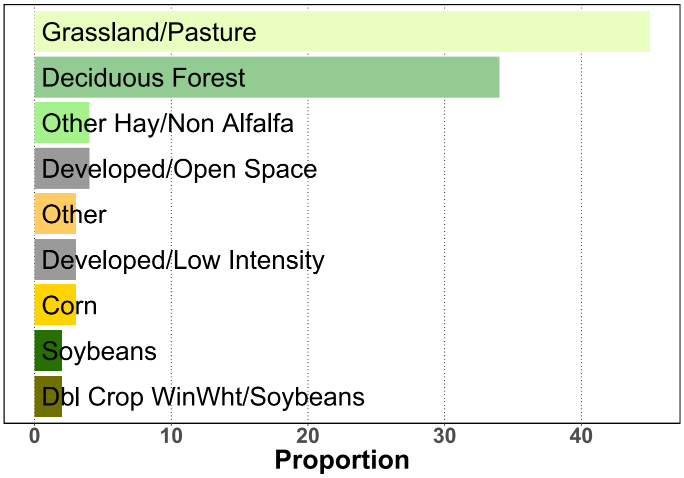

Figure 116B-2: Relative proportions (percentages) of land use in MLRA 116B.

The major resource concerns are excessive nutrients and organic material in surface water; conversion of farmland to urban uses; ground water pollution in areas of karst topography; forest and pasture productivity, health, and vigor; inadequate water sources for domestic animals; and structure failure of dams in areas of ponds and small lakes. The structure failure of dams results from a high amount of kaolinitic clay in the soils. Important conservation practices for this area are management of phosphorus from chicken litter applied to cropland and pasture, forest stand improvement, prescribed grazing, development of springs, riparian forest buffers, and construction of ponds.

116C—St. Francois Knobs and Basins

This MLRA (fig. 116C-1) is entirely in southeast Missouri and makes up about 1,584 square miles (4,102 square kilometers). It consists of igneous knobs, basins, and sedimentary hills. MLRA 116C has a distinct boundary based on physiography with MLRA 116A (Ozark Highland), an area that is underlain by limestone, sandstone, and shale bedrock of Mississippian age.

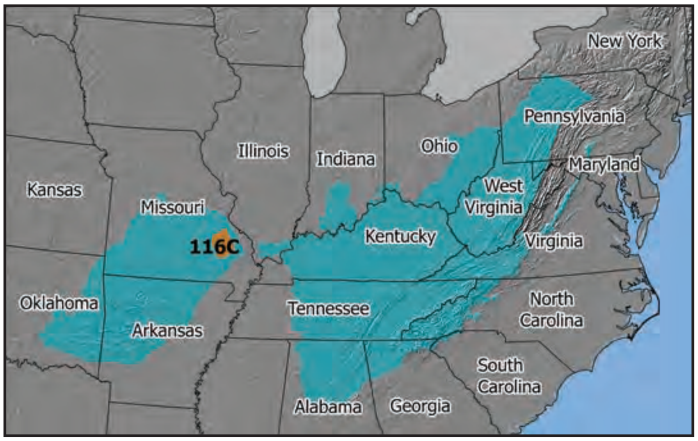

Figure 116C-1: Location of MLRA 116C, which covers 410,200 hectares (1,013,600 acres), within Region N.

Physiography

This area is in the Springfield-Salem plateaus section of the Ozark Plateaus province of the Interior Highlands. It is the structural center of the Ozark Dome. Three different topographic expressions are in this MLRA. One is the prominent Precambrian igneous knobs and hills that rise conspicuously to various elevations. Another is the intervening smooth-floored basins and valleys overlying dolostone and sandstone. The third consists of tracts of deeply dissected, cherty, sedimentary hills of the Ozarks Highlands that are intermixed with the other two kinds of topography. The MLRA boundary was drawn to encompass all of the major Precambrian surfaces in the area. Since the Precambrian surfaces are intermixed with younger Paleozoic surfaces, a large area of cherty, sedimentary rock that generally occurs in the adjacent Ozark Highland (MLRA 116A) is included in this MLRA.

Elevation ranges from about 450 feet (135 meters) along the rivers in the southern part of the area to 1,772 feet (540 meters) on the summit of Taum Sauk Mountain, the highest point in Missouri. Local relief is generally about 300 to 1,000 feet (90 to 305 meters) among the igneous knobs, 100 to 200 feet (30 to 60 meters) in the basins, and 200 to 300 feet (60 to 90 meters) in the sedimentary hills.

Because this MLRA is at the highest elevation in the Ozark Uplift, it includes the headwaters of streams that radiate outward in several directions. The St. Francis River, which has the largest river basin in this MLRA, drains the south-central part of the area. The Castor River flows southward on the eastern boundary of the area. The south-flowing Black River has its headwaters in the western part of the area. The Big River, the largest tributary of the Meramec River, drains to the north.

Geology

The distinctive geologic features of this MLRA are the Precambrian igneous rocks that have been uplifted and exposed by geologic erosion. These exhumed igneous rocks consist primarily of granites with intruded rhyolites and other volcanics. The rocks are resistant to erosion and stand out at high elevations on the landscape. The igneous knobs are broad and rounded. Slopes in areas of rhyolites are noticeably steeper than those in areas of granite. The igneous knobs are interconnected by Early Cambrian sedimentary rocks. The Cambrian strata consist of the LaMotte sandstone, Derby-Doe Run dolostone, Bonne Terre dolostone, and Potosi and Eminence cherty dolostones. The sandstone and cherty dolostones are associated with hilly landscapes, whereas the chert-free dolostones are on the smooth floors of basins. This MLRA has valuable mineral deposits, including lead, iron, manganese, silver, cobalt, and dimension stone (granite). It has one of the largest historic lead-mining districts in the world. Lead mining has left numerous scars on the landscape.

Climate

The average annual precipitation is 40 to 46 inches (1,015 to 1,170 millimeters). The rainfall is fairly evenly distributed throughout the year. Snow falls nearly every winter, but snow cover lasts for only a few days. The annual snowfall averages about 14 inches (355 millimeters). The average annual temperature is about 54 to 56 degrees F (12 to 14 degrees C). The lower temperatures occur at the higher elevations. The freeze-free period averages 200 days and ranges from 185 to 215 days. The shorter freeze-free periods occur at the higher elevations.

Water

In most years the precipitation is adequate for crops and pasture, although summer droughts of sufficient severity and duration to reduce yields are common. Springs, ponds, and streams provide water for livestock. Although springs are common, they are not as large as elsewhere in the Ozarks. Ponds for livestock water are mainly in the cleared basins. Stream gradients are generally steep, and water velocities are high. Stream discharges reach their peak in spring and decline rapidly in summer. They are lowest in fall. Several small lakes have been built for residential developments and water supplies. Taum Sauk Reservoir was built for pumped-storage hydroelectricity generation on the top of Proffit Mountain. Lakes have also been built to impound and settle out tailings from lead mines. Most of the surface water used in this area is for the mining industry. The water is generally of high quality, although in some areas it is affected by lead mining and pollution from urbanization. This MLRA has no natural lakes or large reservoirs.

Ground water is adequate in areas with sedimentary bedrock. It is not abundant in areas of igneous bedrock. Ground water sources include the Cambrian sediments and the Ozark dolomite that occur between the igneous knobs. The water is of good quality. Limited amounts of the water are used for public supply, municipal and industrial supply, and domestic purposes. The Ozark aquifer water is hard or very hard but does not have high levels of iron. Because of the karst topography, where the carbonate sediments are at or very near the ground surface, contaminated water from surface activities has created some local water-quality problems in this bedrock aquifer. Hazardous waste, landfills, municipal and industrial wastewater, and agricultural activities have caused some contamination by heavy metals, bacteria, and nitrates.

Soils

Most of the soils are Alfisols or Ultisols. The soils in the area formed in material weathered from igneous and sedimentary rocks. The less sloping areas have a thin mantle of loess. The soils have a mesic soil temperature regime and a udic soil moisture regime and typically have mixed mineralogy. Downslope movement by gravitational creep and overland waterflow has altered the upper part of the soils. In general, the soils are shallow to very deep, moderately well drained to excessively drained, and moderately coarse textured to fine textured.

The main soils and their series:

Fragiudults on igneous knobs (Delassus and Killarney series)

Hapludults on igneous knobs (Hassler, Irondale, Knobtop, Syenite, Taumsauk, and Trackler series)

Paleudults on igneous knobs (Frenchmill and Mudlick series)

Biological Resources

Most of this area is in oak or oak-pine forest. White oak, northern red oak, and hickories are the dominant tree species on the most productive sites. Post oak, black oak, shortleaf pine, and hickories dominate the drier sites. Warm-season grasses, shrubs, and eastern redcedar are dominant in glades. Fescue and orchardgrass are the dominant introduced grass species.

The major wildlife species are those that prefer woodland habitat, such as white-tailed deer, gray squirrel, raccoon, and wild turkey. Small furry animals, such as red fox, gray fox, opossum, and skunk, are fairly abundant. Wetland habitat is almost nonexistent, and the waterfowl population is low.

Land Use

Timber production, outdoor recreation and tourism, and livestock production are the major land uses (fig. 116C-2). Urban growth is limited to the U.S. Highway 67 corridor and the Ironton area. Corn and soybeans are the major cash crops grown. A few mines are still active in the MLRA.

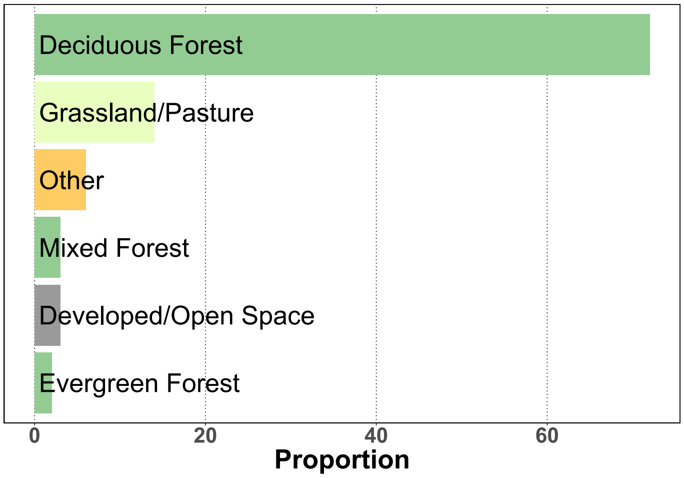

Figure 116C-2: Relative proportions (percentages) of land use in MLRA 116C.

The major natural resource concerns are forest and pasture health and productivity, excessive runoff, excessive nutrients and organic material in the surface water, head-cut erosion in drainageways in pastures, fragmentation of the wildlife habitat, and inadequate water supplies for livestock. Important conservation practices are improvement of forest stands and wildlife habitat, erosion-control structures that include hydrants to supplement livestock water and to control head-cut erosion, prescribed grazing, development of springs, construction of ponds for livestock water, pasture and hayland planting, nutrient management, riparian forest buffers, and exclusion from use as needed.

117—Boston Mountains

The Boston Mountains (fig. 117-1) are remnants of an old, deeply eroded plateau bordering the Ozarks. This area has

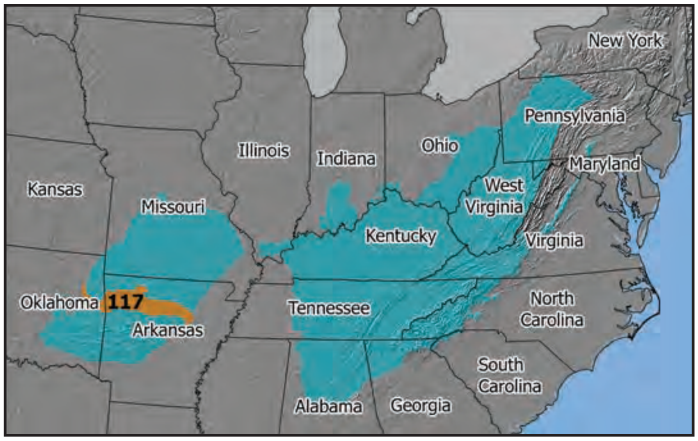

Figure 117-1: Location of MLRA 117, which covers 1,717,100 hectares (4,242,900 acres), within Region N.

deeply eroded plateaus, steep valley walls, and narrow ridges. This MLRA is in Arkansas (84 percent) and Oklahoma (16 percent). It makes up about 6,630 square miles (17,171 square kilometers).

MLRA 117 has a distinct boundary based on physiography with MLRAs 112 (Cherokee Prairies), 118A (Arkansas Valley and Ridges, Eastern Part), 118B (Arkansas Valley and Ridges, Western Part), and 131A (Southern Mississippi River Alluvium). MLRA 112 is less dissected than MLRA 117 and has lower relief and prairie. MLRAs 118A and 118B are also less dissected and have lower relief. MLRA 131A has low relief and alluvial soil parent material. MLRA 117 has a less apparent boundary with MLRA 116A (Ozark Highland) that is based on the boundary between the mesic and thermic soil temperature regimes.

Physiography

This area is mostly in the Boston “Mountains” section of the Ozark Plateaus province of the Interior Highlands. The northern half of the western tip of the area is in the Springfield-Salem plateaus section of the same province and division. The southern half of the western tip is in the Arkansas Valley section of the Ouachita province of the Interior Highlands. This MLRA marks the southern extent of the Ozarks. Ridgetops are narrow and rolling. Valley walls are steep. Elevation ranges from 660 feet (200 meters) on the lowest valley floors to 2,625 feet (800 meters) on the highest ridge crests. Local relief commonly exceeds 100 feet (30 meters). The Mulberry, King, Buffalo, and Middle Fork Little Red Rivers are in the part of this area in Arkansas, and the Illinois River is in the part in Oklahoma.

Geology

Most of this area is underlain by level to slightly tilted shale, sandstone, and siltstone strata in the Pennsylvanian-age Atoka Formation and the Cane, Boyd Shale, and Prairie Grove members of the Hale Formation. Parts of the northern edge are underlain by the Mississippian-age Pitkin Limestone, Fayetteville Shale, and Batesville Sandstone. Deposits of alluvium consisting of an unconsolidated mixture of clay, silt, sand, and gravel are in river valleys.

Climate

The average annual precipitation is 42 to 55 inches (1,065 to 1,395 millimeters). The maximum precipitation occurs in spring and fall, and the minimum occurs in midsummer. Most of the rainfall occurs during high-intensity, convective thunderstorms. Snowfall is uncommon in winter. The average annual temperature is 55 to 61 degrees F (13 to 16 degrees C). The freeze-free period averages 225 days and ranges from 200 to 245 days.

Water

The moderately high precipitation is adequate for crops and pasture. Small ponds on individual farms provide water for livestock, and springs are numerous on the mountainsides and in the valleys. Large reservoirs on a few of the major streams are sources of municipal water and provide flood control and opportunities for recreation. The surface water is generally of good quality and suitable for most uses. Municipal and industrial wastewater discharges and nonpoint pollution have caused some local degradation of water quality.

Shallow wells are the principal sources of water for domestic use. Deep wells are needed to obtain moderate to large quantities of ground water. Water from the Ozark aquifer system in the northern half of this area is suitable for drinking. It is hard or very hard, so treatment to remove calcium and magnesium may be needed. The shallow aquifers within this system have the highest average level of nitrate of all aquifers in Arkansas.

Soils

The dominant soil orders are Ultisols and Inceptisols. The soils in the area dominantly have a thermic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are shallow to very deep, generally well drained, and loamy.

The main soils and their series:

- Dystrudepts that formed in residuum on hills, plateaus, and mountains (Hector series)
- Hapludults that formed in residuum on hills, plateaus, and mountains (Enders, Linker, Mountainburg, and Steprock series)
- Paleudults that formed in alluvium or colluvium over residuum (Allen and Nella series) or in alluvium or colluvium (Leesburg series) on hills and terraces

Biological Resources

This area supports hardwood forests. The primary overstory species are red oak, white oak, and hickory. Shortleaf pine and eastern redcedar are important on disturbed sites, on shallow soils, and on south or west aspects. Big bluestem, switchgrass, Indiangrass, and little bluestem are important understory species under medium to open forest canopy. Broadleaf uniola, longleaf uniola, wildrye, and low panicums are important species under heavy canopy. Major wildlife species in this area include white-tailed deer, coyote, red fox, gray fox, bobcat, beaver, raccoon, opossum, skunk, muskrat, mink, cottontail, fox squirrel, gray squirrel, bobwhite quail, and mourning dove.

Land Use

About two-thirds of this area is forested (fig. 117-2). The forested areas are mainly in farm woodlots, but large tracts in Arkansas are national forests. About one-fourth of the MLRA is grazing land, and a small percentage is cropland. Small grains and hay for livestock are the main crops. Peach and apple orchards are important locally. Most of the pastures support cultivated grasses and legumes, but native grasses grow on the prairie outliers in the western part of the MLRA.

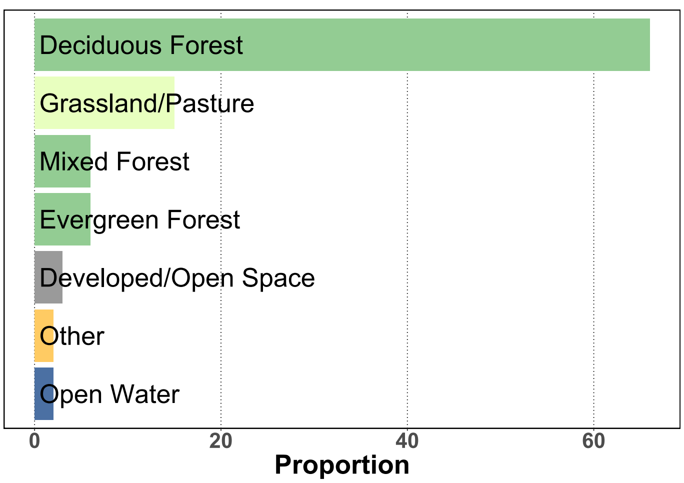

Figure 117-2: Relative proportions (percentages) of land use in MLRA 117.

The major resource concerns in this MLRA are gully and streambank erosion; plant productivity, health, and vigor; soil contaminants from applications of animal waste; and water for livestock. Conservation practices on cropland generally include critical area planting, protection of streambanks and shorelines, fencing, riparian forest buffers, forage harvest management, nutrient management, waste utilization, brush management, pest management, grade-stabilization structures, construction of ponds, and prescribed grazing.

118A—Arkansas Valley and Ridges, Eastern Part

This MLRA (fig. 118A-1) is in Arkansas (76 percent) and Oklahoma (24 percent). It makes up about 6,854 square miles (17,052 square kilometers). It is characterized by long, narrow ridges dissected by valleys.

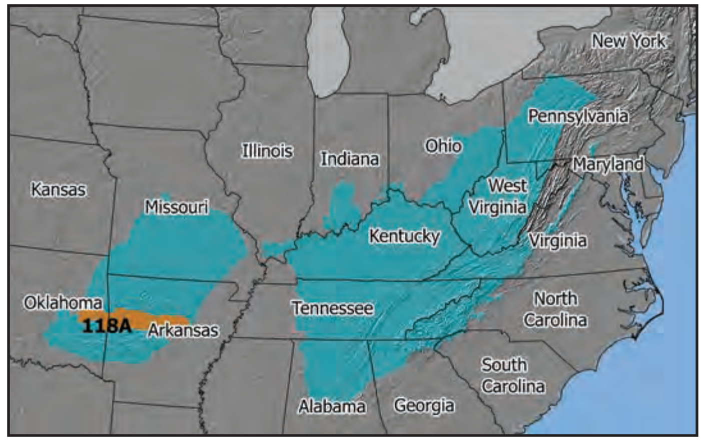

Figure 118A-1: Location of MLRA 118A, which covers 1,705,200 hectares (4,213,700 acres), within Region N.

MLRA 118A has a distinct boundary based on physiography with MLRAs 112 (Cherokee Prairies), 119 (Ouachita Mountains), 131D (Southern Mississippi River Terraces), 133B (Western Coastal Plain), and 117 (Boston Mountains). MLRA 112 is less dissected than MLRA 118A and has lower relief and prairie. MLRA 117 is more dissected than MLRA 118A and has higher relief. MLRA 119 is more dissected than MLRA 118A and has greater relief and steeper gradients. MLRAs 131D and 133B have low relief and alluvial soil parent material. MLRA 118A has a less apparent boundary with MLRA 118B (Arkansas Valley and Ridges, Western Part) that is based on the prevalence of surface mining.

Physiography

Most of this area is in the Arkansas Valley section of the Ouachita province of the Interior Highlands. Small areas in the southeast corner and the south-central part of the MLRA are in the Ouachita Mountains section of the same province and division. The MLRA consists of long, narrow ridges and high flat-topped mountains capped with sandstone that trend northeastward. Crests are narrow and rolling on ridges and broad and flat on mountaintops. The intervening valleys are broad and smooth. Elevation ranges from 300 feet (90 meters) on the lowest valley floors to 2,750 feet (840 meters) on the mountaintops.

The Arkansas River, which is regulated by numerous locks, dams, and reservoirs, is a major inland navigational river. It flows from the northwestern part of the MLRA, at Robert S. Kerr Lake, in Oklahoma, to the southeastern part, at Little Rock, Arkansas.

Geology

The ridges and valleys in this area are underlain by slightly folded to level beds of sandstone and shale, respectively. The area principally consists of the Savanna Formation, McAlester Formation, Hartshorne Sandstone, and the Upper and Lower Atoka Formation. These are all of Pennsylvanian age. The terrace deposits along the Arkansas River include a complex sequence of unconsolidated gravel, sandy gravel, sands, silty sands, silts, clayey silts, and clays. The individual deposits commonly are lenticular and discontinuous. At least three terrace levels are recognized. The lowest is the youngest.

Climate

The average annual precipitation is 41 to 45 inches (1,040 to 1,145 millimeters) in the western one-third of this area. It is 45 to 61 inches (1,145 to 1,550 millimeters) in the eastern two-thirds. Most of the rainfall occurs during frontal storms in spring and early summer. Some high-intensity, convective thunderstorms occur in summer. Precipitation occurs as rain and snow in January and February. The average seasonal snowfall is 5 inches (125 millimeters). The average annual temperature is 58 to 62 degrees F (14 to 17 degrees C). The freeze-free period averages 240 days and ranges from 220 to 260 days. It is shortest at the higher elevations on ridges.

Water

The moderate precipitation generally is adequate for crops and pasture. In the uplands, water for livestock is obtained from small ponds on individual farms. In the valleys, springs, small ponds, and perennial streams provide water for most uses. Several large reservoirs are used for flood control and recreation. Surface water for irrigation is obtained primarily from the Arkansas River. This river is being considered as a source of public supply water. Naturally occurring saline seeps impact the salinity of the Arkansas River, and industrial and municipal waste discharges also cause some degradation in water quality. One of the major uses of water from the Arkansas River is for cooling the nuclear power plant at Russellville, Arkansas. The surface water in the other streams in the area is generally of good quality and suitable for most uses.

This area has very little ground water. It has no bedrock aquifers. Isolated alluvial deposits along the Arkansas River in both States provide high yields to irrigation wells. Water from this aquifer is suitable as irrigation water. It is very hard, however, and has high levels of iron. Extensive treatment is needed to make this water suitable for public supply. Rural landowners in valleys away from the Arkansas River obtain some water for domestic use and livestock from shallow wells in alluvium.

Soils

The dominant soil order is Ultisols. The soils in the area dominantly have a thermic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are stony or nonstony and are medium textured.

The main soils and their series:

- Fragiudults that formed in valleys (Leadvale, Taft, and Guthrie series)
- Haplaquolls that are minor soils along the Arkansas River (Roellen series)
- Hapludalfs that are minor soils along the Arkansas River (Gallion series)
- Hapludults that are well drained, shallow, and moderately deep and formed on ridgetops, benches, and upper slopes (Mountainburg and Linker series); that are well drained and deep and formed on middle and lower slopes and in concave areas between ledges (Enders and Steprock series); that are minor soils on terraces along the smaller streams (Spadra series)
- Paleudalfs that are moderately well drained, nearly level to gently sloping upland soils in valleys (Stigler series)
- Paleudults that are well drained and deep and that formed on the middle and lower slopes and in concave areas between ledges (Nella series)

Biological Resources

The pristine vegetation of this area was oak savanna and oak-hickory-pine forest. The primary overstory species are red oak, white oak, and hickory. Shortleaf pine is important on disturbed sites, shallow soils, and south and west aspects. Big bluestem, switchgrass, Indiangrass, and little bluestem are important understory species under medium to open forest canopy. Broadleaf uniola, longleaf uniola, wildrye, and low panicums are important species under heavy canopy.

Major wildlife species in this area include white-tailed deer, coyote, armadillo, beaver, raccoon, skunk, opossum, muskrat, cottontail, mourning dove, turkey, fox squirrel, and gray squirrel.

Land Use

Most of this MLRA is pasture, hayland, or forestland (fig. 118A-2). Most of the privately owned land consists of farm woodlots and pasture. The poultry business is a major industry. Most of the cropland in the area is in the less sloping valleys, but some is on flat mountaintops. Small grains and hay are the major crops. Soybeans are an important crop on the bottom land along the Arkansas River. Orchards, vineyards, and vegetable crops are important locally. Pastures are on the bottom land along small streams and throughout the cleared parts of uplands. They support a mixture of tame and native grasses and legumes.

The major resource concerns are excessive nutrients and organic material in surface water; forest and pasture

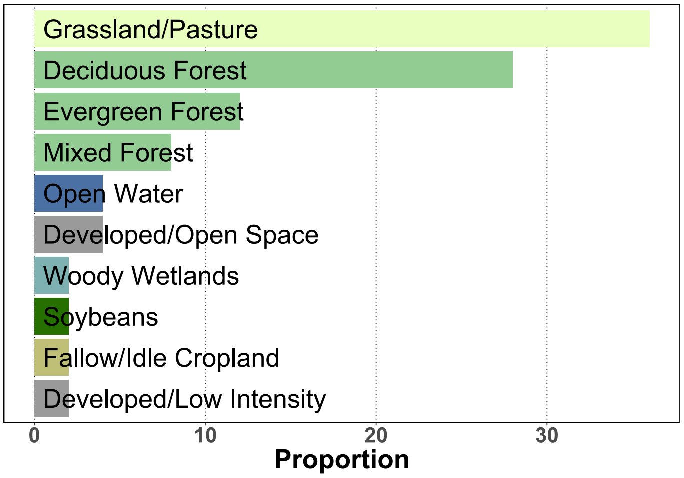

Figure 118A-2: Relative proportions (percentages) of land use in MLRA 118A.

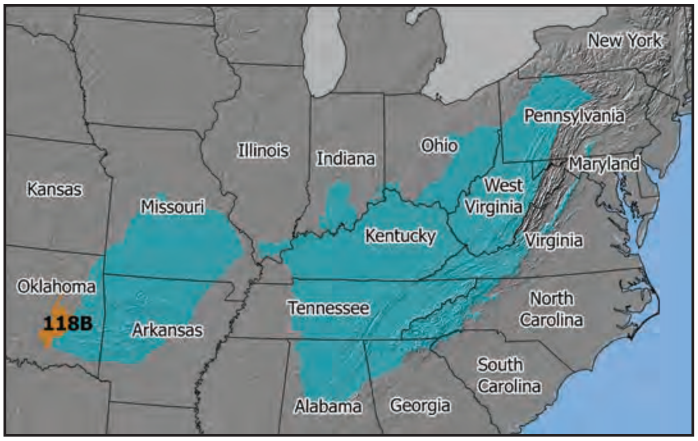

Figure 118B-1: Location of MLRA 118B, which covers 760,100 hectares (1,878,100 acres), within Region N.

productivity, health, and vigor; and inadequate water sources for domestic animals. The important conservation practices in the area are management of phosphorus from chicken litter applied to cropland and pasture, forest stand improvement, prescribed grazing, development of springs, riparian forest buffers, and construction of ponds.

118B—Arkansas Valley and Ridges, Western Part

This MLRA (fig. 118B-1) is entirely in Oklahoma and makes up about 2,935 square miles (7,601 square kilometers). It is characterized by long, narrow ridges dissected by valleys. Strip mining of coal is common throughout the area.

MLRA 118B has a distinct boundary based on physiography with MLRAS 84A (North Cross Timbers), 85A (Grand Prairie), 112 (Cherokee Prairies), 119 (Ouachita Mountains), and 135B (Cretaceous Western Coastal Plain). MLRA 84A has lower relief than MLRA 118B. MLRA 85 is characterized by low relief and is dominated by prairies. MLRA 112 is less dissected than MLRA 118B and has lower relief and prairie. MLRA 119 is more dissected than MLRA 118B and has steeper gradients. MLRA 135B has lower relief and underlying marine sediments. MLRA 118B has a less apparent boundary with MLRA 118A (Arkansas Valley and Ridges, Eastern Part) that is based on less surface mining.

Physiography

Most of this area is in the Osage Plains section of the Central Lowland province of the Interior Plains. Parts on the east side of the area are in the Arkansas Valley and Ouachita Mountains sections of the Ouachita province of the Interior Highlands. Topography is characterized by long, narrow sandstone-capped ridges that trend northeastward. The ridges are dissected by valleys cut by streams at right angles to the ridges. The valleys and scarp areas generally are cut into less resistant shale units. Elevation ranges from 550 feet (170 meters) to 1,500 feet (455 meters).

The North and South Canadian Rivers flow from the western part of this MLRA and merge at Eufaula Lake on the eastern side. A narrow extension of this area catches part of the Arkansas and Verdigris Rivers southeast of Tulsa. The Arkansas River is heavily regulated by locks, dams, and reservoirs. It allows Mississippi River barge traffic to reach land-locked Tulsa, which is northwest of this area.

Geology

This MLRA principally consists of hard and soft sandstone, shale, siltstone, limestone, and some conglomerates of the Cabaniss, Krebs, and Marmaton Groups, all of which are of Pennsylvanian age. The rocks may include economically viable coal deposits. The bedrock geology is tilted 2 to 15 degrees from the horizontal and is gently folded in some areas. Deposits of unconsolidated clay, silt, sand, and gravel are in the river valleys.

Climate

The average annual precipitation is 39 to 46 inches (990 to 1,170 millimeters). Most of the precipitation falls from April through September. The average annual temperature is 59 to 62 degrees F (15 to 17 degrees C). The freeze-free period averages 235 days and ranges from 220 to 255 days. The shorter freeze-free periods occur at the higher elevations on top of major ridges.

Water

The moderate precipitation generally is adequate for crops and pasture. In the uplands, water for livestock is obtained from small ponds on individual farms. Springs, small ponds, and perennial streams provide water for most uses in the valleys. Several large reservoirs are used for flood control, recreation, and some drinking water. The surface water is generally of good quality and is suitable for most uses.

This area has very little ground water and no bedrock aquifers. Isolated alluvial deposits along the Canadian, Arkansas, and Verdigris Rivers provide some public supplies of water. The water in this alluvial aquifer is very hard, so treatment is required to make the water suitable for public supplies. Rural landowners away from the major river valleys obtain small quantities of water for domestic use from shallow wells in alluvium and fractures in the bedrock.

Soils

Most of the soils in this MLRA are Udalfs or Udepts. The soils in the area have a thermic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy.

The main soils and their series:

- Dystrudepts that are shallow and sloping to steep and that formed on narrow ridgetops and upper shoulder slopes (Clebit and Hector series)
- Hapludalfs that are moderately deep and gently sloping to steep and that formed on ridgetops, shoulder slopes, and side slopes (Clearview and Homa series); that are deep and gently sloping to steep and that formed on side slopes and footslopes (Endsaw series); that are very deep, gently sloping to steep minor soils on terraces along streams (Karma series)
- Hapludults that are well drained on slightly sloping uplands (Linker series)
- Paleudalfs that are very deep, gently sloping to steep minor soils on terraces along streams (Kamie, Larton, and Porum series)
- Udifluvents that are nearly level to sloping minor soils along flood plains throughout the area (Kiomatia series)

Biological Resources

The pristine vegetation of this MLRA was oak savanna. The primary trees that make up the overstory are red oak, white oak, and hickory. Pine grows in some isolated areas but is of minor importance. Big bluestem, switchgrass, Indiangrass, and little bluestem are important understory species under medium to open canopy. Broadleaf uniola, longleaf uniola, wildrye, and low panicums are important species under heavy canopy. Major wildlife species include white-tailed deer, bobwhite quail, coyote, eastern turkey, fox squirrel, and gray squirrel.

Land Use

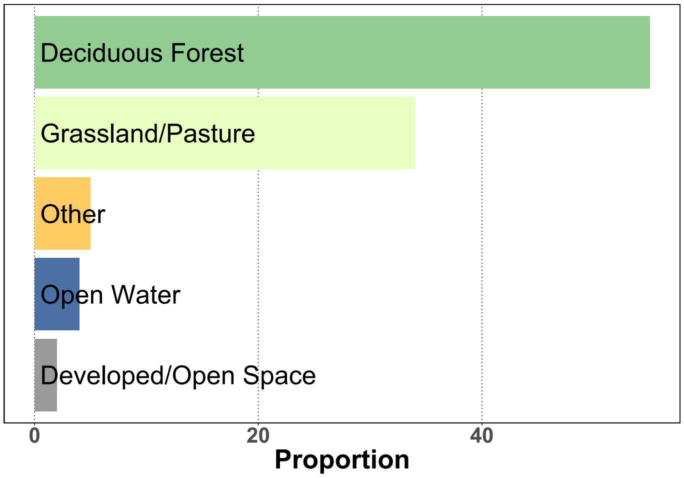

Figure 118B-2: Relative proportions (percentages) of land use in MLRA 118B.

About 32 percent of this area is pasture or hayland, and 18 percent is rangeland (fig. 118B-2). Most of the pasture and rangeland is grazed by beef cattle. The pasture and hayland mainly consist of introduced grasses and legumes. Wheat, soybeans, and grain sorghum are the major crops grown on the small acreage of cropland. The forested areas are covered with low-grade mixed hardwoods, and forest products are of very minor importance to the MLRA. Some areas are used for urban development. Strip mining of coal is common throughout the area. Stabilizing strip-mine spoil and reclaiming mined areas are major management concerns. Maintaining pasture and forest productivity also is important. The important conservation practices in this area are forest stand improvement, prescribed grazing, development of springs, riparian forest buffers, and construction of ponds.

119—Ouachita Mountains

The Ouachita Mountains (fig. 119-1) are characterized by a series of east-west-oriented ridge sand valleys that originally formed in an ocean abyss and were subsequently thrust upwards by the collision of two continental plates. This area supports hardwood-pine forests. It has no major agricultural enterprises. It is in Arkansas (57 percent) and Oklahoma (43 percent) and makes up about 11,949 square miles (30,948 square kilometers).

MLRA 119 has a distinct boundary based on physiography with MLRAs 118A and 118B (Arkansas Valley and Ridges), MLRA 133B (Western Coastal Plain), and MLRA 135B (Cretaceous Western Coastal Plain). MLRAs 118A and 118B have lower relief than MLRA 119. MLRA 133B has low relief and alluvial soil parent material. MLRA 135B has rolling topography and lower relief.

Physiography

This area is in the Ouachita Mountains section of the Ouachita province of the Interior Highlands. The steep mountains are underlain by folded and faulted sedimentary and metamorphic rocks. Most of the stream valleys are narrow and

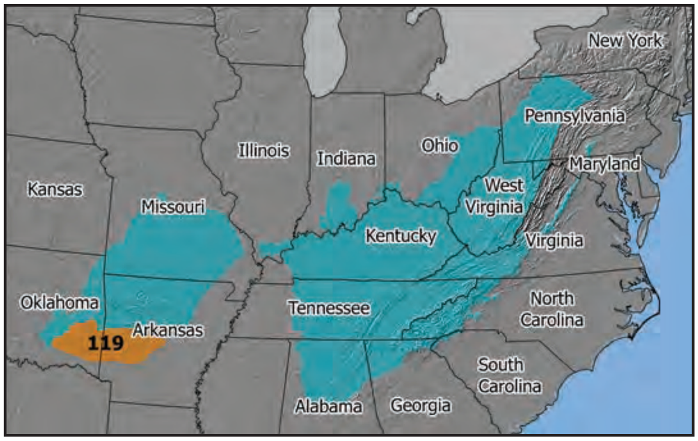

Figure 119-1: Location of MLRA 119, which covers 3,094,800 hectares (7,647,300 acres), within Region N.

have steep gradients, but wide terraces and flood plains border the Ouachita River in western Arkansas. Elevation ranges from 330 feet (100 meters) on the lowest valley floors to 2,625 feet (800 meters) on the highest mountain peaks. Local relief is generally 100 to 200 feet (30 to 60 meters), but it can exceed 980 feet (300 meters).

The Muddy Boggy, Kiamichi, Little, Fourche Maline, and Poteau Rivers are in the part of this MLRA in Oklahoma. The Petit Jean, Fourche LaFaye, Ouachita, and Caddo Rivers are in the part in Arkansas. The Cossatot, Little Missouri, and Mountain Fork Rivers are in the southern part of the MLRA.

Geology

The folded and faulted formations underlying the mountains are dominantly of shale and sandstone. Ordovician-age shale and sandstone are included in the Collier Shale, Crystal Mountain Sandstone, and Womble Shale. Mississippian-age shale, sandstone, novaculite, and chert are included in the Arkansas Novaculite and the Stanley Shale. Pennsylvanian-age shale, slate, quartzite, and sandstone are included in the Jackfork Sandstone, Johns Valley Shale, and Upper Atoka Formation. Alluvial deposits of silt, sand, and gravel are on the wide terraces and flood plains that border the Ouachita River in this area.

Climate

The average annual precipitation in most of the MLRA is 50 to 66 inches (1,270 to 1,675 millimeters). It decreases to 41 to 49 inches (1,040 to 1,245 millimeters) along the western edge of the area. The precipitation is fairly evenly distributed throughout the year. The maximum occurs in spring and early autumn. Most of the rainfall occurs during high-intensity, convective thunderstorms. Snowfall is not common in winter. The average annual temperature is 57 to 63 degrees F (14 to 17 degrees C). The freeze-free period averages 230 days and ranges from 205 to 255 days. The shorter freeze-free periods occur at the higher elevations on major ridges.

Water

The high precipitation, perennial streams, and reservoirs provide abundant water. Several large reservoirs are used for water storage, flood control, and recreation. In the valleys, small ponds and springs are the main sources of water for livestock and domestic use. The surface water is typically of very good quality. Because the area has few municipal or industrial wastewater discharges and there are no major agricultural enterprises, there is very little nonpoint source pollution.

In the valleys, shallow wells in alluvium are the main sources of water for livestock and domestic use. None of the bedrock aquifers in Arkansas or Oklahoma occur in this area. The quality of the shallow ground water is very similar to the quality of the water in the streams and rivers. The ground water is suitable for drinking.

Soils

The dominant soil orders are Ultisols and Inceptisols. The soils in the area dominantly have a thermic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are shallow to very deep, generally somewhat excessively drained to somewhat poorly drained, and loamy.

The main soils and their series:

- Dystrudepts that formed in residuum on hills and mountains (Bismarck and Clebit series)
- Hapludalfs that formed in residuum on hills and mountains (Clearview series)
- Hapludults that formed in colluvium over residuum (Bengal series) and in residuum (Carnasaw, Littlefir, Pirum, Sherless, and Sherwood series)
- Paleudalfs that are well drained on very gently sloping to very steep side slopes and footslopes (Yanush series)
- Udifluvents that formed in alluvium on flood plains (Ceda series)

Biological Resources

This area supports hardwood-pine forests. The primary overstory species are southern red oak, black oak, white oak, and hickories. Pine constitutes as much as 40 percent of the cover. It consists of shortleaf pine in the uplands and loblolly pine on the lower alluvial soils. Switchgrass, little bluestem, and Indiangrass are the primary grass species in the understory. Prairie cordgrass, plumegrass, low panicums, sedges, and rushes occur in smaller amounts.

Major wildlife species include coyote, bobcat, beaver, raccoon, otter, skunk, opossum, muskrat, mink, cottontail, armadillo, gray squirrel, and turkey. Fish species include largemouth bass, bluegill, redear sunfish, channel catfish, spotted bass, white bass, crappie, flathead catfish, sucker, bullhead, bowfin, and gar.

Land Use

More than 70 percent of this MLRA is forested (fig. 119-2). About one-fourth of the forested acreage, mainly in Arkansas, is federally owned. Some of the forestland is in large holdings, but much of it is in farm woodlots. Timber production, wood-using industries, and recreation are important throughout the area. Nearly one-fifth of the MLRA is grazing land. Most of the pastures support a mixture of tame grasses and legumes, but some small prairie outliers in the western part of the MLRA support native grasses. Forage and small grains are the major crops on the small acreage of cropland.

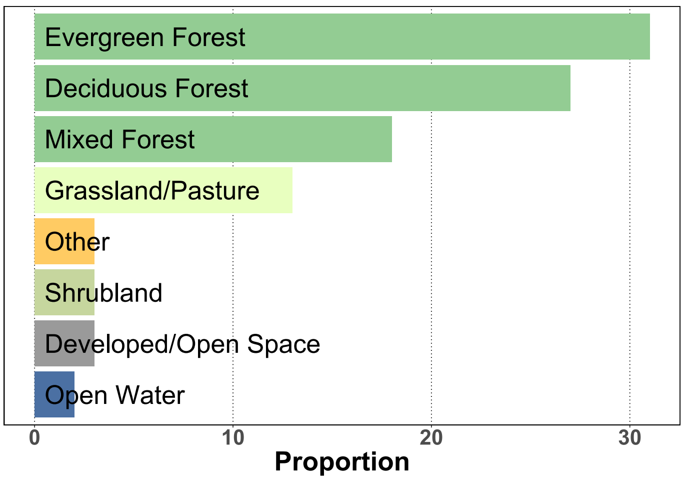

Figure 119-2: Relative proportions (percentages) of land use in MLRA 119.

The major resource concerns are gully and streambank erosion and the erosion caused by road construction; offsite soil deposition; plant productivity, health, and vigor; and livestock water. Conservation practices generally include critical area planting, protection of streambanks and shorelines, riparian forest buffers, fencing, forest site preparation, pruning of trees and shrubs, forest harvest trails and landings, forest stand improvement, pest management, prescribed burning, forage harvest management, construction of ponds, and nutrient management.

120A—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part

This MLRA (fig. 120A-1) is characterized by loess-covered residuum from sandstone and shale of Pennsylvanian or Mississippian age. It is used for row crop agriculture in the less steep areas, livestock production on the more rolling landscapes, and forest on the steeper hills and in the wetter areas along flood plains. This area is primarily in Kentucky (83 percent) and Illinois (17 percent). A very small part is in Indiana. The MLRA makes up about 9,050 square miles (23,440 square kilometers).

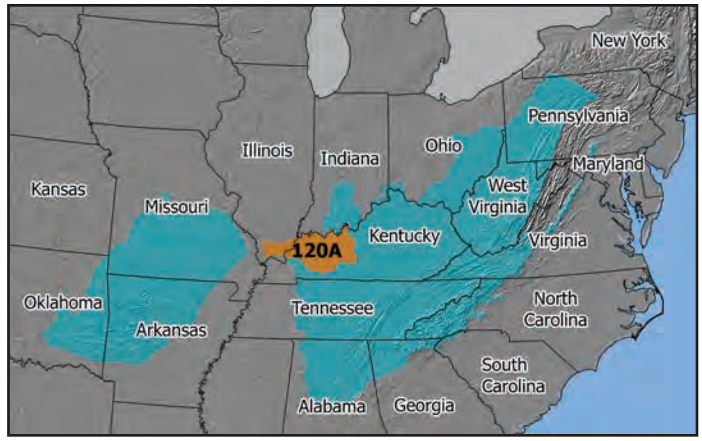

Figure 120A-1: Location of MLRA 120A, which covers 2,344,000 hectares (5,792,100 acres), within Region N.

MLRA 120A has a distinct boundary based on physiography with MLRAs 113 (Central Claypan Areas), 114 (Southern Illinois and Indiana Thin Loess and Till Plain), 122 (Highland Rim and Pennyroyal), 131A (Southern Mississippi River Alluvium), and 134 (Southern Mississippi Valley Loess). MLRAs 113 and 114 have more level and less dissected uplands that are underlain by glacial till. MLRA 122 has soils that are underlain by limestone and dominated by redder parent materials, karst topography, and more broad uplands. MLRA 131A has much lower elevations and nearly level soils that formed from alluvium. MLRA 134 is underlain by unconsolidated gravel, sands, silts, and clays of Tertiary and Cretaceous age.

MLRA 120A has a less apparent boundary with MLRAs 115 (Central Mississippi Valley Wooded Slopes) and 120B (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northwestern Part). The boundary between MLRAs 120A and 115, which have similar loess depth along their edges, is based on depth to bedrock. The boundary between MLRAs 120A and 120B is based on differences in soil types and percentages of lithic bedrock.

Physiography

This area is in the Highland Rim section of the Interior Low Plateaus province of the Interior Plains. Both large and small tributaries of the Ohio River dissect the nearly level to very steep uplands in the MLRA. The major streams and rivers have well defined valleys with broad flood plains and numerous stream terraces. The flood plains along the smaller streams are narrow. The western part of the area is dominated by gently sloping to steep slopes. The eastern part is dominated by sloping to very steep slopes with several levels of benches, the result of alternating beds of soft shale and hard sandstone bedrock. The steep and very steep slopes have many bedrock escarpments. Narrow, nearly level to gently sloping ridgetops are throughout the area. Elevation ranges from 330 feet (100 meters) on the flood plain along the Ohio and Cache Rivers to about 1,064 feet

(324 meters) on the highest ridges. Local relief varies widely. The bluffs along the Ohio River are as much as 250 feet (75 meters) above the river valley floor.

The Ohio River flows through this area, forming the boundary between Indiana and Kentucky and between Illinois and Kentucky. The Saline River, in Illinois, joins the Ohio River in this area. The Green River and its many tributaries drain the part of this area in Kentucky.

Geology

The geologic materials in this MLRA are of Early and Middle Pennsylvanian and Late Mississippian age. The rocks consist mainly of flat-lying, interbedded sandstone, shale, coal, and siltstone with minor areas of limestone. Bedrock outcrops are common on the bluffs along the Ohio River and its major tributaries. Coal mining has affected large portions of this MLRA, mainly in the central portion of the area in western Kentucky. A layer of loess covers nearly all the uneroded uplands and ranges from as much as 3 meters in the west, and places near the Ohio River, to slightly less than a meter in the eastern and southern portions of the MLRA. Other surficial geologic materials are mostly stratified Holocene- and Late Wisconsin-age sediments along the Ohio River and its tributaries. Lake beds are common near the tributaries of the Ohio River, and loess-covered bedrock benches occur on the higher portions of these valleys. Deposits of unconsolidated alluvium are in the river valleys.

Climate

The average annual precipitation in most of this area is 45 to 54 inches (1,145 to 1,370 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs during high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 55 to 58 degrees F (13 to 14 degrees C). The freeze-free period averages 210 days and ranges from 190 to 230 days.

Water

In most years the supply of moisture is adequate for crop production, but in some years yields are reduced by drought. Surface water is abundant in the area. The Ohio River, the many tributary streams of this river, springs, and farm ponds are sources of surface water. The water is used for recreation, public supply, and coal mining and for cooling thermoelectric power plants. Water for livestock is commonly stored in small ponds and reservoirs. The surface water is generally of good quality and suitable for almost all uses.

Good-quality ground water is not abundant in all parts of this area. Water for domestic use, livestock, and coal mining is available from underlying hard rock aquifers and from more shallow sand and gravel deposits in the valleys of the Ohio River and tributary streams.

The Pennsylvanian-Mississippian aquifer underlies most of this area. Low-yield wells are common in this aquifer in Illinois. The water in Illinois is typically high in total dissolved solids, very hard, and very high in iron content. The Pennsylvanian aquifer is in the coal-mining regions of Kentucky in this area. It has water that is less saline and not as hard as the water in the aquifer in Illinois and has about one-third the iron content. Ground water from these two aquifers requires extensive treatment to reduce the hardness and to prevent iron staining.

The Mississippian aquifer in Kentucky is mostly limestone and has much fresher water. It is used for public supply in some communities. Water from the alluvial deposits is similar in quality to that from the Pennsylvanian aquifer and very hard. Before it can be used for most purposes, it requires treatment to reduce hardness and prevent iron staining.

Soils

Most of the soils in this MLRA are Udalfs. Most are medium textured or moderately fine textured, but some on the lower hillsides are fine textured. The soil temperature regime is mesic. Soils mostly have a udic soil moisture regime in the uplands and an aquic regime along the flood plains. Soil mineralogy is mixed. The soils in the area formed in loess or in sandstone, shale, siltstone, or limestone residuum on uplands; in predominantly fine silty alluvium along the larger tributaries; and in coarse silty alluvium along the smaller tributaries. Lacustrine clays are common along lake beds, and some soils in backswamps have similar clay contents.

Uplands are dominated by soils with fragipans. Depth to the fragipan varies with loess thickness. Fragipans tend to be deeper where loess is thicker and shallower as the loess thins. They occur on stable as well as more sloping landscapes in thicker loess. They are most common on stable, less sloping landscapes on thinner loess. Fragipans occur in areas with about 0.5 meter to slightly more than 1.5 meters of loess. Areas with thicker or thinner loess tend to be dominated by Hapludalfs.

The main soils and their series:

- Endoaquepts that formed in loamy alluvium along major rivers (Newark series) and smaller tributaries (Belknap series); that formed in clayey alluvium in slackwater areas along the major rivers on flood plains (Karnak series)
- Epiaqualfs that formed in lacustrine clays on lakebeds along the major rivers on terraces (McGary series)
- Eutrudepts that formed in loamy alluvium along the major rivers on flood plains (Nolin series)
- Fragiudalfs that formed in loess and the underlying residuum with a fragipan, on hills (Grantsburg and Zanesville series)
- Fraglossudalfs that formed in loess and the underlying residuum with a fragipan, on hills (Sadler series)
- Hapludalfs that formed in loess and the underlying residuum on hills (Wellston series)

Udorthents that formed in regolith from surface-mining operations in areas disturbed by mining, across all landforms (Fairpoint series)

Biological Resources

The soils on uplands in this area support native hardwoods. Oak and hickory are the dominant tree species. Mixed beech, sugar maple, yellow-poplar, white ash, red oak, and white oak are in coves and on the cooler slopes. Eastern redcedar commonly grows on the shallower soils. Bottom-land hardwoods include cottonwood, cherrybark oak, pin oak, Shumard oak, sweetgum, swamp chestnut oak, and swamp white oak. Sedge and grass meadows and scattered trees are on some lowland sites. The wettest sites are dominated by cypress and buttonbush.

Major wildlife species in this area include white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, bald eagle, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, and bobwhite quail.

Land Use

Most of this area consists of privately owned farms, which produce both cash-grain crops and livestock (fig. 120A-2). The less sloping soils are used for soybeans and dry-farmed corn for grain. Some small grains, such as winter wheat and grain sorghum, also are grown. About one-third of the area is wooded. Surface coal mines make up a small acreage.

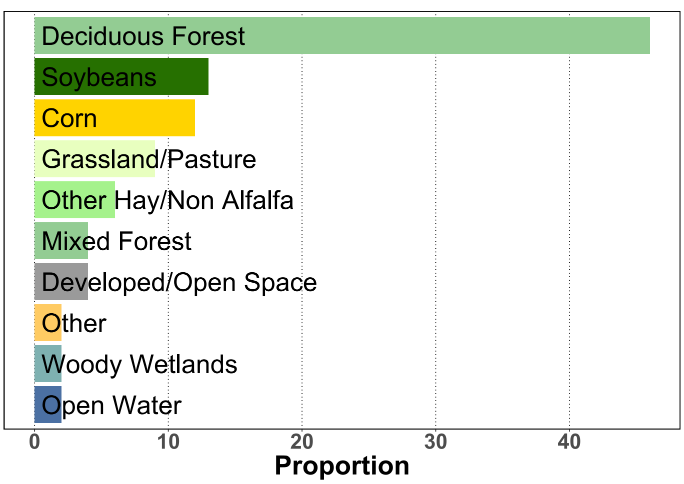

Figure 120A-2: Relative proportions (percentages) of land use in MLRA 120A.

The major soil resource concerns are water erosion, flooding, wetness, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems), cover crops, and nutrient management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important in areas used for timber production.

120B—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northwestern Part

This MLRA (fig. 120B-1) is characterized by loess, about 1 meter thick, overlying residuum from sandstone and shale of Pennsylvanian or Mississippian age. It is used for row crop agriculture in less steep areas, livestock on more rolling landscapes, and forest on the steeper hills and in the wetter areas along flood plains. This MLRA is almost entirely in Indiana. Less than 1 percent is in Kentucky. The area makes up about 2,401 square miles (6,218 square kilometers).

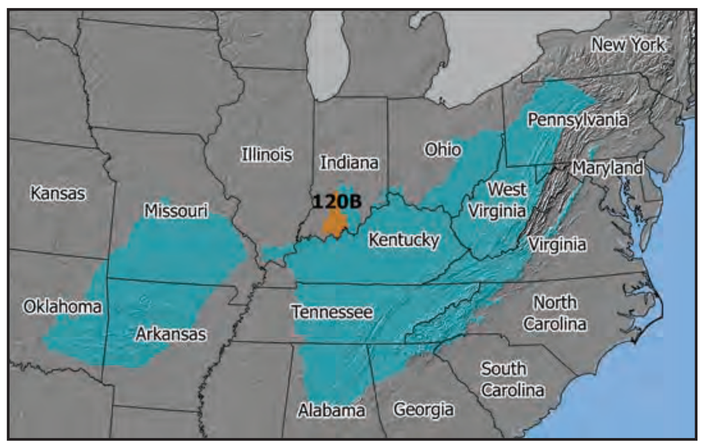

Figure 120B-1: Location of MLRA 120B, which covers 621,800 hectares (1,536,400 acres), within Region N.

MLRA 120B has a distinct boundary based on physiography with MLRAs 114 (Southern Illinois and Indiana Thin Loess and Till Plain) and 122 (Highland Rim and Pennyroyal). MLRA 114 has more level and less dissected uplands that are underlain by glacial till. MLRA 122 has soils that are underlain by limestone and dominated by redder parent materials, karst topography, and more broad uplands.

MLRA 120B has a less apparent boundary with MLRAs 115 (Central Mississippi Valley Wooded Slopes) and 120A (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part). The boundary between MLRAs 120B and 115, which have similar loess depth along their edges, is based on depth to bedrock. The boundary between MLRAs 120B and 120A is based on differences in soil types and percentages of lithic bedrock.

Physiography

This area is in the Highland Rim section of the Interior Low Plateaus province of the Interior Plains. Both large and small tributaries of the Ohio River dissect the nearly level to very steep uplands. The major streams and rivers have well defined valleys with broad flood plains and numerous stream terraces. The flood plains along the smaller streams are narrow. Local relief varies widely. The western part of the area is dominated by gently sloping to steep slopes. The eastern part is dominated by sloping to very steep slopes with several levels of benches, the result of alternating beds of soft shale and hard sandstone bedrock. The steep and very steep slopes have many bedrock escarpments. Narrow, nearly level to gently sloping ridgetops are throughout the area. Elevation ranges from about 390 feet (118 meters) on the flood plain along the Ohio River to about 950 feet (290 meters) on the highest ridges. The bluffs along the Ohio River are as much as 250 feet (75 meters) above the river valley floor.

The Ohio River flows through this area, forming the boundary between Indiana and Kentucky. The Anderson River empties into the Ohio River at Troy, Indiana, in the south-central part of the MLRA. The East Fork of the White River crosses the northern end of the area. A short reach of the Blue River is in the southeastern part. Patoka Lake, in the southern part of the area, is a major reservoir on the Patoka River.

Geology

The geologic materials are of Early and Middle Pennsylvanian and Late Mississippian age. The rocks consist mainly of flat-lying, interbedded sandstone, shale, coal, and siltstone with minor areas of limestone. Bedrock outcrops are common on the bluffs along the Ohio River and its major tributaries. The surficial geologic materials consist mainly of a layer of loess, typically less than 3.5 feet (1 meter) thick, on the less eroded parts of the landscape and stratified sediments of Holocene and Wisconsinan age along the Ohio River and its tributaries. Deposits of unconsolidated alluvium are in the river valleys.

Climate

The average annual precipitation in most of this area is 43 to 48 inches (1,090 to 1,220 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs during high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 53 to 56 degrees F (11 to 13 degrees C). The freeze-free period averages 205 days and ranges from 185 to 225 days. The longer freeze-free periods occur along the Ohio River.

Water

In most years the supply of moisture is adequate for crop production, but in some years yields are reduced by drought. Surface water is abundant in this area. The East Fork of the White River, the Ohio River and its many tributary streams, springs, and farm ponds are sources of surface water. This water is used for recreation, public supply, and coal mining and for cooling thermoelectric power plants. Water for livestock is commonly stored in small ponds and reservoirs. The surface water in this area generally is of good quality and suitable for almost all uses.

Good-quality ground water is not abundant in all parts of this area. Water for domestic use, livestock, and coal mining is available from underlying hard rock aquifers and from shallower sand and gravel deposits in the valleys along the East Fork of the White River, the Ohio River, and tributary streams. The primary aquifer underlying almost all of this area consists of coal-bearing rocks of Pennsylvanian age. The water from this aquifer is very hard. It requires extensive treatment to reduce the hardness and prevent iron staining. Water from the alluvial deposits is similar in quality to that from the Pennsylvanian aquifer. It is very hard. Before it can be used for most purposes, the water requires treatment to reduce hardness and prevent iron staining.

Soils

The dominant soil orders are Alfisols, Ultisols, and Inceptisols. The soils in the area have a mesic soil temperature regime, a udic or aquic soil moisture regime, and dominantly mixed mineralogy. They formed dominantly in less than 40 inches of loess and in residuum or colluvium derived from sandstone, shale, and siltstone. The soils range from moderately deep to very deep and from poorly drained to somewhat excessively drained and are loamy, silty, or clayey.

The main soils and their series:

- Dystrudepts that formed in residuum on strongly sloping to very steep side slopes of hills (Tipsaw series); that formed in alluvium on local flood plains (Cuba series)
- Endoaquepts that formed in loamy alluvium, along the major rivers (Newark series) and smaller tributaries (Stendal series) on flood plains
- Epiaqualfs that formed in lacustrine clays on lakebeds, along the major rivers on terraces (McGary series)
- Eutrudepts that formed in loamy alluvium along headwaters on local flood plains (Gatchel series)
- Fragiudalfs that formed in loess and the underlying residuum with a fragipan, on hills (Apalona and Zanesville series)
- Hapludalfs that formed in loess and the underlying residuum on hills (Wellston series); that formed in residuum on structural benches on hills (Ebal series)

Biological Resources

The soils on uplands support native hardwoods. Oak and hickory are the dominant tree species. Mixed beech, sugar maple, yellow-poplar, white ash, red oak, and white oak are in coves and on the cooler slopes. Eastern redcedar commonly grows on the shallower soils overlying limestone. Bottom-land hardwoods such as cottonwood, cherrybark oak, pin oak, Shumard oak, sweetgum, and swamp white oak are on flood plains. Sedge and grass meadows and scattered trees are on some lowland sites.

Major wildlife species in this area include white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, bald eagle, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, and bobwhite quail.

Land Use

Most of this area consists of privately owned farms (fig. 120B-2). The farms produce both cash-grain crops and livestock. The less sloping soils are used for soybeans and dry-farmed corn for grain. Some small grains, such as winter wheat and grain sorghum, also are grown. About one-third of the area is wooded. Surface coal mines make up a small acreage.

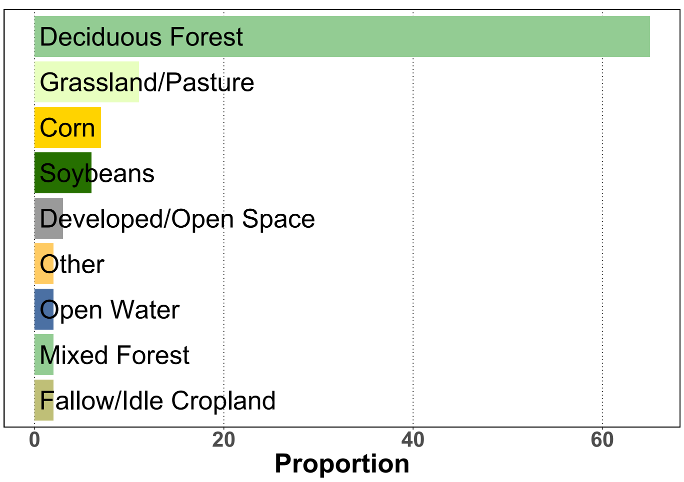

Figure 120B-2: Relative proportions (percentages) of land use in MLRA 120B.

The major soil resource concerns are water erosion, flooding, wetness, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems), cover crops, and nutrient management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important in areas used for timber production.

120C—Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northeastern Part

This MLRA (fig. 120C-1) is characterized by thin loess-covered residuum from siltstone and shale of Pennsylvanian or Mississippian age. It is used for row crop agriculture in the less steep areas, livestock on the more rolling landscapes, and forest on the steeper hills and in the wetter areas along flood plains. The MLRA is entirely in Indiana. It makes up about 984 square miles (2,548 square kilometers).

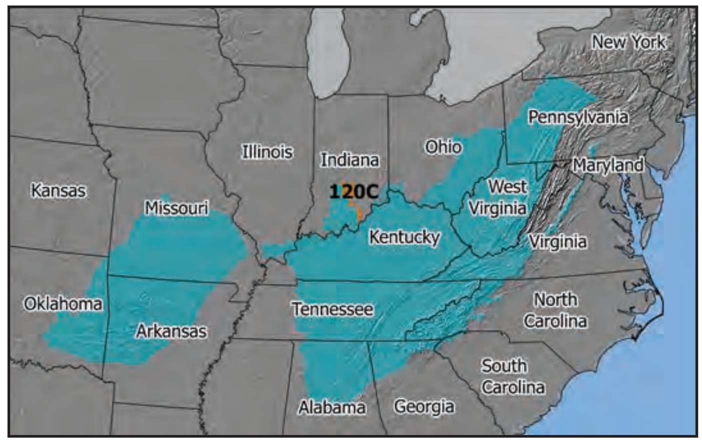

Figure 120C-1: Location of MLRA 120C, which covers 254,800 hectares (629,600 acres), within Region N.

MLRA 120C has a distinct boundary based on physiography with MLRAs 111 (Indiana and Ohio Till Plain), 114 (Southern Illinois and Indiana Thin Loess and Till Plain), 121 (Kentucky Bluegrass), and 122 (Highland Rim and Pennyroyal). MLRAs 111 and 114 have more level, less dissected uplands that are underlain by glacial till. MLRA 121 is distinguishable by the Knobstone Escarpment. MLRA 122 has soils that are underlain by limestone and dominated by redder parent materials, karst topography, and more broad uplands.

Physiography

This area is in the Highland Rim section of the Interior Low Plateaus province of the Interior Plains. Both large and small tributaries of the Ohio River and the East Fork of the White River dissect the nearly level to very steep uplands in the area. The major streams and rivers have well defined valleys with broad flood plains and numerous stream terraces. The flood plains along the smaller streams are narrow. Summits are narrow and nearly level to gently sloping. Elevation ranges from 380 feet (115 meters) on the northernmost flood plain along the Ohio River to about 1,060 feet (325 meters) on the highest ridges. Local relief is mainly 10 to 50 feet (3 to 15 meters), but it is 50 to 100 feet (15 to 30 meters) along drainageways and streams. The Knobstone Escarpment is as much as 250 feet (75 meters) above the valley floor of the rivers.

The Ohio River marks the southern boundary of this area and forms the State line between Indiana and Kentucky. The White River skirts the northern end of the area. The East Fork of the White River and the Muscatatuck and Blue Rivers cross the area. Monroe Lake, on the Salt River, is in the area.

Geology

The geologic materials in this MLRA are of Early and Middle Pennsylvanian and Late Mississippian age. The rocks consist mainly of flat-lying, interbedded sandstone, shale, coal, and siltstone with minor areas of limestone. Bedrock outcrops are common on the bluffs along the Ohio River and its major tributaries. The surficial geologic materials consist mainly of a layer of loess, typically less than 3 feet (1 meter) thick, on the less eroded parts of the landscape and stratified sediments of Holocene and Wisconsinan age along the Ohio River and its tributaries. Unconsolidated alluvium is deposited in the river valleys.

Climate

The average annual precipitation in most of this area is 41 to 47 inches (1,040 to 1,195 millimeters). About 60 percent of the precipitation falls during the freeze-free period. Most of the rainfall occurs during high-intensity, convective thunderstorms in summer. Snowfall is common in winter. The average annual temperature is 52 to 56 degrees F (11 to 14 degrees C). The freeze-free period averages 205 days and ranges from 190 to 220 days. The longer freeze-free periods occur along the Ohio River.

Water

In most years the supply of moisture is adequate for crop production, but in some years yields are reduced by drought. Monroe Lake, rivers and streams, springs, and farm ponds are sources of surface water. This water is used for recreation, public supply, domestic use, and livestock. Water for livestock is commonly stored in small ponds and reservoirs. The surface water is generally of good quality and suitable for almost all uses.

Good-quality ground water is not abundant in all parts of the MLRA. Water for public supply, domestic use, and livestock is available from underlying hard rock aquifers and from shallower sand and gravel deposits in valleys along the East Fork of the White River, the Ohio River, and tributary streams. The primary aquifer underlying almost all of this area consists of coal-bearing rocks of Pennsylvanian age, which have very hard water. Water from this aquifer requires extensive treatment to reduce the hardness and to prevent iron staining. In areas away from the rivers, the ground water supply is the only source of water for rural landowners and communities. Water from the alluvial deposits is similar in quality to that from the Pennsylvanian aquifer. It is very hard. Before it can be used for most purposes, the water requires treatment to reduce hardness and prevent iron staining.

Soils

The dominant soil orders are Alfisols, Ultisols, and Inceptisols. The soils in the area have a mesic soil temperature regime, a udic or aquic soil moisture regime, and dominantly mixed mineralogy. They formed dominantly in loess and in residuum derived from siltstone and shale. They range from moderately deep to very deep and from somewhat poorly drained to well drained and are loamy, silty, or clayey.

The main soils and their series:

- Dystrudepts that formed in residuum on strongly sloping to very steep side slopes of hills (Brownstown series); that formed in alluvium on local flood plains (Beanblossom and Cuba series)
- Endoaquepts that formed in loamy alluvium on smaller tributaries on flood plains (Stendal series)
- Fragiudalfs that formed in a mixture of loess and alluvium on stream terraces (Pekin series)
- Fragiudults that formed in loess and the underlying residuum with a fragipan, on hills and knobs (Spickert series)
- Hapludalfs that formed in residuum on hills and knobs (Kurtz and Wellrock series)
- Hapludults that formed in loess and the underlying residuum (Wrays series) and in residuum (Gilwood series), on hills and knobs

Biological Resources

The soils on uplands support native hardwoods. Oak and hickory are the dominant tree species. Mixed beech, sugar maple, yellow-poplar, white ash, red oak, and white oak are in coves and on the cooler slopes. Bottom-land hardwoods such as cottonwood, pin oak, Shumard oak, sweetgum, and swamp white oak are on flood plains. Sedge and grass meadows and scattered trees are on some lowland sites.

Major wildlife species include white-tailed deer, coyote, gray fox, red fox, beaver, raccoon, skunk, muskrat, opossum, mink, rabbit, fox squirrel, gray squirrel, Canada goose, bald eagle, turkey vulture, turkey, ruffed grouse, woodcock, great horned owl, wood duck, pileated woodpecker, red-bellied woodpecker, and bobwhite quail.

Land Use

Most of this area consists of privately owned farms (fig. 120C-2). The farms produce both cash-grain crops and livestock. Specialty crops, such as tobacco and apple orchards, are grown on a small acreage. The less sloping soils are used for soybeans and dry-farmed corn for grain. Some small grains, such as winter wheat and oats, also are grown in the area. About

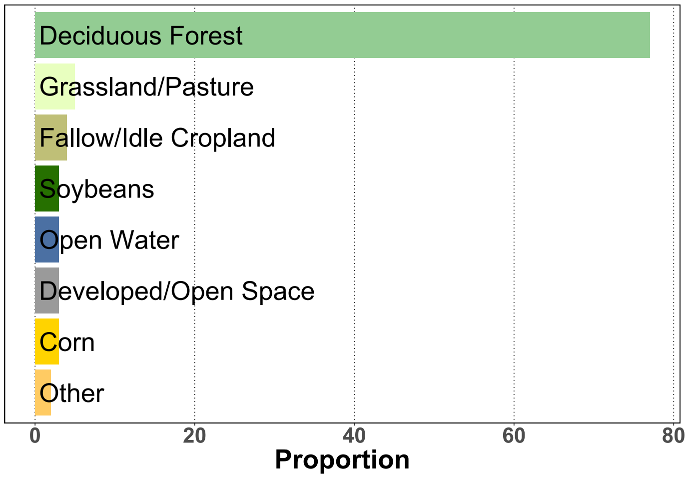

Figure 120C-2: Relative proportions (percentages) of land use in MLRA 120C.

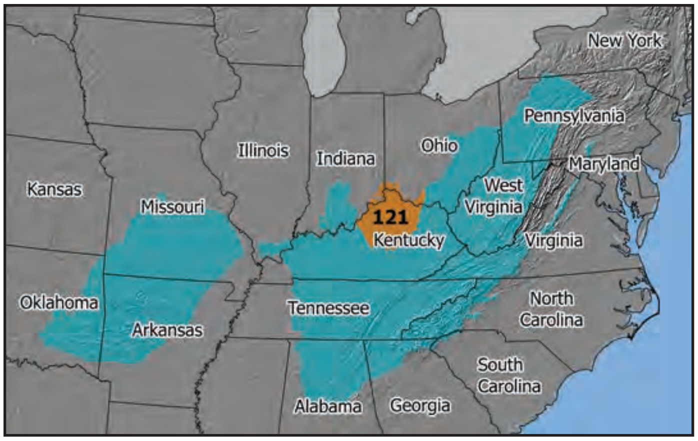

Figure 121-1: Location of MLRA 121, which covers 2,665,900 hectares (6,587,500 acres), within Region N.

13 percent of the area supports introduced and native grasses. About 44 percent is wooded. Monroe Lake makes up almost 8 percent of the area.

The major soil resource concerns are water erosion, flooding, wetness, a limited available water capacity, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems), cover crops, and nutrient management. Woodland management practices, such as exclusion of grazing and timber stand improvement, are important in areas used for timber production.

121—Kentucky Bluegrass

This MLRA (fig. 121-1) is characterized by soils that formed in residuum from Ordovician limestone. It is used for row crop agriculture and pasture in the less steep areas, livestock production and pasture on the more rolling landscapes, and forest on the steeper hills. Some areas have a mantle of loess about 0.5 meter or less in thickness. This MLRA is in Kentucky (86 percent), Ohio (8 percent), and Indiana (6 percent). It makes up about 10,293 square miles (26,659 square kilometers).

MLRA 121 has a distinct boundary with MLRA 111A (Indiana and Ohio Till Plain, Central Part), MLRAs 114A and 114B (Southern Illinois and Indiana Thin Loess and Till Plain, Eastern and Western Parts), MLRA 124 (Western Allegheny Plateau), and MLRA 125 (Cumberland Plateau and Mountains). MLRAs 111A, 114A, and 114B have more level, less dissected uplands that are underlain by glacial till. MLRA 124 consists of steeper Pennsylvanian-age sandstone, siltstone, clay, shale, and coal. MLRA 125 is similar in geology to MLRA 124 but has greater relief.

MLRA 121 has a less distinct boundary with MLRA 122 (Highland Rim and Pennyroyal). MLRA 122 has older underlying geology (Ordovician), has typically thicker residuum, and is mainly separated from MLRA 121 by the Knobs Region. In addition, the interior of MLRA 121 has soils high in phosphatic limestone.

Physiography

This area is primarily in the Lexington Plain section of the Interior Low Plateaus province of the Interior Plains. The parts of the area in Indiana and Ohio generally are in the Till Plains section of the Central Lowland province of the Interior Plains. This MLRA consists of gently rolling terrain with some isolated hills and ridges. Elevation ranges from about 440 feet (134 meters) on the flood plain along the Ohio River to about 1,480 feet (451 meters) on Sand Knob in northeastern Casey County, Kentucky. Local relief is about 160 to 330 feet (50 to 100 meters) on the highly dissected hills and 80 feet (25 meters) on the undulating, broad upland plains.

The Ohio River separates the States of Ohio and Kentucky in the northern part of this MLRA. The Great Miami, White Oak, and Ohio Brush Rivers are all tributaries to the Ohio River. The lower end of the Little Miami River is just west of Cincinnati. The Whitewater River, a major tributary to the Great Miami River, is in southeastern Indiana and southwestern Ohio. The Salt, Kentucky, and Licking Rivers are tributaries to the Ohio River in the part of this area in Kentucky.

Geology

Most of this area has Ordovician-age limestone that was brought to the surface in the Jessamine Dome, a high part of a much larger structure called the Cincinnati Arch. The formation of caves and karst topography was due to the strata of limestone. Younger units of thin-bedded shale, siltstone, and limestone are at the eastern and western edges of the MLRA. The area has no coal-bearing units. Pleistocene-age loess deposits cover most of the bedrock units, and some glacial lake sediments are at the surface in the northwest corner of the area. Deposits of unconsolidated alluvium are in the river valleys.

Climate

The average annual precipitation in most of the MLRA is 41 to 45 inches (1,040 to 1,145 millimeters). It is 45 to 52 inches (1,145 to 1,320 millimeters) along the southern edge of the area. About one-half of the precipitation falls during the growing season. Most of the rainfall occurs during high-intensity, convective thunderstorms. The annual snowfall averages about 14 inches (370 millimeters). The average annual temperature is 51 to 57 degrees F (10 to 14 degrees C). The freeze-free period averages 210 days and ranges from 185 to 230 days.

Water

Water is abundant in most of this area and suitable for all uses. In most years precipitation is adequate for crops, but in some years yields are reduced by drought. Large streams and constructed lakes supply most of the water in urban areas, and waterlines supply much of the water in nearby rural communities. Farm ponds are one of the major sources of water in other rural communities. Water is diverted from the Great Miami River Basin to Mill Creek for the city of Cincinnati.

Large quantities of ground water are available in the valleys along the Ohio River and its major tributaries. The unconsolidated sand and gravel aquifer beneath the lower Great Miami River in southwestern Ohio is one of the most heavily used aquifers in Ohio. Water from the alluvial aquifers is of good quality but very hard. The high levels of iron and manganese primarily come from runoff from surface mining in the upper part of the watershed. Almost all of the samples in the Louisville area exceeded the drinking water standard for nitrates. Leaching from septic tanks is the primary source of this contamination.

Wells and cisterns are the major sources of water in rural communities not served by rural water pipelines from reservoirs. A karst limestone aquifer underlying almost all of this area provides domestic and livestock water. This water is very hard.

Soils

The dominant soil orders are Alfisols, Inceptisols, and Mollisols. The soils in the area dominantly have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey.

The main soils and their series:

- Eutrudepts that formed in alluvium on flood plains (Nolin series)
- Fragiudalfs that formed in thin loess over residuum on ridges (Nicholson series)
- Hapludalfs that formed in residuum on hills and ridges (Beasley, Eden, Faywood, and Lowell series)
- Hapludolls that formed in residuum on hills and ridges (Fairmount series); that formed in alluvium on flood plains (Huntington series)
- Paleudalfs that formed in loess or other silty sediments over residuum on hills and ridges (Bluegrass and Maury series)

Biological Resources

This area generally supports mixed hardwoods. Chinquapin oak, bur oak, blue ash, Shumard oak, white ash, hackberry, American elm, black walnut, black cherry, black locust, and Kentucky coffee tree are important species. Eastern redcedar is dominant on the drier slopes and on abandoned farmland. Major wildlife species in this area include white-tailed deer, raccoon, muskrat, mink, cottontail, gray squirrel, fox squirrel, bobwhite quail, and mourning dove.

Land Use

Most of this area consists of small and medium-size farms (fig. 121-2). Urbanization is of major extent near Louisville and Lexington, Kentucky, and Cincinnati, Ohio. Nearly one-fourth of the area is cropland. The acreage of cropland varies widely from county to county, depending largely on topography. Corn, hay, and tobacco are the major crops. About one-third of the area is pasture, which is grazed mostly by beef cattle. Dairying and horse farms are important in some areas. About one-fourth of the area supports mixed hardwoods, but wood products are not commercially important.

The major resource concerns are water erosion, runoff, sedimentation, and water quality, particularly in areas of urban development. Air quality also is a concern near the urban areas. Conservation practices on cropland generally include conservation tillage, nutrient management, pest management, grassed waterways, field borders, and grass buffers.

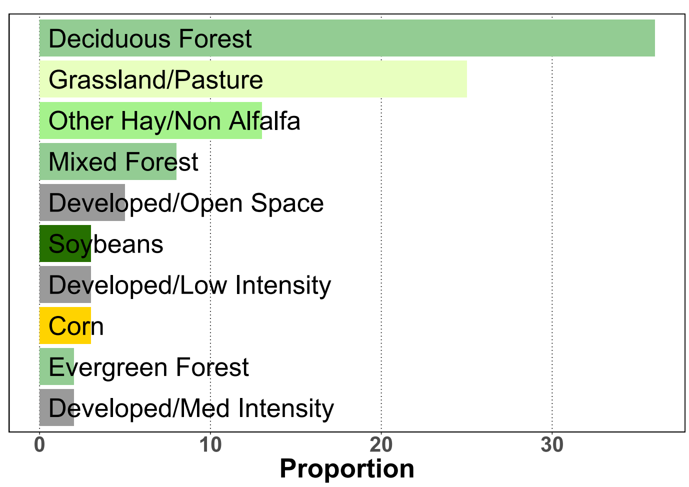

Figure 121-2: Relative proportions (percentages) of land use in MLRA 121.

122—Highland Rim and Pennyroyal

This MLRA (fig. 122-1) is characterized by a plateau with low, rolling hills, upland flats, and narrow valleys. It consists mainly of a patchwork of small, privately owned farms that produce crops, livestock, and forage. About 40 percent of the area is forested, mostly on the steeper slopes. This MLRA is in Tennessee (45 percent), Kentucky (43 percent), Indiana (7 percent), and Alabama (5 percent). It makes up about 21,034 square miles (54,478 square kilometers).

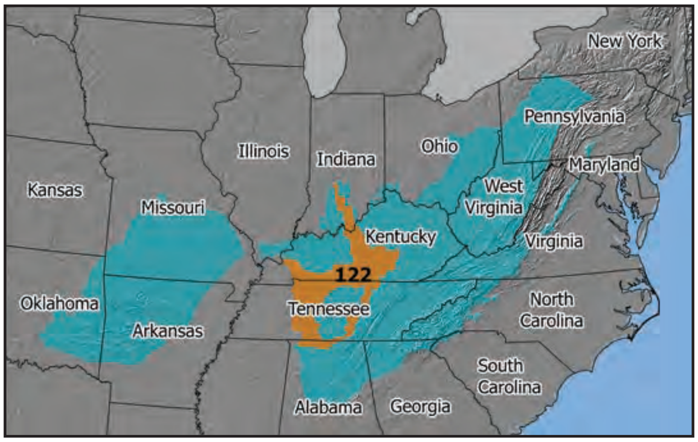

Figure 122-1: Location of MLRA 122, which covers 5,447,800 hectares (13,461,800 acres), within Region N.

MLRA 122 has a distinct boundary based on physiography and differing geology with MLRAs 114 (Southern Illinois and Indiana Thin Loess and Till Plain), 120A (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Southern Part), 120B (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northwestern Part), 120C (Kentucky and Indiana Sandstone and Shale Hills and Valleys, Northeastern Part), 125 (Cumberland Plateau and Mountains), and 128 (Southern Appalachian Ridges and Valleys). MLRA 122 also has a distinct boundary based on physiography with MLRA 133C (Gulf Coastal Plain), MLRA 134 (Southern Mississippi Valley Loess), and MLRAs 121 (Kentucky Bluegrass) and 123 (Nashville Basin), which have more undulating topography and differing geology.

Physiography

This area is in the Highland Rim section of the Interior Low Plateaus province of the Interior Plains. Slopes are steep where the encircled Nashville Basin cuts into the area and along the western edge bordering the Coastal Plain. Elsewhere, except for steep walls and hillsides along deeply cut stream channels, the topography generally is gently rolling to strongly rolling. There are a few broad upland flats and shallow basins. In many areas the land surface is pitted by limestone sinks. Elevation generally is 660 to 980 feet (200 to 300 meters). It ranges from about 330 feet (100 meters) along the deepest valley floors to about 1,310 feet (400 meters) on the crests of isolated hills.

The headwaters of the Kentucky, Green, and Cumberland Rivers occur in the Kentucky part of this MLRA. The Ohio River forms the boundary between Indiana and Kentucky in this MLRA. The Tennessee River follows the western edge of the part of this area in Tennessee. The Buffalo and Cumberland Rivers also are in this area.

Geology

Most of this MLRA is underlain by Ordovician- to Mississippian-age limestone and dolomite that have been exposed through erosion of the Cincinnati Arch. Parts of these rocks are covered by a layer of clay as much as 80 feet thick. Karst features are common in areas without a layer of clay. In the northernmost part of the MLRA, in Indiana, a sizable area is underlain by shale, sandstone, and limestone. Much of the bedrock on uplands and ridges is covered by a loess cap. Significant sand and gravel deposits occur on the valley floor and on terraces along the major rivers.

Climate

The average annual precipitation in this area is 43 to 63 inches (1,090 to 1,600 millimeters), increasing to the south. The maximum precipitation occurs in winter and early spring, and the minimum occurs in fall. Most of the rainfall occurs during high-intensity, convective thunderstorms. Snowfall may occur in winter. The average annual temperature is 52 to 60 degrees F (11 to 16 degrees C), increasing to the south. The freeze-free period averages 210 days and ranges from 185 to 235 days. The longer freeze-free periods occur in the more southerly parts of the area.

Water

In most years precipitation is adequate for crops, but in some years yields are reduced by short dry periods in early summer. The numerous perennial streams and lakes supply abundant water to much of the area. The surface water generally is suitable for all uses. Several medium to large lakes constructed by the U.S. Army Corps of Engineers provide flood control, power production, opportunities for recreation, and water for municipalities. Water lines from metropolitan areas commonly extend far into the countryside where surface water is scarce. Farm ponds provide supplemental water where the supply of other surface water is low.

Most of the ground water used in this area is from a Mississippian-age carbonate aquifer system. The water occurs in solution openings and fractures in the limestone and dolomite. It is very hard but is otherwise of excellent quality. In some areas high levels of iron, manganese, and sulfate can occur. High levels of iron may exceed the national secondary (esthetic) standard for drinking water in Indiana. The iron can stain ceramic and porcelain and precipitate in pipes. In karst areas the aquifer is susceptible to contamination from nonpoint sources of pollution in runoff.

Soils

The dominant soil orders are Alfisols, Inceptisols, and Ultisols. The soils in the area dominantly have a mesic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are moderately deep to very deep, generally moderately well drained or well drained, and loamy or clayey.

The main soils and their series:

Eutrudepts that formed in residuum on hills (Garmon series); that formed in alluvium on flood plains (Nolin series)

Fluvaquents that formed in alluvium on flood plains (Newark series)

Fragiudalfs that formed in loess over residuum on hills and ridges (Bedford and Nicholson series)

Fragiudults that formed in loess over residuum on hills and ridges (Dickson series)

Hapludalfs that formed in residuum on hills and ridges (Caneyville series)

Hapludults that formed in residuum on hills and ridges (Frankstown series)

Paleudalfs that formed in residuum on hills and ridges (Baxter and Vertrees series); that formed in loess over residuum or old alluvium on hills and ridges (Crider, Hammack, and Pembroke series)

Paleudults that formed in residuum on uplands (Frederick series); that formed in loess over residuum on ridges and plateaus (Mountview series)

Biological Resources

This area supports oak-hickory forests. Yellow-poplar is common on the deeper soils. Understory plants include a variety of grasses, forbs, vines, and shrubs. Little bluestem and broomsedge are the dominant grass species.

Major wildlife species in this area include red fox, gray fox, raccoon, skunk, opossum, muskrat, mink, cottontail, gray squirrel, fox squirrel, bobwhite quail, and mourning dove. Fish species include carp, bullhead, largemouth bass, and bluegill.

Land Use

Most of this area consists of small and medium-size farms (fig. 122-2). Extensive forests are on the deeply dissected hills surrounding the Nashville Basin and along the western edge joining the Coastal Plain. Elsewhere, the forests consist mostly of small farm woodlots. Hay and pasture are grown for beef cattle. Corn and soybeans are grown mostly on narrow strips of bottom land and on upland flats and are important locally. Tobacco, especially burley, used to be an important cash crop; dark-fired tobacco was a high-value crop grown on the Tennessee-Kentucky State line. Some areas are used for urban development.

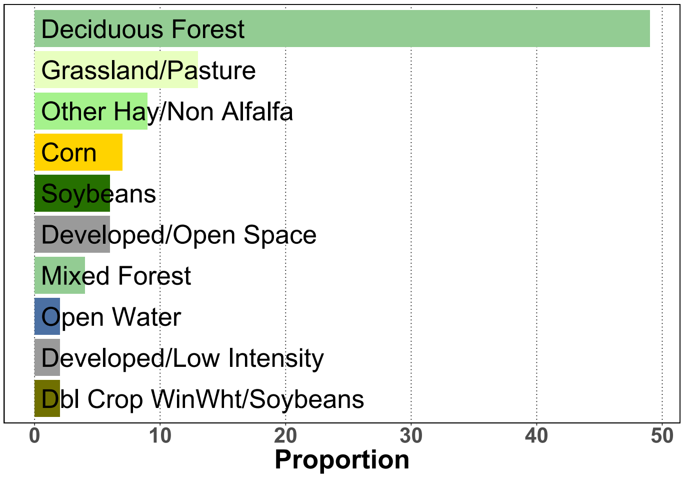

Figure 122-2: Relative proportions (percentages) of land use in MLRA 122.

The major soil resource concern is water erosion. Erosion is a hazard on cropland, streambanks, and construction sites. Minor erosion can occur on overgrazed pastures, and extreme overgrazing can result in gullies in areas of concentrated flow and heavy use. Maintenance of the content of organic matter and productivity of the soils and management of soil moisture are additional resource concerns in areas with long-term erosion.

Conservation practices on cropland generally include systems of crop residue management (especially no-till systems), cover crops, pest management, and nutrient management. Conservation practices on pasture generally include prescribed grazing, watering systems, protection of heavily used areas, nutrient management, and pest management. Conservation practices on hayland generally include forage harvest management, nutrient management, and pest management. Critical area planting helps to prevent gully erosion in all areas.

123—Nashville Basin

The Nashville Basin is characterized by an outer part of steep slopes and an inner part that is dominantly undulating and rolling with many limestone sinks and limestone outcrops. This MLRA (fig. 123-1) is entirely in Tennessee and makes up about 5,910 square miles (15,306 square kilometers).

MLRA 123 has a distinct boundary based on physiography with MLRA 122 (Highland Rim and Pennyroyal), which borders it entirely. MLRA 122 has younger bedrock and steeper topography.

Physiography

Most of this area is in the Nashville Basin section of the Interior Low Plateaus province of the Interior Plains. A small part of the northeast corner and the western and southern

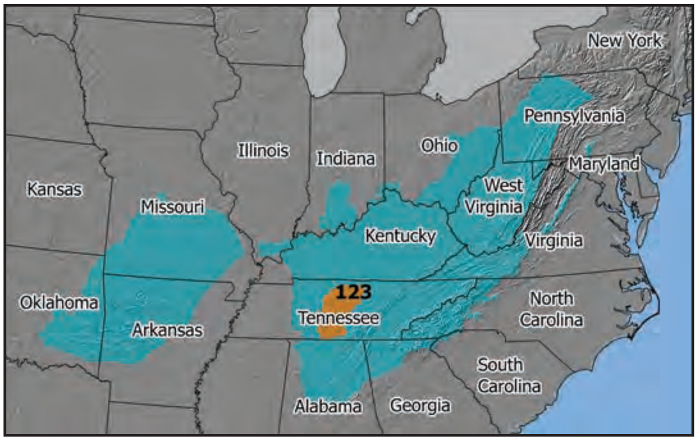

Figure 123-1: Location of MLRA 123, which covers 1,530,600 hectares (3,782,200 acres), within Region N.

fourth of the area are in the Highland Rim section of the same province and division. Most of the outer part of the Nashville Basin is deeply dissected and consists of steep slopes between narrow, rolling ridgetops and narrow valleys. The inner part of the basin is dominantly undulating and rolling. In many areas the land surface is deeply pitted by limestone sinks, and outcrops of limestone are almost everywhere. Elevation generally is about 650 feet (200 meters), but it is as high as 1,000 to 1,325 feet (305 to 405 meters) on isolated hills and as low as 450 feet (135 meters) in some of the more deeply cut stream channels.

The Cumberland River is in the northern part of this area. Two major tributaries of this river, the Harpeth and Stones Rivers, are also in this MLRA.

Geology

The bedrock geology in this area consists of Ordovician limestone exposed by geologic erosion of the top of the Nashville Dome (a high part of the Cincinnati Arch). The common sinkholes in limestone are either open to the subsurface or covered by soils and colluvium that have collected in depressions on the land surface above the sinkholes. Younger rocks occur as a rim just outside this area. Surficial deposits include loess on the less eroded landforms and alluvium along the rivers and streams.

Climate

The average annual precipitation is 48 to 57 inches (1,220 to 1,450 millimeters). The maximum precipitation occurs in midwinter and early spring, and the minimum occurs in autumn. Rainfall primarily occurs during high-intensity, convective thunderstorms. Some snow occurs in winter, but it does not remain on the ground for long periods. The average annual temperature is 56 to 60 degrees F (14 to 16 degrees C). The freeze-free period averages 210 days and ranges from 195 to 230 days. The longer freeze-free periods occur in more southerly parts of the area.

Water

The moderately high precipitation generally provides adequate moisture for crops and pasture, but short periods of drought in summer reduce pasture and crop yields in some years. Permanent streams and lakes are important sources of water. The Cumberland River has dams for flood control, power production, navigation, and recreation. Farm ponds provide supplemental water, especially where surface water is scarce because of limestone sinks.

Ground water from wells and springs is an important source of water for livestock and domestic use. This water comes from the Ordovician carbonate aquifer that underlies this area and is hard. It is in solution openings in the aquifer and is susceptible to contamination from surface activities in karst areas. For example, septic systems have contaminated the shallow water in the part of this aquifer in the Nashville area.

Soils

Many of the soils in the area are Udalfs. The MLRA also has a significant acreage of Mollisols. Rock outcrops are common on uplands.

The main soils and their series:

Aquolls that are somewhat poorly drained or poorly drained and formed in loamy or clayey alluvium derived from limestone, on flood plains (Agee, Godwin, and Lanton series)

Rendolls that are very shallow, well drained, and clayey and that formed in limestone residuum dominantly in undulating to rolling parts of the inner basin area (Gladeville series)

Udalfs that are moderately deep to very deep, well drained, and clayey, that formed in limestone residuum, and that are dominantly in rolling to steep parts of the outer basin area (Mimosa, Braxton, Gladdice, and Hampshire series) and the undulating to hilly parts of the inner basin area (Talbott and Bradyville series)

Udalfs that are very deep, well drained, and clayey or loamy and that formed in alluvium and loess over alluvium or limestone residuum in nearly level to undulating areas (Armour, Cumberland, Harpeth, Lomond, and Maury series); that generally are moderately well drained to somewhat poorly drained and that formed in loamy or clayey alluvium and residuum (Byler, Capshaw, Colbert, and Tupelo series)

Udepts that are moderately well drained or well drained, on flood plains (Lindell and Ocana series)

Udolls that are shallow or moderately deep, well drained, and clayey and that formed in limestone residuum dominantly in rolling to steep areas (Ashwood and

Barfield series); that are very deep and well drained or moderately well drained and that formed in loamy or clayey alluvium derived from limestone, on flood plains (Arrington, Egam, Lynnville, and Staser series)

Biological Resources

This area supports stands of oak and hickory. Yellow-poplar grows on north aspects, and eastern redcedar and cedar-hardwood stands grow in limestone glades and on rocky, clayey sites. The understory vegetation includes many grasses, forbs, vines, and shrubs. Broomsedge bluestem is the dominant grass species.

Major wildlife species in this area include white-tailed deer, gray fox, red fox, raccoon, muskrat, cottontail, mink, gray squirrel, bobwhite quail, and mourning dove. Fish species include bass, crappie, and walleye.

Land Use

The MLRA has many small and medium-size, privately owned farms that produce crops, livestock, and forage (fig. 123-2). About 36 percent of the area is wooded. Much of the farmland has been converted to residential use and to small estate-type farms, particularly around Nashville. Hay, pasture, and some grain are grown for beef and dairy cattle. Small acreages are used for soybeans. Some large rocky sites, commonly called “Glady Land,” support redcedar forest or redcedar-deciduous brush.

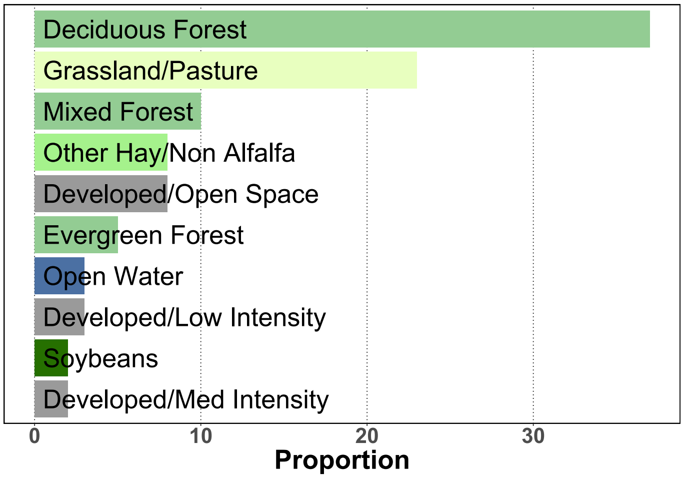

Figure 123-2: Relative proportions (percentages) of land use in MLRA 123.

The major soil resource concerns are water erosion, deposition of sediment, depletion of soil organic matter, surface compaction, and soil contaminants. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems), cover crops, and nutrient management. The important conservation practice on pasture is prescribed grazing.

124—Western Allegheny Plateau

This MLRA (fig. 124-1) is on a dissected plateau that has narrow, level valley floors, rolling ridgetops, and hilly to steep side slopes. About 60 percent of the area is forested, mostly on the steep slopes; the valley floors are commonly used for production of crops or livestock. This area is in Ohio (62 percent), Kentucky (21 percent), and Pennsylvania (17 percent). It makes up about 12,553 square miles (32,511 square kilometers). The Wayne National Forest covers a significant part of the area in southern Ohio.

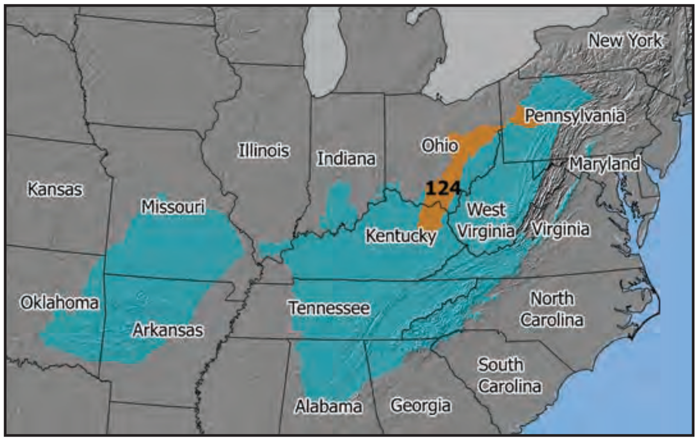

Figure 124-1: Location of MLRA 124, which covers 3,251,100 hectares (8,033,700 acres), within Region N.

MLRA 124 has a distinct boundary based on physiography with MLRAs 111 (Indiana and Ohio Till Plain), 121 (Kentucky Bluegrass), 127 (Eastern Allegheny Plateau and Mountains), and 139 (Lake Erie Glaciated Plateau). These adjacent MLRAs are more or less deeply dissected areas along rivers and streams or show glacial influence.

MLRA 124 has a less apparent boundary with MLRAs 125 (Cumberland Plateau and Mountains) and 126 (Central Allegheny Plateau). These adjacent MLRAs have narrower ridgetops and steeper side slopes.

Physiography

This area is primarily in the Kanawha section of the Appalachian Plateaus province of the Appalachian Highlands. The southern edge is in the Cumberland Plateau section of the same province and division. The southwestern edge is in the Lexington Plain section of the Interior Low Plateaus province of the Interior Plains. Elevation ranges from 660 feet (200 meters) on the lowest valley floors to 1,310 feet (400 meters) on the highest ridgetops. Local relief is about 160 to 330 feet (50 to 100 meters).

The Allegheny River crosses the part of this area in Pennsylvania. The Muskingum, Raccoon, Scioto, and West Fork

Little Beaver Rivers are in the part of this area in Ohio. The Ohio River forms the boundary between Ohio and Kentucky in the southern part of the area.

Geology

Cyclic beds of sandstone, siltstone, clay, shale, and coal of Pennsylvanian age form the bedrock in this area. Similar rocks of Mississippian age occur along the southwest edge of the area in Kentucky and southern Ohio. The MLRA is on the east side of the Cincinnati Arch, so the bedrock is tilted to the east in Kentucky and Ohio. Old glacial drift deposits are in some of the major river valleys. Wisconsin-age glacial outwash deposits of unconsolidated sand and gravel are near the surface in river valleys in Pennsylvania and Ohio. Wisconsin-age glacial drift covers the surface in areas to the east and north of the MLRA.

Climate

The average annual precipitation in most of this area is 37 to 45 inches (940 to 1,145 millimeters). It is 45 to 50 inches (1,145 to 1,270 millimeters) at the southern tip. The precipitation generally is evenly distributed throughout the year but is slightly more in late spring and slightly less in late autumn. Rainfall occurs during high-intensity, convective thunderstorms in summer. Winter precipitation occurs as snow. The average annual temperature is 46 to 56 degrees F (8 to 13 degrees C). The freeze-free period averages 185 days and ranges from 155 to 220 days. It is longest along the southern edge of the area.

Water

The moderate precipitation and many perennial streams supply an abundance of surface water. Springs are among the principal sources of water for domestic use and livestock. Reservoirs on many streams provide water for industrial and municipal uses in most of the cities in this MLRA and also in some cities in adjoining MLRAs. The surface water is suitable for almost all uses with minimal treatment. Municipal and industrial wastewater discharges, nonpoint pollution from agricultural lands, sedimentation from surface mining of coal, and some acid mine drainage are the primary water-quality concerns.

Shallow wells are another major source of water for domestic use and livestock in this area. These wells are in the sandstone, shale, and coalbeds or in unconsolidated silt, sand, and gravel deposits along the rivers and streams throughout the area. The water in these wells is dominantly moderately hard and, except for high levels of iron, generally meets the national drinking water standards. Water from fractures in the sandstone generally is soft, and water from fractures in the shale generally is hard. The highest iron concentrations are in water from the coal-bearing units.

Deep oil and gas exploration wells tap abundant ground water, but this water is briny. For example, water from wells in the sandstone aquifer in Ohio is salty below a depth of 300 feet (90 meters). Contamination from septic systems located near domestic wells is a common water-quality concern.

Good-quality ground water can be obtained from the glacial outwash and recent alluvium deposited in the larger stream valleys throughout this area. High-yield wells are common in this aquifer, and many municipalities, industries, and thermoelectric power plants tap this aquifer. The water generally is very hard but typically meets national drinking water standards. In some areas it has high levels of iron that exceed the secondary drinking water standard.

Soils

The dominant soil orders are Ultisols and Inceptisols. The soils in the area have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy. They generally are moderately deep to very deep, excessively drained to somewhat poorly drained, and loamy.

The main soils and their series:

- Dystrudepts that formed in residuum on hills and ridges (Berks series)
- Eutrudepts that formed in alluvium on flood plains along the major streams (Chagrin series)
- Fragiudults that formed in colluvium on footslopes and alluvial fans (Ernest series)
- Hapludalfs that formed in alluvium on flood plains along the major streams (Guernsey series); that formed in residuum on hills and ridges (Coshocton series)
- Hapludults that formed in colluvium on footslopes and alluvial fans (Shelocta series); that formed in residuum on hills and ridges (Gilpin, Rayne, and Wharton series)
- Udorthents that formed in spolic material derived from surface mining of coal (Bethesda series)

Biological Resources

This area supports mixed oak forest vegetation. White oak, black oak, northern red oak, and scarlet oak are the dominant tree species. Shagbark hickory, bitternut hickory, pignut hickory, and mockernut hickory also occur. Oak, blackgum, flowering dogwood, sassafras, Virginia pine, pitch pine, and shortleaf pine grow mostly on ridgetops.

Major wildlife species include white-tailed deer, fox, beaver, raccoon, woodchuck, rabbit, squirrel, red-tailed hawk, crow, turkey, pheasant, ruffed grouse, pileated woodpecker, and mourning dove.

Land Use

Most of this area consists of farms, but about one-fourth of the acreage is used for other purposes (fig. 124-2). Hay and feed grains are grown for livestock. Fruits and vegetables are important locally. Less than one-fifth of the area is pasture. Nearly two-thirds of the area is forested. About half of the forested areas consist of farm woodlots, and about half consist

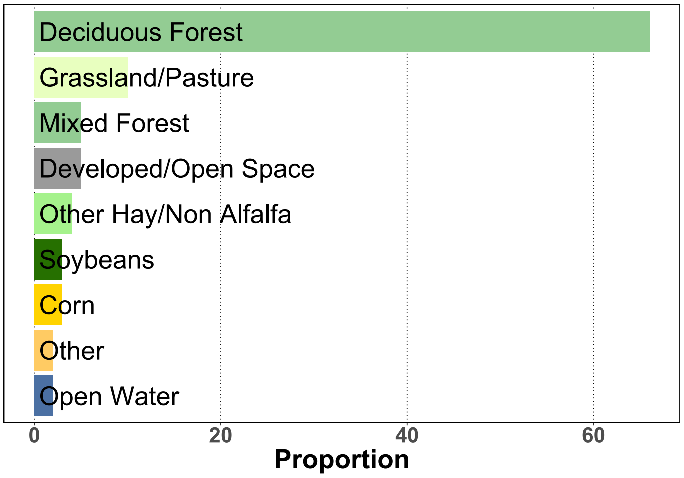

Figure 124-2: Relative proportions (percentages) of land use in MLRA 124.

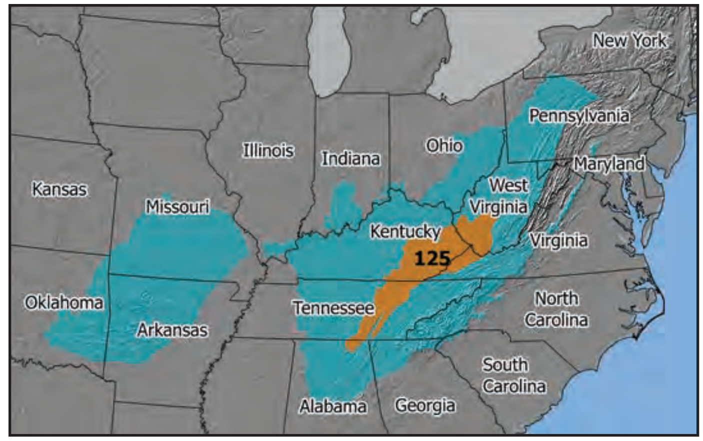

Figure 125-1: Location of MLRA 125, which covers 5,582,300 hectares (13,794,200 acres), within Region N.

of State and national forests and large commercial holdings. Surface mining of coal is an important industry in the northern part of the area and, to a lesser extent, in the southern part, but only a small portion of the MLRA has been surface mined.

The major soil resource concerns are sheet and rill erosion on pasture, land slippage, subsidence resulting from mining, streambank erosion, gullying, surface compaction caused by livestock trampling, and a reduced content of soil organic matter on cropland. Conservation practices on cropland generally include crop rotations, contour farming, nutrient management, grassed and forested riparian buffers, cover crops, hayland planting, diversions, and grassed waterways. Pasture management includes rotational grazing, watering systems, fencing, managed livestock access to streams, pasture planting, and nutrient management. Forest management includes properly constructed forest harvest trails, critical area planting, and water bars on trails.

125—Cumberland Plateau and Mountains

This MLRA (fig. 125-1) is on a dissected plateau that has narrow, level valley floors, narrow ridgetops, and steep side slopes. About 80 percent of the area is forested, mostly on the steep slopes and ridgetops. The valley floors are commonly used for urban development and small farms that produce crops and livestock. Coal mining, which was the major industry in the past, has altered the landscape throughout the MLRA. This area is in Kentucky (43 percent), Tennessee (25 percent), West Virginia (22 percent), Virginia (8 percent), and Alabama (2 percent). It makes up about 21,553 square miles (55,823 square kilometers).

MLRA 125 has a distinct boundary based on physiography with MLRAs 121 (Kentucky Bluegrass), 122 (Highland Rim and Pennyroyal), 126 (Central Allegheny Plateau), and 128 (Southern Appalachia Ridges and Valleys). Boundaries with MLRAs 121 and 122 are marked by distinct changes in geology, elevation, and soil parent material. The boundary with MLRA 126 is marked by distinct changes in geology and soil parent material. The boundary with MLRA 128 is marked by sharp changes in geology and elevation.

MLRA 125 has a less apparent boundary with MLRAs 124 (Western Allegheny Plateau), 127 (Eastern Allegheny Plateau and Mountains), and 129 (Sand Mountain). The boundaries with MLRAs 127 and 129 are marked by gradual changes in geology and soil parent material. MLRA 124 has less sloping ridgetops and less sloping side slopes.

Physiography

The northern third of this area is primarily in the Kanawha section of the Appalachian Plateaus province of the Appalachian Highlands. The southern two-thirds and a strip along the central part of the east edge of the MLRA are in the Cumberland Mountain section of the same province and division. Small areas along the southwestern edge are in the Highland Rim section of the Interior Low Plateaus province of the Interior Plains.

This highly dissected MLRA occurs mainly as a series of long, steep side slopes between narrow ridgetops or crests and narrow stream flood plains. Elevation ranges from 650 feet (200 meters) on the flood plain along the Ohio River to about 980 feet (300 meters) on nearby ridgetops. It gradually increases towards the Virginia-Kentucky border, ranging to about 1,650 feet (505 meters) on local flood plains and about 3,950 feet (1,205 meters) on the higher mountains.

The Kanawha River is the largest river in the West Virginia part of this MLRA. The Tug Fork and Big Sandy Rivers form the State boundary between West Virginia and Kentucky. The Clinch River forms the southwestern boundary in the Virginia part of this MLRA. The headwaters of the Licking, Kentucky, and Cumberland Rivers are in the Kentucky part. The New, Obey, Obed, Caney Fork, and Collins Rivers are in the Tennessee part. The Tennessee River is in the Alabama part.

Geology

Cyclic beds of sandstone, siltstone, clay, shale, and coal of Pennsylvanian age make up the bedrock in most of this area. Pennsylvanian limestone composes part of the bedrock in the Alabama part of the MLRA. Coal mining was the major industry in this MLRA, and oil and gas wells also have been developed. Unconsolidated deposits of silt, sand, and gravel are in the major river valleys and on terraces along the rivers. The lower parts of many hillslopes have a thick layer of colluvium.

Climate

The average annual precipitation is mostly 37 to 45 inches (940 to 1,145 millimeters) in the northern third of this area and 45 to 60 inches (1,145 to 1,525 millimeters) in the southern two-thirds. It is almost 60 inches (1,525 millimeters) at the higher elevations in the northern third of the area and is as much as 75 inches (1,905 millimeters) in the mountains in the southern two-thirds. Almost half of the annual precipitation falls during the growing season. Rainfall typically occurs during high-intensity, convective thunderstorms in summer. During winter, snow occurs in the northern part of the area, with significantly more snow at the higher elevations. The average annual temperature is 50 to 60 degrees F (10 to 15 degrees C). The freeze-free period averages 200 days and ranges from 170 to 225 days. The shorter freeze-free periods are at the higher elevations and in the more northern parts of the area.

Water

Water is abundant in most of the area. In most years precipitation is adequate for crops, but in some years yields are reduced by drought. The large streams and constructed lakes supply most of the urban water. Farm ponds can be sources of water in rural communities. The water generally is suitable for all uses, although some sedimentation in surface-mined areas and local acid mine drainage impact water quality in northern Tennessee and in Kentucky, Virginia, and West Virginia.

Large quantities of generally good-quality ground water are available in some of the larger river valleys, but only small quantities are locally available in the rest of the area. Water in the valley of the Kanawha River has levels of iron and manganese that exceed the national drinking water standards. The Pennsylvanian Sandstone aquifer is the primary bedrock aquifer in this area. This aquifer is called the Appalachian Plateau aquifer in Virginia and the Middle and Lower Pennsylvanian aquifer in West Virginia. Its water is in the bedding planes, joints, and fractures in the sandstone, siltstone, shale, and coalbeds. In Alabama and along the Alabama-Tennessee border, the Paleozoic Carbonate aquifer is a source of ground water. In this limestone and dolomite aquifer, water is in solution openings and caverns. The ground water in both aquifers is suitable for all uses. High iron concentrations occur in water from the coal-bearing units. The level of total dissolved solids, however, is very low because of the shallow depth of wells and their location near the recharge zones for these aquifers. Wells more than 250 to 300 feet (60 to 90 meters) deep provide salty water. The water from the sandstone is soft, but the water from the carbonate and shale layers is hard. Some communities in Alabama and southern Tennessee use both of these aquifers for their water supply. In the rest of this area, the Pennsylvanian Sandstone aquifer provides domestic and livestock water. Contamination from septic systems located near domestic wells is one of the most common water-quality problems in this area.

Soils

The dominant soil orders are Ultisols and Inceptisols. The soils in the area have a mesic or frigid soil temperature regime, a udic soil moisture regime, and mainly mixed mineralogy. They generally are moderately deep to very deep, excessively drained to somewhat poorly drained, and loamy. Soils derived from surface mining for coal are common in this MLRA.

The main soils and their series:

- Dystrudepts that formed in residuum on hills and ridges (Matewan and Marrowbone series); that formed in colluvium on side slopes (Highsplint series)
- Eutrudepts that formed in alluvium on flood plains along the major streams (Grigsby series)
- Hapludults that formed in colluvium on side slopes and footslopes (Shelocta and Pineville series); that formed in residuum on hills and ridges (Gilpin and Lily series)
- Udorthents that formed in spolic material derived from surface mining of coal (Kaymine and Fairpoint series)

Biological Resources

This area supports a variety of woody and herbaceous plant communities. Mixed hardwoods are in coves and on north- and east-facing slopes. Yellow-poplar, beech, black walnut, basswood, red oak, white oak, hemlock, and buckeye are among the 20 or more tree species. Oak-hickory communities, shortleaf pine, pitch pine, and Virginia pine are on ridges and south- and west-facing slopes. Willows, sycamore, sweetgum, and river birch grow on flood plains.

Major wildlife species in this area include white-tailed deer, elk, red fox, raccoon, cottontail, muskrat, gray squirrel, fox squirrel, mink, ruffed grouse, woodcock, bobwhite quail, and mourning dove.

Land Use

Most of this area consists of small and medium-size farms (fig. 125-2). An extensive acreage in Kentucky is in the Daniel Boone National Forest, and some large tracts are owned by

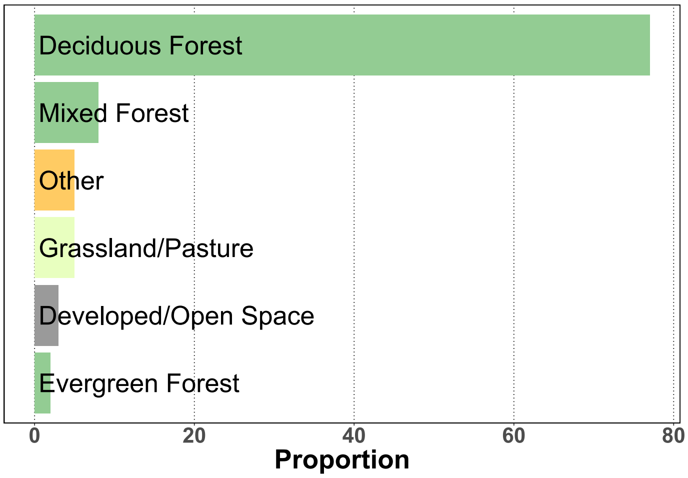

Figure 125-2: Relative proportions (percentages) of land use in MLRA 125.

coal and timber companies. The forested areas support mostly mixed hardwoods. Hardwood lumber is an important product in the area. Corn, hay, and vegetables are the major crops grown on the small acreage of cropland. More than one-tenth of the MLRA is pasture, which is used mostly for grazing by beef cattle. Some areas along the valley floor are used for urban development. Stabilizing surface-mined areas is a major resource management concern.

The major soil resource concerns are water erosion, deposition of sediment, depletion of organic matter, surface compaction, and soil contaminants. Conservation practices on cropland generally include systems of crop residue management (especially no-till systems), cover crops, and nutrient management. The most important conservation practice on pasture is prescribed grazing. Forest management practices generally include planting, timber stand improvement, and harvesting methods that minimize disturbance of the surface and minimize surface compaction.

126—Central Allegheny Plateau

This MLRA (fig. 126-1) consists of a dissected plateau with narrow, level valley floors, narrow, sloping ridgetops, and long, steep to very steep side slopes. About 60 percent of the area is forested, mostly on the steep slopes, and the common land use is the production of crops or livestock. This area is in West Virginia (49 percent), Ohio (26 percent), Pennsylvania (23 percent), and Kentucky (2 percent). It makes up about 17,507 square miles (45,343 square kilometers). The Wayne National Forest covers a significant part of the area in southern Ohio.

MLRA 126 has a distinct boundary based on physiography with MLRAs 127 (Eastern Allegheny Plateau and Mountains) and 139 (Lake Erie Glaciated Plateau). These adjacent MLRAs are more deeply dissected areas along rivers and streams, or they have glacial influence.

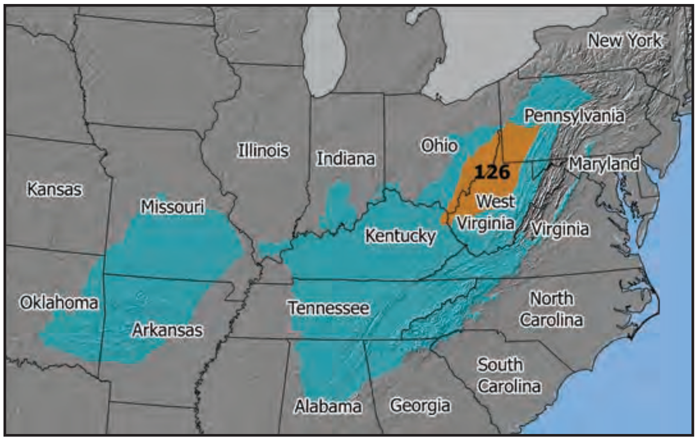

Figure 126-1: Location of MLRA 126, which covers 4,534,300 hectares (11,204,500 acres), within Region N.

MLRA 126 has a less apparent boundary with MLRAs 124 (Western Allegheny Plateau) and 125 (Cumberland Plateau and Mountains). MLRA 124 has rolling ridgetops and hilly to steep side slopes. MLRA 125 has narrower ridgetops and steeper side slopes.

Physiography

This area is in the Kanawha section of the Appalachian Plateaus province of the Appalachian Highlands. It is on a dissected plateau that is underlain mainly by horizontally bedded sedimentary rocks. The narrow, level valleys and narrow, sloping ridgetops are separated by long, steep and very steep side slopes. Elevation ranges from 650 feet (200 meters) on the lowest valley floors to 1,310 feet (400 meters) or more on the highest ridgetops. Local relief is about 330 feet (100 meters).

The Allegheny and Monongahela Rivers join in Pittsburgh to form the Ohio River. The Ohio River forms the State boundary between Ohio and West Virginia in this area. The Kanawha and Little Kanawha Rivers in West Virginia join the Ohio River in the southern part of the area. The headwaters of the Monongahela River are in the part of this area in north-central West Virginia. The major tributaries of the Ohio River in the Ohio part of the area include the Muskingum, Little Muskingum, and Hocking Rivers and Duck, Raccoon, and Symmes Creeks.

Geology

The plateau is underlain by flat-lying cyclic beds of mainly shale, sandstone, siltstone, mudstone, and minor amounts of limestone and coal of Permian and Pennsylvanian age. The valleys along the Ohio, Muskingum, and Kanawha Rivers have significant deposits of river alluvium (unconsolidated silt, sand, and gravel). The lower parts of hillslopes have a thin layer of colluvium. Gas and oil wells have been developed in most areas.

Climate

The average annual precipitation in most of this area is 34 to 45 inches (865 to 1,145 millimeters). It increases to as much as 51 inches (1,295 millimeters) at the higher elevations along the eastern edge of the area. The precipitation is somewhat unevenly distributed throughout the year. The maximum occurs in midsummer, and the minimum occurs in autumn and early winter. Rainfall occurs during high-intensity, convective thunderstorms in summer. The annual snowfall ranges from less than 35 inches (890 millimeters) to more than 50 inches (1,270 millimeters). The average annual temperature is 48 to 56 degrees F (9 to 13 degrees C). The freeze-free period averages 190 days and ranges from 165 to 215 days. The longer freeze-free periods occur in the southwestern part of the area and at the lower elevations.

Water

Water from springs, farm ponds, and reservoirs is plentiful. The surface water in this area generally is suitable for most uses. Water quality during periods of low flow commonly is a concern because of contamination. Reservoirs are used to augment low flows in some areas. Sedimentation and acid mine drainage from coal mining and industrial and municipal wastewater discharges degrade surface water throughout the MLRA. Improved environmental practices help to prevent stream pollution. Demands for surface water for industry, coal mining, and cooling of thermoelectric power plants can create local shortages. Flows for navigation take precedence over most water rights, so some public water suppliers may not obtain all the water they need for customers during periods of low flow.

Supplies of domestic and agricultural water from wells vary, so storage tanks are commonly used with wells. The Pennsylvanian-age sandstone, siltstone, shale, coal, and limestone bedrock in this area is the primary source of ground water. The water is in bedding planes, fractures, and joints in most of the rocks in this aquifer, so low-yield wells are typical. Ground water is in solution openings in the limestone. This aquifer is called the Upper Pennsylvanian aquifer in West Virginia, the Shaly Sandstone and Shale aquifer in Ohio, and the Sandstone and Shale aquifer in Pennsylvania. The ground water is typically of good quality and suitable for all uses. High levels of iron and manganese can affect taste and cause staining. Topographic position impacts the water quality in much of this aquifer. The higher amounts of iron and manganese concentrations are common in wells in valleys, as opposed to wells on hilltops. Where limestone is more common, in the eastern half of this area, the water from valleys is softer than the water from hilltops but has higher sodium concentrations. Large quantities of ground water can be obtained from deep wells, but the water generally is highly mineralized.

Some communities and industries obtain ground water from high-yield wells in the alluvium in the major river valleys. This water is generally suitable for all uses. It is very similar in quality to the water in the bedrock but much harder. Very high concentrations of naturally occurring manganese are common in wells in the valley along the Ohio River. Iron and manganese concentrations in the valley along the Kanawha River greatly exceed national drinking water standards. No other significant contamination problems occur in these sand and gravel aquifers in the area.

Soils

The dominant soil orders are Alfisols, Ultisols, and Inceptisols. The soils in the area have a mesic soil temperature regime, a udic soil moisture regime, and mixed mineralogy. They generally are shallow to very deep, excessively drained to somewhat poorly drained, and skeletal to clayey.

The main soils and their series:

- Eutrudepts that formed in alluvium on flood plains along the major streams (Chagrin and Sensabaugh series)
- Fragiudults that formed in alluvium on flood plains along the major streams (Monongahela series)
- Hapludalfs that formed in residuum on hills and ridges (Coshocton, Culleoka, Dormont, Upshur, and Westmoreland series)
- Hapludults that formed in residuum on hills and ridges (Gilpin series)
- Udorthents that formed in spolic material derived from the surface mining of coal (Bethesda series)

Biological Resources

This area supports deciduous forest vegetation. White oak, red oak, black oak, hickory, and associated upland hardwoods are the major species. Scarlet oak, chestnut oak, and hickory along with scattered Virginia pine, shortleaf pine, and white pine grow on dry ridges and on the shallower soils. Yellow-poplar, black walnut, red oak, red maple, and other species that require a lot of moisture grow in sheltered coves, on footslopes, and on north-facing slopes. Major wildlife species include white-tailed deer, black bear, red fox, raccoon, cottontail rabbit, muskrat, gray squirrel, pheasant, grouse, and migratory songbirds.

Land Use

Most of this MLRA consists of farms, but less than one-half of the area consists of income-producing farms (fig. 126-2). Farm income is dominantly from beef cattle operations and dairy farms associated with hay, grassland, and cultivated crops. More than one-half of the MLRA is forested, and the sale of timber is important in some areas. Urban expansion, including industrial and residential development, is increasing along the Ohio River and its major tributaries. Much of the cropland has been converted to urban uses. Large acreages are owned or leased for surface mining of coal.

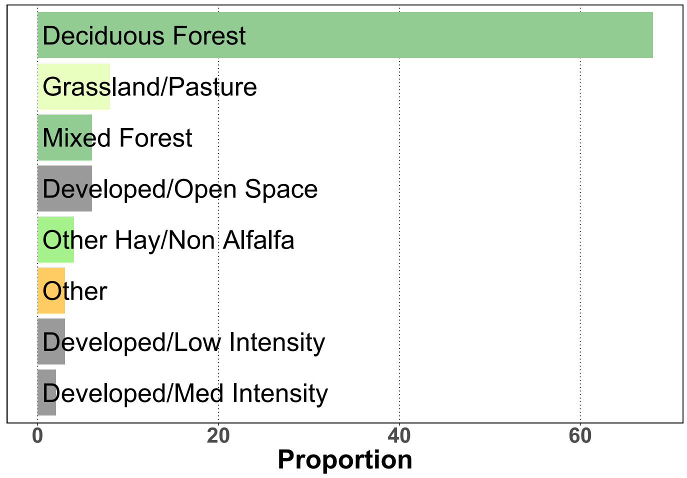

Figure 126-2: Relative proportions (percentages) of land use in MLRA 126.

The major soil resource concerns are sheet and rill erosion on pasture, land slippage, subsidence resulting from mining, streambank erosion, gullying, surface compaction caused by livestock trampling, and a reduced content of soil organic matter on cropland. Conservation practices on cropland generally include crop rotations, contour farming, nutrient management, grassed and forested riparian buffers, cover crops, hayland planting, diversions, and grassed waterways. Pasture management includes rotational grazing, watering systems, fencing, managed livestock access to streams, pasture planting, and nutrient management. Forest management includes forest harvest trails, critical area planting, and water bars on trails.

127—Eastern Allegheny Plateau and Mountains

This MLRA (fig. 127-1) is on a deeply dissected plateau with the Allegheny Front, which appears as a mountain range, as its eastern boundary. This area is mainly forested and supports high-quality hardwood tree species. It is in Pennsylvania (55 percent), West Virginia (40 percent), Maryland (4 percent), and New York (1 percent). It makes up about 19,072 square miles (49,395 square kilometers).

MLRA 127 has a distinct boundary based on physiography with MLRAs 124 (Western Allegheny Plateau), 126 (Central Allegheny Plateau), 128 (Southern Appalachian Ridges and Valleys), 140 (Glaciated Allegheny Plateau and Catskill Mountains), and 147 (Northern Appalachian Ridges and Valleys). The boundaries with MLRAs 124, 126, 128, and 140 are marked by distinct changes in geology, elevation, and soil parent material. MLRA 147 has tilted and folded bedrock. MLRA 127 has a less apparent boundary with MLRA 125 (Cumberland Plateau and Mountains) based on gradual changes in geology and soil parent material.

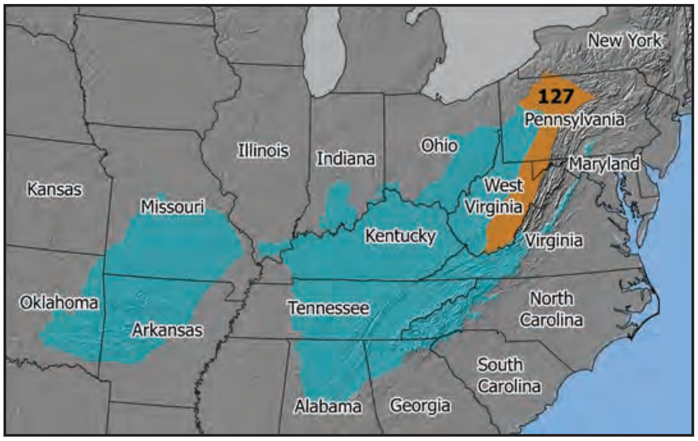

Figure 127-1: Location of MLRA 127, which covers 4,939,500 hectares (12,205,800 acres), within Region N.

Physiography

The southern third and northwest corner of this area are in the Kanawha section of the Appalachian Plateaus province of the Appalachian Highlands. The rest of the area is in the Allegheny Mountain section of the same province and division. The deeply dissected plateau terminates in a high escarpment, the Allegheny Front, in the eastern part of the area. Steep slopes are dominant, but level to gently rolling plateau remnants are conspicuous in the northern part of the area.

Elevations range from 980 feet (300 meters) in the lowest valleys to 1,970 to 2,620 throughout much of the plateau. Spruce Knob, at an elevation of 4,862 feet, is the highest peak in West Virginia. Local relief is mainly 330 feet (100 meters) with some mountain peaks in the eastern and southern portions of the MLRA reaching more than 1,000 feet (330 meters).

The New, Cranberry, and Greenbrier Rivers are in this part of the MLRA in West Virginia. The Youghiogheny River is in Maryland and Pennsylvania. The Cheat River and the North Branch of the Potomac River are in West Virginia and Maryland. The headwaters of many tributaries to the Allegheny River to the west and the Susquehanna River to the east are in the part of this area in Pennsylvania. Some tributaries of the Kanawha River occur in this MLRA.

Geology

This area consists of alternating beds of sandstone, limestone, coal, and shale. These units are mostly flat-lying. A few distinct folds and faults are along the southeastern edge of the part of this area in West Virginia. These bedrock units are Permian to Mississippian in age in Pennsylvania and Pennsylvanian to Cambrian in age in West Virginia. Coal is mined throughout most of this area, and oil and gas wells have been developed. There are no coal mines in the older rocks along the southeastern edge of this area, in West Virginia. The major river valleys are filled with unconsolidated deposits of clay, silt, sand, and gravel. Some outwash and glaciofluvial deposits are in the river valleys in the northwest corner of this area, in Pennsylvania. The lower portions of most hills are mantled with a layer of colluvium.

Climate

The average annual precipitation in this area is 33 to 68 inches (840 to 1,725 millimeters), increasing to the south and with elevation. The maximum precipitation occurs in spring and summer, and the minimum occurs in fall. Most of the rainfall occurs during high-intensity, convective thunderstorms. The average annual snowfall ranges from 35 inches (890 millimeters) in the southern part of the area to more than 90 inches (2,285 millimeters) in the northern part. The average annual temperature is 43 to 54 degrees F (6 to 12 degrees C). The freeze-free period averages 160 days and ranges from 115 to 205 days, decreasing in length to the north and with elevation.

Water

Water from farm ponds, reservoirs, and streams is plentiful. The area has several large reservoirs, including Deep Creek Lake, the Youghiogheny River Reservoir, and the Allegheny Reservoir. Deep Creek Lake is the largest reservoir in Maryland. The quality of the surface water is impaired in a few streams because of acid mine drainage or municipal and industrial waste discharges.

Ground water is plentiful, although well yields and water quality are highly variable. Water from alluvium in the major river valleys in West Virginia commonly is used as drinking water. It is of good quality and requires little treatment. In the rest of the MLRA, alternating beds of sandstone, siltstone, shale, and limestone on uplands of the Appalachian Plateau are the primary sources of ground water. Coalbeds in the Pennsylvanian-age rocks also are considered aquifers. Ground water collected in coal mines commonly is used for industrial supplies. The water in these bedrock units is in fractures, in partings along bedding planes, and in solution openings in limestone. The different rock types and their elevation impact water quality. Hard water occurs in limestone- and shale-dominated layers, and soft water occurs in sandstone-dominated units. The water is freshest on ridgetops where active recharge occurs. Hardness and levels of iron, manganese, and total dissolved solids commonly increase from ridgetops to valley floors. The freshwater in the bedrock is on top of a layer of brine water, which is typically about 300 feet (90 meters) below the valley floors. Manganese concentrations in the bedrock aquifers exceed the national drinking water standard.

Soils

The dominant soil orders are Ultisols and Inceptisols. The soils in the area dominantly have a mesic or frigid soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They generally are moderately deep to very deep, excessively drained to somewhat poorly drained, and loamy.

The main soils and their series:

- Dystrudepts that formed in residuum on hills and ridges (Dekalb and Hazleton series); that formed in residuum at high elevations and are frigid, on hills and ridges (Leatherbark and Mandy series)
- Endoaquults that formed in residuum on hills and ridges (Cavode series)
- Fragiudepts that formed in colluvium at high elevations on side slopes (Simoda and Snowdog series)
- Fragiudults that formed in colluvium on footslopes and alluvial fans (Buchanan and Ernest series); that formed in residuum on ridges (Cookport series)
- Hapludults that formed in residuum on hills and ridges (Gilpin, Hartleton, Leck Kill, Rayne, and Wharton series)
- Udorthents that formed in spolic material derived from the surface mining of coal in mesic areas (Cedarcreek and Kaymine series) and frigid areas (Briery series)

Biological Resources

This area supports high-quality hardwoods. Oak, black cherry, yellow-poplar, maple, and other associated hardwoods are the principal species at the lower elevations. White pine, Virginia pine, and black walnut also occur but are of lesser extent. Red spruce, hemlock, birch, and maple species grow on the high mountains. Sugar maple, black cherry, and red oak commonly grow at intermediate elevations. Major wildlife species include black bear, white-tailed deer, fox, beaver, raccoon, muskrat, mink, cottontail, gray squirrel, pheasant, ruffed grouse, woodcock, and mourning dove.

Land Use

Most of this area consists of farms (fig. 127-2). Corn, small grains, and forage are grown for dairy and beef cattle. Other important crops are potatoes and soybeans. Dairy, beef, and poultry farms are important enterprises. About three-fourths of the MLRA is in hardwood forests. Most of the forestland is privately owned, although the area has large blocks of State forest and game lands and national forests. Less than one-tenth of the MLRA consists of urban areas and disturbed land, including surface-mined areas. Stabilizing and revegetating surface-mined areas and controlling acid drainage water from deep mines are major management concerns.

The major soil resource concerns are sheet and rill erosion on pasture, land slippage, subsidence caused by mining, streambank erosion, gullying, surface compaction caused by livestock trampling, and a reduced content of soil organic matter on cropland. Conservation practices on cropland generally include crop rotations, contour farming, nutrient management, grassed and forested riparian buffers, cover crops,

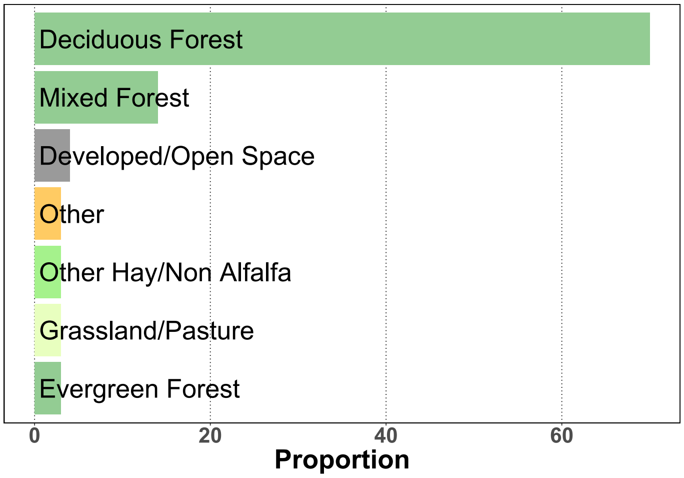

Figure 127-2: Relative proportions (percentages) of land use in MLRA 127.

hayland planting, diversions, and grassed waterways. Pasture management includes rotational grazing, watering systems, fencing, managed livestock access to streams, pasture planting, and nutrient management. Forest management includes properly constructed forest harvest trails, critical area planting, and water bars on trails.

128—Southern Appalachian Ridges and Valleys

This MLRA (fig. 128-1) forms a broad arc between the Blue Ridge Mountains and the Allegheny and Cumberland Plateaus (Stanley, 1999). It is characterized by long, even ridges with long, continuous valleys in between. This area is in Tennessee (35 percent), Alabama (29 percent), Virginia (23 percent), and Georgia (13 percent). It makes up about 22,260 square miles (57,653 square kilometers).

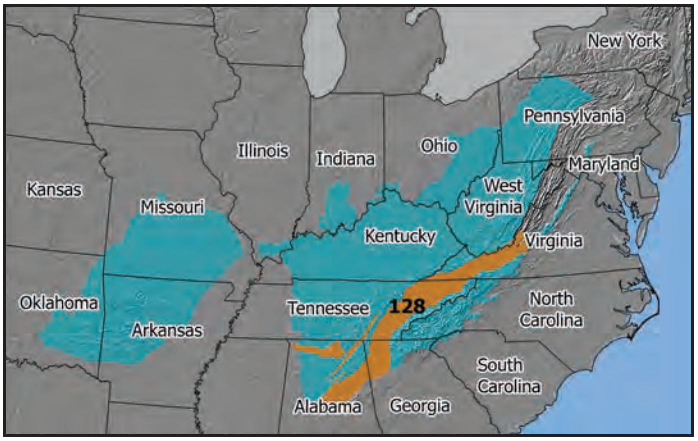

Figure 128-1: Location of MLRA 128, which covers 5,765,300 hectares (14,246,400 acres), within Region N.

MLRA 128 has a distinct boundary based on physiography with MLRAs 125 (Cumberland Plateau and Mountains), 127 (Eastern Allegheny Plateau and Mountains), 129 (Sand Mountain), 130A (Northern Blue Ridge), and 130B (Southern Blue Ridge). The boundaries with MLRAs 125, 129, 130A, and 130B are marked by sharp changes in geology and elevation. The boundary with MLRA 127 is marked by changes in elevation and soil parent material.

MLRA 128 has a less apparent boundary with MLRAs 122 (Highland Rim and Pennyroyal), 133C (Gulf Coastal Plain), 136 (Southern Piedmont), and 147 (Northern Appalachian Ridges and Valleys). The boundary with MLRA 147 is based on gradual increases in elevation and changes in geology. The boundaries with MLRAs 133C and 136 are based on gradual changes in geology and soil parent material. The boundary with MLRA 122 is based on gradual changes in elevation, geology, and soil parent material.

Physiography

Most of this area is in the Tennessee section of the Valley and Ridge province of the Appalachian Highlands. The thin stringers in the western part of the area are mostly in the Cumberland Plateau section of the Appalachian Plateaus province of the Appalachian Highlands. A separate area of the MLRA in northern Alabama is in the Highland Rim section of the Interior Low Plateaus province of the Interior Plains. The western side of the MLRA is dominantly hilly to very steep and is rougher and much steeper than the eastern side, much of which is rolling and hilly. Elevation ranges from 660 feet (200 meters) near the southern end of the area to more than 2,400 feet (730 meters) in the part of the area in the western tip of Virginia. Some isolated linear mountain ridges rise to nearly 4,920 feet (1,500 meters) above sea level. This area is highly diversified. It has many parallel ridges, narrow intervening valleys, and large areas of low, irregular hills. Many ridges and valleys have a difference in elevation of 660 feet (200 meters).

The Tennessee River and its main tributaries, the Clinch, Holston, Obed, Hiwassee, and Sequatchie Rivers, are located in this MLRA. Other tributaries in the MLRA are the French Broad and Little Rivers. The Tennessee River is one of the largest rivers in the United States. It is a navigable waterway because of numerous locks and dams.

Geology

The bedrock in this area belongs to the Valley and Ridge geologic province and consists of Paleozoic-age sedimentary rocks. These rocks were folded and thrust faulted by the tectonic events that formed the Appalachian Mountains, creating a series of northeast-southwest-trending anticlines and synclines. Subsequent erosion of these structures formed the valleys and ridges. The less erosion-resistant limestones and shales typically underlie the valleys, and the more erosion-resistant sandstones and conglomerates commonly cap the ridges.

Caverns and sinkholes are common in some areas underlain by limestone. The MLRA has a trellis drainage pattern created by a combination of the valleys and gaps in the ridges. The gaps were formed from the gradual erosion across the ridges by older rivers and the gentle plunging of the folds to the northeast and southwest.

Climate

The average annual precipitation in most of this area is 41 to 55 inches (1,040 to 1,395 millimeters). It increases to the south and is as much as 66 inches (1,675 millimeters) at the highest elevations in east Tennessee and the northwest corner of Georgia. The maximum precipitation occurs in midwinter and midsummer, and the minimum occurs in autumn. Most of the rainfall occurs during high-intensity, convective thunderstorms. Snowfall may occur in winter. The average annual temperature is 52 to 63 degrees F (11 to 17 degrees C), increasing to the south. The freeze-free period averages 205 days and ranges from 165 to 245 days. It is longest in the southern part of the area and shortest at high elevations and the northern end of the area.

Water

In most years precipitation is adequate for crops, but in some years yields are reduced by short dry periods in early summer. Perennial streams, originating on either side of the mountains, carry water to nearly all parts of the area. Several dams, constructed by the Tennessee Valley Authority on the Tennessee River and its major tributaries, provide flood control, facilitate navigation and power production, provide opportunities for recreation, and provide municipal and industrial water. The surface water generally is suitable for all uses. Rivers below reservoirs in this area commonly contain water with low levels of dissolved oxygen because of the release of water from the bottom of the reservoirs. This water is very cold, and the releases can cause water temperature fluctuations, which can negatively impact fish and wildlife.

The ground water used in this area is from a Cambrian- to Mississippian-age carbonate aquifer system that has beds of limestone, dolomite, shale, and sandstone. The water occurs in solution openings, joints, and fractures in these units. It is hard or very hard but is otherwise of excellent quality. Wells in this aquifer generally are less than 300 feet (90 meters) deep and the aquifer is constantly recharged with freshwater (rainfall), so the level of total dissolved solids is fairly low for a carbonate aquifer. High levels of iron occur in the Tennessee part of this MLRA. These high levels of iron may exceed the national secondary (esthetic) standard for drinking water. The iron can stain ceramic and porcelain and precipitate in pipes. Since this aquifer is close to the surface and water moves through it quickly, it is highly susceptible to contamination from runoff. Many communities and rural landowners in areas away from surface water supplies rely on this aquifer for drinking water.

Soils

The soils in this area are mainly Ultisols and, to a lesser extent, Inceptisols. They have a udic soil moisture regime and a thermic or mesic soil temperature regime; have dominantly mixed mineralogy; are well drained, strongly acid, and highly leached; and have a clay-enriched subsoil. Soil depth ranges from shallow on sandstone and shale ridges to very deep in valleys and on large limestone formations.

The main soils and their series:

- Dystrudepts that formed in residuum on steep sides of ridges and are steep, shallow or moderately deep, and shaly and stony (Weikert and Montevallo series)
- Eutrudepts that formed in calcareous shale and limestone and are shallow and shaly, in areas of the shale formation extending along the eastern side of the MLRA (Bays and Dandridge series); that formed in alluvium on narrow flood plains and drainageways (Hamblen and Pettyjon series)
- Hapludults that formed in residuum in valleys underlain by acid shale (Townley series)
- Paleudults that formed in limestone residuum or in 1 to 2 feet of old alluvium and the underlying residuum from limestone, on crests, side slopes, nose slopes, and base slopes of gently sloping to steep uplands (Dewey series); that formed in residuum in which the upper portion is colluvium or soil creep, in steeper areas on crests, side slopes, nose slopes, and base slopes (Fullerton series)

Biological Resources

This area supports hardwoods or mixed hardwoods and pine. The deeper soils support oak-hickory stands. The shallower soils, mostly on south and west aspects, support pine or oak-pine types. The understory vegetation also is affected by aspect. Little bluestem is the dominant grass species.

Major wildlife species in this area include red fox, gray fox, raccoon, skunk, opossum, muskrat, mink, cottontail, gray squirrel, fox squirrel, bobwhite quail, and mourning dove. Fish species include carp, bullhead, largemouth bass, and bluegill.

Land Use

Most of this area consists of small and medium-size farms (fig. 128-2). More than two-fifths of the MLRA supports mixed hardwoods. Most of the forestland, except for a few wooded mountain ridges, consists of small farm woodlots. Hay, pasture, and some grain are grown for beef and dairy cattle. Some cotton is grown south of Chattanooga, Tennessee. Corn and soybeans are grown on small acreages throughout the area, mainly in narrow strips of bottom land and on the adjacent low terraces.

The major soil resource concerns are sheet and rill erosion on pasture, land slippage, streambank erosion, gullying, surface compaction caused by livestock trampling, and a reduced

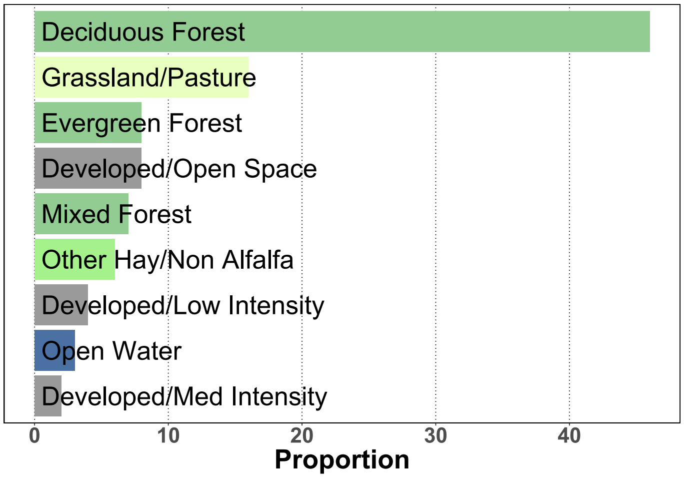

Figure 128-2: Relative proportions (percentages) of land use in MLRA 128.

content of soil organic matter on cropland. Conservation practices on cropland generally include crop rotations, contour farming, nutrient management, grassed and forested riparian buffers, cover crops, hayland planting, diversions, and grassed waterways. Pasture management includes rotational grazing, watering systems, fencing, managed livestock access to streams, pasture planting, and nutrient management. Forest management includes properly constructed forest harvest trails, critical area planting, and water bars on trails.

129—Sand Mountain

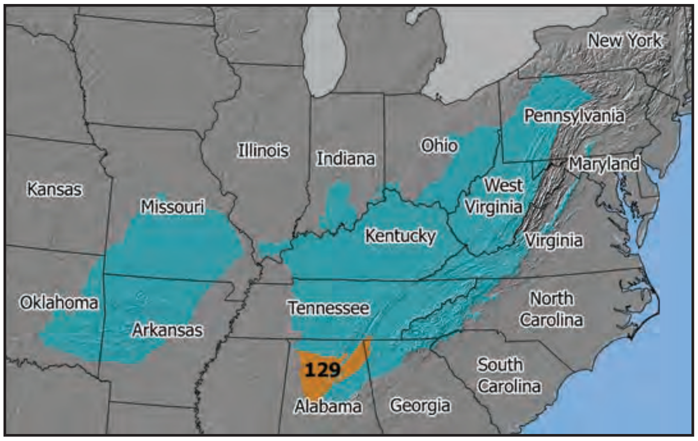

Figure 129-1: Location of MLRA 129, which covers 2,049,800 hectares (5,065,100 acres), within Region N.

This MLRA (fig. 129-1) is characterized by gentler topography in the northern and eastern portions and dominantly strongly sloping land underlain by sandstone and shale in the southern and western portions. About 70 percent of the area is forestland, mostly on the moderate to steeper slopes. This area is in Alabama (95 percent), Georgia (4 percent), and Tennessee (1 percent). It makes up about 7,914 square miles (20,498 square kilometers).

MLRA 129 has a distinct boundary based on physiography with MLRAs 128 (Southern Appalachian Ridges and Valleys) and 133C (Gulf Coastal Plain). The boundary with MLRA 133C is based on changes in geology, and the boundary with MLRA 128 is based on sharp changes in geology and elevation.

Physiography

Most of this area is in the Cumberland Plateau section of the Appalachian Plateaus province of the Appalachian Highlands. This MLRA is deeply dissected and consists mainly of narrow valleys, steep escarpments, and broad plateaus that are underlain by consolidated bedrock. Elevation ranges from 330 to 2,300 feet (100 to 700 meters). Valley floors are commonly about 100 to 400 feet (30 to 120 meters) below the adjacent plateau summits, but local relief may be as much as 1,200 feet (365 meters). The Sipsey Fork, Locust Fork, and Mulberry Fork Rivers, headwaters of the Black Warrior River, are in this area. The Tennessee River forms part of the area's northern boundary.

Geology

The bedrock in this area consists of alternating beds of limestone, dolomite, shale, and sandstone of Early Paleozoic age (mostly Mississippian and Pennsylvanian). The summits of ridges are capped with the more resistant carbonate and sandstone layers, and valleys have been eroded into the less resistant shale beds. These mostly level-bedded sedimentary rocks are at the southernmost extent of the Appalachian Mountains. The narrow river valleys are filled with unconsolidated deposits of clay, silt, sand, and gravel.

Climate

The average annual precipitation in most of this area is 53 to 60 inches (1,345 to 1,525 millimeters). It is as much as 68 inches (1,725 millimeters) at the higher elevations in the northern tip of the area. The precipitation is somewhat unevenly distributed throughout the year. The maximum occurs in midwinter. The amount decreases gradually from spring to autumn and increases slightly in midsummer. Winter rainfall occurs during moderate-intensity tropical storms that can produce large amounts of rain. During the rest of the year, rainfall occurs during high-intensity, convective thunderstorms. Snowfall is rare in winter, and the snow does not remain on the ground for long periods. The average annual temperature is 55 to 63 degrees F (13 to 17 degrees C). The freeze-free period averages 225 days and ranges from 200 to 255 days. The longer freeze-free periods occur in some of the valleys.

Water

In most years, precipitation is adequate for crops and pasture. Droughts are short and infrequent. Streams, springs, and ponds provide water for livestock. Most streams flow intermittently and are often dry in summer and autumn, except after rainstorms. A few large reservoirs on the Elk and Tennessee Rivers are in the area. The surface water is suitable for almost all uses. Rivers below the reservoirs in this area commonly have water with low levels of dissolved oxygen because of the release of water from the bottom of the reservoirs.

Deep wells provide an adequate supply of water for most domestic, municipal, and industrial uses. Good-quality ground water occurs in solution channels in limestone and dolomite and in fractures and partings along bedding planes in shale and sandstone layers. The ground water is very hard. This Paleozoic aquifer system is susceptible to contamination from surface sources because of the vertical fractures and the cavernous limestone and dolomite layers.

Soils

The dominant soil orders are Ultisols and Inceptisols. The soils in the area dominantly have a thermic temperature regime, a udic moisture regime, and mixed or siliceous mineralogy. They are shallow to very deep, generally well drained, and loamy. They formed in residuum on hills, ridges, and plateaus and in residuum and colluvium on mountainsides

The main soils and their series:

- Dystrudepts that formed in residuum from sandstone on rolling ridges and steep hillslopes (Bankhead, Hector, and Montevallo series)
- Fragiudults that formed from sandstone on nearly level to sloping ridges (Wynnville series)
- Hapludults that formed from sandstone on nearly level to steep hillslopes (Albertville, Hartsells, Gorgas, Linker, Nauvoo, Sipsey, Sunlight, and Townley series)

Biological Resources

This area supports mixed oak, hickory-pine, and oak-hickory forests. Shortleaf pine, loblolly pine, Virginia pine, sweetgum, yellow-poplar, hickory, American beech, red oak, and white oak are the major overstory species. Dogwood and redbud are the major midstory species. Japanese honeysuckle, greenbrier, low panicums, bluestems, and native lespedezas are the major understory species. Major wildlife species in this area include white-tailed deer, fox, bobcat, raccoon, skunk, opossum, mink, rabbit, gray squirrel, quail, and mourning dove.

Land Use

Most of the MLRA is forestland and pasture (fig. 129-2). About three-fifths of the forestland is privately owned, about one-tenth is industry owned, and less than one-tenth is federally owned. Timber production occurs mostly in the western half of the MLRA. The poultry industry, which produces broilers and eggs, is the major farm enterprise. Corn, soybeans, tomatoes, and potatoes are the major cash crops. Pastures are grazed mainly by beef cattle and are important disposal areas for poultry waste. Haying provides feed during the long winters. Some areas are used for coal mining or urban development.

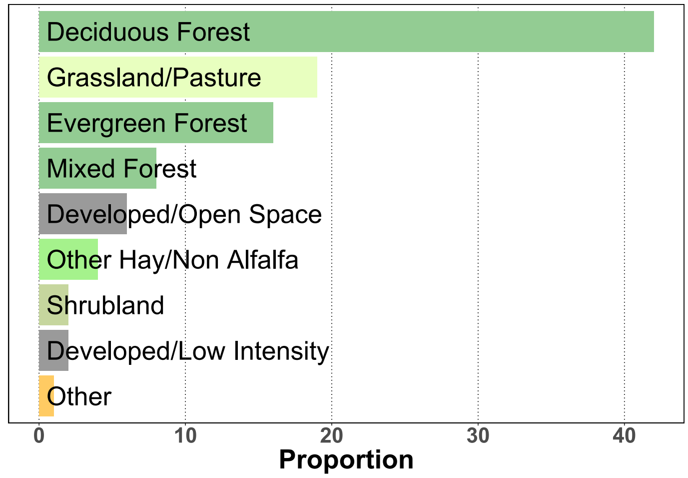

Figure 129-2: Relative proportions (percentages) of land use in MLRA 129.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include crop residue management, cover crops, crop rotations, water disposal, pest management, and nutrient management. The most important conservation practice on pasture is prescribed grazing. Critically eroding areas and areas of livestock concentration need to be monitored regularly and treated promptly.

130A—Northern Blue Ridge

This MLRA (fig. 130A-1) is in Virginia (72 percent), Pennsylvania (14 percent), Maryland (13 percent), and West Virginia (1 percent). It makes up about 2,073 square miles (5,369 square kilometers). It is locally known as the Northern Appalachians. It is characterized by steep rugged mountains underlain by igneous and metamorphic rocks that rise relatively abruptly above the limestone valleys to the west and east. The backbone of this narrow mountain range is an anticline formed during tectonic activity in the Permian Period, about 290 million years ago. The ridge runs northeast to southwest. Its northernmost point is in Cumberland County, Pennsylvania, and its southernmost tip is in Roanoke County, Virginia. Despite the ruggedness, much of this MLRA has been subjected to human activity, including logging, settlement, or other disturbance. As a result, many of the forests are mid successional, in which pines (typically Virginia or white pine) or tuliptree may be codominant or dominant. American chestnut was once a major part of the forest canopy but was nearly eradicated by the chestnut blight. Where mature forests exist, they are dominated by oak and hickory.

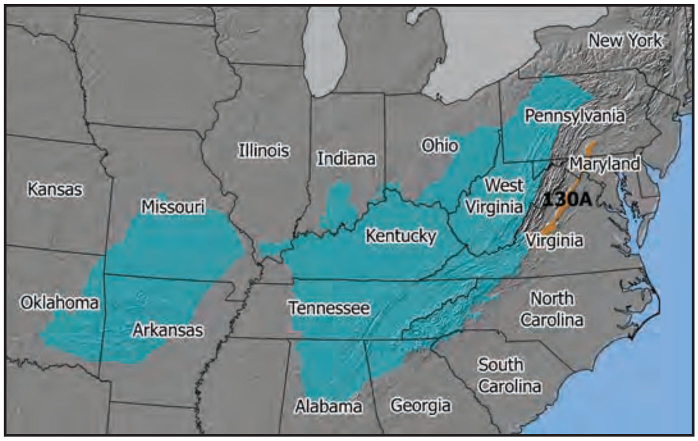

Figure 130A-1: Location of MLRA 130A, which covers 536,900 hectares (1,326,700 acres), within Region N.

MLRA 130A has a distinct boundary based on physiography with MLRAs 128 (Southern Appalachian Ridges and Valleys), 147 (Northern Appalachian Ridges and Valleys), 148 (Northern Piedmont), and 136 (Southern Piedmont). MLRAs 128 and 147 have limestone-dominated valleys. MLRAs 148 and 136 have older, less-resistant geology.

Physiography

Most of this area is in the Northern section of the Blue Ridge province of the Appalachian Highlands. The eastern third of the area is in the Piedmont Upland section of the Piedmont province of the Appalachian Highlands. The southern tip of the area is in the Southern section of the Blue Ridge province. The rugged mountains in this MLRA have steep slopes, sharp crests, and narrow valleys. Stream dissection is deep and intricate. The major streams and their tributaries flow through gorges and gaps in the mountains. Broad valleys and basins and rolling hills are extensive throughout the area. Elevation ranges from about 820 feet (250 meters) in the lower valleys and on footslopes along the Potomac River just east of Harpers Ferry, where West Virginia joins Maryland and Virginia, to more than 4,200 feet (1,280 meters) along the Appalachian Trail in Bedford County, Virginia. Apple Orchard Mountain, at an elevation of 4,225 feet (1,288 meters), is the highest peak.

From north to south, the major rivers in this area are the Conococheaque River in Pennsylvania, the Catoctin and Potomac Rivers in Maryland, and the Shenandoah, Rappahannock, Rapidan, James, and Roanoke Rivers in Virginia.

Geology

This area includes the eroded core of the Appalachian Mountains, formed during a period of post-Cretaceous uplift along the east coast of North America. The part of the area that extends into Maryland and Pennsylvania, including the South and Catoctin Mountains, is the northeast plunging nose of the Catoctin-Blue Ridge anticline. This is an old fold that was exposed during the latest uplift. A resistant, Late Proterozoic to Cambrian cover sequence (that includes chlorite-actinolite schist, schistose metabasalt, siliceous metabreccia, laminated metasedimentary gneiss, quartzite, phyllitic, and rhyolitic layers) forms linear ridges that flank the coarse grained granitoid and gneissic basement rocks exposed in the Proterozoic core of the anticline in northern Virginia. In central Virginia, the Blue Ridge has a series of upthrust crystalline shingle blocks of resistant granite, augen gneiss, or quartzite where narrow fault valleys are underlain by less resistant mylonitic gneiss and schist units. Surficial Pleistocene deposits and more recent deposits include colluvial material on fans and aprons along the higher ridges and alluvial material along the major streams.

Climate

The average annual precipitation in most of this area is 36 to 45 inches (915 to 1,145 millimeters). It can be as much as 61 inches (1,550 millimeters) at the higher elevations. Snow covers the ground frequently in winter and is a major contributor to the annual amount of precipitation. The average annual temperature is 49 to 56 degrees F (9 to 14 degrees C). The freeze-free period averages 195 days and ranges from 165 to 225 days. The lower temperatures and shorter freeze-free periods occur at the higher elevations.

Water

Streams, some ponds, and springs provide water for livestock. Springs also provide some domestic drinking water. The many rivers crossing this area are sources of public supply and industrial water. Most of this water is of good quality and suitable for most uses. The water from the South Fork of the Shenandoah River at the north end of this area has limited use because of residual mercury from historic industrial waste discharges.

Springs and shallow wells provide domestic water in rural areas, but the yield of ground water from wells is generally small and variable. The water is in joints and fractures in the rocks, so deep wells are required to intercept enough openings to obtain a suitable yield. The abundance of ground water depends largely on landscape position and geology. The most abundant sources are in coves and valleys. The water sources on side slopes and ridge summits are not as abundant or dependable.

The primary source of domestic ground water in this area is the Piedmont and Blue Ridge crystalline rock aquifer in Virginia and Maryland. It consists of intrusive igneous and metamorphic rocks. The water from this aquifer has very low levels of total dissolved solids and is generally soft or moderately hard. It generally is acidic, however, and the acidity can damage copper and lead in pipes and plumbing connections. The iron content and hardness vary with the mineralogy of the source rocks, and naturally high radiation levels are common.

The sandstone and shale aquifer is the primary source of ground water in the northern end of this area, in Pennsylvania. The quality of the water in this aquifer is similar to that of the water in the Piedmont and Blue Ridge crystalline rock aquifer to the south, but radiation contamination is not a problem in the sedimentary rocks in Pennsylvania.

Soils

The dominant soils in this MLRA are Dystrudepts, Hapludults, Hapludalfs, and Kanhapludults. The soils in the area range from moderately deep to very deep and from loamy-skeletal and sandy-skeletal to clayey (fine textured). They have a mesic temperature regime, a udic moisture regime, and dominantly mixed mineralogy. Boulders and outcrops of bedrock are extensive in some areas on mountain slopes.

The main soils and their series:

- Dystrudepts that formed in mixed metamorphic and granitic residuum on the steep slopes of mountains (Peaks and Cataska series); that formed in coarse alluvium along narrow, frequently flooded streams (Craigsville series)
- Eutrudepts that formed in meta-basalt residuum on steep mountain slopes (Catoctin series)
- Hapludalfs that formed in meta-basalt residuum on steep mountain slopes (Myersville series) and on toeslopes and flood plains (Rohrersville series)
- Hapludults that formed in mixed metamorphic and granitic residuum on steep mountain slopes (Edneytown and Edgemont series); that formed in colluvium on footslopes and in coves (Braddock series)
- Kanhapludults that formed in mixed metamorphic and granitic residuum on the broader and flatter summits and shoulders and on the less steep side slopes (Hayesville series)

Biological Resources

This area supports Appalachian oaks. White pine-hemlock, chestnut oak, white oak-red oak-hickory, northern red oak-basswood-white ash, yellow-poplar-white oak-northern red oak, and loblolly pine-shortleaf pine are the most common cover types. The understory includes dogwood, hornbeam, pawpaw, sassafras, persimmon, greenbrier, leatherwood, mountain laurel, rhododendron, and witchhazel.

The major large mammals in this area are raccoon, white-tailed deer, coyote, beaver, black bear, red fox, gray fox, and bobcat. The smaller mammals include white-footed mouse, eastern chipmunk, gray squirrel, and eastern cottontail. The MLRA has numerous species of birds. Open areas, fences, riparian strips, forests, wetlands, ponds, and rocky areas support the avian diversity. The MLRA has three species of trout—the native Southern Appalachian brook trout and the introduced rainbow trout and brown trout. Smallmouth bass, largemouth bass, sunfish, bluegills, and crappies inhabit some of the manmade lakes and ponds. This area provides excellent habitat for snakes, turtles, frogs, newts, toads, and salamanders.

Land Use

About three-fifths of this area is forested (fig. 130A-2). About one-fifth of the area consists of national parks and forests. Parts of the area are popular resort and recreation sites. About one-tenth of the area is cropland, mainly in small farms in valleys and coves, and one-sixth is pasture. Corn and hay are the main crops, but small grains, potatoes, and many kinds of fruits and vegetables also are grown. Tobacco is an important crop in some areas. Most of the farms are part-time enterprises.

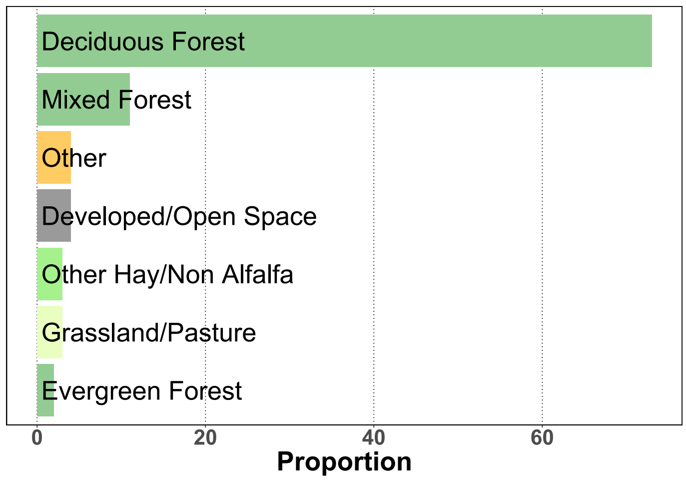

Figure 130A-2: Relative proportions (percentages) of land use in MLRA 130A.

Erosion along poorly constructed and maintained access roads is a major management concern. Sediment from access roads and urban development is the main pollutant of streams in the area. This sedimentation not only is harmful to aquatic life but also impacts local economies that depend on tourism and recreational industries. With increasing urbanization, access roads and homes are being built in marginally suitable areas, such as steep side slopes. Because of improper site preparation, the hazards of sedimentation, soil slippage, and slope instability are increased in these areas.

Poor air quality, especially in summer, is both a health and economic concern. Air pollution flowing from the industrial Midwest affects people sensitive to pollutants, such as ozone, and those who suffer from breathing disorders. Decreased visibility from air pollution impacts the tourism industry. Air quality also is a concern in urbanized intermountain basins where thermal inversions trap pollutants.

Proper woodland management is extremely important since privately held forestland makes up a significant portion of the land area in the MLRA. Promotion and use of the best management practices among private landowners can help to maintain timber quality and productivity. Proper design and construction of access roads and stabilization of roadbanks can minimize the impact of timber management on water quality.

Conservation practices on cropland generally include field borders, grassed waterways, diversions, and riparian buffers along streams. Prescribed grazing and proper forage, nutrient, and pest management practices are critical in maintaining the productivity of grazing land.

Where streams have been channelized, riparian areas have been removed. Streambank erosion is a major concern. Stabilizing streambanks and channels and restoring and maintaining riparian forest buffers help to maintain or improve water quality. The condition of streambanks and channels becomes increasingly important in managing the stormwater runoff from growing urban areas.

130B—Southern Blue Ridge

This MLRA (fig. 130B-1) is characterized by mountains and valleys of the southern Appalachian Mountain Range. It is mainly used for recreation, with a small amount of acreage used for timber production, dairy farms, crops, and Christmas tree production. This area is in North Carolina (52 percent), Georgia (17 percent), Tennessee (16 percent), Virginia (12 percent), and South Carolina (3 percent). It makes up about 15,954 square miles (41,320 square kilometers). It is locally known as the Southern Appalachians.

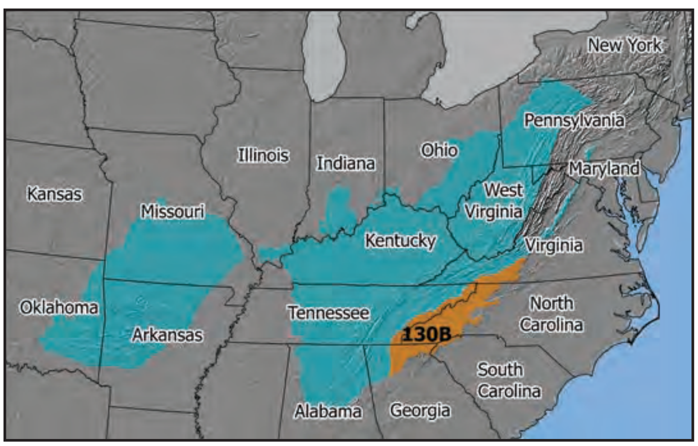

Figure 130B-1: Location of MLRA 130B, which covers 4,132,000 hectares (10,210,300 acres), within Region N.

MLRA 130B has a distinct boundary based on physiography with MLRA 136 (Southern Piedmont). MLRA 130B is characterized by high elevations, steep slopes, and bedrock exposure, whereas MLRA 136 has low relief, gently rolling surfaces, and few bedrock exposures. MLRA 130B has a distinct boundary based on geology with MLRA 128 (Southern Appalachian Ridges and Valleys).

Physiography

This MLRA is mainly in the Southern section of the Blue Ridge province of the Appalachian Highlands. The southern tip of the MLRA and two protruding areas to the east are in the Piedmont Upland section of the Piedmont province of the Appalachian Highlands. The MLRA consists of several distinct topographic areas, including the Blue Ridge Escarpment on its eastern edge, the New River Plateau on the northern end, interior low and intermediate mountains throughout, intermountain basins between the major mountains, and the high mountains, which make up the bulk of the area. Elevation ranges from about 900 feet (275 meters) at the south and southwest boundaries of the MLRA to more than 6,600 feet (2,010 meters) at the crest of the Great Smoky and Black Mountains.

From north to south, the major rivers in this area are the New River in Virginia; the Yadkin, Catawba, French Broad, Little Tennessee, and Hiwassee Rivers in North Carolina; the Saluda, Seneca, Chattooga, and Tugaloo Rivers in South Carolina; and the Toccoa and Coosawattee Rivers in Georgia. The Tugaloo River is a headwater stream of the Savannah River, and the French Broad, Little Tennessee, Hiwassee, and Ocoee Rivers also flow into Tennessee in this area.

Geology

The bedrock geology consists mostly of Precambrian metamorphic rock formations with a few small bodies and windows of igneous and sedimentary rocks. The degree of metamorphism varies but generally decreases westward. High-grade metamorphic rocks include formations of gneiss, schist, and amphibolite. Low-grade metamorphic formations in the southwestern part of the MLRA include distinct and interbedded bodies of metasandstone, slate, phyllite, metasiltstone, and metaconglomerate. Surficial deposits include colluvial material on fans and aprons along the ridges and alluvial material along the major streams.

Climate

The average annual precipitation is 30 to 60 inches (915 to 1,525 millimeters). At the higher elevations, much of the precipitation occurs as snow. Precipitation amounts are lowest in the fall. The average annual temperature is 46 to 60 degrees F (8 to 16 degrees C). The freeze-free period averages 185 days and ranges from 135 to 235 days.

Water

Streams, some ponds, and springs provide water for livestock. Springs also supply some domestic drinking water. The many rivers in this area are sources of public supply and industrial water. Several reservoirs and dams are operated for electric power production, flood control, water supply, and recreation. Protected watersheds and reservoirs supply water to municipal areas. These watersheds commonly are protected lands managed by the U.S. Forest Service and are sources of high-quality water suitable for most uses. Acid mine drainage from coal mines in the Appalachian Plateau to the west of the northern end of the MLRA causes some contamination in rivers draining that area. The limestone bedrock underlying these drainages provides carbonates in runoff water to mitigate some of the contamination. Wastewater discharges from textile, wood, and paper mills in North Carolina cause some local water-quality problems.

Springs and shallow wells provide domestic water in rural areas, but yields of ground water from wells are generally small and variable. The water is in joints and fractures within the rocks, so deep wells are required to intercept enough openings to obtain a suitable yield. The abundance of ground water depends largely on landscape position and geology. The most abundant sources generally are in coves and valleys. The sources on side slopes and ridge summits are not as abundant or dependable.

The primary source of domestic ground water is the Piedmont and Blue Ridge crystalline rock aquifer in Virginia and South Carolina. The Crystalline Rock aquifer is a good source of domestic water in the other States in the MLRA. It consists of intrusive igneous and metamorphic rocks. This water has very low levels of total dissolved solids and ranges from soft to moderately hard. In Virginia, it generally is acidic, and the acidity can damage copper and lead in pipes and plumbing connections. The iron content and hardness vary with the mineralogy of the source rocks. Iron levels are generally less than the limit for the national secondary (esthetic) standard for drinking water. The median level of iron in the ground water in Tennessee is twice the level in the ground water in the other States in the MLRA. Naturally high radiation levels are common in the ground water in Virginia.

Soils

The dominant soil orders in this MLRA are Inceptisols and Ultisols. The soil moisture regime is udic. The soil temperature regime typically is mesic, but it is frigid at elevations above 4,200 feet (1,280 meters). Soil depth ranges from shallow to very deep. The general textural class is loamy or clayey. At elevations of less than 3,500 feet (1,065 meters), the soils on uplands generally are red, fine-loamy or fine Typic Hapludults. At elevations between 3,500 and 4,200 feet (1,065 and 1,280 meters), the soils on uplands generally are brown, fine-loamy or coarse-loamy Dystrudepts. At elevations above 4,200 feet (1,280 meters), the soils on uplands generally are brown, fine-loamy or coarse-loamy Humic Dystrudepts that have a frigid soil temperature regime. Ultisols are most common on the more stable stream terraces.

The main soils and their series:

Coarse-loamy Typic Dystrudepts that formed in residuum weathered from felsic or mafic igneous and high-grade metamorphic rocks on gently sloping to very steep ridges and side slopes (Ashe series); that formed in residuum weathered from coarse grained low-grade metasedimentary rocks, such as metasandstone and metagraywacke, on ridges and side slopes (Soco series)

Typic Dystrudepts that formed in residuum weathered from felsic or mafic igneous and high-grade metamorphic rocks on south- and west-facing ridges and side slopes (Edneyville and Chestnut series)

Humic Dystrudepts that formed in residuum weathered from felsic to mafic high-grade metamorphic and igneous rocks on north- and east-facing shaded ridges and side slopes (Porters series); that formed in colluvium derived from materials weathered from igneous and high-grade metamorphic crystalline rocks on benches, toeslopes, and footslopes in coves (Tusquitee series)

Typic Hapludults that formed in fine-loamy residuum weathered from felsic to mafic igneous and high-grade metamorphic rocks on ridges and hillslopes (Evard and Cowee series); that formed in fine-loamy residuum weathered from low-grade metasedimentary rocks on ridges and side slopes (Junaluska series); that formed in fine textured kaolinitic residuum weathered from igneous and high-grade metamorphic rocks on gently sloping to very steep ridges and side slopes (Hayesville series)

Biological Resources

This area supports a wide diversity of plant and animal life because of highly varied topography and climatic conditions. The kind of vegetation changes with elevation and slope aspect. At the lower elevations, below 3,000 feet (915 meters), the most common trees are white oak, black oak, scarlet oak, chestnut oak, hickory, eastern white pine, Virginia pine, and pitch pine. Yellow-poplar and northern red oak are common in the northern part of the MLRA. At the middle elevations, the most common trees are yellow-poplar, black cherry, black birch, sugar maple, northern red oak, American basswood, eastern hemlock, and yellow buckeye. At the higher elevations, above 5,000 feet (1,525 meters), red spruce and Fraser fir are the dominant tree species. Some areas at a high elevation have grassy and heath balds, which are large meadows or treeless areas. Grassy balds support rare shade-intolerant plant varieties. Heath balds support shrubs, such as rhododendron, mountain laurel, blueberry, flame azalea, hawthorn, huckleberry, and sandmyrtle.

The diverse plant communities provide habitat for many species of wildlife. Black bear, white-tailed deer, and wild turkey are plentiful. The higher elevations provide suitable habitat for the birds and animals common in northern latitudes, such as northern saw-whet owl, Canada warbler, common raven, northern flying squirrel, and red squirrel.

Land Use

More than two-thirds of this area is forestland used for timber production, watershed protection, recreation, and wildlife habitat (fig. 130B-2). The federally owned forestland is mainly U.S. Forest Service or National Park Service land. The small acreage of cropland is used for vegetables, fruit orchards, native ornamental crops, and Christmas trees as well as corn and small grain. About 10 percent of the MLRA is in pastured areas used for dairy, beef, and wool production. The largest urban area is Asheville, North Carolina. The MLRA is a popular region for tourism and retirement living. As a result, many areas have steady or rapid urban growth.

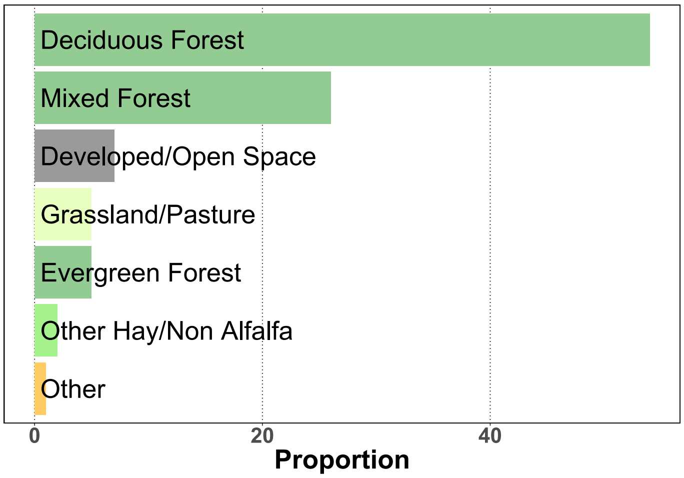

Figure 130B-2: Relative proportions (percentages) of land use in MLRA 130B.

Erosion from poorly constructed and maintained access roads is a major management concern. Sediment from access roads and urban development is the main pollutant of streams. Poor air quality, especially ozone in summer, is both a health and economic concern. At high elevations, air pollution and acid deposition are partially responsible for damage to the spruce and fir forests.

Proper woodland management is extremely important since privately held forestland makes up a significant portion of the land area. Proper design and construction of access roads and stabilization of roadbanks can minimize the impact of timber management on water quality.

Conservation practices in agricultural areas include field borders, grassed waterways, diversions, and riparian buffers along streams. Prescribed grazing and proper forage, nutrient, and pest management practices are critical in maintaining the productivity of grazing land.

Where streams have been channelized, riparian sites are gone and streambank erosion is a major concern. Stabilizing streambanks and channels and restoring and maintaining riparian forest buffers can maintain or improve water quality. The condition of streambanks and channels becomes increasingly important in managing the stormwater runoff from growing urban areas.

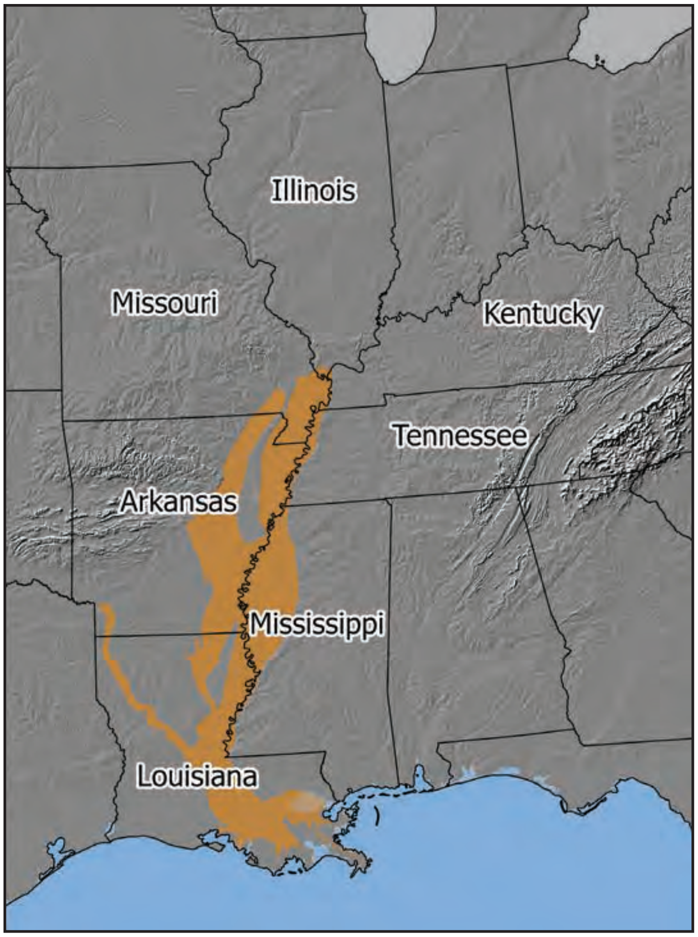

Figure O-1: Location and size of Land Resource Region O, which covers 106,160 square kilometers (40,990 square miles) from the confluence of the Ohio and Mississippi Rivers in southernmost Illinois to the Gulf of Mexico.

O—Mississippi Delta Cotton and Feed Grains Region

Land Resource Region O (fig. O-1) is the huge alluvial valley of the Mississippi River south of its confluence with the Ohio River at Cairo, Illinois. This alluvial valley, almost all of which has an aquic soil moisture regime, contains river flood-plain and terrace sediments deposited by one of the largest river systems in the world, one that drains about 40 percent of the continental United States. Deposits range in age from Holocene on active flood plains to Pleistocene on the higher terraces. The ancestral Mississippi River carried and deposited Pleistocene sediments from melting glacial ice to form intravalley ridges, most prominently represented by the loess-capped Crowley's Ridge (which is included in Region P). The southernmost section of the alluvial valley is a deltaic plain formed by shifting termini of the Mississippi River during the Late Holocene. Region O contains four major land resource areas. The extent of these MLRAs and their range in elevation are shown in table O-1.

The eastern boundary of Region O, its longest boundary, with the loess-capped coastal plain of Region P forms an abrupt edge with loess bluffs. The bluffs formed on the leeward side of the Mississippi River flood plain as silts were deposited by Late Pleistocene winds blowing from the west. The boundary of Region O to the west with Region P is along the unconsolidated sands, silts, and clays of the coastal plain. Farther northwest, Region O has a clear boundary with the Paleozoic bedrock of Region N's units of limestone, dolostone, sandstone, and shale, which is marked by a notable change in elevation of more than 100 feet from the alluvial valley to the uplands of the Ozark Highlands.

Climatically, Region O has long, hot summers and short, mild winters. The mean annual precipitation is 52 to 56 inches (1,315 to 1,430 millimeters), generally increasing from north to south. The precipitation falls almost entirely as rainfall during frontal storms in late fall, winter, and early spring; as rainfall in convective storms during the growing season; and as heavy rainfall produced by tropical storms. The annual air temperature throughout most of the region is 63 to 66 degrees F (17 to 19 degrees C). The soil temperature regime is thermic, except in southern Louisiana, where it is hyperthermic. The mean freeze-free period ranges from 245 to 265 days. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables O-2 and O-3.

Soils of the region are dominated by Vertisols (Epiaquerts) where the alluvium contains large amounts of shrink-swell clay, Alfisols (Epiaqualfs) on Pleistocene-age terraces, and Inceptisols (Epiaquepts) and Entisols (Udifluvents) on Holocene alluvium (fig. 2, page 6). Some of the alluvium is calcareous, having been carried from drier climates by the Arkansas River and especially the Red River (fig. 5, page 9). Some of the Alfisols in the north have natric horizons (fig. 11, page 15). Argillic horizons are only on the older terraces, not on active flood plains (fig. 12, page 16). Organic carbon accumulation in Region O is greatest in the wetlands of the south (fig. 14, page 18).

Land use in Region O reflects the fact that it is one of the major agricultural crop regions in the United States (fig. 8, page 12). Fertile soils, smooth topography, abundant moisture, and a long growing season favor agricultural production, including soybeans, cotton, corn, and rice, in addition to woody wetlands (fig. O-2). Crop production, with the exception of rice, requires artificial drainage to lower the water table. Levees are used to protect cropland from flood damage. In addition to excess water, the major management concern on cropland is contamination of ground water. The

Table O-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
131A	80,245	30,985	0	0	0	0	40	130	80	270	180	600
131B	10,680	4,125	10	30	10	60	40	130	60	210	90	310
131C	7,195	2,775	0	0	10	40	30	100	60	210	140	460
131D	8,035	3,105	10	50	40	130	50	190	70	230	150	500

Table O-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
131A	14.1	57	15.1	59	17.4	63	20.1	68	21.1	70	205	223	252/255	308	345
131B	16.5	62	16.9	62	17.6	64	18.3	65	18.8	66	230	245	250/250	258	260
131C	17.3	63	17.5	64	18.9	66	19.5	67	20	68	230	241	262/265	281	295
131D	15.8	60	16.4	62	17	63	17.6	64	18.2	65	220	231	245/245	251	260

Table O-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
131A	1,130	45	1,224	48	1,380/1,390	54/55	1,595	63	1,720	68
131B	1,240	49	1,274	50	1,347/1,360	53/53	1,439	57	1,550	61
131C	1,270	50	1,301	51	1,465/1,430	58/56	1,542	61	1,580	62
131D	1,230	49	1,256	49	1,276/1,315	50/52	1,429	56	1,480	58

wet soils also support deciduous bottom-land hardwood trees and bald cypress as the native vegetation.

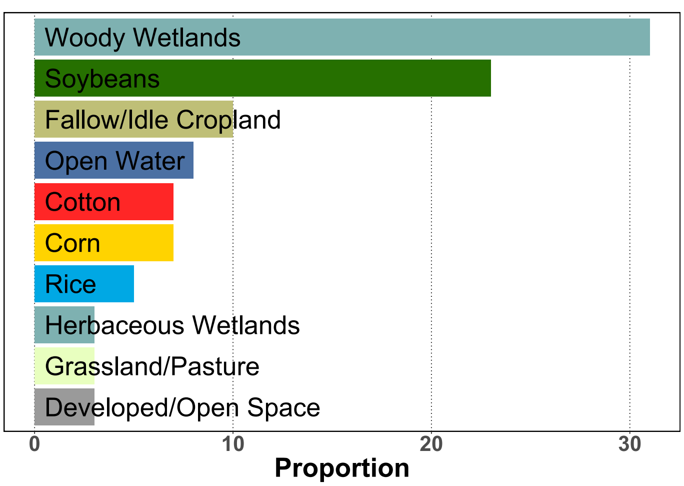

Figure O-2: Relative proportions (percentages) of land use in Land Resource Region O based on 2018 data from the National Agricultural Statistics Service.

131A—Southern Mississippi River Alluvium

This area (fig. 131A-1) consists of nearly level to gently undulating, thick, fertile Holocene- and Pleistocene-age alluvial deposits along the Lower Mississippi River, south of the confluence of the Mississippi and Ohio Rivers to the Gulf of Mexico. It is used extensively for cash and grain crop production as well as numerous national wildlife refuges. This MLRA is in Louisiana (35 percent), Arkansas (26 percent), Mississippi (25 percent), Missouri (10 percent), Tennessee (3 percent), and Kentucky (1 percent). A small part is in Illinois. The area makes up about 30,983 square miles (80,247 square kilometers).

MLRA 131A has a distinct boundary with MLRA 134 to the west and the few interior loess-capped island landforms within the main part of the MLRA. This boundary separates the river valley from the bluffs and adjacent, dissected loess-capped Southern Coastal Plain uplands of Tertiary age. To the northwest, the MLRA has a distinct boundary where it contacts the physiographically dissimilar Ozark Highland (MLRA 116A). To the west, it has a less apparent boundary as valleys of

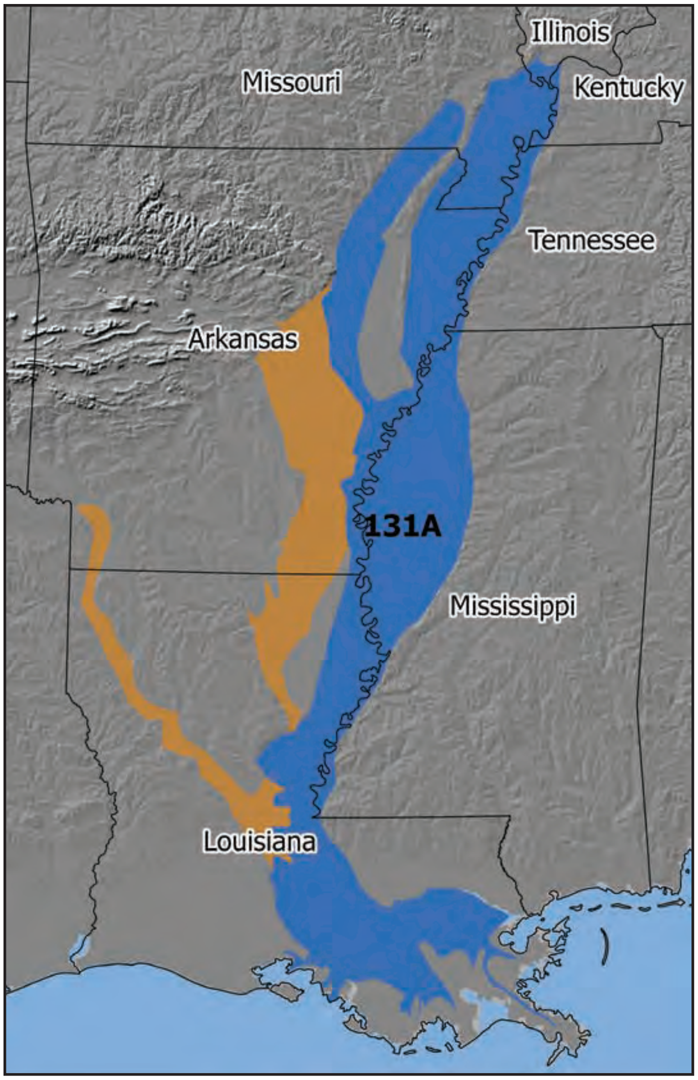

Figure 131A-1: Location of MLRA 131A, which covers 8,024,700 hectares (19,829,400 acres), within Region O.

the principal tributaries of the Arkansas and Red Rivers merge within the main Mississippi Valley (including MLRAs 131B, 131C, and 131D). To the south, MLRA 131A has a diffuse boundary with fingerings of the Gulf Coast Marsh (MLRA 151). This transition formed from a dynamic and episodic cycle of the seaward progradation of deltas (regressive deposition) and the subsequent landward retreat of deltaic headlands, when deltas were abandoned, reworked, and submerged by marine waters (transgressive deposition).

Physiography

This area is divided into the Mississippi Alluvial Plain, which extends from the confluence of the Ohio and Mississippi Rivers to central Louisiana, and the Mississippi River Delta, from central Louisiana to the Gulf of Mexico. These sections make up the larger Coastal Plain province of the Atlantic Plain. The landscape consists of multiple large, gently undulating Holocene-age meander belts. Tertiary-age upland remnants and Pleistocene-age terraces and ridges subdivide the MLRA into six major lowlands or basins, which are separate topographic depressions and hydrologic units and mostly bounded by a Mississippi River meander belt. The major lowlands and basins are the St. Francis, Yazoo, Tensas, and Atchafalaya Basins; the Western Lowlands; and the deltaic plain.

The landforms in the area are level or depressional to very gently undulating meander scrolls, backswamps, oxbows, natural levees, and terraces. South of Baton Rouge, Louisiana, the alluvial valley merges with the deltaic plain. Landform shapes range from convex on natural levees and undulating terraces to concave in oxbows. These shapes differentiate water-shedding positions from water-receiving positions, both of which have a major role in soil formation and hydrology. Average elevations gradually rise from sea level, in the southern part of the area, to about 330 feet (100 meters), in the northwestern part. Maximum local relief is about 15 feet (5 meters), but relief is considerably lower in most of the area.

Geology

This area consists of sandy to clayey Quaternary-age alluvial deposits many meters thick as a result of the flooding and lateral migration of the Mississippi River over Tertiary- and Cretaceous-age bedrock. The Yazoo, Tensas, and Atchafalaya Basins and the deltaic plain formed from deposits of Holocene-age meander belts, while the St. Francis Basin, the Western Lowlands in the northwestern part of the MLRA, and some surfaces surrounded by the Yazoo Basin, in the central part of the MLRA, formed from Wisconsin-stage (Pleistocene-age) glacial outwash deposits.

Climate

The average annual precipitation in most of this area is 44 to 68 inches (1,130 to 1,715 millimeters). Most of the rainfall occurs during frontal storms in late fall, winter, and early spring, although a significant amount of precipitation also occurs during convective thunderstorms in the early part of the growing season. Hurricanes also can produce high amounts of rainfall. The percentage of the precipitation that occurs as snow ranges from less than 1 percent in the southern part of the MLRA to 28 percent in the northern part. The average annual temperature is 57 to 70 degrees F (14 to 21 degrees C), increasing from north to south. The freeze-free period averages 285 days. It ranges from 210 days in the northern part of the area to 355 days in the southern part.

Water

The Mississippi River Levee System, which is maintained by the U.S. Army Corps of Engineers, protects most of the basins from annual overbank flooding of the river, while impeding river flow into internal streams and former channels. The internal streams provide crucial drainage for each basin. They depend on the lowered river levels to drain properly. Headwater and backwater flooding remains a major concern for most of the area. In most years the supply of moisture is adequate for maximum crop production.

Surface water for public supply, industrial use, and some irrigation is available from the bayous, oxbow lakes, canals, and rivers throughout the area. High concentrations of suspended sediments, agricultural chemicals, and municipal and industrial wastewater discharges may be local water-quality concerns. Numerous small, above-ground water impoundments are used for raising commercial catfish throughout the area.

The majority of all the ground water used in Mississippi and almost all the irrigation water used in the “boot heel” area of Missouri and the Yazoo Basin are pumped from sandy and loamy Mississippi River alluvial deposits that formed an alluvial aquifer. This aquifer consists of thick, impermeable or very slowly permeable, smectitic clay layers over coarse sandy material. Recharge water moves through the clays via large desiccation cracks that open during dry periods and swell closed during wet periods. In the last 20 years, the aquifer withdrawal has outpaced recharge, especially in the central Yazoo Basin, and alluvial aquifer decline is now a major concern. The ground water is used primarily for domestic purposes and irrigation, but it also is used for public supply and industry. It typically has levels of total dissolved solids that are less than the national secondary drinking water standard.

Ground water quality is a concern in Arkansas and the extreme southern end of the MLRA. In Arkansas, water supplies tend to have extremely high iron content. In Louisiana, intrusion of seawater has raised the level of total dissolved solids enough that the water is not suitable for drinking or industrial use. Calcium, manganese, sodium, sulfate, and bicarbonate are the major ions in Louisiana’s ground water. Where the ground water in the alluvial aquifer is of poor quality, rural landowners obtain better quality drinking water from Tertiary and Cretaceous sands below the river alluvium.

Soils

The dominant soil orders in this MLRA are Alfisols, Vertisols, Inceptisols, and Entisols. The soil temperature regime is thermic in most of the MLRA; it is hyperthermic south of Baton Rouge, Louisiana. The soils in the MLRA dominantly have an aquic moisture regime, smectitic clay mineralogy, and mixed sand and silt fraction mineralogy. They are very deep, dominantly poorly drained or somewhat poorly drained, and dominantly loamy or clayey.

The main soils and their series:

Endoaqualfs that are nearly level to gently sloping and somewhat poorly drained and formed in loamy alluvium (Dundee series) or are poorly drained and formed in loamy and clayey alluvium (Forestdale series), on old natural levees and meander scroll ridges of Holocene age and terraces of Pleistocene age; that formed in loamy alluvium on low terraces in the Western Lowlands of Arkansas and Missouri and are depressional to nearly level and somewhat poorly drained (Patterson series) or poorly drained (Amagon and Tuckerman series)

Endoaquepts that formed in silty and loamy alluvium on low broad natural levees and meander scroll ridges of recent Holocene age, are nearly level to gently sloping, and are somewhat poorly drained (Commerce and Convent series) or poorly drained (Mhoon series); that have a hyperthermic soil temperature regime (Carville series); that formed in clayey over loamy alluvium on transitional slopes and clay-capped point bars of recent Holocene age (Newellton series); that are level to depressional and very poorly drained and formed in clayey alluvium on alluvial flats, swales, and oxbows of Holocene age (Dowling series); that are in the hyperthermic soil temperature regime (Fausse series); that are hyperthermic and formed in firm clayey alluvium overlying fluid clayey sediments in broad backswamp positions on the lower Mississippi River delta plain in south Louisiana (Harahan series)

Epiaquerts that are level or nearly level, are poorly drained, and formed in clayey alluvium on alluvial flats, meander scroll swales, depressional backswamps, and abandoned channels of Holocene age (Sharkey series); that are in the hyperthermic soil temperature regime (Shriever series); that are poorly drained and formed in clayey over fine-silty alluvium on alluvial flats and the lower parts of natural levees of recent Holocene age in the hyperthermic soil temperature regime (Gramercy series)

Haplosaprists that are very poorly drained and organic and formed in wood plant remains in large backswamps of the lower Mississippi River delta plain in south Louisiana (Maurepas series)

Hapludalfs that are nearly level to gently sloping and well drained and formed in loamy alluvium on old natural levees and meander scroll ridges of Holocene age and terraces of Pleistocene age (Dubbs series); that formed on terraces of Late Pleistocene age in the Western Lowlands of Arkansas (Bosket series); that are moderately well drained and formed in loamy alluvium on low terraces of Late Pleistocene age (Askew series)

Udifluvents that are level to gently sloping and well drained and formed in loamy alluvium on natural levees and meander scroll ridges of recent Holocene age on the Mississippi River flood plain (Robinsonville series); that are excessively drained and formed in sandy alluvium on natural levees of the Mississippi River and its tributaries (Bruno series); that are level to undulating and moderately well drained and formed in loamy alluvium on natural levees and the Mississippi River flood plain (Caruthersville series)

Biological Resources

This area is predominantly cropland but once supported large expanses of bottom-land hardwood deciduous forests and mixed hardwood and cypress swamps, which were broken only by Native American settlements or pockets of prairies and savannas. The current tree species and cover types vary markedly depending on landform, flooding regime, and soil characteristics. Bald cypress, water tupelo, Drummond's maple, pumpkin ash, water locust, overcup oak, water hickory, and green ash, with an understory of black willow, common buttonbush, planertree, lizard's tail, sedges, and rushes, are in depressions such as oxbows, bayous, and flooded riverine forests. The clayey backswamps commonly support overcup oak, Nuttall oak, willow oak, water hickory, sweetgum, and green ash, with an understory of American elm, persimmon, red maple, swamp privet, planertree, possumhaw holly, greenbrier, and redvine. A drier association occurs on the higher levees. It generally consists of eastern cottonwood, water oak, cherrybark oak, green ash, American elm, sugarberry, pecan, and hickory. Except for a few small natural areas and remnant strands, the prairies and savannas are gone. They mostly occurred on Pleistocene-age terraces and outwash sediments. These systems were commonly characterized by big bluestem, little bluestem, switchgrass, Indiangrass, milkweeds, wild indigo, and various sunflowers and asters and maintained by periodic fires.

Wildlife species include the Louisiana black bear, white-tailed deer, feral hogs, red fox, coyote, rabbit, gray squirrel, American alligator, water turtles, water snakes, frogs, river otters, beavers, bobcat, mink, armadillo, crawfish, wild turkey, mourning doves, ducks, geese, and several bat species. Over 150 species of fish inhabit the Lower Mississippi River and its tributaries, oxbow lakes, and bayous. They include largemouth bass, smallmouth bass, catfish, paddlefish, drum, sunfish, bluegill, gar, yellow perch, and sturgeon. Catfish, crawfish, and gar are important commercial species.

MLRA 131A is within a significant migratory bird corridor called the Mississippi Flyway. A large percentage of North America's migratory bird species breed, overwinter or migrate through this area, or both. The region is renowned for its importance as overwintering grounds for waterfowl.

Land Use

Most of this area is in farms that produce mainly cash crops (fig. 131A-2). Cotton, soybeans, milo, and corn are the main crops; sugarcane is a major crop in the southernmost part of the MLRA. Furrow irrigation is used in many areas during droughty periods of the growing season. Rice is grown in some land-leveled, flood-irrigated areas. Catfish and crawfish are produced commercially on farm ponds that are contained by levees. The catfish are produced throughout the MLRA, and the crawfish are produced in the southern part of the area. Migratory waterfowl are harvested throughout the MLRA. Hardwood timber is harvested on most forested wetlands, and most of the forested areas are managed for wildlife.

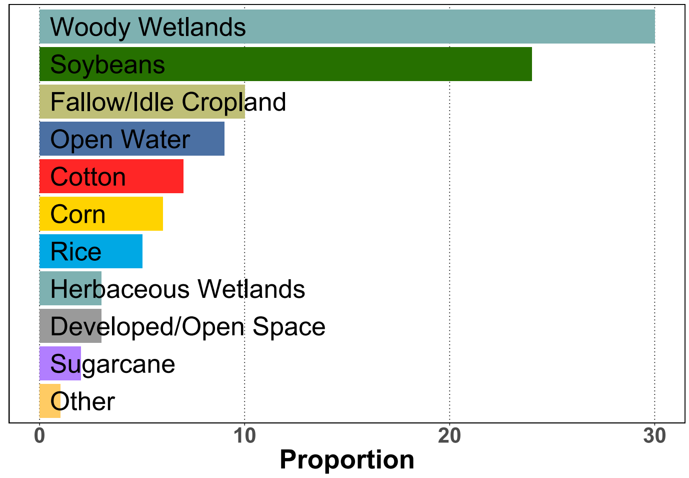

Figure 131A-2: Relative proportions (percentages) of land use in MLRA 131A.

About 29 percent of this MLRA is not protected from flooding and is occasionally or frequently flooded. Levees protect nearly all the cropland, urban land, and grassland from flooding. Most areas of forested wetlands are not protected from flooding. Networks of drainage canals and ditches help to remove excess surface water from cropland.

The major resource concerns are water quality, control of surface water, management of soil moisture, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include nutrient management, crop residue management, and alternative tillage systems, especially limited tillage systems that reduce the cost of tillage. In many areas, land leveling or shaping increases irrigation water efficiency. However, it has been shown to have long-term effects on watershed drainage control, resulting in large quantities of surface water runoff during wet seasons. Other major cropland management practices are control of competing vegetation and insects through aerial or ground spraying and fertility management programs that make use of chemical fertilizers.

131B—Arkansas River Alluvium

This MLRA (fig. 131B-1) consists of the broad alluvial plains of the Arkansas and Ouachita Rivers, which empty into the Mississippi River fluvial system. The soils in the area have a wide variety of textures since source materials included overbank, levee, channel, splay, backswamp, and oxbow sediments deposited by river flooding and meandering during the Holocene. This area of bottom-land hardwood deciduous forests, cypress swamps, and agriculture includes Aqualfs, Aquepts, Aquerts, Udalfs, Udepts, Udolls, Udifluvents, and Udipsamments. The MLRA is in Arkansas (64 percent) and Louisiana (36

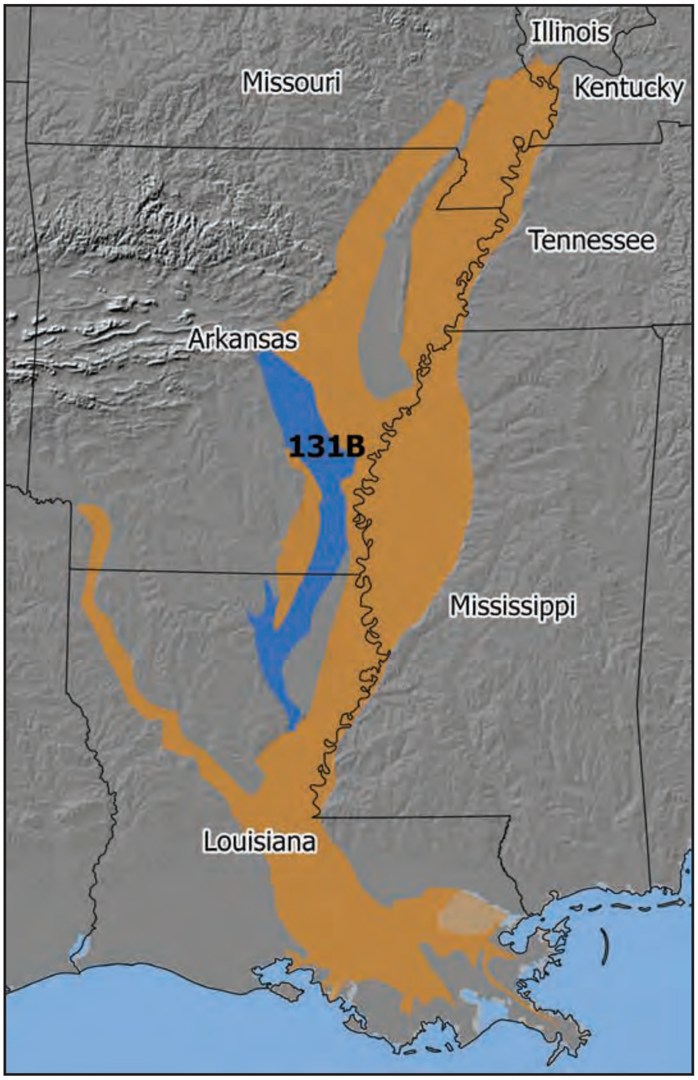

Figure 131B-1: Location of MLRA 131B, which covers 1,068,200 hectares (2,639,500 acres), within Region O.

percent). It makes up about 4,124 square miles (10,682 square kilometers).

Sharp boundaries delineate the contacts between the river alluvium of MLRA 131B and the adjacent higher Pleistocene terraces of MLRA 131D. Similar apparent boundaries occur between the river alluvium and the topographically higher and considerably older Ultisols of the Western Coastal Plain (MLRA 133B). Less apparent is the boundary between the river alluvium of MLRA 131B and the river alluvium of the southern Mississippi River (in MLRA 131A). MLRA 131A has sediments from different river systems and a greater concentration of agriculture.

Physiography

This area is in the Mississippi Alluvial Plain section of the Coastal Plain province of the Atlantic Plain. It is on the alluvial plains along the lower Arkansas River in Arkansas and the Ouachita River in Louisiana and Arkansas. The landforms in the area are level or depressional to very gently undulating alluvial plains, backswamps, oxbows, natural levees, and terraces. Landform shapes range from convex on natural levees and undulating terraces to concave in oxbows. They differentiate water-shedding positions from water-receiving positions, both of which affect soil formation and hydrology. Elevations gradually rise from about 50 feet (15 meters), in the southern part of the MLRA, to about 250 feet (75 meters), in the northwestern part. Maximum local relief is about 10 feet (3 meters), but relief is considerably lower in most of the area. The lower reaches of the Arkansas River, the Ouachita River, and the tributaries of both these rivers drain the entire MLRA.

Geology

Bedrock in this area consists of Tertiary and Cretaceous sands that formed as beach deposits during the retreat of the Cretaceous ocean from the midsection of the United States. Alluvial deposits from flooding and lateral migration of the Arkansas and Ouachita Rivers typically lie above the bedrock. These sediments are sandy to clayey fluvial deposits of Holocene to Late Pleistocene age and are several meters thick. The geologic surfaces are identified as the Arkansas Lowlands, which extend from the Yazoo Basin up the Arkansas River to the margin of the Coastal Plain, and the parts of the Tensas Basin west of Macon Ridge. The deposits on both of these surfaces are of Holocene age. In some areas Late Pleistocene terrace deposits are within several meters of the present surfaces, but they do not crop out in the MLRA.

Climate

The average annual precipitation ranges from 49 to 58 inches (1,245 to 1,475 millimeters), increasing from north to south. Most of the rainfall occurs during frontal storms in late fall, winter, and early spring, although an appreciable amount of precipitation also occurs during convective thunderstorms in the early part of the growing season. The total amount of the precipitation that occurs as snow ranges from less than 1 percent in the southern part of the MLRA to 5 percent in the northern part. The average annual temperature is 62 to 65 degrees F (16 to 18 degrees C). The freeze-free period averages 260 days and ranges from 250 to 275 days. It increases in length from north to south.

Water

In most years the supply of moisture is adequate for maximum crop production. Surface water for public supply, industrial use, and some irrigation is available from bayous, oxbow lakes, canals, and rivers throughout the MLRA. The dominant use of surface water in the area is for cooling thermoelectric power plants. Numerous small, above-ground water impoundments are used for raising commercial catfish throughout the MLRA. Most of the surface water is of good quality and suitable for most uses with some treatment. High concentrations of suspended sediments, agricultural chemicals, and municipal and industrial wastewater discharges contribute to some local water-quality problems. Flooding is a major concern in most of the MLRA.

The principal sources of ground water in this area are sandy and loamy materials within the Arkansas and Mississippi River alluvial deposits. The ground water is used primarily for irrigation, but it also is used for public supply and industry. The water is very hard. The iron content is extremely high in the part of this area in Arkansas but generally is not a significant problem in the part in Louisiana. The level of total dissolved solids can make the water from the alluvial aquifer unusable. The Sparta and Cockfield bedrock aquifers are used in the northern tip of the MLRA. The ground water in these aquifers is lower in salts than the water in the alluvial aquifer and is soft. The iron content generally is below the national secondary standard. These aquifers provide drinking water for rural landowners and small communities. They also provide water for public supply in larger communities and for industry. Irrigation wells continue to be developed in the Sparta aquifer.

Soils

The dominant soil orders are Vertisols, Alfisols, Inceptisols, and Entisols. The soils in the area have a thermic soil temperature regime. They dominantly have an aquic soil moisture regime, smectitic clay mineralogy, and mixed sand and silt fraction mineralogy. They are very deep and generally are poorly drained to well drained and loamy or clayey.

The main soils and their series:

- Argiudolls on nearly level to gently undulating, Holocene-age natural levees along the older meander scars (Caspiana series)
- Epiaqualfs on nearly level to gently undulating, Holocene-age natural levees along the older meander scars (Hebert series)
- Vertic Epiaquepts on nearly level to gently sloping, recent Holocene-age natural levees (Latanier series); on nearly level, Holocene-age alluvial flats and backswamps (Portland series)
- Epiaquerts on nearly level, Holocene-age alluvial flats and backswamps (Perry series)
- Eutrudepts on nearly level to gently sloping, recent Holocene-age natural levees (Coushatta series)
- Hapludalfs on nearly level to gently undulating, Holocene-age natural levees along the older meander scars (Rilla and Sterlington series)
- Vertic Hapludolls on nearly level, Holocene-age alluvial flats and backswamps (Desha series)
- Udifluvents that are nearly level to gently sloping and on recent Holocene-age natural levees (Roxana series); that are nearly level to gently undulating, sandy, and on recent Holocene-age levee splays and point bars (Bruno series)
- Udipsamments that are nearly level to gently undulating, sandy, and on recent Holocene-age levee splays and point bars (Crevasse series)

Biological Resources

This MLRA once consisted entirely of bottom-land hardwood deciduous forest and mixed hardwood and cypress swamps. The major tree species in the native plant communities in the areas of bottom-land hardwoods formerly were and currently are water oak, Nuttall oak, cherrybark oak, native pecan, red maple, sweetgum, eastern cottonwood, and hickory. The major tree species in the native plant communities in the swamps formerly were and currently are cypress, water tupelo, water oak, green ash, red maple, and black willow. The important native understory species are palmetto, greenbrier, wild grape, and poison ivy in the areas of bottom-land hardwoods and buttonbush, lizard’s tail, waterlily, water hyacinth, sedges, and rushes in the swamps.

Major wildlife species in this area include white-tailed deer, feral hogs, red fox, coyote, rabbit, gray squirrel, American alligator, water turtles, water snakes, frogs, otters, beavers, armadillo, crawfish, wild turkey, mourning doves, ducks, and geese. Fishing is mainly in oxbow lakes, rivers, and bayous. Fish species include largemouth bass, smallmouth bass, catfish, drum, bluegill, gar, and yellow perch.

Land Use

Farms and scattered tracts of forested wetlands make up nearly all of this area (fig. 131B-2). The farms produce mainly cash crops. Cotton, soybeans, milo, and corn are the main crops. In many areas furrow irrigation is used during droughty periods in the growing season. Throughout the area, catfish are produced commercially on farm ponds that are contained by levees. Migratory waterfowl are harvested throughout the area. Hardwood timber is harvested on some forested wetlands, and most forested areas are managed for wildlife.

About 15 percent of this MLRA is not protected from flooding. Flooding occurs occasionally or frequently in the unprotected areas. Levees protect nearly all of the cropland from flooding but most of the forested wetlands are not protected. Networks of drainage canals and ditches help to remove excess surface water from cropland.

The major resource concerns are control of surface water, management of soil moisture, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include nutrient management, crop residue management, and alternative tillage systems, especially no-till. In many areas land leveling or shaping optimizes the control of surface water. Other major cropland management practices are control of competing vegetation and insects through aerial or ground spraying of herbicides and

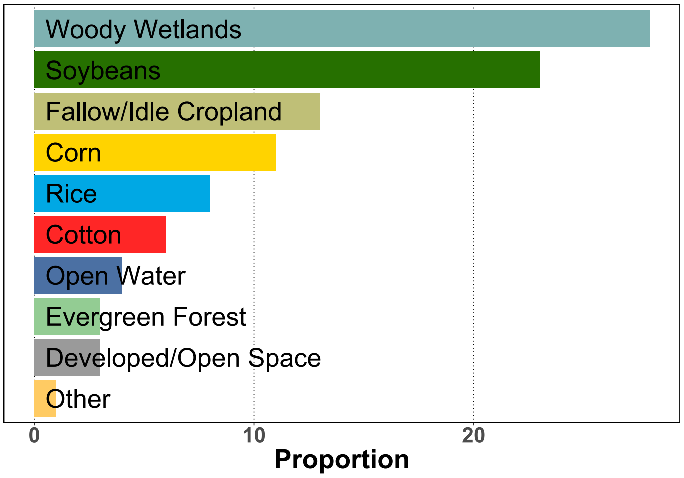

Figure 131B-2: Relative proportions (percentages) of land use in MLRA 131B.

insecticides and fertility management programs that make use of chemical fertilizers.

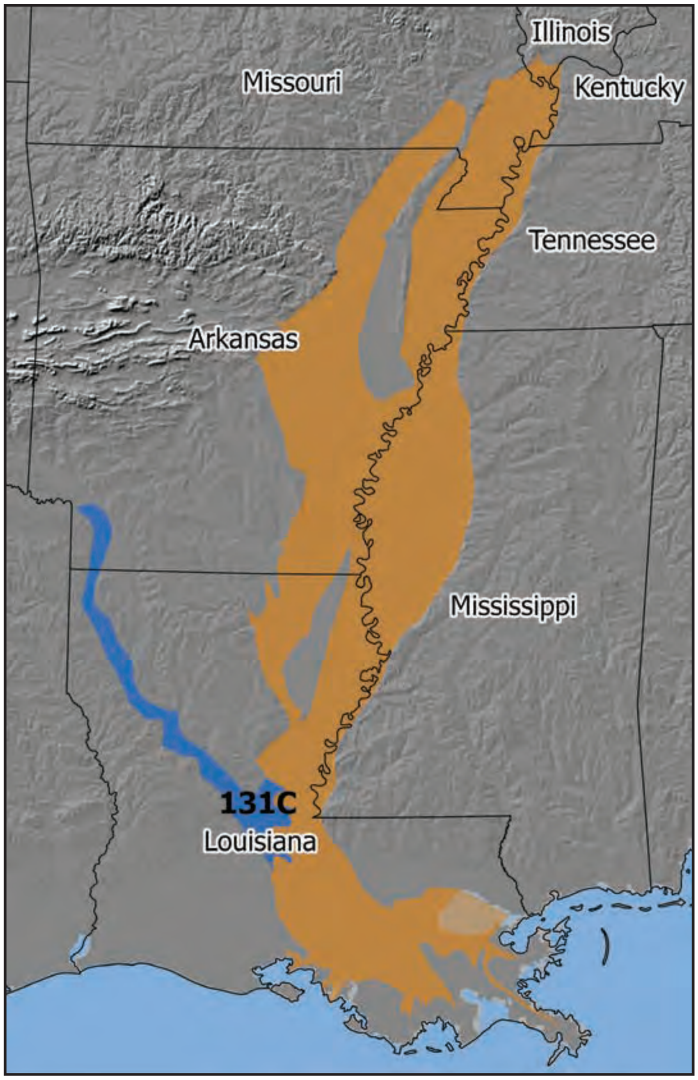

Figure 131C-1: Location of MLRA 131C, which covers 719,300 hectares (1,777,400 acres), within Region O.

131C—Red River Alluvium

This MLRA (fig. 131C-1) consists of nearly level to gently undulating, very deep soils in a fertile alluvial plain and valley along the Red River. The soils formed in Holocene and Pleistocene sediments from the Permian Redbeds in Oklahoma and Texas. The area is used to produce cash and grain crops. It is in Louisiana (87 percent) and Arkansas (13 percent). It makes up about 2,777 square miles (7,193 square kilometers).

MLRA 131C has a distinct boundary to the north, east, and west. To the north are MLRAs 133B (Western Coastal Plain) and 135B (Cretaceous Western Coastal Plain), to the east is MLRA 133B, and to the west are MLRAs 131A (Southern Mississippi River Alluvium) and 131B (Arkansas River Alluvium). MLRA 131C has a gradual climatic boundary to the south, with MLRA 133B and MLRA 152B (Western Gulf Coast Flatwoods).

Physiography

Almost all of this area is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. The southern end is in the Mississippi Alluvial Plain section of the same province and division. This MLRA is on the alluvial plain along the lower Red River in Arkansas, Louisiana, Oklahoma, and Texas. The landforms are level or depressional to very gently undulating alluvial plains, backswamps, oxbows, natural levees, and terraces. Landform shapes range from convex on natural levees and undulating terraces to concave in oxbows and backswamps. Landform shapes differentiate water-shedding positions from water-receiving positions, both of which have a major effect on soil formation and hydrology. Average elevations range from about 40 feet (12 meters) in the southern part of the area to about 270 feet (80 meters) in the northwestern part. Elevation changes gradually. Maximum local relief is about 10 feet (3 meters), but relief is considerably lower in most of the area.

Geology

This MLRA consists of Tertiary and Cretaceous sands that formed as beach deposits during the retreat of the Cretaceous ocean from the midsection of the United States. Alluvial deposits from flooding and lateral migration of the Red River typically lie above the bedrock. These sediments are sandy to clayey fluvial deposits of Holocene to Late Pleistocene age and are many meters thick. In some areas, Late Pleistocene terrace deposits are within several meters of present-day surfaces, but they do not crop out in this MLRA.

The geologic history of the area was greatly influenced by a large logjam that formed in the Red River channel in the middle part of the area during the late 18th and early 19th centuries. At the time of its largest extent, the logjam obstructed the river and its tributary outlets for a distance of 160 miles downstream from the Arkansas State boundary. This logjam caused backwater flooding, reformation of natural levees, and crevasse splays, covering large parts of the area with a mantle of recent clayey to sandy material. Destruction of the logjam in the late 1800s resulted in the drainage of many of the recently formed large lakes.

Climate

The average annual precipitation ranges from 47 to 62 inches (1,195 to 1,575 millimeters), increasing from north to south. Most of the rainfall occurs during frontal storms in late fall, winter, and early spring, although an appreciable amount of precipitation also occurs during convective thunderstorms in the early part of the growing season. The percentage of precipitation that occurs as snow ranges from less than 1 percent in the southern part of the area to 5 percent in the northern part. The average annual temperature ranges from 63 to 67 degrees F (17 to 19 degrees C). The freeze-free period averages 280 days. It ranges from 255 days in the northern part of the area to 305 days in the southern part.

Water

The principal sources of ground water in this area are sandy and loamy materials within the Red River alluvial deposits. Impermeable or very slowly permeable smectitic clays overlie these aquifers in many parts of the MLRA, and these clay layers are many meters thick in some places. Water moves through the smectitic clays via large desiccation cracks that open during dry periods and swell closed and form slickensides during wet periods. The ground water is used primarily for irrigation, but it also is used for public supply and industry. The water is very hard. The iron content is generally high in the part of this area in Arkansas, but it generally is not a significant problem in the part in Louisiana. The level of total dissolved solids in the water from the alluvial aquifer in the southwest corner of the part of the MLRA in Arkansas makes the water unusable.

The Sparta and Cockfield bedrock aquifers are used in the northern end of this area, in Arkansas. The ground water in these aquifers has a lower mineral content than the water in the alluvial aquifer, and it is soft. The iron content generally is below the national secondary standard for drinking water. These aquifers provide drinking water for rural landowners and small communities. They also provide public water supplies in the larger communities. More and more irrigation wells are being developed in the Sparta aquifer.

Soils

The dominant soil orders are Vertisols, Entisols, Inceptisols, and Alfisols. The soils in the area have a thermic temperature regime. They dominantly have an aquic moisture regime, smectitic clay mineralogy, and mixed sand and silt fraction mineralogy. They are very deep, generally poorly drained to moderately well drained, and loamy or clayey.

The main soils and their series:

- Argiudolls that dominate the Holocene-age natural levees along the older meander scars (Caspiana series)
- Epiaquerts that dominate the Holocene-age alluvial flats, backswamps, and oxbows (Bossier, Perry, and Yorktown series)
- Eutrudepts that dominate the Holocene-age natural levees (Coushatta series)
- Hapludalfs that dominate the Holocene-age natural levees along the older meander scars (Gallion and Rilla series)
- Hapluderts that dominate the Holocene-age clayey alluvial flats and backswamps (Moreland, Buxin, and Billyhaw series); that dominate the Holocene-age natural levees (Latanier series)
- Udifluvents that dominate the Holocene-age levee splays and point bars (Caplis and Kiomatia series); that dominate the Holocene-age natural levees (Severn and Roxana series)

Biological Resources

This area once consisted entirely of bottom-land hardwood deciduous forest and mixed hardwood and cypress swamps. The major tree species in the native plant communities in the areas of bottom-land hardwoods formerly were and currently are water oak, Nuttall oak, cherrybark oak, native pecan, red maple, sweetgum, eastern cottonwood, and hickory. The major tree species in the native plant communities in the swamps formerly were and currently are cypress, water tupelo, water oak, green ash, red maple, and black willow. The important native understory species are palmetto, greenbrier, wild grape, and poison ivy in the areas of bottom-land hardwoods and buttonbush, lizard’s tail, waterlily, water hyacinth, sedges, and rushes in the swamps.

Major wildlife species in this area include white-tailed deer, feral hogs, red fox, coyote, rabbit, gray squirrel, American alligator, water turtles, water snakes, frogs, otters, beavers, armadillo, crawfish, wild turkey, mourning doves, ducks, and geese. Fishing is mainly in oxbow lakes, rivers, and bayous. Fish species include largemouth bass, smallmouth bass, catfish, drum, bluegill, gar, and yellow perch. Red River Wildlife Refuge, Lake Ophelia National Wildlife Refuge, and Grand Cote National Wildlife Refuge are in this area. The area is along a major flightpath of migratory waterfowl.

Land Use

Farms and scattered tracts of forested wetlands make up nearly all of this area (fig. 131C-2). The farms produce mainly cash crops, including cotton, soybeans, milo, and corn. Sugarcane is a major crop in the southernmost part of the MLRA. In many areas furrow irrigation is used during droughty periods of the growing season. Catfish are produced commercially throughout the MLRA on farm ponds that are contained by levees. Migratory waterfowl are harvested throughout the area. Hardwood timber is harvested on some forested wetlands, and most forested areas are managed for wildlife. About 22 percent of this MLRA is not protected from flooding and is occasionally or frequently flooded. Levees protect nearly all of the cropland from flooding but most of the forested wetlands are not protected.

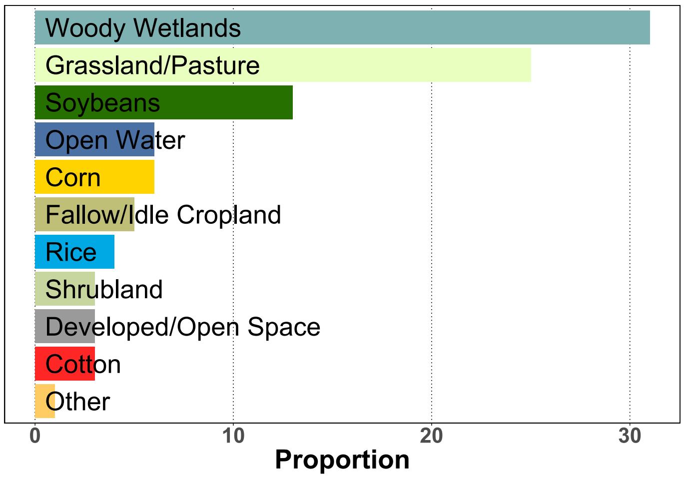

Figure 131C-2: Relative proportions (percentages) of land use in MLRA 131C.

131D—Southern Mississippi River Terraces

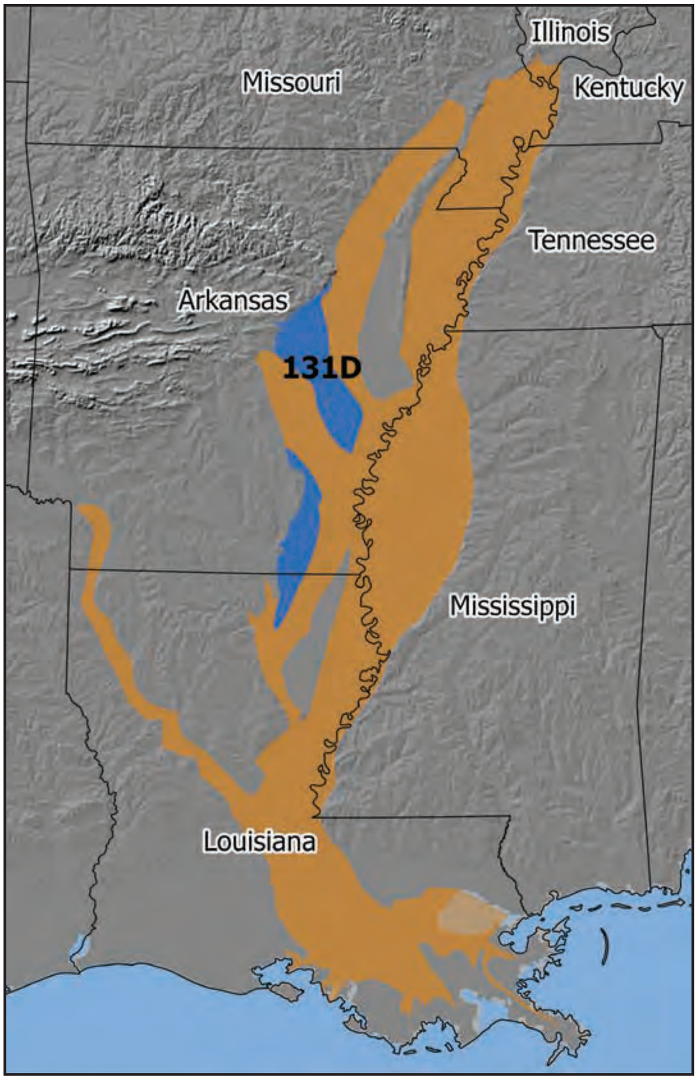

Figure 131D-1: Location of MLRA 131D, which covers 803,700 hectares (1,985,920 acres), within Region O.

This MLRA (fig. 131D-1) consists of large Pleistocene terraces produced by the Mississippi River fluvial system. Alluvial sediments laid down during the filling of the Mississippi valley were isolated as terraces during subsequent valley erosion. The terraces are old enough for illuvial clay accumulation and the formation of argillic horizons (Alfisols). They occur as two separate areas, mostly in Arkansas (91 percent) but also in northern Louisiana (9 percent).The MLRA makes up about 3,103 square miles (8,037 square kilometers).

Scarps form the boundaries between the terraces and neighboring lower and younger alluvial deposits, where Inceptisols and Vertisols are common. The contact between the terraces of MLRA 131D and adjacent uplands to the west mark a sharp boundary based on landform and soil parent material, where the alluvial Alfisols meet the more chemically weathered Ultisols of the Western Coastal Plain and Arkansas Valley and Ridge.

Physiography

This MLRA is in the Mississippi Alluvial Plain section of the Coastal Plain province of the Atlantic Plain. It consists dominantly of Pleistocene-age, level to gently sloping terraces along the Mississippi River. Slopes generally range from level to gently sloping but are steep along terrace escarpments. Channel scars are evident in some areas. Elevation is generally 50 to 250 feet (15 to 75 meters) on the terraces. Bayou Bartholomew and La Grue Bayou are major tributaries in this area. La Grue Bayou drains the Grand Prairie area.

Geology

Bedrock in this area consists of Tertiary and Cretaceous sands that formed as beach deposits during the retreat of the Cretaceous ocean from the midsection of the conterminous United States. Alluvial deposits from the flooding and lateral migration of rivers crossing the area typically lie above the bedrock. These sediments form Pleistocene-age alluvial terraces. Silty alluvium underlies most of the MLRA. Clayey sediments are in old channel scars. The Pleistocene terraces are part of the Prairie Terrace complex. A minor portion of the MLRA is in the Deweyville and Montgomery terrace formation. These terraces have a base of red alluvium capped by 1 to several meters of brownish alluvium.

Climate

The average annual precipitation is 49 to 56 inches (1,245 to 1,420 millimeters), increasing from north to south. Most of the rainfall occurs during frontal storms in spring and early summer. Some high-intensity, convective thunderstorms occur in summer. The average seasonal snowfall is 5 inches (12 centimeters). The average annual temperature is 61 to 65 degrees F (16 to 18 degrees C), increasing from north to south. The freeze-free period averages 255 days. It ranges from 245 days in the northern part of the area to 270 days in the southern part.

Water

In most years the supply of moisture is not adequate for maximum crop production because of the distribution of rainfall during the growing season. Some surface water for industrial use and some limited irrigation is available from bayous, canals, and rivers throughout the area. Most of the surface water is of good quality and suitable for most uses with some treatment. Some farms and small communities depend on treated surface water. High concentrations of suspended sediments, agricultural chemicals, and municipal and industrial wastewater discharges contribute to local water-quality problems.

The principal sources of ground water are the sandy and silty materials within the alluvial terraces and the Cockfield and Sparta bedrock aquifers. The Sparta aquifer is a sole-source aquifer for most of the communities in the area. The ground water is used primarily for irrigation but is also used for domestic purposes, public supply, and industry. The water in the alluvial aquifer is very hard. The iron content is generally high in the part of this MLRA in Arkansas, but it is generally not a significant problem in the part in Louisiana. The water in the Sparta and Cockfield bedrock aquifers typically has a lower content of salts than the water in the alluvial aquifer and is soft. The content of iron generally is below the national secondary standard for drinking water. These aquifers provide drinking water for rural landowners and small communities. They also provide water for public supply in the larger communities. Irrigation wells are continually being developed in the Sparta aquifer.

The aquifers in this area are recharged by the Arkansas and White Rivers. Pumping has exceeded the amount of recharge, so water levels have been dropping almost 1 foot per year. The historical decline in the elevation of the water table has prompted a major federally funded water resources project in the Grand Prairie part of this MLRA. The focus of the project is on improving irrigation water management. The U.S. Army Corps of Engineers, in cooperation with the Natural Resources Conservation Service, other Federal agencies, and State agencies, is assisting farmers in the construction of canals, pipelines, and on-farm reservoirs for irrigation tailwater reclamation and reuse.

Soils

The dominant soils in this MLRA are Alfisols. They have a thermic soil temperature regime, an ustic or aquic soil moisture regime, and mixed mineralogy. They are very deep and formed dominantly in silty alluvium. They generally are moderately well drained to poorly drained.

The main soils and their series:

- Albaqualfs that are level and on low terraces and natural levees (Dewitt series)
- Dystrudepts that are nearly level and along drainageways and on flood plains (Oaklimeter series)
- Endoaqualfs that are level and on low terraces and natural levees (Idee series); that are nearly level and level and on low terraces, natural levees, and flood plains (Tichnor and Forestdale series)
- Epiaqualfs that are level and on low terraces and natural levees (Lagrue series)
- Fragiaqualfs that are level and on low terraces and natural levees (Henry series)
- Fraglossudalfs that are gently sloping to level and on broad interfluves and along terrace escarpments (Grenada series)
- Glossaqualfs that are level and on low terraces and natural levees (Ethel series)
- Hapludalfs that are gently sloping and on natural levees and low terraces (Goodwill series); that are gently sloping to level and on broad interfluves and along terrace escarpments (Immanuel and Stuttgart series)

Biological Resources

This area supports hardwoods and pines. The Grand Prairie area, in Arkansas, originally supported tall prairie grasses interspersed with hardwood timber. Cherrybark and Shumard oak are widely distributed. Yellow-poplar, white ash, cottonwood, and black walnut are important species on the flood plains. Loblolly pine and shortleaf pine are on a wide variety of sites, mainly on the eroded soils on uplands and ridges. Other hardwood species common in this area are white oak, basswood, sweetgum, water oak, American elm, blackgum, sycamore, sassafras, southern red oak, chinquapin oak, American beech, and hickory.

Major wildlife species in this area include white-tailed deer, coyote, bobcat, beaver, raccoon, skunk, armadillo, mink, cottontail, turkey, mourning dove, ducks, and geese. Fish species include channel catfish, largemouth black bass, crappie, and bluegill.

Land Use

Scattered tracts of forests and farms make up nearly all of this MLRA (fig. 131D-2). Rice, soybeans, and wheat are the main crops. In most areas furrow or flood irrigation is used throughout the growing season. Hardwood timber is harvested on some forested wetlands, and most forested areas are managed for wildlife. Bait fish are produced commercially in ponds that are contained by levees. Migratory waterfowl are harvested throughout the area.

The major soil resource concerns are management of soil moisture, erosion control, and maintenance of the content of organic matter and productivity of the soils. Depletion of ground water through excessive pumping is a major concern in the Grand Prairie area.

Conservation practices on cropland generally include nutrient management, crop residue management, and alternative tillage systems, especially no-till systems that reduce the need for tillage. In many areas, land leveling or shaping optimizes the control of surface water. Other major cropland management practices are control of competing vegetation and insects through aerial or ground spraying of herbicides and insecticides and fertility management programs that make use of chemical fertilizers.

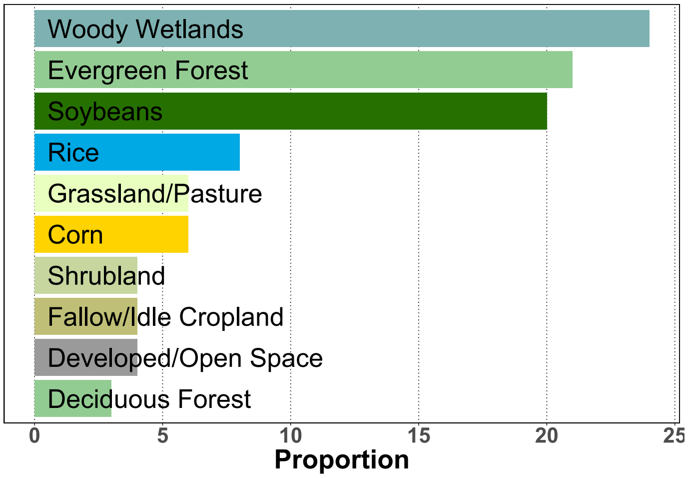

Figure 131D-2: Relative proportions (percentages) of land use in MLRA 131D.

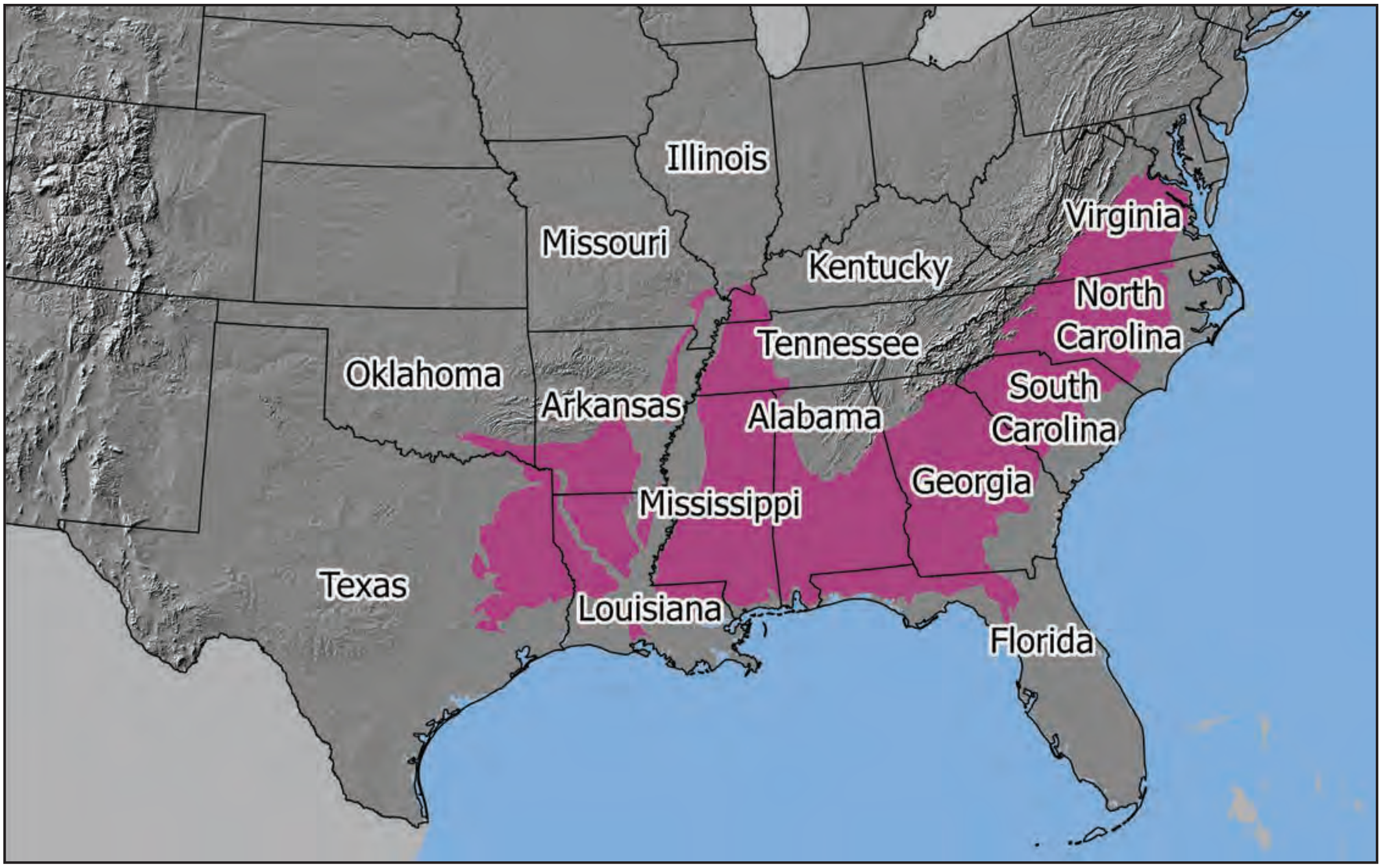

Figure P-1: Location and size of Land Resource Region P, which covers 687,070 square kilometers (265,280 square miles). Elevations range from sea level, where Region P contacts the Gulf of Mexico at Mobile Bay in Alabama, to 790 meters (2,580 feet) in the piedmont. Mean elevation is 110 meters (370 feet).

P—South Atlantic and Gulf Slope Cash Crops, Forest, and Livestock Region

Land Resource Region P (fig. P-1) extends southward from northern Virginia across North Carolina, South Carolina, Georgia, northern Florida, and Alabama; bends northward through Mississippi, west Tennessee, and west Kentucky to reach southernmost Illinois and southeast Missouri; then turns south again to cross into southern Arkansas, southeastern Oklahoma, northern Louisiana, and east Texas. It includes the intravalley ridges of Region O's alluvial valley. Only Regions D and M are larger (fig. 1, page 5). Region P combines the geologically dissimilar Piedmont and Coastal Plain physiographic divisions. The Piedmont extends along the northwest side of the Coastal Plain from northern Virginia to central Alabama. It consists of Paleozoic metamorphic and intrusive rocks (such as gneiss, schist, slate, granite, and gabbro) in contrast to the unconsolidated Cretaceous to Quaternary sediments laid down in the onshore, nearshore, and offshore depositional environments of the Coastal Plain. This region contains nine major land resource areas. The extent of these MLRAs and their range in elevations are shown in table P-1.

The boundary between Regions P and N along the Piedmont (fig. 1) is long and sharp. It is marked by the up-thrusted strata of the Blue Ridge and Valley and Ridge (in Region N). The boundary between Regions P and S, to the north, is the thermic-mesic boundary. The boundary between Regions P and N, to the west, is the contact between unconsolidated Coastal Plain and Paleozoic marine and clastic bedrock. The boundary between Regions P and O delineates the alluvial plain of the Mississippi River that crosscuts and buries Region P from north to south. Region P's western boundary with Region O is a sharp contact between forested Ultisols on a rolling Coastal Plain landscape (Region P) and cropland on poorly drained Alfisols, Inceptisols, and Vertisols of the low-gradient alluvial sediments (Region O). The boundary between Regions P and J, unlike the other boundaries, is not physiographic (as both are on the Coastal

Table P-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
133A	123,680	47,755	0	0	20	70	50	170	100	330	200	660
133B	116,485	44,975	0	0	40	140	70	250	120	400	230	760
133C	147,690	57,025	0	0	30	110	90	310	150	500	330	1,080
134	69,705	26,915	0	0	20	80	90	310	130	450	210	710
135A	26,330	10,165	10	30	40	140	70	250	120	410	240	790
135B	10,795	4,170	40	150	80	260	120	400	170	570	250	830
136	165,035	63,720	100	325	90	320	190	630	310	1,030	400	1,315
137	21,660	8,365	0	0	60	200	110	360	160	530	240	810
138	5,690	2,195	0	0	10	30	20	80	40	140	90	310

Table P-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
133A	13.3	56	15	59	18.2	65	19.5	67	20.1	68	190	212	241/245	273	295
133B	16.4	61	17	63	18.3	65	19.1	66	20.7	69	220	230	251/250	264	310
133C	14	57	15.9	61	18	64	19.2	67	20	68	185	207	241/240	262	300
134	13.7	57	14.6	58	16.4	62	19.1	66	20.1	68	195	208	232/235	262	330
135A	15.4	60	16.4	62	17.5	64	18.1	65	18.6	65	205	217	232/230	247	260
135B	15.9	61	16.6	62	16.9	62	17.3	63	17.7	64	215	244	231/230	239	245
136	11.5	53	13.7	57	15.7	60	17	63	18.3	65	175	198	215/215	231	255
137	15.6	60	16.3	61	17.4	63	17.9	64	18.4	65	215	226	234/235	240	255
138	19.8	68	20	68	20.3	68	20.4	69	20.6	69	250	263	275/275	285	290

Table P-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
133A	1,020	40	1,148	45	1,186/1,235	47/49	1,415	56	1,610	63
133B	1,030	41	1,176	46	1,341/1,330	53/52	1,473	58	1,580	62
133C	1,180	47	1,354	53	1,449/1,470	57/58	1,631	64	1,730	68
134	1,150	45	1,250	49	1,395/1,400	55/55	1,578	62	1,680	66
135A	1,210	48	1,326	52	1,400/1,390	55/55	1,453	57	1,500	59
135B	1,050	42	1,162	46	1,310/1,295	52/51	1,366	54	1,430	56
136	1,010	40	1,114	44	1,166/1,200	46/47	1,341	53	1,860	73
137	1,020	40	1,137	45	1,161/1,170	46/46	1,214	48	1,280	50
138	1,290	51	1,302	51	1,319/1,330	52/52	1,361	54	1,500	59

Plain) but climatic. Region P is primarily forested and has an udic soil moisture regime and Ultisols. Region J is primarily native prairies, has an ustic udic soil moisture regime, and has Alfisols with a notable increase in carbonate content. The boundary between Regions P and T is where the older, drier coastal plain sediments (Region P) contact the younger, wetter sediments (Region T) within an aquic soil moisture regime.

Climatically, Region P's abundant moisture and long growing season favor agricultural production. On the lower marine terraces, artificial drainage typically is required to lower the water table for crop production. The humid climate is characterized by long, hot summers and short, mild winters. The mean annual precipitation is 46 to 58 inches (1,170 to 1,470 millimeters) and occurs almost entirely as rainfall. The mean annual air temperature in most of the region is 60 to 68 degrees F (16 to 20 degrees C). The freeze-free period ranges from 215 to 275 days. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables P-2 and P-3.

The soils of Region P are dominantly Ultisols, regardless of whether they formed in the igneous-metamorphic residuum of the Piedmont or the unconsolidated sediments of the Coastal Plain. Notable exceptions include the Alfisols that formed in mafic parent materials of the Piedmont, the Alfisols that formed in the loess deposits on the leeward side of the Mississippi River flood plain, and the Alfisols along the border with the climatically drier Region J. Other notable exceptions are the Vertisols and Inceptisols that formed in the Black Belt Prairies of Alabama and Mississippi on marly coastal plain deposits. Entisols and Inceptisols occur throughout the region on flood plains and terraces. Entisols also occur in the sandhills region where the Piedmont dips below the coastal plain sediments (fig. 2, page 6). Paralithic bedrock, densic-like material, and fragipans occur throughout the region. Fragipans are especially common in the loess east of the Mississippi River (figs. 9 and 11, pages 13 and 15). Plinthite has formed in coastal plain sediments across the breadth of the region (fig. 13, page 17). Carbonates occur in the marly coastal plain deposits in Alabama and Mississippi (fig. 5, page 9). Argillic horizons occur throughout the region, except in the marly deposits and geologically young eolian and fluvial deposits (fig. 12, page 16). Organic carbon content is relatively low in this region, especially in the Piedmont (fig. 14, page 18).

Land use in Region P is primarily evergreen forest, but deciduous forest, woody wetlands, and pasture also comprise a substantial acreage (fig. P-2). Soybeans are the crop most extensively grown in the region, but their acreage is less than that of developed open space and areas of low-intensity land use. Other crops include cotton, peanuts, corn, rice, sugarcane, and wheat (fig. 8, page 12). The major management concerns on cropland include maintenance of soil productivity, control of erosion, and prevention of ground water contamination.

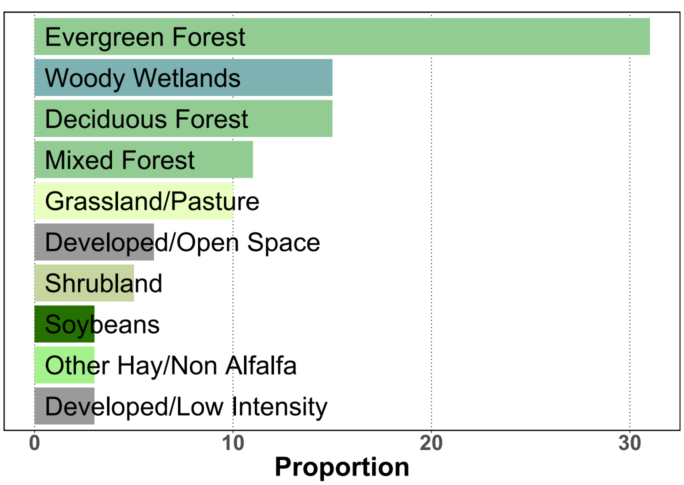

Figure P-2. Relative proportions (percentages) of land use in Land Resource Region P based on 2018 data from the National Agricultural Statistics Service.

133A—Southern Coastal Plain

This MLRA (fig. 133A-1) is a large coastal plain with a southeastward-dipping, benched landscape that is dissected into gently undulating valleys and gently to steeply sloping uplands. Cash crops of soybeans, cotton, peanuts, corn, wheat, and flue-cured tobacco are of major economic importance to this area. This area is in Georgia (45 percent), North Carolina (18 percent), Virginia (12 percent), South Carolina (11 percent), Florida (10 percent), and Alabama (4 percent). It makes up about 47,753 square miles (123,680 square kilometers).

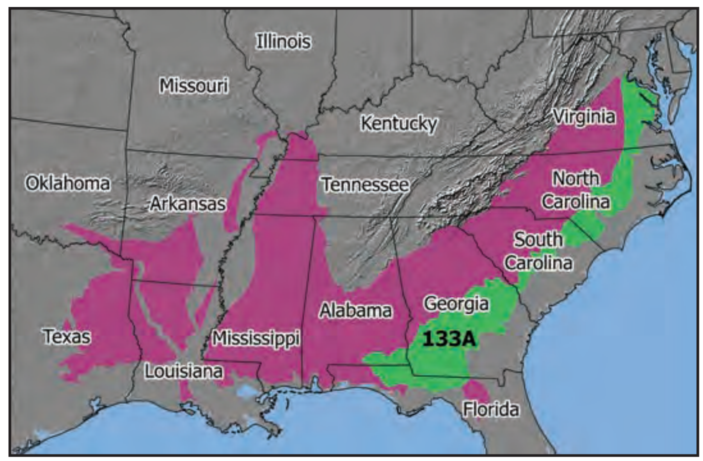

Figure 133A-1: Location of MLRA 133A, which covers 12,368,000 hectares (30,562,000 acres), within Region P.

This MLRA's boundary with MLRA 133C is not apparent but consists of subtle changes in soil properties and slightly more dissected landscapes, which limit agricultural practices. MLRA 133A has a diffuse boundary with MLRA 153A (Tertiary to Quaternary age), which lies on a slightly lower marine terrace (8 to 90 meters in elevation) east of the Surry Scarp. The boundary with MLRA 137 west of the Orangeburg Scarp is intermingled (discontinuous) with patchy eolian sand overlying the unconsolidated fluviomarine terrace material of MLRA 133A. The boundary with MLRA 138 is not apparent and is characterized by similar fluviomarine deposits over limestone bedrock. MLRA 133A has a distinct boundary with MLRA 153B (in the northernmost reaches of MLRA 133A) and MLRA 152A (in the southernmost reaches), which are on low-lying (less than 8 meters in elevation) younger marine terraces along the Atlantic Ocean and Gulf of Mexico, respectively. The boundary with MLRA 149A to the north is gradual as eolian deposits thin from west to east. The boundaries with MLRAs

136 and 148 to the west are well defined by the fall line, which separates sedimentary, metamorphic, and igneous bedrock from coastal plain sediments.

Physiography

This area extends from the southeastern corner of Alabama and the Florida panhandle to northern Virginia. It is entirely within the Embayed and Sea Island sections within the Coastal Plain province of the Atlantic Plain. The northern part is in the Embayed section, and the middle part is in the Sea Island section. Most of the major rivers that cross this area originate in the Appalachian Mountains and flow east and southeast to the Atlantic Ocean.

This MLRA is divided by the Orangeburg Scarp and its corollaries into an upper, or inland part, and a middle, or seaward part. The upper part is strongly dissected into nearly level or gently undulating uplands separated by valleys with sloping to steep side slopes and nearly level or gently sloping base slopes. The middle part is essentially a nearly level plain locally incised by blackwater swamps. Stream valleys in the MLRA generally are narrow in their upper reaches but become broad with widely meandering stream channels as they approach the coast.

Elevation ranges from 80 to 655 feet (25 to 200 meters), increasing gradually away from the coast. Local relief is mainly 10 to 20 feet (3 to 6 meters), but it is 80 to 165 feet (25 to 50 meters) in some of the more deeply dissected areas.

Geology

This MLRA is underlain, at increasing depths toward the Atlantic Coast, by eroded igneous and metamorphic bedrock. Rivers and streams draining the Appalachians deposited a thick wedge of silt, sand, and gravel east and south of the fall line as delta deposits in the Atlantic Ocean shoreline during the Mesozoic Era. Cretaceous river sediments were eventually exposed as the Coastal Plain was uplifted and the sea level became lower. When the sea level rose again, the Coastal Plain was submerged and covered by Cretaceous sands in the eastern half of the MLRA. In the western part of the MLRA, the water was deeper and limestone, dolomite, and calcareous sands were deposited. Several subsequent Tertiary and Quaternary marine transgressions and regressions deposited unconsolidated clay, silt, sand, and gravel over Cretaceous sediments and Tertiary sand and carbonates. Changes in the sea level created terraces along many of the streams and rivers draining this area. In some places the MLRA has a benched appearance because of the cycles of erosion and deposition that occurred as the area was exposed and submerged numerous times.

Climate

The average annual precipitation in most of this area is 40 to 63 inches (1,028 to 1,604 millimeters), increasing from north to south. Minimum precipitation throughout the area occurs in autumn. Maximum precipitation occurs during midsummer in the eastern part of the area and during winter and spring in the western part. Rainfall typically occurs during high-intensity, convective thunderstorms in summer, but moderate-intensity tropical storms can produce large amounts of rainfall in winter in the eastern and southwestern parts of the area. Snowfall does not occur in the southern part of the area and occasionally occurs in the northern part. The average annual temperature is 56 to 68 degrees F (13 to 20 degrees C), increasing from north to south. The freeze-free period averages 250 days and ranges from 200 to 305 days, increasing in length from north to south.

Water

In general, annual precipitation is sufficient to maintain waterflow in perennial streams. Late summer droughts can reduce flow and stress vegetation in some years. The many perennial streams have the potential to supply quality water for industrial and municipal use but generally are not used for these purposes. Water for livestock is primarily obtained from perennial streams and small farm ponds. A few large reservoirs are available for recreation and other uses.

Domestic water supplies are obtained mainly from shallow wells. In most areas, one or more aquifers provide ample ground water for industrial, municipal, and agricultural purposes. The Floridan aquifer (limestone, dolomite, and calcareous sand) is heavily used in the southern part of the MLRA, and the Cretaceous sand aquifer is extensively used throughout the area. Both of these aquifers have high-quality water. The water is typically soft or moderately hard. Several other shallow aquifers are used throughout the area. These aquifers are susceptible to contamination from agricultural activities, septic systems, and runoff from urban areas. Wells occasionally may exceed the national drinking water standard for sodium.

Soils

The dominant soil orders are Ultisols, Entisols, and Inceptisols. The soils in the area dominantly have a thermic temperature regime, a udic or aquic moisture regime, and siliceous or kaolinitic mineralogy. They generally are very deep, somewhat excessively drained to poorly drained, and loamy.

The main soils and their series:

- Endoaquepts that formed in alluvium on flood plains (Chastain and Kinston series)
- Hapludults that formed in marine sediments on hills and ridges (Emporia, Kempsville, and Slagle series)
- Kandiudults that formed in marine sediments on hills and ridges (Dothan, Fuquay, Norfolk, and Wagram series)
- Kanhapludults that formed in marine sediments on ridgetops and side slopes (Cowarts, Nankin, and Uchee series)
- Paleaquults that formed in marine and fluvial sediments on terraces (Rains and Coxville series)

Paleudults that formed in mixed marine and fluvial sediments on uplands and stream terraces (Blanton, Bonneau, and Ocilla series)

Quartzipsamments that formed in sandy eolian or marine material on uplands (Kershaw and Alaga series)

Biological Resources

This area supports mixed oak-pine vegetation. Because of slight climatic differences between the northern and southern reaches of this MLRA, vegetative communities vary with latitude. Loblolly pine, longleaf pine, slash pine, shortleaf pine, sweetgum, yellow-poplar, red oak, and white oak are the major overstory species. Dogwood, gallberry, and farkleberry are the major understory species. Common sweetleaf, American holly, greenbrier, southern bayberry, little bluestem, Elliott's bluestem, threeawn, grassleaf goldaster, native lespedezas, and low panicums are other understory species.

Major wildlife species include white-tailed deer, turkey, rabbit, squirrel, bobwhite quail, and mourning dove. Fish species include bass, bluegill, and channel catfish.

Land Use

Timber production, cash-grain crops, and forage production are important in this MLRA (fig. 133A-2). Soybeans, cotton, peanuts, corn, wheat, and flue-cured tobacco are the major crops grown throughout the area. Pastures are grazed mainly by beef cattle. Some dairy cattle, poultry, and hogs are raised in the area. Large tracts of pine forests are managed for commercial and recreational purposes.

The major resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, control of surface water, artificial drainage, and management of surface compaction and soil moisture. Conservation practices on cropland generally include systems of crop residue management, cover crops, crop rotations, water disposal, subsoiling or deep tillage, pest management, and nutrient management. The most important conservation practice in pastured areas is prescribed grazing. Pastures commonly are overseeded with small grains or legumes, or both, to supplement forage production during winter. Haying also helps to provide supplemental feed during the long winters. Critically eroding areas and areas where animals congregate need to be monitored and treated.

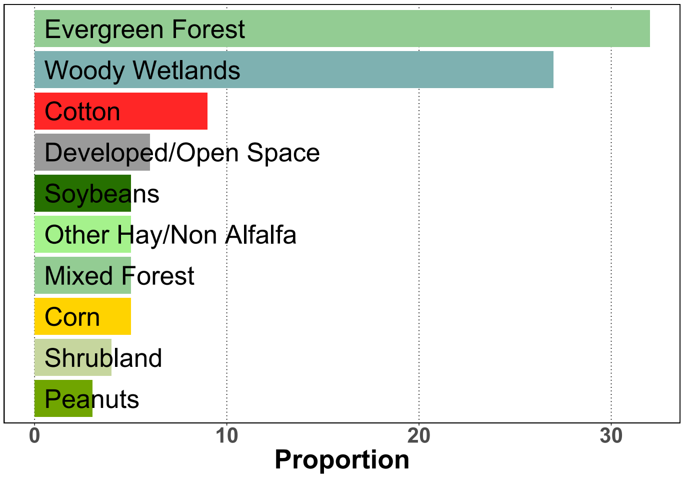

Figure 133A-2: Relative proportions (percentages) of land use in MLRA 133A.

133B—Western Coastal Plain

This MLRA (fig. 133B-1) consists of nearly level to steep soils on uplands that are intricately dissected by streams and support pine-hardwood forests. It is in Texas (47 percent), Louisiana (31 percent), Arkansas (21 percent), and Oklahoma (1 percent). It makes up about 44,975 square miles (116,485 square kilometers).

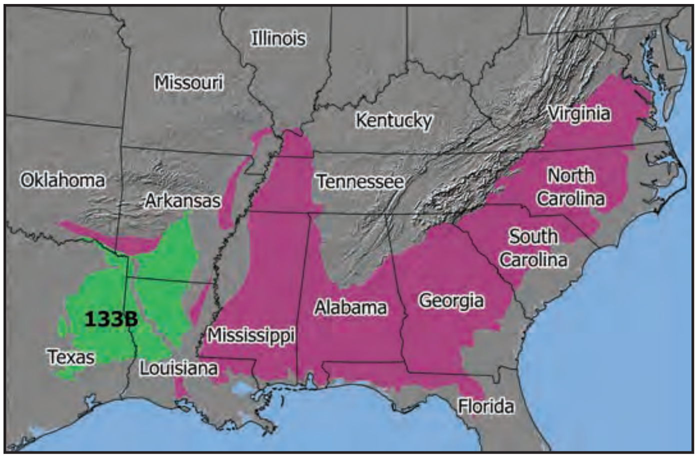

Figure 133B-1: Location of MLRA 133B, which covers 11,648,500 hectares (28,784,000 acres), within Region P.

The boundaries with neighboring MLRAs are distinct and apparent and based on a physical characteristic. To the north are MLRAs 135B (Cretaceous Western Coastal Plains) and 119 (Ouachita Mountains). To the east are MLRAs 131A (Southern Mississippi River Alluvium), 131B (Arkansas River Alluvium), and 131D (Southern Mississippi River Terraces). To the south are MLRA 131A and MLRA 131C (Red River Alluvium). To the west is MLRA 131C.

Physiography

This area is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. It consists of level to steep uplands that are intricately dissected by streams. Broad flood plains and terraces are along some streams. Elevation ranges from 80 to 650 feet (25 to 200 meters), increasing gradually from southeast to northwest. Local relief is generally less than 30 feet (9 meters).

The headwaters of the Angelina, Calcasieu, Dugdemona, and Neches Rivers are in this area. The Trinity River passes through the far western part of the area. Tributaries of the Ouachita, Red, and Sabine Rivers also drain the area.

Geology

Tertiary and Cretaceous marine sediments underlie most of this area. Tertiary units include the Wilcox and Midway Groups, the Claiborne Group (Cockfield, Cook Mountain, and Sparta Formations), the Jackson Group, and the Catahoula Formation. They consist of interbedded sandstone, siltstone, and shale and unconsolidated sands, silts, and clays. Pleistocene terrace units include the Willis or Williana, Bently, Montgomery, and Prairie Formations. The Reklaw and Weches Formations in the Claiborne Group form the Redland area in east Texas. The Cretaceous marine sediments of the Fleming and Oakville Formations are of minor extent in the MLRA. They consist of calcareous clays and marls. Sand, silt, and clay alluvium underlies the flood plains and terraces along the major drainages.

Climate

The average annual precipitation in this area is 39 to 63 inches (990 to 1,600 millimeters). It increases from northwest to southeast. Most of the rainfall occurs during frontal storms in spring and early summer. High-intensity, convective thunderstorms occur in late summer and in fall. Some heavy rains occur during tropical storms in winter. The average annual temperature is 61 to 68 degrees F (16 to 20 degrees C). The freeze-free period averages 270 days. It ranges from 235 days in the northern part of the area to 305 days in the southern part.

Water

Water supplies generally are abundant because of precipitation, perennial streams, and ground water. Although summer rainfall is generally adequate for crops, droughts are common. There is a summer moisture deficit of 2 to 6 inches (50 to 150 millimeters). Wet soils need to be drained before they can be used for crops. Several large reservoirs on the major streams provide municipal and industrial water and also serve as recreational sites. The surface water in the area is used dominantly for industry and for cooling thermoelectric power plants. Most of the surface water is of good quality and suitable for most uses with some treatment. High concentrations of suspended sediments, agricultural chemicals, and municipal and industrial wastewater discharges contribute to some local water-quality problems. The lower tributaries of the Ouachita River are contaminated with wastes from oil and gas production. Amounts of fecal coliform bacteria in the Red River near Shreveport and in the Toledo Bend Reservoir on the Sabine River are water-quality concerns. A low level of dissolved oxygen is a concern for rivers below reservoirs where deep, oxygen-deficient water is released. Flooding is a concern in many parts of the MLRA.

The principal sources of ground water in this area are bedrock aquifers. They include the Carrizo-Wilcox aquifer in Texas and Louisiana, the Trinity Group in Texas, the Cockfield and Sparta aquifers in Arkansas and Louisiana, the Wilcox aquifer in Arkansas, and the Pliocene-Miocene aquifers in Louisiana. The Wilcox aquifer in southwest Arkansas is not used extensively in this area. The ground water is used primarily for industry but also for public supply. Most rural landowners rely on the bedrock aquifers for domestic and livestock water. The ground water is soft in Louisiana and Arkansas and moderately hard to very hard in Texas. The iron content can be very high in some areas in Arkansas, and it may also cause some problems in the part of the MLRA in Louisiana. A declining water level is a concern for the Trinity Group aquifer in Texas. About 30 percent of the samples from this aquifer exceeded the national drinking water standard for nitrate. The water in the Pliocene-Miocene sands in west-central Louisiana has high levels of fluoride, and its color limits its use for drinking water. Locally, the color of the water in the Cockfield and Sparta aquifers in Louisiana limits the use of those aquifers for public supply. The water levels in the Cockfield and Sparta aquifer also are declining.

Soils

The dominant soil orders are Alfisols and Ultisols. The soils in the area dominantly have a thermic soil temperature regime, a udic or aquic soil moisture regime, and siliceous, mixed, or smectitic mineralogy. They generally are very deep, well drained to poorly drained, and loamy or clayey.

The main soils and their series:

- Endoaquults that formed in old alluvium on stream terraces (Amy series)
- Fragiudults that formed in mixed marine sediments and alluvium on uplands and stream terraces (Savannah series)
- Glossaqualfs that formed in alluvium on flood plains and stream terraces (Guyton series); that formed in old alluvium on stream terraces (Wrightsville series)
- Hapludalfs that formed in marine sediments on hills and ridges (Eastwood and Woodtell series); that formed in silty and loamy alluvium on stream terraces (Frizzell and Kolin series); that formed in clayey alluvial sediments on stream terraces (McKamie series)
- Hapludults that formed in residuum on hills and ridges (Cuthbert and Kirvin series); that formed in marine sediments on hills and ridges (Sacul series)
- Paleudalfs that formed in clayey alluvial sediments on stream terraces (Gore and Morse series)
- Paleudults that formed in marine sediments on uplands (Bowie and Malbis series); that formed in mixed marine sediments and alluvium on uplands (Ruston series)

Biological Resources

This area supports pine-hardwood vegetation. The dominant trees are loblolly pine, shortleaf pine, sweetgum, southern red oak, white oak, flowering dogwood, and post oak. American beautyberry, greenbrier, hawthorns, and berry vines are included in the woody understory. Little bluestem and pinhole bluestem are the dominant herbaceous species. Other major grasses include beaked panicum, longleaf uniola, spike uniola, and yellow Indiangrass. The plant community has many species of low-growing panicums and paspalums and perennial forbs. Major wildlife species in this area include white-tailed deer, coyote, beaver, raccoon, skunk, opossum, muskrat, mink, cottontail, squirrel, weasel, armadillo, and mourning dove.

Land Use

The forested areas in this MLRA are used for the production of lumber and pulpwood (fig. 133B-2). The cleared land is used mostly for pasture and hay. Where the water supply is adequate, corn, grain sorghum, oats, soybeans, peanuts, rice, and vegetables are grown.

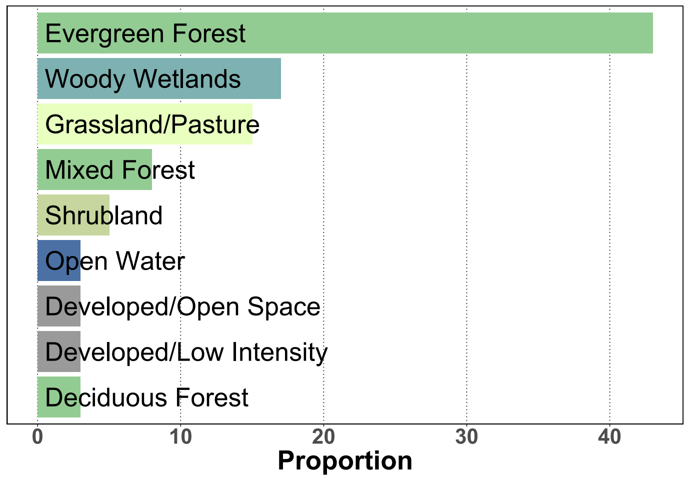

Figure 133B-2: Relative proportions (percentages) of land use in MLRA 133B.

The major resource concerns are water erosion, wetland restoration, and water supplies for livestock. Conservation practices on cropland generally include buffer strips, which help to control erosion and runoff. They also include the proper use and timing of irrigation.

133C—Gulf Coastal Plain

This MLRA (fig. 133C-1) is in Alabama (43 percent), Mississippi (40 percent), Tennessee (6 percent), Florida (6 percent), Louisiana (3 percent), and Georgia (2 percent). It makes up about 57,024 square miles (147,690 square

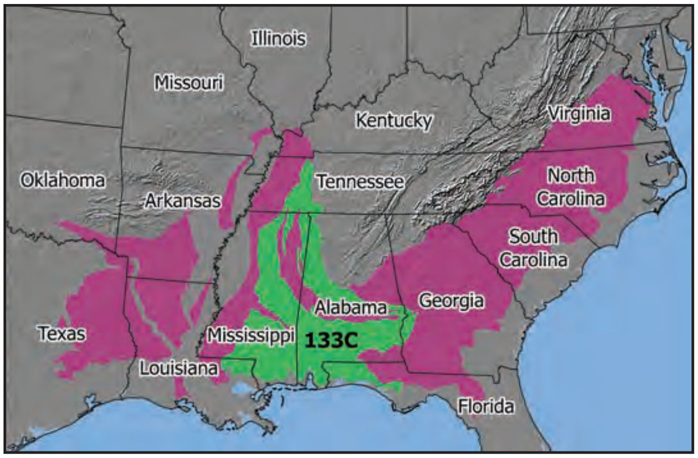

Figure 133C-1: Location of MLRA 133C, which covers 14,769,000 hectares (36,494,900 acres), within Region P.

kilometers). It was previously part of MLRA 133A. MLRA 133C consists of a southward-dipping benched landscape that is strongly dissected into gently undulating valleys and gently sloping to steep uplands.

MLRA 133C has a diffuse boundary with MLRA 134 to the west as loess deposits increase in thickness from east to west. It has a distinct boundary with MLRA 152A to the south, which is in the low-lying areas (elevation of less than 50 feet) along the Gulf of Mexico shoreline. It has a distinct boundary with MLRA 135A, which occurs as an island within MLRA 133C and has drastically different soil parent material (marl and chalk). It has an indistinct boundary with MLRA 133A, which has subtle differences in soil properties and slightly less dissected landscapes. Its boundary with MLRAs 122, 123, 128, and 129, to the north, is well defined by the fall line and dramatically different sedimentary, metamorphic, and igneous residual soil parent material.

Physiography

This area extends from the far western edge of Georgia to western Tennessee and central Mississippi. It is entirely within the Coastal Plain province of the Atlantic Plain. Stream valleys generally are narrow in their upper reaches and become broad with widely meandering stream channels as they approach the coast. Most major rivers originate in the Appalachian Mountains north of the MLRA and cross the area to empty into the Gulf of Mexico. Elevation ranges from 40 to 836 feet (12 to 255 meters), and local relief is 10 to 20 feet (3 to 6 meters). More deeply dissected areas may have local relief between 80 and 200 feet (24 and 61 meters).

Buried Jurassic sediments produce economically important oil and gas deposits near the coast. They are associated with structural upheaval (salt domes) and collapse (subsidence and coastal downwarping) that affect topography and geologic surface outcroppings, all of which are used to distinguish MLRA 133C from MLRA 133A.

Geology

This MLRA is bordered to the north by the fall line, which is a line of waterfalls marking the northern extent of the unconsolidated coastal plain sediments. It consists of an erosional scarp that formed in the Mesozoic Era when this area was the Atlantic Ocean shore. The area is underlain by eroded sedimentary, igneous, and metamorphic bedrock. Rivers and streams draining the Appalachians deposited a thick wedge of silt, sand, and gravel south of the fall line as delta deposits in the Atlantic Ocean. These Jurassic and Cretaceous river sediments were eventually exposed as the Coastal Plain was uplifted and the sea level changed. Changes during the Mississippi Embayment period, which runs from the Late Cretaceous to the younger Tertiary Oligocene Epoch, were the primary influence in the northern portion of Mississippi and Tennessee. When the sea level rose again, the Coastal Plain was submerged and covered by a thin layer of Cretaceous sands in the southern half of the MLRA. As the Coastal Plain continued to be uplifted and the sea level dropped again, Quaternary material consisting of unconsolidated clay, silt, sand, and gravel was deposited over the Tertiary sand and carbonates. Subsequent changes in the sea level created terraces in these younger deposits along many of the streams and rivers draining this area. Much of the MLRA has a benched appearance and is dissected by a dendritic drainage pattern due to the cycles of erosion and deposition. The area was exposed and submerged numerous times in its geologic history.

Climate

The average annual precipitation is 47 to 68 inches (1,185 to 1,728 millimeters), increasing from north to south. The minimum precipitation occurs in autumn, and the maximum occurs in winter and spring. Rainfall typically occurs during high-intensity, convective thunderstorms in summer, but moderate-intensity tropical storms can produce large amounts of rainfall in winter. Snowfall does not occur in the southern part of the area but occasionally occurs in the northern part. The average annual temperature is 57 to 68 degrees F (14 to 20 degrees C), increasing from north to south. The freeze-free period averages 250 days and ranges from 200 to 305 days, increasing in length from north to south. The mean annual air temperature and the length of the freeze-free period increase from north to south.

Water

Annual precipitation provides an abundance of surface and ground water for this area. In general, the many perennial streams supply suitable water for commercial, municipal, human, and agricultural consumption. A few large reservoirs are available for recreation and other uses. Domestic water supplies in this area are obtained mainly from shallow wells.

The Floridan aquifer (limestone, dolomite, and calcareous sand) is heavily used in the southern part of the area, and the Cretaceous sand aquifer is used extensively throughout the rest. These aquifers have quality water that is typically soft to moderately hard. Since the ground water is shallow throughout the area, nitrate contamination from barnyards, confined animal-feeding operations, septic systems, and poor nutrient management practices is always a potential. Some nearshore ground water in Mississippi has naturally high levels of iron, and many wells exceed the national drinking water standard for sodium. Brine water is commonly encountered in wells in the part of this area in Mississippi. The brine originates from salt domes and moves up to the shallow aquifers along faults created by the upward migration of the domes.

Soils

The dominant soil orders are Ultisols, Entisols, and Inceptisols. The soils in the area have a thermic temperature regime, a udic or aquic moisture regime, and siliceous or mixed mineralogy. They are very deep and loamy and range from somewhat excessively drained (on uplands) to very poorly drained (on low-lying alluvial landforms).

The main soils and their series:

- Endoaquepts that formed in siliceous alluvium on flood plains (Mantachie series)
- Fluvaquents that formed in siliceous alluvium on flood plains (Bibb series)
- Fragiudults that formed in siliceous fluviomarine sediments on uplands and stream terraces (Ora and Savannah series)
- Hapludults that formed in mixed fluviomarine sediments on hills and ridges (Luverne and Sweatman series); that formed in siliceous fluviomarine sediments on hills and ridges (Smithdale series)
- Paleudults that formed in siliceous fluviomarine sediments on uplands and stream terraces (Heidel and Wadley series)

Biological Resources

Natural vegetation consists of diverse upland cover types and rich flood-plain forests. Because of slight climatic differences between the northern and southern reaches of this MLRA, vegetative communities vary with latitude. The major upland cover types transition from dominantly oak-hickory forests (in the north) to shortleaf pine-oak forests (in the middle latitudes) to longleaf pine communities (in the south).

Composition of the oak-hickory forests commonly differs according to moisture gradients. White oak, northern red oak, southern red oak, sweetgum, tuliptree, American beech, and hickory typically grow on moist slopes and in ravines whereas post oak, black oak, scarlet oak, blackjack oak, and pignut hickory grow on dry, exposed slopes and ridges. In the middle latitudes, shortleaf and loblolly pines increase in extent where they occur with post, white, black, southern red, scarlet, and blackjack oaks. The southern portion of the MLRA is largely defined by the natural range of longleaf pine, where the species historically occurred in open, pure stands and in communities of mixed species. Important components of the various longleaf systems include loblolly and slash pines in moist flatwood environments; turkey, blackjack, sand post, and bluejack oaks on dry, sandy ridges; and mixed southern hardwoods of sweetgum, southern red oak, water oak, blackjack oak, and laurel oak where fire has been suppressed. Throughout the MLRA, these upland cover types are interrupted by rich flood-plain forests that consist of willow oak, water oak, cherrybark oak, swamp chestnut oak, sweetgum, tuliptree, elm, and hickory and inclusions of swamp laurel oak in the south. Baldcypress, water tupelo, water hickory, and overcup oak typically grow in the wettest environments.

Major wildlife species include white-tailed deer, turkey, rabbit, squirrel, bobwhite quail, and mourning dove. Fish species include bass, bluegill, and channel catfish. Species of conservation concern include the red-cockaded woodpecker, indigo snake, gopher tortoise, Red Hills salamander, and dusky gopher frog.

Land Use

Major commodities for this area are timber, poultry and eggs, cattle and calf operations, and pasture and hay (fig. 133C-2). Of moderate importance are sweet potatoes, hogs, and catfish. This MLRA has a great extent of outdoor recreational areas due to the vast acreage of open space and water.

The major soil resource concerns are related to organic matter content, compaction, and soil moisture. They directly relate to crop productivity, water erosion, control of surface water, and artificial drainage. Conservation practices on cropland generally include systems of crop residue management, cover crops, crop rotations, water disposal, deep tillage, pest management, and nutrient management. The most important conservation practice in pastured areas is prescribed grazing. Pastures commonly are overseeded with small grains or legumes, or both, to supplement forage production during winter. Haying also helps to provide supplemental feed during the long winters. Critically eroding areas and areas where animals congregate need to be monitored and treated.

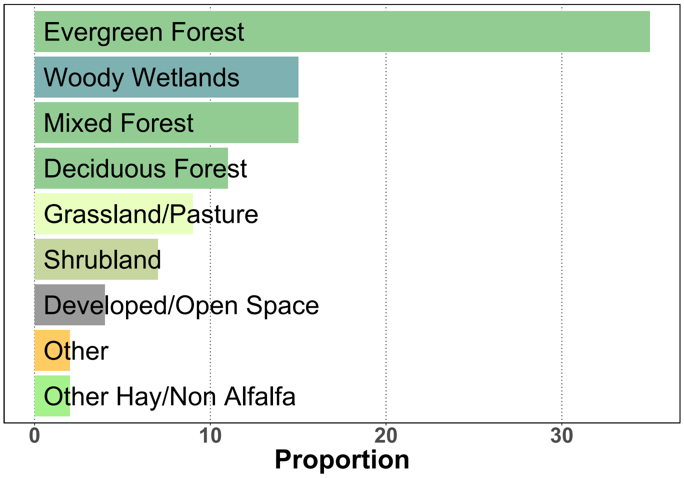

Figure 133C-2: Relative proportions (percentages) of land use in MLRA 133C.

134—Southern Mississippi Valley Loess

This MLRA (fig. 134-1) is a loess-mantled region of the Coastal Plain uplands within the Mississippi Valley and consists of two distinctively different landscapes. The main belt portion of the MLRA consists of loess bluffs and moderate to steeply dissected hills with loess soils that gradually thin to the east. This portion produces high-quality hardwoods. To the west of the main belt, this MLRA occurs as a series of detached areas completely surrounded by MLRA 131A. The gently undulating landscapes associated with these areas consist of highly fertile soils that produce an abundance of cash and grain crops.

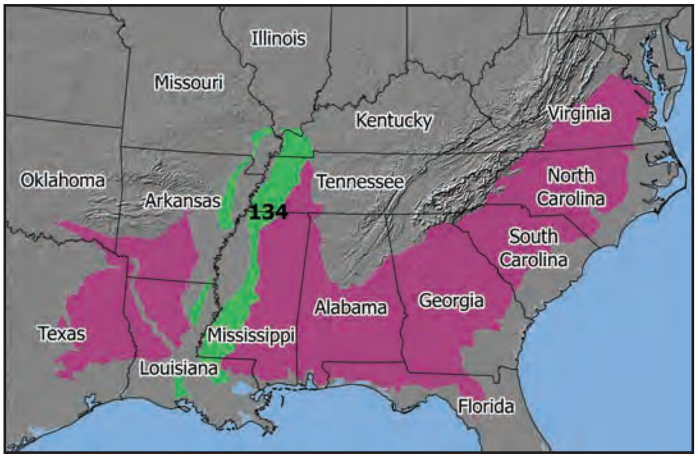

Figure 134-1: Location of MLRA 134, which covers 6,970,700 hectares (17,224,800 acres), within Region P.

The main belt of MLRA 134 east of the Mississippi River has distinct western and southern boundaries that are defined by the Mississippi River flood plain (in MLRA 131A). To the east and north, this main belt of loess gradually decreases in thickness, grading into MLRA 133C (Gulf Coastal Plain). Outliers of MLRA 134 west of the Mississippi River have distinct boundaries marked by various flood plains and other physiographically dissimilar landscapes. Crowley's Ridge in Arkansas is surrounded by the Mississippi River flood plains, and Macon Ridge in Louisiana is bounded by the Mississippi River flood plain to the east and the Arkansas River flood plain to the west. Further south in Louisiana, the Avoyelles Prairie is surrounded by the flood plains of the Mississippi and Red Rivers. The Lafayette Loess is bounded by the Red River flood plain to the north, the Mississippi River flood plain to the east, the Gulf Coast Prairies to the west, and the Gulf Coast Marsh to the south.

This area is in Mississippi (39 percent), Tennessee (23 percent), Louisiana (15 percent), Arkansas (10 percent), Kentucky (9 percent), Missouri (3 percent), and Illinois (1 percent). It makes up about 26,914 square miles (69,707 square kilometers).

Physiography

Most of the eastern main belt of MLRA 134 is in the East Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. The western edge of the main belt, known as the Loess Bluff Hills, and western outliers, including Crowley's Ridge, Macon Ridge, and the Avoyelles Prairie, are in the northern reaches of the Mississippi Alluvial Plain. The Lafayette Loess is in the West Gulf Coastal Plain section. The sharply dissected plains in this MLRA have a loess mantle that is thick at the valley wall and thins rapidly as distance from the valley wall increases. Valley sides are hilly to steep, especially in the western part of the main loess belt. The intervening ridges generally are narrow and rolling, but some of the interfluves between the upper reaches of the valleys are broad and flat. Stream valleys are narrow in the upper reaches but broaden rapidly downstream, where they have wide, flat flood plains and meandering stream channels. Elevation ranges from 16 to 600 feet (5 to 185 meters). Local relief is mainly 10 to 20 feet (3 to 6 meters), but it ranges from 80 to 165 feet (25 to 50 meters).

Geology

This area is mantled with several discrete loess sheets that form an eastward-thinning belt. This belt reaches a maximum thickness of more than 75 feet in the Vicksburg-Natchez area. Below the loess mantle are Late Tertiary and Quaternary fluvial deposits, which overlie the unconsolidated sand, silt, and clay of older Tertiary marine sediments. Crowley's Ridge is underlain by Pliocene sand and gravel. The seas of the Mississippi Embayment extended up the present-day lower Mississippi River Valley during the Tertiary Period, when these sediments were deposited by rivers draining the surrounding uplands. Throughout the Pleistocene Epoch, the valley floor received fine grained sediments from glacial outwash each time the ancestral Mississippi River flooded. After these sediments dried, winds picked them up and deposited them as loess in the uplands on each side of the valley.

There are five known periods of loess deposition in the area. The surface deposit is Peoria Loess, which is of Late Wisconsin age (about 10,000 years ago) and is the only loess sheet that has been recognized in all parts of the area. Roxana loess, which is of Middle Wisconsin age (about 20,000 to 40,000 years ago), occurs in some areas. This loess is thinner than the yellowish brown Peorian Loess and is generally redder or darker. Sicily Island Loess, which is of Pre-Wisconsin age (85,000 to 130,000 years ago), is at the surface in some areas in the southern part of the MLRA. It has a well developed reddish paleosol (buried soil). Peoria and Sicily Island are the only loess sheets identified in Louisiana. In addition to the Peoria, Roxana, and Sicily Island sheets, two other loess deposits have been described on Crowley's Ridge. They have been identified as Marianna Loess and Crowley's Ridge Loess. These deposits are not exposed at the surface and have well developed paleosols.

Climate

The average annual precipitation is 46 to 66 inches (1,156 to 1,671 millimeters), increasing from north to south. The maximum precipitation occurs in winter and spring. The precipitation decreases gradually throughout summer, except for a moderate increase in midsummer. Rainfall occurs primarily during high-intensity, convective thunderstorms, but moderate-intensity tropical storms can produce large amounts of rainfall during winter in the southern part of the area. Snowfall generally occurs in the northern part. The average annual snowfall in Stoddard County, Missouri, is 11 inches (28 centimeters). South of the Missouri-Arkansas State line, snowfall occurs but is rare. The average annual temperature is 57 to 68 degrees F (14 to 20 degrees C), increasing from north to south. The freeze-free period averages 270 days and ranges from 215 to 325 days, increasing in length from north to south.

Water

Precipitation in this area is abundant, but most streams are small and have intermittent flow during summer and fall. Reservoirs store water for use when flows in streams decline. In the uplands, ponds and rural water systems are the main sources of water for domestic use and livestock. The surface water in the area is suitable for almost all uses.

Ground water is abundant in this MLRA and suitable for all uses. Shallow wells provide small quantities of water and are used to fill cisterns for domestic use and livestock. Deep wells in the underlying unconsolidated sand and gravel of Cretaceous and Tertiary age yield large quantities of water. Some water in the Kentucky area requires treatment for high levels of iron if it is to be used as drinking water. Water quality is also a concern in parts of Louisiana west of the Mississippi River where water from the Chicot aquifer system exceeds the drinking water standards for iron. Water from the alluvial aquifer is generally not suitable for drinking.

Soils

The dominant soil orders are Alfisols, Entisols, Inceptisols, and Ultisols. The soils in the area are very deep or deep, are medium textured, and have a thermic temperature regime, a udic moisture regime, and mixed mineralogy.

The main soils and their series:

Epiaqualfs that are nearly level to gently sloping, are somewhat poorly drained, and formed in deposits of loess 2 to 4 feet (1 meter) thick, on stream terraces in Lafayette Loess (Patoutville series); that are poorly drained and formed in thick loess alluvium on stream terraces and in depressions in the northern extent of the main loess belt (Routon series)

Eutrudepts that are deep, gently sloping, and well drained and formed in silty material or in a mantle of loess and the underlying Late Pleistocene loamy terrace material (Weyanoke series); that are well drained and formed in thick deposits of loess on loess bluffs (Natchez series); that are moderately well drained and formed in loess alluvium on flood plains and alluvial fans (Adler series)

Fluvaquents that are somewhat poorly drained and on broad flood plains (Falaya and Gillsburg series)

Fragiudalfs that are well drained and formed in thick deposits of loess (Loring series); that are moderately well drained, gently sloping to steep, and on ridgetops and side slopes where the loess mantle thins (Dulac, Providence, and Gigger series)

Fraglossudalfs that are moderately well drained and somewhat poorly drained and formed in thick deposits of loess (Olivier, Grenada, and Calloway series); that are deep, gently sloping, and somewhat poorly drained and formed in silty material or in a mantle of loess and the underlying Late Pleistocene loamy terrace material (Fluker and Necessity series)

Hapludalfs that are well drained and nearly level to very steep and formed in thick deposits of loess on uplands (Memphis and Feliciana series); that are nearly level to gently sloping, are well drained to somewhat poorly drained, and formed in deposits of loess 2 to 4 feet (1 meter) thick (Colyell, and Coteau series); that are nearly level and very gently sloping, are well drained to somewhat poorly drained, and formed in a thin mantle of loess over loamy alluvium or mixed loess and loamy alluvium (Dexter, Liddieville, and Satsuma series)

Biological Resources

This area supports hardwood-pine vegetation. Cherrybark oak, Shumard oak, white oak, post oak, southern red oak, and southern magnolia are widely distributed. Loblolly pine and shortleaf pine are the dominant pines. Yellow-poplar, white ash, swamp chestnut, cottonwood, sweetgum, and black walnut are important species on the flood plains. Loblolly pine and shortleaf pine are on a wide variety of sites, but mainly on the eroded soils on uplands and ridges. Other hardwood species common to this area are white oak, basswood, sweetgum, water oak, American elm, blackgum, sycamore, sassafras, southern red oak, chinquapin oak, American beech, and hickory. Beech-magnolia-holly forests are dominant on narrow ridges and in steep ravines in the Tunica Hills of Louisiana.

Major wildlife species include white-tailed deer, red fox, gray fox, raccoon, opossum, skunk, muskrat, cottontail, gray squirrel, fox squirrel, bobwhite quail, and mourning dove. Fish species include largemouth bass, bluegill, and bullhead.

Land Use

Land use and management in this MLRA differs based on landscape (fig. 134-2). The vast majority of cash crops and grain are produced in the gently undulating portion of the MLRA, while forestry, livestock production, and hay and pasture are the dominant land uses on the loess bluffs and more dissected topography. Cultivated crops are cotton, corn, soybeans, and wheat. Strawberries are important in Louisiana. Feed grains and forage are grown on dairy farms. Mixed pines and hardwoods are significant for lumber and pulp wood production. Currently, there is a trend toward the conversion of pasture and forest to cropland. Some areas are used for urban development, which is expanding near the metropolitan areas. Wildlife habitat and recreation are also of significant importance to this MLRA.

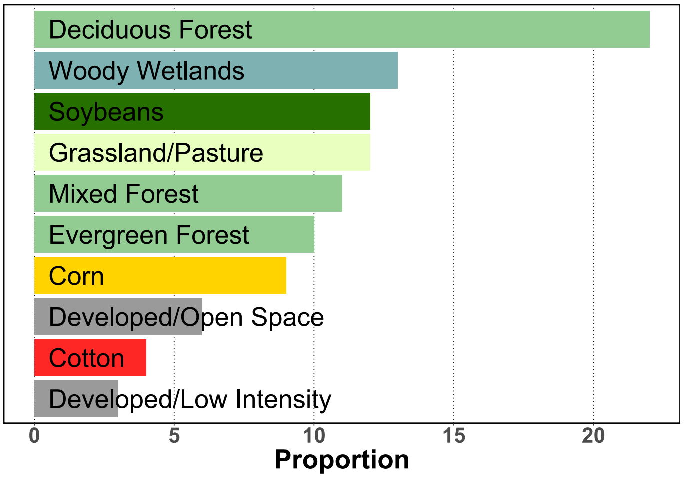

Figure 134-2: Relative proportions (percentages) of land use in MLRA 134.

The major soil resource concerns are water erosion, maintenance of organic matter content, soil fertility, and soil moisture. Most soils in MLRA 134 are considered highly erodible. Urban development and tree and crop harvesting increase the potential for water erosion on slopes greater than 2 percent unless precautionary measures are taken. Conservation practices on forestland generally include systems of tree residue management and reforestation. Conservation practices on cropland generally include limited or no tillage, crop residue management (which increases the content of soil organic matter), and applications of lime in areas of low pH. Many of the flood-plain soils remain wet or have a high water table for part or most of the year. Measures that improve drainage are required, or crops adapted to wet conditions need to be selected for planting.

135A—Alabama and Mississippi Blackland Prairie

This MLRA (fig. 135A-1) has two narrow (less than 40 miles wide), long, arching bands known as the Blackland Prairie and the Jackson Prairie, which are characterized by clayey, alkaline and acid soils with a high shrink-swell potential. Several major drainageways bisect this region on their way to larger tributaries. Very little native prairie vegetation remains due to agriculture and forestry activities. This area is in eastern Mississippi (57 percent) and central and western Alabama (43 percent). It makes up about 10,165 square miles (26,328 square kilometers).

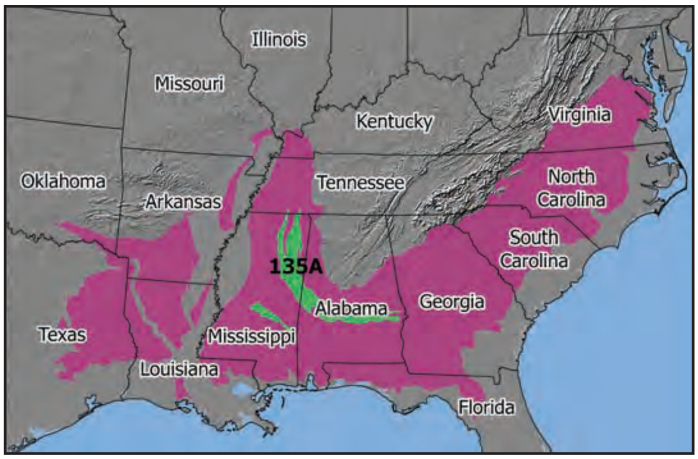

Figure 135A-1: Location of MLRA 135A, which covers 2,632,800 hectares (6,505,800 acres), within Region P.

Most of this region is surrounded by the distinctly different MLRA 133C, which has sandy soils and stratified, coastal sediment mineralogy. A very small section of MLRA 135A has a diffuse boundary with MLRA 134 that occurs as a loess cap that gradually thins from west to east.

Physiography

This area is in the East Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. The northern part of the area is a slightly elevated, hilly plain. The separate southwestern part is locally known as the Jackson Prairie portion of the East Gulf Coastal Plain section in Mississippi. Elevation ranges from 100 to 590 feet (30 to 180 meters). Local relief is mainly 50 to 100 feet (15 to 30 meters).

Tributaries of the Tombigbee, Pearl, and Pascagoula Rivers cross the part of this area in Mississippi. The valleys along the Tombigbee and Alabama Rivers separate the three parts of this area in Alabama.

Geology

Most of this area is underlain by Cretaceous-age clay, marl, soft limestone, or chalk of the Selma Group. The Jackson Prairie part, in southern Mississippi, and parts of the MLRA in southwest Alabama are underlain by Tertiary-age clay, marl, soft limestone, or chalk of the Vicksburg and Jackson Groups.

Climate

The average annual precipitation is 48 to 59 inches (1,217 to 1,494 millimeters). The maximum precipitation occurs in early winter, spring, and midsummer. The lowest rainfall occurs in autumn. The rainfall typically occurs during high-intensity, convective thunderstorms in summer, but some heavy rains occur during tropical storms in winter. The average annual temperature is 60 to 65 degrees F (16 to 18 degrees C), decreasing from south to north. The freeze-free period averages 250 days and ranges from 230 to 275 days, increasing in length to the south.

Water

Precipitation and perennial streams are important sources of water. Ponds provide water for livestock and are used locally for recreation. A few large reservoirs are available for recreation and other uses. The surface water in the area is suitable for all uses. Most of it is used for cooling thermoelectric power plants.

Moderately deep and deep wells are the principal sources of ground water for both domestic and municipal uses in this area. In Alabama, good-quality ground water is obtained primarily from Tertiary and Cretaceous sand aquifers. The southern part of the area in Alabama also has access to the Floridan and Citronelle aquifers. The ground water in Alabama generally is hard but is low in total dissolved solids. Most of the part of this MLRA in Mississippi has no significant aquifers. The Cockfield silty clay and sand aquifer underlies parts of the isolated portion of this area in southern Mississippi. The water from this aquifer is soft. It generally exceeds the color standard for drinking water, which has no known effects on health.

Soils

The dominant soil orders are Inceptisols and Vertisols. The soils in the area dominantly have a thermic temperature regime, a udic or aquic moisture regime, and smectitic or carbonatic mineralogy. They are alkaline and acidic, shallow to very deep, generally well drained to somewhat poorly drained, and loamy or clayey.

The main soils and their series:

- Dystruderts that formed in clayey sediments on uplands (Oktibbeha, Hannon, and Vaiden series)
- Epiaquepts that formed in clayey alluvium on flood plains (Leeper and Urbo series)
- Epiaquerts that formed in clayey alluvium on flood plains (Sucarnoochee and Houlka series)
- Eutrudepts that formed in loamy alluvium on flood plains (Marietta series); that formed in clayey sediments and residuum on uplands (Sumter series)

Hapluderts that formed in clayey sediments on uplands (Brooksville, Faunsdale, Houston, Maytag, Okolona, and Watsonia series)
Hapludolls that formed in clayey alluvium on flood plains (Catalpa series)
Paleudalfs that formed in clayey sediments on uplands (Kipling and Searcy series)
Udorthents that formed in residuum on ridges and hills (Demopolis series)

Biological Resources

This area supports both deciduous hardwoods and conifers. Red oak, white oak, sweetgum, blackgum, loblolly pine, and shortleaf pine are the dominant overstory species. Forests of mixed oaks and loblolly pine are dominant on acid soils. Mixed hardwood forests dominate flood plains, and forests of eastern redcedar and sugarberry dominate alkaline hills and side slopes. Eastern redcedar, dogwood, and Osage-orange are the major mid-story species. Japanese honeysuckle, greenbrier, little bluestem, native lespedezas, plumegrass, low panicums, sedges, and rushes are the dominant understory species. Major wildlife species include white-tailed deer, cottontail, squirrel, turkey, bobwhite quail, and mourning dove.

Land Use

Most areas have been disturbed, and only small remnants of the former prairie vegetation remain. The major crop in the MLRA is soybeans, but corn, small grains, and cotton also are grown. Pastures are used mainly for beef production, but dairy production is important in some areas. About three-fourths of the forestland is privately owned, and about one-fourth is owned by industry. The production of pond-raised catfish is important in west Alabama. Some areas are used for urban development (fig. 135A-2).

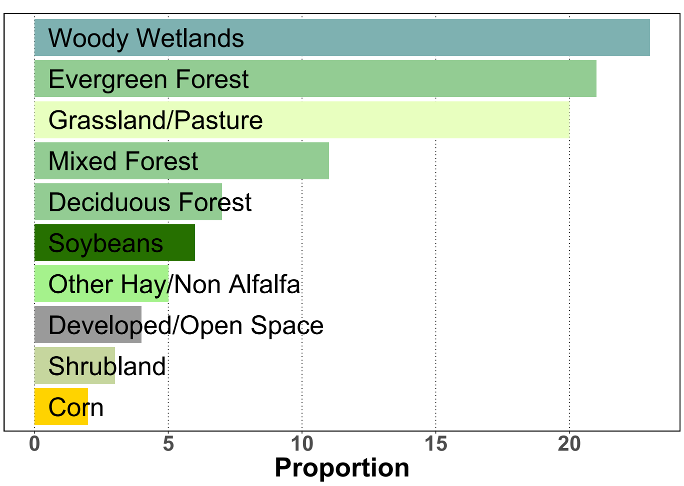

Figure 135A-2: Relative proportions (percentages) of land use in MLRA 135A.

The major soil resource concerns are water erosion, maintenance of the organic matter content and productivity of the soils, and soil moisture. Water erosion and infestation by Johnsongrass are major management concerns in cultivated areas. Conservation practices on cropland generally include systems of crop residue management, cover crops, crop rotations, water disposal, pest management, and nutrient management. The most important conservation practice on pasture is prescribed grazing. Pastures commonly are overseeded with small grains or legumes, or both, to supplement forage production during winter. Haying also helps to provide supplemental feed during the long winters. Critically eroding areas and areas where animals congregate need to be monitored and treated.

135B—Cretaceous Western Coastal Plain

MLRA 135B (fig. 135B-1) consists of dissected uplands, marine terraces, and stream valleys. Dominant soil parent materials are loamy, gravelly, acidic marine sediments, marl, chalk, and local alluvium. This MLRA is in Arkansas (56 percent) and Oklahoma (44 percent). It makes up about 4,168 square miles (10,795 square kilometers).

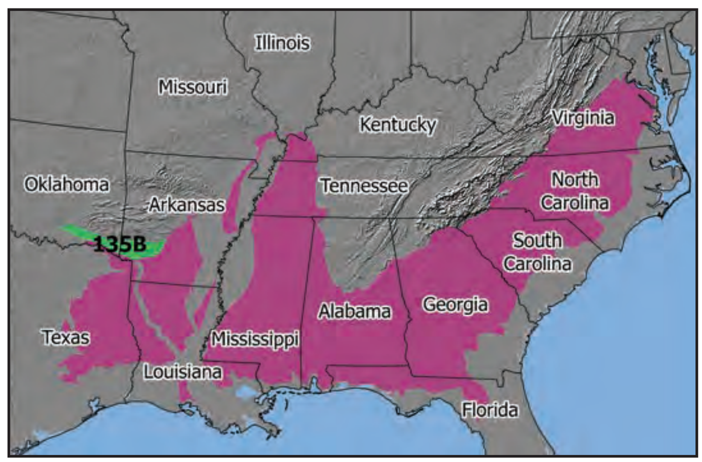

Figure 135B-1: Location of MLRA 135B, which covers 1,079,500 hectares (2,667,400 acres), within Region P.

MLRA 135B has a distinct boundary based on physiography with MLRAs 84B (West Cross Timbers), 85A (Grand Prairie), 87B (Texas Claypan Area, Northern Part), 118B (Arkansas Valley and Ridges, Western Part), 119 (Ouachita Mountains), and 133B (Western Coastal Plain). MLRA 84B is undulating with low relief and has nearly level to rolling uplands. MLRA 85 consists of gently rolling to hilly, dissected limestone plateaus. MLRA 87B has low relief and clayey soil parent materials. MLRA 118B has higher relief than MLRA 135B. MLRA 119 has more dissected relief and steeper gradients. MLRA 133B has low relief and alluvial soil parent material.

Physiography

This MLRA is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. It consists of nearly level to moderately sloping uplands and level and nearly level, low terraces and flood plains. Valley floors, side slopes, and ridgetops are underlain by clay, marl, and chalk. These soil parent materials are highly erodible, and the area is cut by gullies. Elevation generally ranges from 80 to 350 feet (25 to 105 meters), but it is less than 80 feet (25 meters) on some of the more prominent valley floors and is more than 360 feet (110 meters) on a few ridgetops. Local relief is mainly a few meters.

The Little River flows from the western part of this MLRA, in Oklahoma, into Millwood Lake, in Arkansas. The Cossatot and Saline Rivers flow into Millwood Lake from the northern part of the area in Arkansas.

Geology

Cretaceous marine sediments underlie almost all of this area. Geologic members of the Lower Cretaceous include a basal member of gravel and conglomerate rocks. Other formations are dominantly limestone that is crystalline and contains many fossils. Gypsum is mined commercially from the limestone in parts of the MLRA. Members of the Upper Cretaceous Period consist of clay marls, thin limestones, sandy marls, and some fine grained sands. Other formations consist of chalk and marly chalk, which are hard and contain many fossils.

Climate

The average annual precipitation in this area is 41 to 55 inches (1,040 to 1,400 millimeters). Most of the rainfall occurs during frontal storms in spring and early summer. Some high-intensity, convective thunderstorms occur in summer. The average seasonal snowfall is 5 inches (12 centimeters). The average annual temperature is 61 to 64 degrees F (16 to 18 degrees C). The freeze-free period averages about 250 days and ranges from 235 to 265 days, increasing in length to the south.

Water

Precipitation and perennial streams are important sources of water in this area. Ponds provide water for livestock and are used locally for recreation. A few large reservoirs are available for recreation and other uses. The surface water is dominantly used for industry and for cooling thermoelectric power plants, but some communities use the water for public supply. Most of the surface water is of good quality and suitable for most uses with some treatment. High concentrations of suspended sediments, agricultural chemicals, and municipal and oil and gas production wastewater discharges contribute to local water-quality problems.

The principal sources of ground water are bedrock aquifers, including the Antlers aquifer in Oklahoma and the Nacatoch aquifer in Arkansas. The Antlers aquifer is the northern end of the carbonate and clastic rock aquifer in Texas, which is called the Trinity Group. The ground water in this area is used primarily for public supply. Most rural landowners also rely on the bedrock aquifers for domestic water. The ground water is soft to hard in Arkansas and very hard in Oklahoma. The iron content may require treatment in some areas in Arkansas.

Soils

The dominant soil orders are Inceptisols and Alfisols. Entisols and Vertisols are of lesser extent. The soils in the area dominantly have a thermic soil temperature regime, an ustic soil moisture regime, and smectitic or mixed mineralogy. They generally are moderately deep or deep over soft limestone or chalk and typically shrink, swell, and crack.

The main soils and their series:

- Dystrudepts that are somewhat poorly drained on level to undulating flood plains (Sardis series)
- Glossaqualfs that are poorly drained or very poorly drained, on local stream flood plains and in depressional areas (Guyton series)
- Hapludalfs that are moderately well drained to poorly drained, on wide ridgetops and narrow side slopes (Oktibbeha series)
- Hapludults that are moderately well drained and well drained and shallow to very deep and occur intermittently along the outer perimeter of the MLRA (Sacul, Tiak, and Saffell series)
- Paleudalfs that are moderately well drained to somewhat poorly drained and occur intermittently along the outer perimeter of the MLRA (Bernow, Boswell, and Muskogee series)
- Paleudults that are well drained, on slightly sloping uplands (Ruston series)

Biological Resources

This MLRA dominantly supports deciduous hardwoods. A few areas are suitable for pine. Red oak, white oak, sweetgum, and blackgum are the dominant overstory species. Eastern redcedar, dogwood, and Osage-orange are the major midstory species. Japanese honeysuckle, greenbrier, little bluestem, native lespedezas, plumegrass, low panicums, sedges, and rushes are the dominant understory species.

Major wildlife species in this area include white-tailed deer, coyote, armadillo, bobcat, beaver, raccoon, skunk, mink, cottontail, turkey, and mourning dove. Fish species include channel catfish, flathead catfish, white bass, largemouth black bass, and bluegill.

Land Use

Nearly all of this area is privately owned land consisting of farm woodlots and pasture (fig. 135B-2). The poultry business

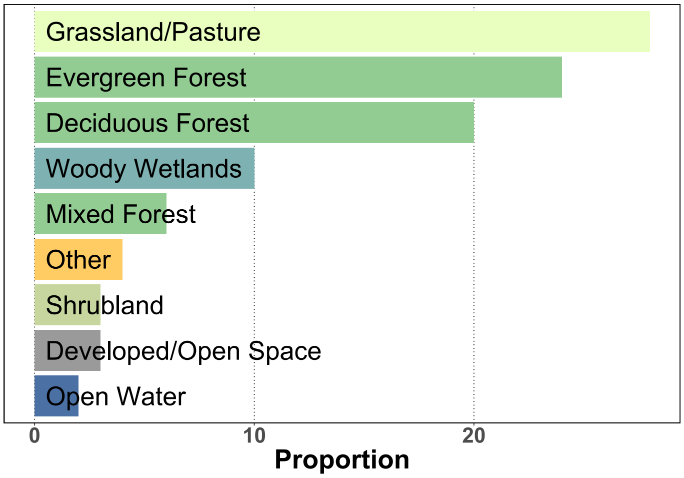

Figure 135B-2: Relative proportions (percentages) of land use in MLRA 135B.

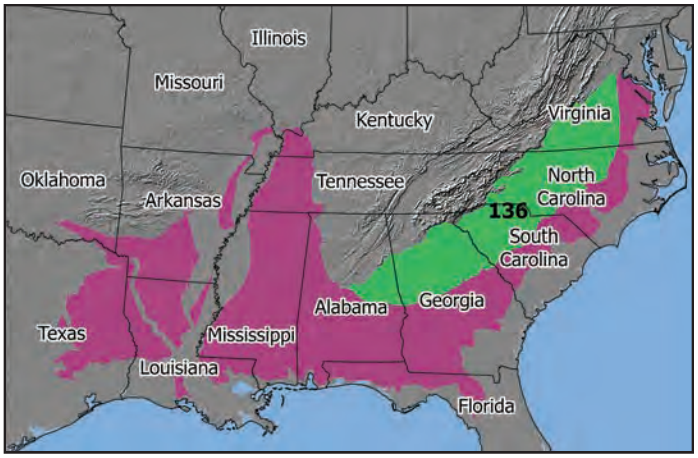

Figure 136-1: Location of MLRA 136, which covers 16,503,400 hectares (40,780,800 acres), within Region P.

is a major industry in the area. Most of the cropland is on the less sloping soils. Small grains and hay are the major crops. Orchards, vineyards, vegetable crops, and watermelons are important locally. Pastures on the bottom land along small streams and throughout cleared parts of the uplands support a mixture of cultivated and native grasses and legumes.

The major resource concerns are excessive nutrients and organic material in surface water; forest and pasture productivity, health, and vigor; inadequate water sources for domestic animals; and structure failure of dams caused by a high content of smectitic clay in the soils. The structure failures result in the formation of ponds and small lakes.

Conservation practices on cropland generally include proper management of the application of chicken litter and riparian forest buffers. Conservation practices on pasture generally include proper management of the application of chicken litter, prescribed grazing, ponds, pipelines, development of springs, and riparian forest buffers. Conservation practices on forestland generally include forest stand improvement and riparian forest buffers. The riparian forest buffers on cropland, pasture, and forestland help to preserve water quality.

136—Southern Piedmont

This MLRA (fig. 136-1) is on a large piedmont with a dissected landscape of metamorphic and igneous bedrock that is rolling to hilly and covered with mixed hardwood pine forest. The area has many small and medium-size farms that produce crops and livestock. Metropolitan cities throughout the MLRA are expanding onto lands that have been historically used for timber and agriculture. This area is in North Carolina (29 percent), Georgia (27 percent), Virginia (20 percent), South Carolina (17 percent), and Alabama (7 percent). It makes up about 63,720 square miles (165,034 square kilometers).

MLRA 136 has only subtle differences with the adjacent MLRA 148, which is a continuation of the mesic temperature regime on piedmont bedrock. It has an apparent boundary with MLRA 133A (at its northern extent) and MLRA 133C (at its southern extent) along the fall line, where coastal plain sediments intersect resistant metamorphic and igneous bedrock. It has an apparent boundary with MLRA 137 (which also occurs along the fall line) distinguishable by eolian sands over fluviomarine sediments. To the northwest, it has well defined and distinct boundaries with MLRAs 128, 130A, and 130B due to uniquely different sedimentary and metamorphic residual soil parent material and elevated hilly and rugged terrain.

Physiography

This MLRA is in the Piedmont Upland section of the Piedmont province of the Appalachian Highlands that stretches from north-central Virginia to central Alabama. It is a rolling to hilly upland with a well defined drainage pattern. Streams have dissected the original plateau, forming narrow to fairly broad upland ridgetops and short slopes adjacent to the major streams. The valley floors are generally narrow and make up about 10 percent or less of the land area. The associated stream terraces are of minor extent. Elevation ranges from 325 to 1,315 feet (100 to 400 meters).

The major rivers in this MLRA include, from north to south, the James, Roanoke, Cape Fear, Savannah, Altamaha, Chattahoochee, and Alabama Rivers. These rivers typically form within the Piedmont province, flow east and south across the Coastal Plain province, and empty into the Atlantic Ocean or the Gulf of Mexico.

Geology

Precambrian and Paleozoic metamorphic and igneous rocks underlie almost all of this MLRA. The dominant metamorphic rock types include biotite gneiss, schist, slate, quartzite, phyllite, and amphibolite. The dominant igneous rock types are granite and metamorphosed granite. Some gabbro and other mafic igneous rocks also occur, and diabase dikes are not uncommon. The Carolina Slate Belt occurs just east of an imaginary centerline in this MLRA. It consists of metamorphic rocks with some metavolcanics and metasediments. Triassic basins bounded by faults are scattered from South Carolina to south of Charlottesville and Richmond, Virginia. These basins have Triassic and Jurassic siltstone, shale, sandstone, and mudstone. River valleys have recent alluvium and few terraces.

Climate

The average annual precipitation is 40 to 70 inches (1,016 to 1,777 millimeters). In general, the precipitation is evenly distributed throughout the year with occasional drought-like conditions extending from late summer into autumn. Most of the rainfall comes from high-intensity, convective thunderstorms during the growing season. Significant moisture also comes from the movement of warm and cold fronts across the MLRA from November to April. At the same time of year, high amounts of rain can occur during hurricanes. Snowfall typically is light. The average annual temperature is 54 to 65 degrees F (12 to 18 degrees C). The freeze-free period averages 230 days and ranges from 185 to 275 days. Both the mean annual temperature and length of the freeze-free period increase from north to south and with decreasing elevation.

Water

Precipitation, perennial streams, rivers, and lakes provide an abundance of good-quality, soft surface water throughout this MLRA. Small farm ponds are important sources of water for livestock. Industry uses a significant amount of the surface water in this area. Toxins, nutrients, and sediment are the primary contaminants in the water. Fecal coliform contamination from point and nonpoint sources may occur.

Ground water supplies are relatively small, but shallow and deep wells in the crystalline bedrock aquifer are the principal sources of water for domestic use in the area. The water is drawn from joints, fractures, and bedding planes in the crystalline rocks. It generally is soft, but it can be hard or very hard, depending on the type of rock from which the well draws its water. High concentrations of manganese and iron can occur in some wells.

Soils

The dominant soil orders are Ultisols, Inceptisols, and Alfisols. The soils in the area dominantly have a thermic temperature regime, a udic moisture regime, and kaolinitic or mixed mineralogy. They are shallow to very deep, generally well drained, and loamy or clayey. Anthroportic soils are throughout the area and are a result of cut-and-fill activities associated with construction and urbanization.

The main soils and their series:

- Dystrudepts that formed in alluvium on flood plains (Chewacla series)
- Hapludalfs that formed in residuum on hills and ridges (Enon and Wilkes series)
- Hapludults that formed in residuum on hills and ridges (Badin, Nason, and Tatum series)
- Kanhapludults that formed in residuum on hills and ridges (Appling, Cecil, Georgeville, Herndon, Madison, Pacolet, and Wedowee series)
- Udults in the Rhodic subgroup that formed in old alluvium on stream terraces or in residuum derived from mafic rocks (Davidson, Hiwassee, and Lloyd series)

Biological Resources

The uplands in this area generally support a mixture of hardwoods and pine. Because of slight climatic differences between the northern and southern reaches of this MLRA, vegetative communities vary with latitude. Loblolly pine, slash pine, white oak, red oak, gum, yellow-poplar, and sycamore are the principal species. Pine is dominant on eroded sites. Hardwoods or mixed stands of pines and hardwoods are on slightly eroded soils and the flood plains along streams. The understory includes dogwood, honeysuckle, pinehill bluestem, and briars. Major wildlife species in this area include white-tailed deer, cottontail, squirrel, bobwhite quail, and mourning dove.

Land Use

Most of the land in this MLRA was historically cultivated but has since reverted to mixed stands of pines and hardwoods (fig. 136-2). Most of the remaining agriculture is in small family farms, where crops such as soybeans, corn, cotton, and small grains are grown. Burley tobacco remains a crop of local

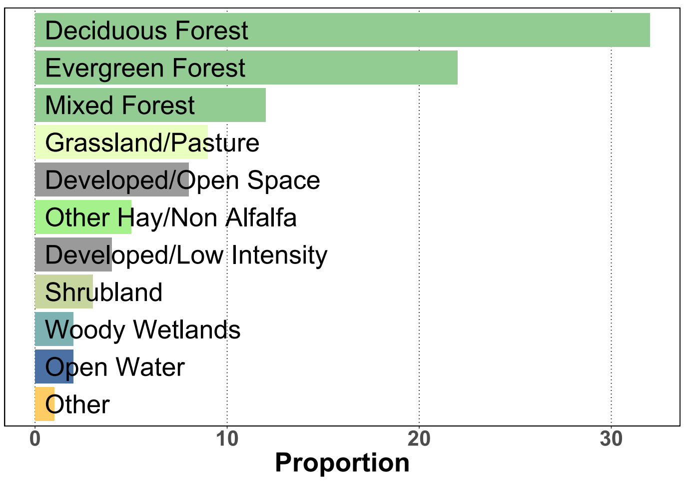

Figure 136-2: Relative proportions (percentages) of land use in MLRA 136.

importance. Most of the open areas are used as pasture for beef cattle and, to a lesser extent, for dairy cattle. Poultry is of great economic importance in the MLRA. A sizable acreage is controlled by companies making forest products. Rural land adjacent to the major cities is being converted to residential use and associated urban development. This change in land use is occurring rapidly in the corridor called the Piedmont Crescent, which extends from Atlanta, Georgia, to Raleigh, North Carolina.

The major soil resource concerns are water erosion and the increasing conversion of prime farmland and farmland of statewide importance to urban uses. Conservation practices on cropland generally include conservation tillage, crop residue management, field borders, vegetative wind barriers, and nutrient and pest management. The most important conservation practice in pastured areas is prescribed grazing. Pastures commonly are overseeded with small grains or legumes, or both, to supplement forage production during winter. Haying also helps to provide supplemental feed during the long winters. Critically eroding areas and areas where animals congregate need to be monitored and treated.

137—Carolina and Georgia Sand Hills

This MLRA (fig. 137-1) lies in a band between the Piedmont (MLRA 136) and Coastal Plain (MLRAs 133A and 133C) from the eastern edge of Alabama to the middle of North Carolina. It consists of a long narrow band of stabilized sand dunes and eolian material over unconsolidated fluviomarine deposits and has droughty sandy soils. The rolling to hilly uplands are covered by pine and scrub forest and warm-season grasses that have been historically subject to fire. This area is in South Carolina (45 percent), Georgia (37 percent), and North Carolina (18 percent). It makes up about 8,363 square miles (21,660 square kilometers).

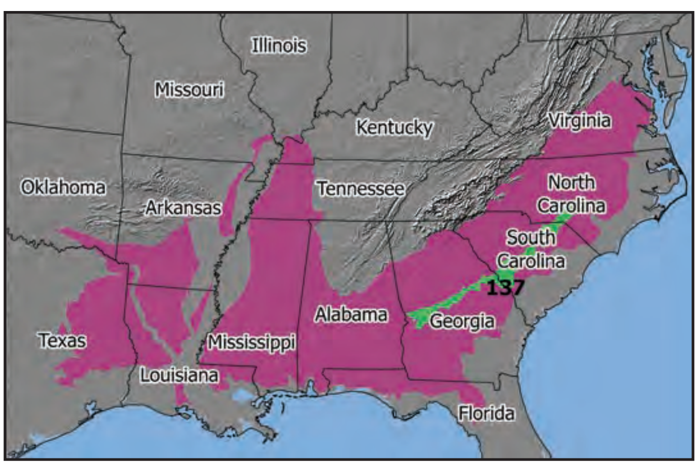

Figure 137-1: Location of MLRA 137, which covers 2,166,000 hectares (5,352,200 acres), within Region P.

The boundary with MLRAs 133A and 133C is intermingled with patchy eolian sand overlying the fluviomarine terrace material. The boundary with MLRA 136 to the west is well defined by the fall line and consists of dramatic differences in sedimentary, metamorphic, and igneous residual bedrock.

Physiography

Most of the MLRA is in the Sea Island section of the Coastal Plain province of the Atlantic Plain. Part of the area in Alabama and the western half of the area in Georgia are in the East Gulf Coastal Plain section of the same province and division. This MLRA is a rolling to hilly upland composed of stabilized dunes separated by dissected areas. Elevation ranges from 165 to 660 feet (50 to 200 meters), increasing gradually from south to north. Local relief is mainly 10 to 20 feet (3 to 6 meters), but a few hills are 80 to 165 feet (25 to 50 meters) above adjacent areas.

From North Carolina to Alabama, the major rivers that either cross or have headwaters in this area are the Lumber, Great Pee Dee, Little Lynches, Lynches, Wateree, Congaree, Edisto (North and South Forks), Savannah, Brier, Ogeechee, Oconee, Ocmulgee, Flint, and Chattahoochee Rivers.

Geology

The Sand Hills area is just southeast of the fall line, which marks the boundary between the older crystalline rocks of the Piedmont terrane and the younger, unconsolidated sediments of the Coastal Plain. Deep Cretaceous sands deposited in this ancient shoreline area were reworked during periods of the Pleistocene Epoch when the Coastal Plain was submerged. Several areas have deposits of kaolin and high-silica sands that are mined. Stabilized sand dunes are common in the MLRA. Deposits of siltstone, shale, and marl generally lie beneath the Coastal Plain part of this MLRA, and the crystalline rocks of the Piedmont lie beneath the sands on the inland part.

Climate

The average annual precipitation is 40 to 50 inches (1,025 to 1,278 millimeters). The maximum precipitation occurs in midsummer, and the minimum occurs in autumn. Rainfall occurs during high-intensity, convective thunderstorms in summer. Snowfall is light if it occurs at all. The average annual temperature is 60 to 65 degrees F (16 to 18 degrees C). The freeze-free period averages 250 days and ranges from 220 to 280 days, increasing in length to the south.

Water

Precipitation, perennial streams, and aquifers provide an abundance of water. The kind and amount of plant growth are severely limited by low moisture in the rapidly permeable, sandy soil dominant in this area. The surface water is suitable for all uses. A significant amount of surface water is used for industrial purposes.

Ground water is available in both the crystalline igneous and metamorphic rocks aquifer and the Cretaceous sediments aquifer. Both of these aquifers have soft water that is very low in total dissolved solids. Water in the Cretaceous aquifer is a sodium-bicarbonate type and is typically used for industry and public supply. It also is used for irrigating the many golf courses in this area. In North Carolina, the Cretaceous aquifer is the surficial aquifer. Water from this aquifer in North Carolina has low pH, so it can be corrosive. The Middendorf sands are the primary sources of ground water in the part of this area in Georgia. The water in these sands is similar in quality to the water in the surficial aquifer in North Carolina. The crystalline rocks aquifer has a calcium-bicarbonate type of water and supplies mostly domestic water in the area. The water in some wells in the crystalline rocks exceeds the secondary drinking water standard for iron.

Soils

The dominant soil orders are Ultisols and Entisols. The soils in the area have a thermic temperature regime, a udic moisture regime, and kaolinitic or siliceous mineralogy. They generally are very deep, well drained to excessively drained, and loamy or sandy.

The main soils and their series:

Kandiudults that formed in eolian-capped fluviomarine sediments on uplands (Candor and Troup series)

Kanhapludults that formed in fluviomarine sediments on hills, ridges, and side slopes (Ailey, Cowarts, Pelion, and Vaucluse series)

Quartzipsamments that formed in eolian deposits on uplands (Alpin and Foxworth series)

Biological Resources

This area is well known for vegetative communities dominated by longleaf pine. A typical fire-maintained site in native vegetation is characterized by a longleaf pine overstory with an herbaceous layer dominated by wiregrass. Other typically associated species are turkey oak, deerberry, and dwarf huckleberry. With the exclusion of fire, offsite oaks, including blackjack oak, bluejack oak, and sand live oak, become canopy. These oak species change the fire and light-transmission dynamics and, as a result, native ecological functions become impaired. Native vegetation includes Atlantic white cedar, pond pine, and other hardwood and bay species.

Animals in this area are adapted to the historical fire regime. Red-cockaded woodpeckers bore nesting cavities in large-diameter, live longleaf pines and forage in a relatively open understory. The deep sands of the Sand Hills provide suitable habitat for the gopher tortoise, which is generally associated with the flatter Southern Coastal Plain. Bachman's sparrow, which nests and feeds on the ground, inhabits the area if the grasses and shrubs do not become too dense from lack of fire. Fox squirrels feed primarily on longleaf pine nuts and typically live in the upper canopy, where flames do not reach. Pine snakes use stump holes as protection from heat and flames.

Land Use

The majority of this area consists of pine and scrub oak forestland that is managed for pulpwood and lumber products (fig. 137-2). About one-tenth of the area is federally owned and used for military posts and training areas. Part-time and subsistence farmers generally grow corn and cotton with the use of irrigation. Droughty conditions make agriculture difficult without irrigation. Peach orchards are also an important land use. Metropolitan cities are expanding onto lands that have been historically used for timber, recreation, and agriculture.

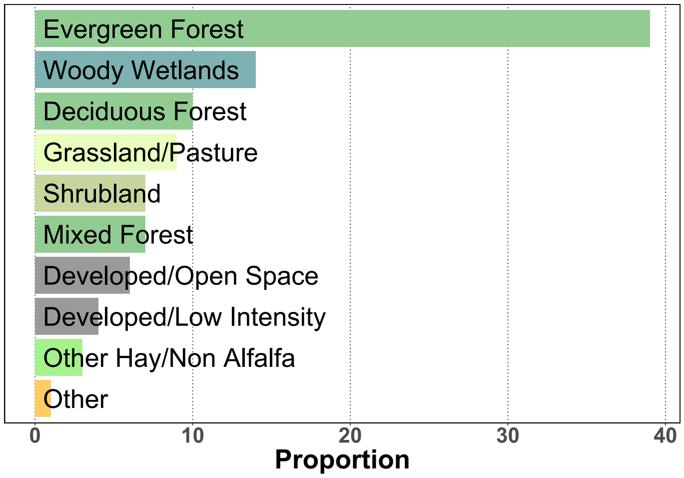

Figure 137-2: Relative proportions (percentages) of land use in MLRA 137.

The major resource concerns are controlling water erosion and enhancing the available water capacity of the soils. Conservation practices on cropland generally include systems of crop residue management, diversions, and grassed waterways. Field borders provide cover for bobwhite quail and cottontail. Conversion to a permanent cover of vegetation has been a continuing recommendation for the soils that are low in natural productivity.

138—North-Central Florida Ridge

This MLRA (fig. 138-1) is on a limestone upland that is mantled with sand marine deposits and has an irregular, gently rolling topography. Because of the underlying karst topography, there are a moderate number of limestone sinkholes, some filled with water. Production of cash crops and hay and pasture is the primary land use. This area comprises about 2,196 square miles (5,688 square kilometers) and is entirely within Florida.

This area borders MLRA 133A to the south, which has only slight differences in use and management due to the underlying karst topography. Its boundaries with MLRA 152A to the west and MLRA 153A to the east are distinguishable by an abrupt

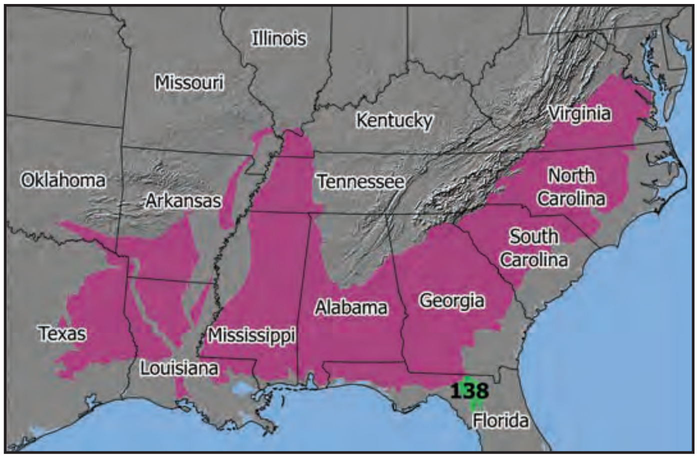

Figure 138-1: Location of MLRA 138, which covers 568,800 hectares (1,405,500 acres), within Region P.

scarp on a lower, younger marine terrace. Its boundary with MLRA 154 is a gradual transition to slightly younger marine sediments.

Physiography

Most of this area is in the East Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. The southern one-quarter is in the Floridian section of the same province and division. Elevation ranges from 26 to 197 feet (8 to 60 meters). Local relief is generally 10 to 20 feet (3 to 6 meters) but can be as much as 35 feet (10 meters).

The Suwannee River, which originates in the Okefenokee Swamp to the northeast and is spring-fed, flows through this MLRA. The Alapaha and Withlacoochee Rivers join the Suwannee River in the area. Another Suwannee River tributary, the Santa Fe River, crosses the southern part of the area.

Geology

This area is underlain by sediments of the Quaternary Period (present to 2.58 million years ago) that overlie the Neogene (2.53 to 23.03 million years ago) and Paleogene (23.03 to 66 million years ago) formations of the Hawthorn Group (Green et al., 2006). The rocks are progressively older to the south. The Quaternary sediments are largely undifferentiated marine deposits consisting of fine to coarse sands that are poorly to moderately sorted with variable admixtures of clay and organic material. The formations of the Hawthorn Group are, from youngest to oldest, the Statesville Formation, Coosawhatchie Formation, Suwannee Limestone, and Ocala Limestone. The Statesville Formation consists of thinly interbedded, and commonly cross-bedded, dolostone and clay alternating with beds of sand. Phosphate grains are common to abundant. The Coosawhatchie Formation is made up of poorly to moderately sorted sandy clay or clayey sand with phosphate grains, limestone, and dolostone. The Suwannee Limestone is a cream-colored to tan, crystalline, vuggy and muddy, fossiliferous, variably dolomitic carbonate. It has chert nodules in some areas. The Ocala Limestone was deposited in the Eocene (33.9 to 56 million years ago) and is the oldest rock formation exposed in Florida. It is a white to cream-colored, fossiliferous limestone and has chert nodules in some areas.

Climate

The average annual precipitation is 51 to 59 inches (1,294 to 1,497 millimeters). The maximum precipitation occurs in summer, and the minimum occurs in winter and late autumn. Rainfall occurs during high-intensity, convective thunderstorms in summer. The average annual temperature is 68 to 69 degrees F (20 to 21 degrees C). The freeze-free period averages 295 days and ranges from 280 to 305 days.

Water

The abundant rainfall and the Floridan aquifer are the principal sources of water in the area. The many lakes and ponds are used for recreation. Except for one tributary below an active phosphate mine, the river water is suitable for almost all uses.

Shallow and deep wells in the Floridan aquifer provide water for public supply, domestic use, industry, mining, livestock, and irrigation. This aquifer is one of the most productive sources of ground water in the United States. Its water is hard but of good quality. Wells yield large quantities of the calcium-bicarbonate type of water. The Floridan aquifer is a thick sequence of Tertiary limestone and dolomite. The Eocene Avon Park Formation and Ocala Limestone are the thickest and most productive units in the aquifer system.

Soils

The dominant soil orders are Ultisols, Entisols, and Alfisols. The soils in the area dominantly have a thermic temperature regime, a udic moisture regime, and siliceous mineralogy.

The main soils and their series:

- Alaquods that are poorly drained and sandy and have a weakly cemented layer (Mascotte series)
- Paleudults that are well drained and somewhat poorly drained and have thick sandy layers over a loamy subsoil (Blanton and Albany series)
- Quartzipsamments that are excessively drained and moderately well drained and sandy throughout (Alpin series)

Biological Resources

This area supports open pine and oak vegetation. Longleaf pine and turkey oak are the dominant trees. Several bluestem species, Indiangrass, and several threeawn species dominate the ground cover. Hairy panicgrass and sedges are in scattered areas. The MLRA also supports legumes and annual forbs. Major wildlife species include white-tailed deer, raccoon, skunk, opossum, rabbit, gray squirrel, fox squirrel, turkey, bobwhite quail, and mourning dove.

Land Use

A significant portion of this MLRA along riparian areas remains wooded with some larger holdings used exclusively for forestry (fig. 138-2). Pulpwood and lumber are the principal forest products. Hay and pasture are of great extent throughout this MLRA. The cropland in the area is used mainly for corn, peanuts, tobacco, soybeans, vegetables, and melons.

The major resource concerns are maintenance of the content of organic matter and productivity of the soils, management of soil moisture, and management of animal waste. Conservation practices on cropland generally include crop rotations, cover crops, nutrient management, pest management, and irrigation water management.

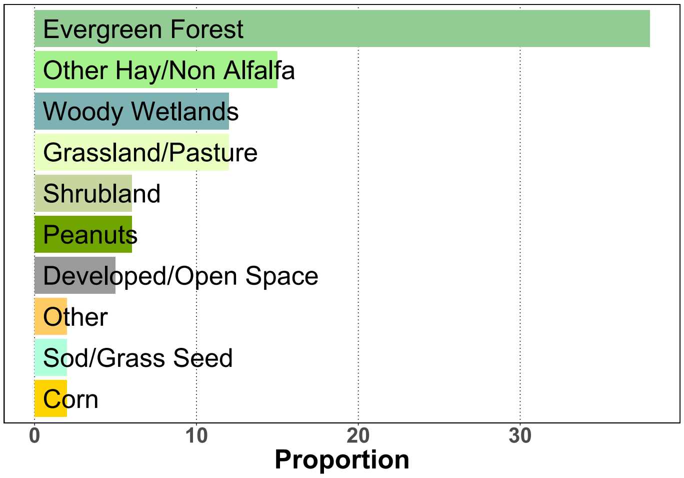

Figure 138-2: Relative proportions (percentages) of land use in MLRA 138.

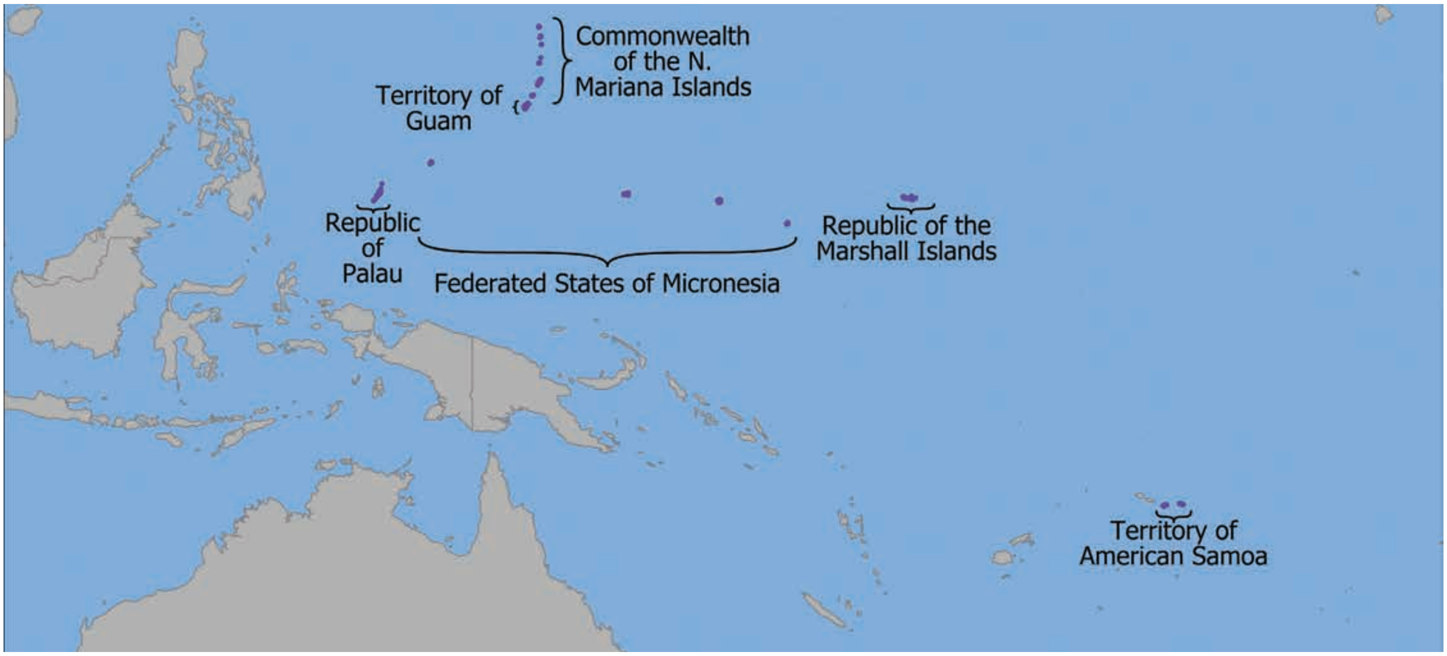

Figure Q-1: Maps of the island groups in the Pacific Ocean that comprise the Pacific Basin Region.

Q—Pacific Basin Region

Land Resource Region Q (fig. Q-1) consists of the Pacific Ocean island groups, including American Samoa, Guam, the Federated States of Micronesia, the Northern Mariana Islands, the Republic of Palau, and the Marshall Islands (fig. 4, page 8). Collectively, this region makes up 999 square miles (2,585 square kilometers). It contains eight major land resource areas. The extent of these MLRAs is shown in table Q-1.

The islands in this region are typically high volcanic islands (such as Pohnpei, Chuuk, Kosrae, and Palau), coralline limestone islands (Tinian), or atolls (the Marshall Islands and Ulithi Atoll). Many of the volcanic areas are steep; some have slopes of more than 100 percent. Gently rolling terrain with steep escarpments is common on the coralline limestone islands. Some of the atoll islands have a high elevation of only 6 feet (2 meters) above mean high tide, while Pohnpei has volcanic peaks of more than 3,050 feet (930 meters) and Guam has coralline limestone plateaus as high as 570 feet (175 meters).

The climate in this region is generally wet, hot, and humid. The annual precipitation is 80 to 145 inches (2,030 to 3,685 millimeters) in most of the region. It decreases to the north, away from the equator, and is more than 200 inches (5,080 millimeters) in high-elevation areas. The wettest part of the year is from December to March in American Samoa and from July to November in the rest of the region. The driest part of the year is from June to September in American Samoa and from January or February to April or May in the rest of the region. The average annual temperature is about 81 degrees F (27 degrees C), and the entire region is freeze-free. Daily fluctuations in air temperature are typically wider than the annual variability. Statistical distribution of temperature and precipitation data for the MLRAs in this region is shown in tables Q-2 and Q-3.

Soils in this region are dominantly Mollisols, but Entisols, Inceptisols, and Oxisols also are common. Andisols, Alfisols, and Histosols are of more limited extent. The soils on the Mariana Islands have an ustic moisture regime. Those on the other islands in the region have a perudic or udic moisture regime. All of the soils have an isohyperthermic temperature regime. They formed in residuum derived from weathered or hard volcanic rock, coralline sand, or weathered ash over coralline limestone.

Land use is dominantly tropical forest. The forests are used for ground water recharge, agroforestry, woodland, and wildlife habitat. Many eroded mountainous areas are in savanna because of periodic fires during short dry periods. Mangrove forests ring some of the islands protected by fringing or barrier reefs. Examples of these islands are Pohnpei, Kosrae, Chuuk, Yap, and Palau. The coral reefs and beaches support a variety of tourism services, such as snorkeling, diving, sailing, sea kayaking, hiking, and fishing. The tourism industry is significant on some islands and has drawn many people into more concentrated urban centers, especially on Guam and Palau. Golf courses and high-rise hotels are common new additions to the landscape in the Mariana Islands. The capital of the Federated States of Micronesia on the island of Pohnpei draws people from the surrounding Caroline Islands in search of economic opportunity.

Table Q-1.—Extent and Elevation by MLRA
[Dashes indicate data were not available.]

MLRA	Extent	
	km²	mi²
190	145	55
191	655	255
192	200	75
193	460	180
194	70	25
195	545	210
196	30	10
197	195	75

Table Q-2.—Temperature and Freeze-Free Period
[Data are based on a 30-year average. Dashes indicate data were not available.]

MLRA	Temperature									
	Low		10th percentile		50th percentile		90th percentile		High	
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F
190	---	---	---	---	---	---	---	---	---	---
191	24	75	26.1	79	26.7	80	27.3	81	27.7	82
192	24.7	77	25.9	79	26.6	80	27	81	27.4	81
193	25.7	78	26.4	80	26.8	80	27.1	81	27.1	81
194	25.9	79	26.6	80	27.1	81	27.1	81	27.1	81
195	22.2	72	24.8	77	26.7	80	27.2	81	27.4	81
196	---	---	---	---	---	---	---	---	---	---
197	21.4	71	24.8	77	26.7	80	27.5	82	27.8	82

Table Q-3.—Precipitation
[Dashes indicate data were not available.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
190	---	---	---	---	---	---	---	---	---	---
191	1,740	69	1,898	75	2,348/2,240	92/88	2,501	98	3,100	122
192	2,320	91	2,453	97	2,585/2,600	102/102	2,792	110	2,960	116
193	3,340	132	3,449	136	3,623/3,620	143/143	3,781	149	3,900	153
194	3,310	131	3,324	131	3,483/3,465	137/136	3,626	143	3,670	144
195	3,720	147	4,196	165	5,288/5,430	208/214	6,862	270	8,170	322
196	---	---	---	---	---	---	---	---	---	---
197	2,250	89	2,987	118	4,367/4,420	172/174	5,857	231	,7510	296

The resultant growth in population has increased pressure on the local resources.

Most of the agriculture in this region is at the subsistence level. Shifting cultivation is the norm. Many families have gardens and maintain free-ranging pigs and poultry. Steep slopes, low soil fertility, stoniness, and high acidity limit the variety of agriculture on most soils throughout the region. High humidity and rainfall also are important management concerns. Small but profitable commercial farms in the Mariana Islands produce cabbage, taro, sweet potatoes, cucumbers, melons, papaya, and other fruits and vegetables for local consumption. In most of the region, the population lives in the coastal areas where commercial or subsistence fishing is an important activity.

190—Stratovolcanoes of the Mariana Islands

MLRA 190 (fig. 190-1) is made up of steep and very steep stratovolcanoes of the Mariana Islands group in the north Pacific Ocean. It consists of Pagan (26 percent); Anatahan (17 percent); Agrigan, or Agrihan (16 percent); Alamagan (6 percent); Sarigan, or Sariguan (3 percent); and five smaller islands (32 percent). It makes up about 55 square miles (145 square kilometers). This MLRA is north of Saipan, in the western Pacific Ocean, about 1,600 miles (2,580 kilometers) east of the Philippines and 3,800 miles (6,130 kilometers) west-southwest of Hawaii. This island group makes up the Commonwealth of the Northern Mariana Islands (CNMI). The islands are largely unpopulated. Pagan and Sarigan have no permanent residents. Evacuations of Pagan in 1981 and Anatahan in 2003 were due to volcanic activity. Civil Defense authorities have not allowed residents to resettle these volcanically active islands. MLRA 190 is bordered to the south by MLRA 191, which consists of older, high limestone plateaus.

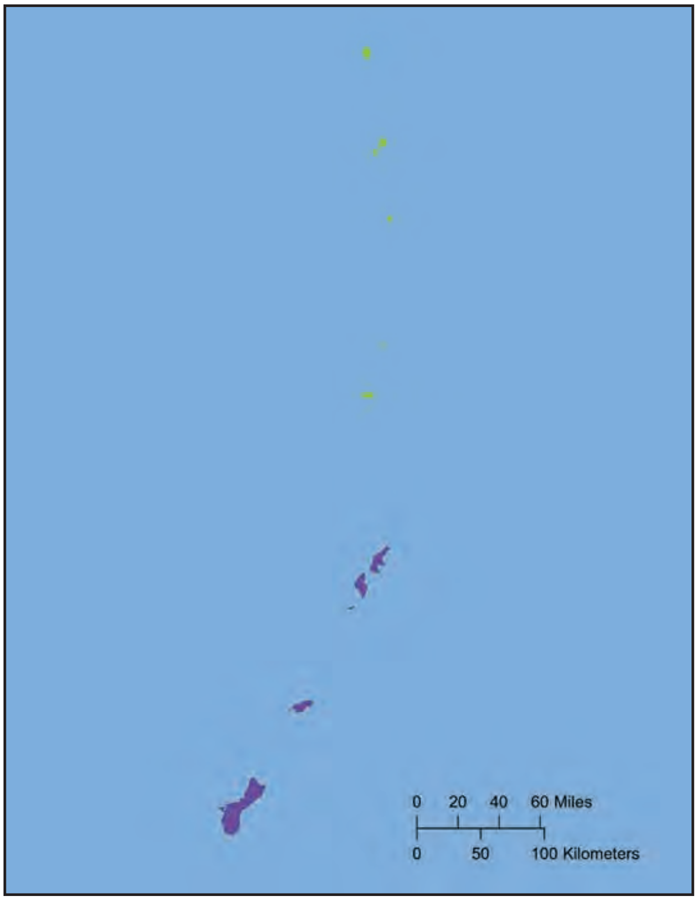

Figure 190-1: Location of MLRA 190, which covers 14,200 hectares (35,300 acres), within Region Q.

Physiography

This area is in the Pacific Islands province of the Pacific Rim area. The Northern Mariana Islands form the northern group of the Mariana Arc archipelago. They are the younger (Quaternary age) of two arcuate chains of volcanoes that make up the archipelago. They formed at the subduction zone between the Philippine and Pacific tectonic plates. The cone-shaped stratovolcanoes are covered with volcanic ash and cinder deposits. Many steep slopes have eroded into deep gulches. Cliffs, steep slopes, and boulder and cobble beaches characterize the coastlines. This area has small streams but no rivers. Agrigan has the highest elevation in the Mariana Arc, which ranges from sea level to 3,185 feet (970 meters).

Geology

Quaternary-age basalt and andesite lavas dominate these stratovolcanoes. Lava flows, volcanic ash, and cinder deposits are common. The volcano on northern Pagan Island is considered active, having last erupted in 1981. Anatahan Island last erupted in April 2005. The United States Geological Survey considers Maug a “volcano of concern” in this area and also notes that hot spots offshore could become volcanoes.

Climate

The average annual precipitation is about 80 inches (2,030 millimeters). About two-thirds of the precipitation falls between July and November. The average annual temperature is about 79 degrees F (26 degrees C). The cooler dry season is between January and May. It is enhanced by persistent trade winds from the northeast and east-northeast. Typhoons frequently pass close to the Northern Mariana Islands. Typhoons are less common in the north than on Guam in the MLRA to the south, which is severely impacted by large storms about once every 8 years on average. This area is freeze-free.

Water

The water in this area is mainly used for domestic supply, and the local people rely on surface water as their primary source of drinking water. There are no perennial streams in the Northern Mariana Islands. Two saline lakes are on Pagan. Also on Pagan, ground water can be obtained from wells that reach sea level, as is likely the case for all of the Northern Mariana Islands. Hot springs and seeps occur on the islands but are generally not of sufficient quality or quantity to be considered water sources. Catchment water has the best water quality on the islands, and it is used as drinking water. Rainfall is nearly double the potential evapotranspiration from July through November but only half of the potential evapotranspiration from January into May.

Soils

Because of the young age of volcanic deposits in this area, there are no great differences among soils. The soil orders in this MLRA are Andisols, Inceptisols, and Entisols. The soil moisture regime is ustic in most areas but aquic in depressions. All of the soils have an isohyperthermic temperature regime. Most of the soils are well drained and on steep mountainsides or ridges. Although some soils are very shallow or moderately deep to bedrock or cemented pyroclastic layers, most are very deep. Cinder land, rock outcrops, and lava flows make up a considerable amount of the surficial materials. A soil survey has been completed on the islands of Agrigan, Alamagan, Anatahan, Pagan, and Sarigan. The total acreage of the Northern Mariana Islands covered by soil surveys is 48.8 square miles (126.4 square kilometers).

The main soil series:

Apilam series—Haplustepts that formed in volcanic ash and cinders on the crests of ridges that are separated by narrow gullies on side slopes of stratovolcanoes

Dekairu series—Ustivitrands that formed in basaltic and andesitic volcanic ash and cinders; on the dissected footslopes and backslopes of large remnant caldera rims and cinder-covered \`a\`a lava plains of stratovolcanic islands

Hatisu series—Ustivitrands that formed in volcanic ash and cinders on dissected backslopes and footslopes on mountainsides of stratovolcanic islands

Plasanbola series—Haplustands that formed in volcanic ash and cinders from fallout on the crests of ridges on the dissected backslopes and footslopes of stratovolcanic islands

Songsong series—Ustivitrands that formed in volcanic alluvium on dissected alluvial fans and terraces and steep remnant terraces

Biological Resources

Abandoned copra (coconut) plantations are on low-elevation coastal sites. Areas above an elevation of 330 feet (100 meters) are dominated by grassland, consisting of mainly swordgrass. Forest species are mixed tropical hardwoods, including ironwood, pandanus, joga, coconut, and beach hibiscus.

Large populations of feral cows, pigs, and goats inhabit some of the islands. The endemic fruit bat and coconut crab are locally important food sources (although the fruit bat is a federally listed endangered species). Several skinks and geckos also are native to the Mariana Islands. Several endemic bird species, rufous fantail, the fairy tern, and the Vanikoro swiftlet, also an endangered species, inhabit the islands. A wide range of coral, anemones, shellfish, and reef and pelagic fish species are within the surrounding reef systems and open waters.

Land Use

Ground water recharge and wildlife habitat are the main land uses in this area (fig. 190-2). Asuncion, Farallon de Pajaros (Uracas), Guguan, and Maug Islands are wildlife reserves for sea birds. There are small areas of subsistence farming and agroforestry on Agrigan, Anatahan, and Alamagan Islands. The main subsistence crops are coconut, bananas, breadfruit, mango, limes, taro, and yams.

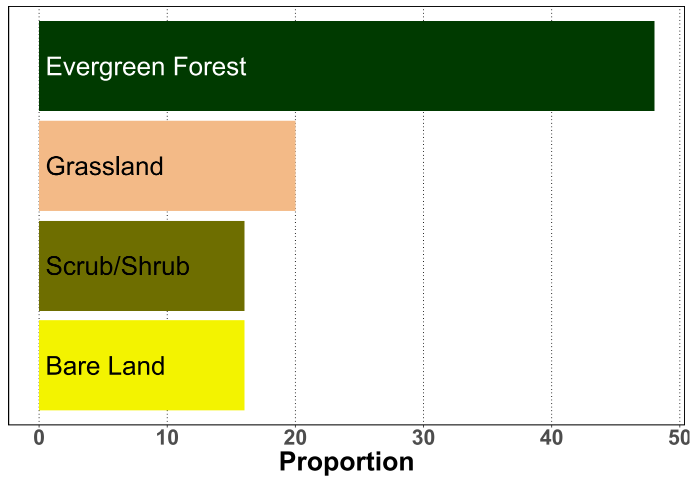

Figure 190-2: Relative proportions (percentages) of land use in MLRA 190.

The major resource concerns are the threat of lava flows and ash deposition from volcanic eruptions on Pagan and Anatahan. Feral animals contribute to erosion and changes in the plant community. Multistory cropping is the main conservation practice in this area.

191—High Limestone Plateaus of the Mariana Islands

MLRA 191 (fig. 191-1) consists of the northern half of Guam (53 percent) and the islands of Saipan (18 percent), Tinian (15 percent), Rota (13 percent), and Aguijan, or Aguiguan (1 percent). It makes up about 256 square miles (663 square kilometers). These islands are in the western Pacific Ocean, roughly 1,600 miles (2,580 kilometers) east of the Philippine Islands and approximately 3,730 miles (6,015 kilometers) west-southwest of Hawaii. This area includes the Territory of Guam and the Commonwealth of the Northern Mariana Islands (CNMI). Guam is the largest of the Mariana Islands and the economic hub of Micronesia.

MLRA 191 is bordered to the north by MLRA 190, which consists of younger stratovolcanoes. It has a distinct boundary to the south with MLRA 192, on the Island of Guam. MLRA 192 consists of volcanic highlands.

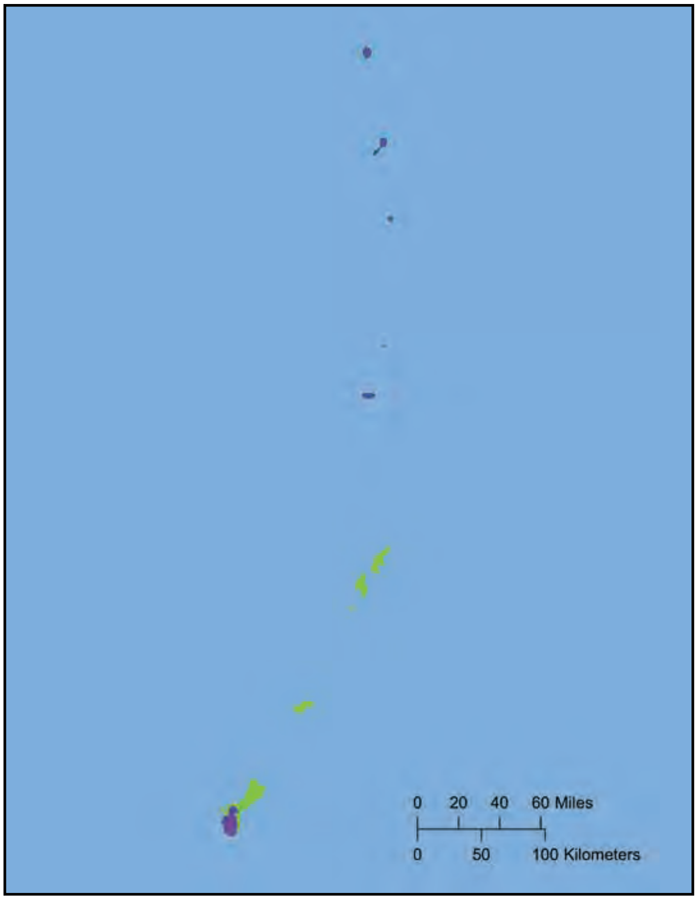

Figure 191-1: Location of MLRA 191, which covers 65,500 hectares (161,800 acres), within Region Q.

Physiography

This MLRA is in the Pacific Islands province of the Pacific Rim area. Its islands are the southernmost islands of the Mariana Arc archipelago. The topography ranges from nearly level to gently sloping limestone plateaus to steep, complex slopes in areas of volcanic bedrock. Precipitous cliffs along limestone plateaus surround most of the northern half of Guam and Saipan as well as areas of Rota and Tinian. Cliffs, steep slopes, beaches, and reef flats characterize the coastlines. The highest elevations are 1,637 feet (499 meters) on Rota, 1,555 feet (474 meters) on Saipan, 617 feet (188 meters) on Tinian, and 828 feet (252 meters) in the northern part of Guam. This area has streams and a few small rivers, and barrier and fringing reefs are around it.

Geology

The volcanic cores of these islands are the result of the Pacific tectonic plate sliding under the Philippine tectonic plate. Earthquakes are common. Reef and lagoon deposits formed around the central volcanic cores of the islands. As a result, limestone is the most extensive exposed bedrock. Most of the limestone dates to the Pliocene and Pleistocene Epochs. The limestone plateaus and volcanic peaks were uplifted through tectonic activity during the Tertiary and Quaternary Periods. Deeply weathered volcanic rock is exposed on ridges and slopes.

Climate

The average annual rainfall is about 100 inches (2,540 millimeters) on northern Guam and 80 inches (2,030 millimeters) on Saipan, Tinian, Aguijan, and Rota. The rainy season is from July through November, and the dry season is from December through June. The dry season is enhanced by persistent trade winds from the northeast. The average annual temperature is 79 degrees F (26 degrees C). Humidity is high throughout the year, averaging 76 percent. Typhoons frequently pass close to the islands. The chance of a typhoon severely impacting Guam is once in 8 years. The chance of one severely impacting the CNMI is slightly less. Wind and rainfall are the most variable climatic factors in this area, whereas temperature and humidity remain fairly constant throughout the year. This area is freeze-free.

Water

Except for springs around the periphery of the shoreline and in areas of volcanic rocks, there are few areas of fresh surface water. There are generally no streams or rivers on the limestone bedrock. Some streams cut through the limestone where they originate in volcanic landscapes upslope. Two springs on Saipan and one on Rota are developed as a freshwater supply.

Almost all of the people on Saipan and about 80 percent of the population on Guam rely on ground water for domestic and public supplies. Crops are irrigated by the domestic water delivery system. Some farms and homes still rely on rainwater catchment systems.

The principal aquifers in this area are the Tagpochau and Mariana Limestone on Saipan and the Barrigada and Mariana Limestone in northern Guam. The water in these aquifers occurs as a thin lens of freshwater that floats on denser, basal saltwater. The water from all the aquifers is very hard. During the dry season on Saipan, the freshwater lens becomes overdrawn, resulting in saltwater intrusion. The two limestone aquifers on Guam have been designated as “principal source aquifers” by the U.S. Environmental Protection Agency, and Guam has established special management practices to protect the quality of the ground water. The increasing population in this MLRA is putting more pressure on the ground water resources. The increased pumping is creating more problems with saltwater intrusion, and the increasing extent of impervious surfaces in urbanized areas is decreasing the amount of freshwater recharging the aquifers.

Soils

The soil orders in this MLRA are Alfisols, Andisols, Entisols, Mollisols, and Oxisols. The dominant soil moisture regime is ustic, and all of the soils have an isohyperthermic temperature regime. The soils are very shallow to deep, moderately well drained to somewhat excessively drained, and fine textured or coarse textured. They have amorphic, carbonatic, ferruginous, gibbsitic, kaolinitic, mixed, oxidic, parasesquic, or smectitic mineralogy. Almost all of the soils consist of highly weathered clays and formed in limestone residuum. In some areas volcanic ash has been added to the soils. All of the soil orders occur on nearly level or rolling limestone plateaus. Most of the soils overlying limestone are shallow.

The main soil series:

- Chacha series—Paleustalfs that formed in alluvial sediments and volcanic saprolite overlying limestone; in concave basin positions on limestone plateaus
- Chinen series—Haplustolls that formed in sediments overlying porous limestone; on uplifted limestone plateaus
- Dandan series—Haplustepts that formed in sediments overlying porous coralline limestone; on uplifted limestone plateaus
- Guam series—Ustorthents that formed in sediments overlying porous coralline limestone; on uplifted limestone plateaus
- Pulantat series—Argiustolls that formed in residuum derived from argillaceous coralline limestone; on upland plateaus and hills
- Ritidian series—Ustorthents that formed in slope alluvium, loess, and residuum from sediments overlying coralline limestone; on limestone plateaus and escarpments
- Saipan series—Eutrustox that formed in sediments overlying porous coralline limestone; on uplifted limestone plateaus
- Takpochao series—Haplustolls that formed in sediments overlying coralline limestone on limestone plateaus, side slopes, and escarpments
- Yigo series—Eutrustox that formed in sediments overlying porous coralline limestone in depressions; on limestone plateaus

Biological Resources

The native vegetation consists of mixed tropical hardwoods, but the introduced tangantangan is the dominant forest species in areas underlain by limestone. Other prominent trees are gulos, Formosan koa, puting (or fish kill tree), and gaogao (or tiger claw).

The only mammal endemic to the Mariana Islands is the Marianas fruit bat. Other mammals, such as sambar deer, pigs, goats, and water buffalo, have been introduced and can be seen in the wild. Several skinks and geckos are native to the Mariana Islands. Several endemic bird species, rufous fantail, the fairy tern, and the Vanikoro swiftlet, an endangered species, inhabit the islands. The native bird populations on Guam have been decimated through the accidental introduction of the brown tree snake. A wide range of coral, anemones, and shellfish and various reef and pelagic fish species are in the surrounding reef systems and open waters.

Land Use

The U.S. Department of Defense has a significant impact on these islands. A considerable amount of land has been developed for airstrips, barracks, and fortifications, especially on Guam and Tinian. Level areas are used for diverse agricultural systems, ranging from traditional subsistence farming and gardening to modern commercial farming (fig. 191-2). The important commercial crops are bananas, taro, eggplant, beans, cucumbers, green peppers, tomatoes, many other vegetable and fruit crops, and ornamentals. Urban development is occurring on a significant acreage of these islands. Remote areas are used for wildlife habitat, ground water recharge, and recreation.

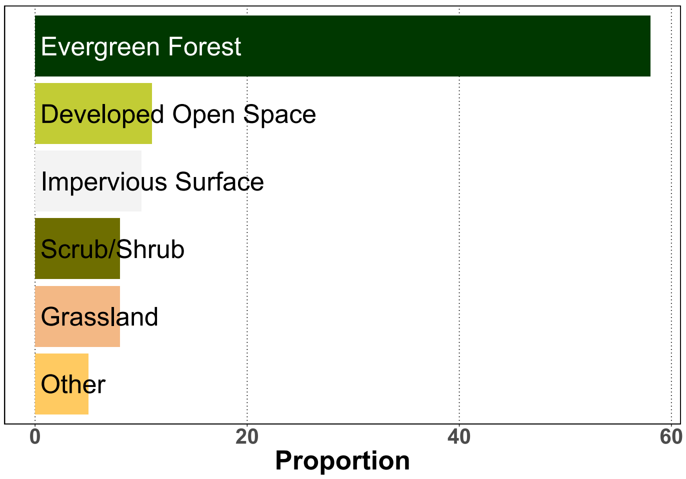

Figure 191-2: Relative proportions (percentages) of land use in MLRA 191.

The major soil resource concerns are water erosion and maintenance of soil productivity. Saltwater intrusion into the fresh ground water lens that is used for domestic purposes also is a concern, especially on Saipan. Conservation practices on cropland generally include contour tillage and cover crops. In northern Guam, no-till, strip-till, and mulching are common conservation practices.

192—Volcanic Highlands of the Mariana Islands

This area is entirely in southern Guam (fig. 192-1). It makes up about 78 square miles (202 square kilometers) or about 37 percent of Guam. The Territory of Guam is in the western

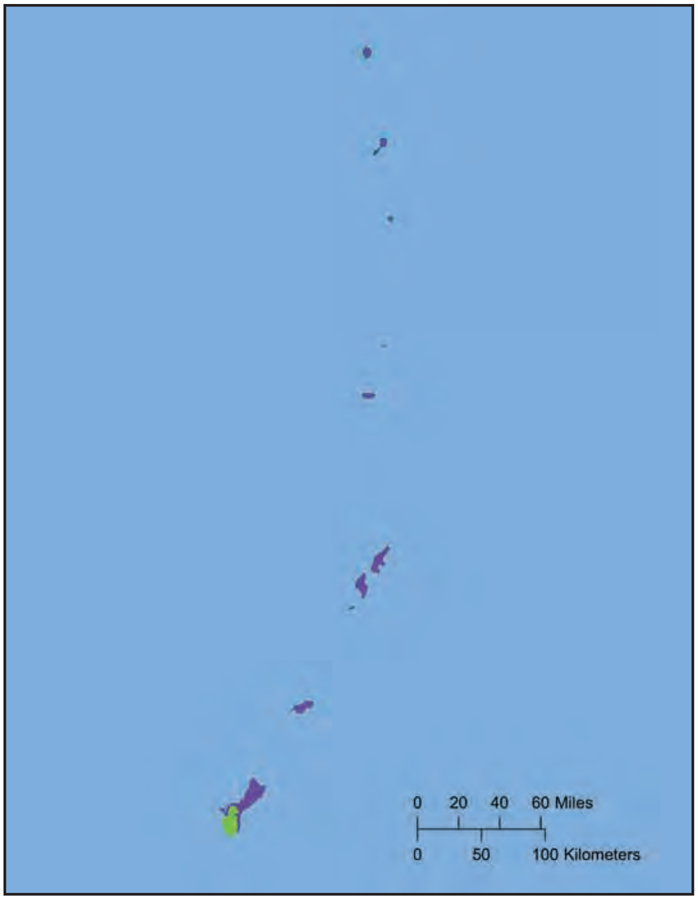

Figure 192-1: Location of MLRA 192, which covers 20,000 hectares (49,500 acres), within Region Q.

Pacific Ocean, about 1,600 miles (2,580 kilometers) east of the Philippine Islands and about 3,800 miles (6,130 kilometers) west-southwest of Hawaii. Guam is the largest island of the Mariana Islands and the economic hub of Micronesia.

MLRA 192 has a distinct boundary with MLRA 191 to the north. MLRA 191 consists of uplifted, high limestone plateaus. Almost all of its soils are highly weathered clays that formed in limestone residuum. Southwest of MLRA 192 is MLRA 193, which consists of the volcanic islands of western Micronesia.

Physiography

This area is in the Pacific Islands province of the Pacific Rim area. Guam is the largest and southernmost island of the Mariana Arc archipelago. The interior of south Guam has steep or very steep mountains deeply dissected by numerous streams and some rivers. The windward east side of the area consists of nearly level to moderately sloping plateaus that are highly dissected by streams. The highest elevation in Guam, 1,336 feet (407 meters), is on a north-to-south-trending ridge on the leeward west side. Cliffs, gentle to steep slopes, beaches, and reef flats characterize the shoreline. Barrier and fringing reefs occur around the area. The MLRA has more than 40 rivers and streams forming the drainage pattern, and the Fena Reservoir is near its center.

Geology

South Guam consists primarily of deeply weathered volcanic rock from an uplifted submarine volcano. The volcanic origin is linked to the tectonic subduction of the Pacific Plate under the Philippine Plate. Movement along the plate boundary results in frequent earthquakes. The volcanic material is primarily andesite and basalt reworked as tuff, tuff breccia, tuffaceous sandstone, shale, and volcanic conglomerate formed during the Oligocene and Miocene Epochs. Areas of limestone are along the southeast coast and on the tops of ridges in some of the highest mountains.

Climate

The average annual rainfall ranges from about 85 to 100 inches (2,160 to 2,540 millimeters) in the northern half of this MLRA and from about 95 to 118 inches (2,415 to 2,995 millimeters) in the southern half. The average annual temperature is 79 degrees F (26 degrees C). The primary seasons are the dry season, from January through April, and the rainy season, from July through November. Trade winds are persistent during the dry season. Relative humidity is generally high, averaging 76 percent. Variations in temperature and humidity are small throughout the year. Typhoons frequently pass close to Guam. The chance of a typhoon severely impacting the island is once in 8 years. This area is freeze-free.

Water

All of the water used in this area is from surface water sources. Many rivers and streams on the volcanic bedrock provide abundant, good-quality surface water. Municipal water is stored in the Fena Reservoir. The Ugum River is a source of domestic water. The water in some small ponds is used for irrigating crops. Irrigation water also is obtained from the domestic water delivery system. In addition to the Mariana and Barrigada limestone aquifers (described in text for MLRA 191), the Umatac and Alutom Formations are two volcanic rock aquifers that provide some good-quality water for domestic use in southern Guam. Some domestic water is pumped from sedimentary material in the northwest corner of the area, along the coast.

Soils

The soils in this MLRA are Alfisols, Inceptisols, Mollisols, or Oxisols. The dominant soil moisture regime is ustic, and all of the soils have an isohyperthermic temperature regime. The soils are shallow to deep, well drained to somewhat poorly drained, and fine textured.

The main soil series:

Agfayan series—Haplustolls that formed in residuum from marine-deposited tuff, tuff breccia, and tuffaceous sandstone on volcanic uplands

Akina series—Haplustox that formed in residuum from tuff and tuff breccia on volcanic hillslopes

Inarajan series—Endoaquepts that formed in alluvium on broad valley bottoms and coastal plains

Togcha series—Haplustepts that formed in slope alluvium from weathered tuff and tuff breccia on rolling volcanic uplands

Ylig series—Ustifluvents that formed in alluvium derived from weathered tuff and tuff breccia on concave hillsides and in drainageways

Biological Resources

This area is a mosaic of savanna grassland and patches of forest. Except for remnants of a forest plant community in the wetter gulches and river valleys, the native vegetation has been largely replaced by grasses through repeated burning. The common grasses are tall swordgrass and foxtail. The bottoms of ravines and hillside springs are filled with coarse reeds, karriso, and neti, which are adapted to wet soils. Forests occur dominantly in ravines and on valley bottoms but also on some hillsides. They include pago (or beach hibiscus), kafu (or pandanus or screw pine), and ahgao (or false elder).

The only mammal endemic to the Mariana Islands is the Marianas fruit bat. Other mammals, such as sambar deer, pigs, goats, and water buffalo, have been introduced and can be seen in the wild. Several skinks and geckos are native to the Mariana Islands. Several endemic bird species, rufous fantail, the fairy tern, and the Vanikoro swiftlet, an endangered species, inhabit the islands. The native bird populations on Guam have been decimated through the accidental introduction of the brown tree snake. A wide range of coral, anemones, and shellfish and various reef and pelagic fish species are in the surrounding reef systems and open waters.

Land Use

This MLRA is dominantly undeveloped grassland and forest and mainly used for drinking water supply and wildlife habitat (fig. 192-2). Small truck farms operate on valley bottoms and gently sloping uplands. The main crops are bananas, taro, eggplant, beans, cucumbers, green peppers, other vegetable crops, and ornamentals. The U.S. Department of Defense manages the Fena Reservoir. Urban development is primarily along the coastline.

The major soil resource concern is water erosion. Excessive erosion has led to the formation of badlands, which are difficult to revegetate. Excessive sediment overloads the filtration capacity of the domestic water supply system and causes periodic water delivery shutdowns during prolonged periods of rainfall. Siltation of the adjacent coral reefs adversely affects fisheries. Curbing human-induced grassland fires and revegetating bare areas are additional resource management concerns. The most common conservation practices are contour farming, strip-till or no-till, mulching, hillside ditches, terraces, and grassed waterways on uplands and strip-till or no-till, riparian forest buffers, filter strips, and field borders on the wetter lowlands.

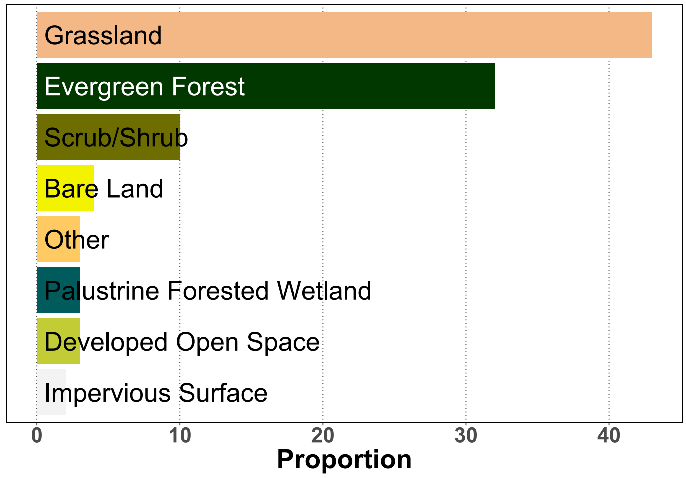

Figure 192-2: Relative proportions (percentages) of land use in MLRA 192.

193—Volcanic Islands of Western Micronesia

This area (fig. 193-1) includes most of the Palau (77 percent) and Yap (23 percent) Islands in the western Caroline Islands group. It makes up about 180 square miles (460 square kilometers). The Palau Islands are about 4,600 miles (7,420 kilometers) west-southwest of Hawaii and about 560 miles (905 kilometers) east of the southern Philippine Islands. The Yap Islands are approximately 290 miles (465 kilometers) northeast of Palau. The islands of Babeldaob, Koror, Malakal, and Arakabesan are in the northern part of the Republic of Palau. The Yap islands are in the western part of the Federated States of Micronesia (FSM).

MLRA 193 is bordered to the northeast by MLRA 192, which consists of volcanic highlands of the Mariana Islands. It is bordered to the southwest by MLRA 194, which consists of the low limestone islands of western Micronesia.

Physiography

This area is in the Pacific Islands province of the Pacific Rim area. It is characterized by uplands underlain by volcanic and metamorphic rocks. The Palau Islands range from level to very steep and are characterized by deep, dendritic drainageways and generally rounded hills. Raised marine terraces are exposed in a few areas. The Yap Islands range from nearly level on raised,

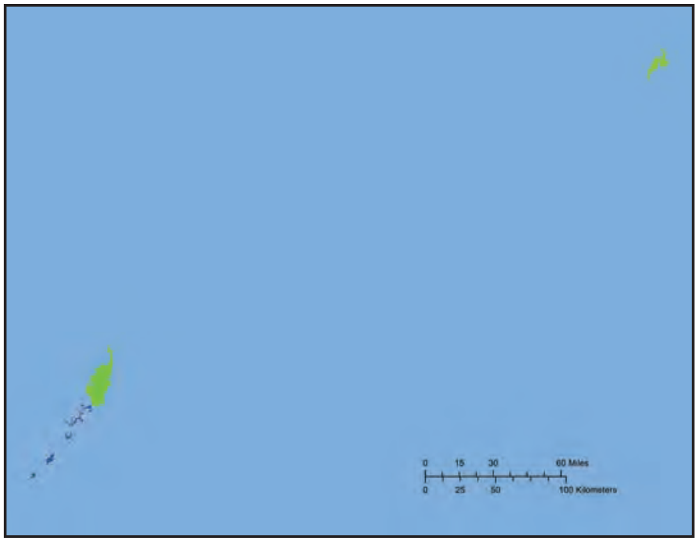

Figure 193-1: Location of MLRA 193, which covers 45,900 hectares (113,600 acres), within Region Q.

dissected benches of volcanic rocks to hilly and mountainous in areas of metamorphic rocks. The highest elevation is about 794 feet (242 meters) on Palau and about 555 feet (169 meters) on Yap. Mangrove swamps, barrier reefs, and some fringing reefs surround both of these island groups. This MLRA includes small streams and rivers.

Geology

The Palau and Yap Islands are primarily of volcanic origin, consisting of tuff and breccia derived from basalt and andesite. Eocene, and probably Oligocene, eruptions were mainly submarine. Tectonic forces subsequently uplifted the islands. Schist, a metamorphic rock derived from volcanic rocks, is the bedrock in about half of the main Yap Islands. Like the Mariana Islands to the north, the islands in this MLRA formed on the boundary where the Pacific tectonic plate is being subducted under the Philippine tectonic plate. Marine terraces and raised coral formations are scattered mainly in coastal areas. Bauxite was mined on volcanic rocks on Babeldaob in the 1920s and 1930s.

Climate

This MLRA is in the intertropical convergence zone. This zone is an area of low pressure where the northeast trade winds meet the southeast trade winds near the equator. As these winds converge, moist air is forced upward and thunderstorms and heavy rainfall occur. The rain intensifies with increased solar heating during summer and diminishes as the sun moves farther from the earth. The driest season is from February through April. The average annual rainfall is 122 to 145 inches (3,100 to 3,685 millimeters). Humidity averages about 90 percent at night and 75 to 80 percent during the day. The average annual temperature is 81 degrees F (27 degrees C). Typhoons are not common in this area. The area is freeze-free.

Water

Almost all of the water used in this area is for domestic supply, and its source is perennial streams. Some areas on both island groups use water catchment systems. Crops are not typically irrigated. The Ngerikiil Watershed provides most of the drinking water for approximately 75 percent of the people of Palau. The island of Babeldaob has 16 watersheds that supply continuous surface water for the potable water needs of that island. About 70 percent of the rain falling on the island runs off to the ocean. In the past, test wells were drilled in the fractured volcanic rocks on the islands and ground water was obtained. The high levels of iron and manganese in the water, however, created a favorable environment for anaerobic bacteria. The bacteria caused blockages in the pumps, so the wells did not yield water for long. Shallow wells in bedrock that draw water from surface sources provide some domestic water in this area.

Soils

Volcanic soils on uplands in this MLRA are mostly Oxisols but include Ultisols and Inceptisols. Alfisols and Mollisols are in areas underlain by schist bedrock. Histosols, Inceptisols, and Entisols are in low areas and coastal areas. The dominant soil moisture regimes are perudic, udic, and aquic. The area is characterized by an isohyperthermic soil temperature regime. The soils generally are moderately deep to very deep, poorly drained to somewhat excessively drained, and fine textured.

The main soil series:

Aimeliik series—Kandiperox that formed in saprolite derived from basalt, andesite, dacite, volcanic breccias, tuff, or bedded tuff; in all hillslope positions on volcanic islands

Babelthuap series—Kandiperox that formed in saprolite derived from basalt, andesite, dacite, volcanic breccias, tuff, or bedded tuff; on erosional crests of hills on volcanic islands

Dechel series—Endoaquepts that formed in organic deposits and alluvial sediments derived from basalt, andesite, dacite, marine deposits, volcanic breccias, tuff, bedded tuff, or schist; in swamps, marshes, and backswamps and on flood plains of valley floors on volcanic islands

Ilachetomel series—Sulfihemists that formed in organic deposits derived dominantly from decomposing mangrove roots and litter; in the intertidal zone of mangrove swamps, salt marshes, and tidal marshes adjacent to volcanic islands

Mesei series—Haplosaprists that formed in deposits of organic material overlying alluvial sediment on bottom land

Ngersuul series—Dystrudepts that formed in alluvium derived from volcanic rock on flood plains

Rumung series—Hapludalfs that formed in residuum derived from green, chlorite, and talc schist on uplands

Weloy series—Argiudolls that formed in material weathered from hard and soft, green, chlorite, and talc schist on uplands

Biological Resources

The native vegetation consists of tropical hardwood trees and savanna grasses. The mountainous areas support tropical hardwoods. The upland forest in Palau is considered one of the most diverse forests in Micronesia. Because different languages are spoken on the individual islands, there are numerous common names for the many plant species in this area. For this reason, scientific names for plants are given in this section.

The common tree species in the uplands are *Campnosperma brevipetiolata, Parinari corymbosa, Alphitonia carolinensis*, and *Rhus taitensis*. Open savanna on Babeldaob and the Yap Islands is common and is thought to be the result of human activity, such as wildfire and land clearing. *Pandanus* species may form a scattered overstory with grasses (*Ischaemum species* and *Miscanthus floridulus*). Some degraded savanna is dominated by the fern *Gleichenia linearis*. The savanna also has a component of shrubs, including *Wikstroemia elliptica, Melastoma malabathricum*, and *Decaspermum* species. Swamp forest, which is inundated with fresh or slightly brackish water, is characterized by *Hibiscus tiliaceus, Horsfieldia amklaal*, and *Cynometra ramiflora*. Mangrove forests occupy most of the coastal intertidal wetlands. They are dominantly *Sonneratia alba* and *Rhizophora mucronata* near the sea and *Lumnitzera littorea* and *Xylocarpus granatum* on the landward side of the mangroves. The surrounding reef systems and open waters have a wide range of coral, anemones, shellfish, and other marine and pelagic fish species.

Land Use

Forest, grassland, and agroforestry are the main land uses (fig. 193-2). Valley bottoms and low-lying areas along the coast are the most productive agricultural lands. Traditional agroforestry systems are dominant, especially on Yap. Small commercial farms growing truck crops are on uplands and bottom lands on Babeldaob. Coconut, breadfruit, betel nut, papaya, bananas, cassava, and taro are the principal crops.

The major soil resource concern is maintaining the quality and productivity of infertile soils with a thin topsoil. Preserving the quality of drinking water in southern Babeldaob also is a major concern.

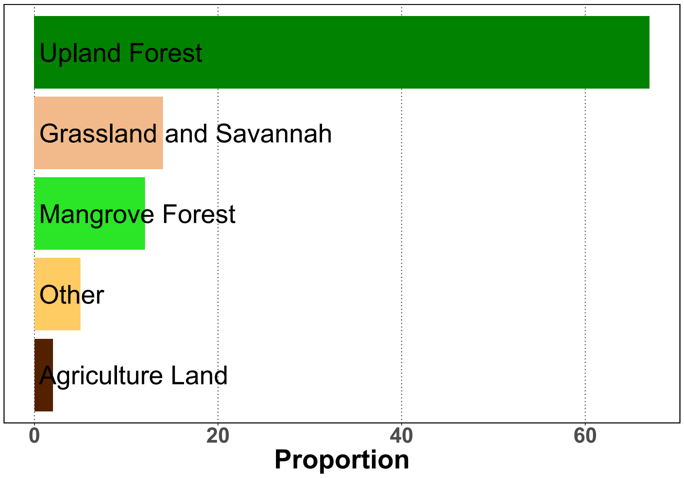

Figure 193-2: Relative proportions (percentages) of land use in MLRA 193.

194—Low Limestone Islands of Western Micronesia

This MLRA (fig. 194-1) includes hundreds of islands in the southern part of the Palau archipelago in the Western Caroline Islands group of Micronesia. It is characterized by uplands underlain by coral bedrock. It makes up about 27 square miles (70 square kilometers). The Palau Islands are about 3,830 miles (6,180 kilometers) west-southwest of Hawaii and about 450 miles (725 kilometers) east of the southern Philippine Islands. The main islands in this MLRA are Peleliu and Angaur, which are 55 miles (90 kilometers) and 69 miles (110 kilometers), respectively, southwest of the capital Koror. Over 350 smaller Rock Islands are between Koror and Peleliu.

Figure 194-1: Location of MLRA 194, which covers 6,700 hectares (16,700 acres), within Region Q.

MLRA 193 is to the northeast. It consists of the volcanic islands of western Micronesia. Most of the volcanic soils on uplands in this MLRA are Oxisols. MLRA 195 is to the east. It consists of the volcanic islands of central and eastern Micronesia, including dozens of high volcanic islands and low islands and atolls consisting of coral. The high volcanic islands are steep and very steep, highly dissected mountains. The dominant soil moisture regime is perudic.

Physiography

This MLRA is in the Pacific Islands province of the Pacific Rim area. It is characterized by low, raised coralline limestone islands. Broad areas of Angaur and Peleliu are nearly flat and have an elevation of 15 to 30 feet (5 to 10 meters). Prominent ridges of rugged limestone are as much as 262 feet (80 meters) above sea level. North of these islands lies a maze of large and small, extremely steep and rugged limestone islands, referred to as the Rock Islands. There are no streams or rivers in this area. Barrier and fringing reefs surround the islands.

Geology

The islands in this area consist of uplifted limestone. Phosphate deposits were once mined on Angaur and Peleliu.

Climate

This MLRA is in the intertropical convergence zone. This zone is an area of low pressure where the northeast trade winds meet the southeast trade winds near the equator. As these winds converge, moist air is forced upward, and heavy rainfall occurs. The rain intensifies with increased solar heating during summer. The rainiest months are June, July, and August. The driest season is February through April. The average annual rainfall is 148 inches (3,760 millimeters). Humidity averages about 90 percent at night and 75 to 80 percent during the day. Typhoons are not common in this area. The average annual temperature is 81 degrees F (27 degrees C). The MLRA is freeze-free.

Water

The islands are too small to have an adequate supply of fresh ground water. Wells provide mostly brackish water on Peleliu and Angaur. Catchment water is used for domestic purposes. Crops are not irrigated.

Soils

Most of the soils on uplands are Mollisols that formed in limestone residuum. Histosols are of lesser extent in the areas underlain by limestone. Entisols formed in wind- and water-deposited coral sand in low-lying coastal areas. The dominant soil moisture regimes are perudic and udic, and the area is characterized by an isohyperthermic soil temperature regime. The soils generally are shallow, well drained, and fine textured.

The main soil series:

- Chelbacheb series—Udifolists that formed in organic material over coralline limestone and probably in additions of volcanic ash and tropospheric dust; on karrens of solution, wave-cut, and raised coralline platforms and karrens on cones, valleys, and towers of karst islands
- Ngedebus series—Udipsamments that formed in water- and wind-deposited coral sand adjacent to coastal beaches and within interiors of atoll islands
- Peleliu series—Eutrudepts that formed in residuum derived from coral limestone on raised coral limestone islands

Biological Resources

The area supports a diverse forest community. Because different languages are spoken on the individual islands, there are numerous common names for the many plant species in this area. For this reason, scientific names for plants are given in this section. Some of the more common species are *Gulubia palauensis, Ptychosperma palauensis, Semecarpus venenosus, Intsia bijuga, Psychotria* species, *Premna obtusifolia, Cordia* species, *Clerodendrum inerme, Pandanus* species, *Dracaena multiflora*, and *Bikkia palauensis*. Mangrove forest occurs in protected areas on Angaur and Peleliu. It includes *Rhizophora apiculata, Bruguiera gymnorhiza*, and *Ceriops tagal*.

Common bird species are the fruit dove, Micronesian pigeon, collared kingfisher, white tern, black noddy, brown noddy, and tropicbirds. The only native mammals are insectivorous bats and fruit bats. Macaque monkeys are an introduced species on Angaur. Saltwater crocodiles inhabit mangrove swamps. The surrounding reef systems and open waters have a wide range of coral, anemones, shellfish, and other marine and pelagic fish species.

Land Use

Most of this MLRA consists of a tropical hardwood forest (fig. 194-2). Low-lying areas along the coast of Angaur and Peleliu are the most productive agricultural lands. Coconut, cassava, breadfruit, betel nut, papaya, bananas, and taro are the principal crops. Small areas of urban land are near the coast. Deep pits and surface scars remain in areas that formerly were mined for phosphate.

The major soil resource concern is maintaining soil quality. Water erosion is not a concern. Measures that curb the spread of invasive species and preserve the quality of the forests and marine life are needed because this area is heavily used for ecotourism. Developing a supply of quality drinking water is a major concern. The most common conservation practices are multistory cropping, mulching, hillside ditches, contour farming, and cover crops.

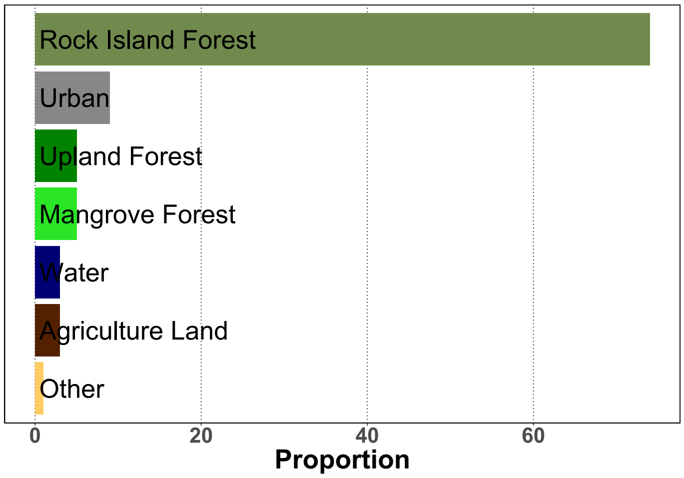

Figure 194-2: Relative proportions (percentages) of land use in MLRA 194.

195—Volcanic Islands of Central and Eastern Micronesia

MLRA 195 (fig. 195-1) consists of dozens of high volcanic islands and low islands and atolls made up of coral. It includes the islands of Pohnpei (59 percent) and Kosrae (19 percent) and the Chuuk Islands (22 percent) in the eastern Caroline Islands group. It makes up about 210 square miles (545 square kilometers). The Chuuk Islands are approximately 2,100 miles (3,380 kilometers) south-southeast of Tokyo, Japan, and 3,500 miles (5,630 kilometers) southwest of Honolulu, Hawaii. Pohnpei is approximately 440 miles (710 kilometers) east of Chuuk, and Kosrae is approximately 360 miles (580 kilometers) east-southeast of Pohnpei. The States of Pohnpei (Ponape), Chuuk (Truk), and Kosrae (Kosaie) are in the Federated States of Micronesia (FSM).

MLRA 195 is bordered to the northeast by MLRA 196, which consists of coral atolls of Micronesia. To the west are MLRAs 193 and 194, which consist of the volcanic islands of western Micronesia and the low limestone islands of western Micronesia, respectively.

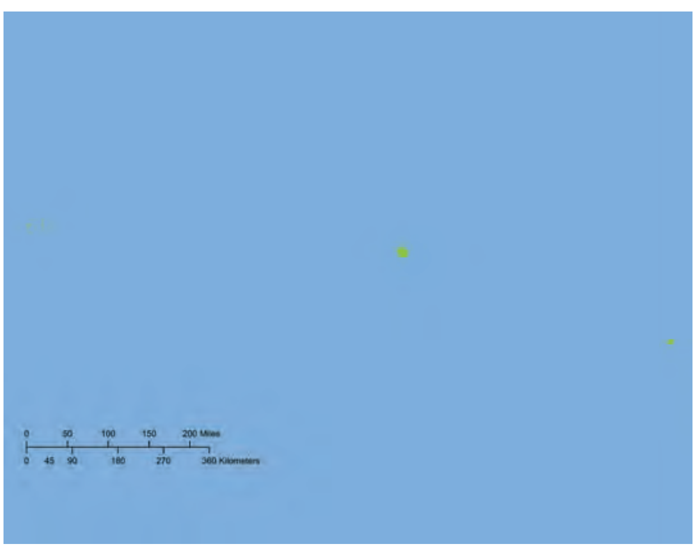

Figure 195-1: Location of MLRA 195, which covers 54,500 hectares (134,800 acres), within Region Q.

Physiography

This MLRA is in the Pacific Islands province of the Pacific Rim area. The high volcanic islands are steep and very steep, highly dissected mountains. Only about a third of the area of most of the islands consists of rolling hills, alluvial coastal plains, and mangrove swamps that surround the mountainous areas. Coastal plains account for most of the relatively flat ground. Elevations range from sea level to about 1,444 feet (440 meters) in Chuuk, 2,625 feet (800 meters) in Pohnpei, and 2,077 feet (633 meters) in Kosrae. Fringing and barrier coral reefs surround these islands. The area includes streams and small rivers.

Geology

The high islands are derived from Tertiary-age, basic igneous rock, mainly basalt, andesite, and trachyte lava flows and dikes. According to geomorphic development, Chuuk is the oldest of the major islands. It is the most eroded, and drowned river valleys attest to recent subsidence. To the east are the younger islands of Pohnpei and Kosrae, which also are highly eroded.

Climate

The climate is characterized by high rainfall, high temperatures, and high humidity. The average annual rainfall generally ranges from about 145 to 225 inches (3,685 to 5,715 millimeters) but is estimated to be as high as 295 inches (7,495 millimeters) in the highest mountains. January through March is the driest season. Northeasterly trade winds affect the weather from November to June. The islands are frequently under the influence of the intertropical convergence zone between July and November, when moist southerly winds and tropical disturbances are most frequent and when humidity is often very high. The average annual temperature is 81 degrees F (27 degrees C). Variations in temperature are very minimal throughout the year. Typhoons are not common in this MLRA. The area is freeze-free.

Water

Domestic water is supplied by perennial streams and rivers. In some areas water catchment systems provide water for domestic use. Crops typically are not irrigated. Wells tap the freshwater in joints and fractures in the volcanic rocks or solution openings in the limestone or coral deposits that have been raised above sea level.

Soils

Most of the soils on the volcanic uplands are Inceptisols or Oxisols, whereas the soils on bottom land are Entisols or Histosols. The dominant soil moisture regime is perudic, and the soil temperature regime is isohyperthermic. The soils are dominantly shallow to very deep and are well drained to very poorly drained. The soils on uplands are mostly fine textured and have mixed or oxidic mineralogy. The soils on bottom land generally are sandy and have carbonatic mineralogy.

The main soil series:

Chia series—Sulfihemists that formed in organic deposits derived dominantly from decomposing mangrove roots and litter over water-deposited coralline sand and gravel; in the intertidal zone of mangrove swamps, salt marshes, and tidal marshes adjacent to atolls and karst islands

Dolekei series—Dystrudepts that formed in material weathered from basic igneous rock on uplands

Dolen series—Dystrudepts that formed in residuum derived from highly weathered basic igneous rock on uplands

Fomseng series—Dystrudepts that formed in residuum derived from highly weathered basic igneous rock on uplands

Insak series—Psammaquents that formed in organic materials and water-deposited coralline sand; in brackish waters of mangrove swamps, salt marshes, and tidal marshes adjacent to shorelines of atolls and karst islands

Naniak series—Sulfaquents that formed in alluvium derived from basalt in coastal tidal marshes

Rakied series—Acroperox that formed in material derived from basaltic flows on uplands and terraces

Tolonier series—Paleudalfs that formed in residuum and colluvium derived from basic igneous rock on uplands

Umpump series—Acroperox that formed in residuum derived from volcanic lava on highly weathered volcanic lava flows

Biological Resources

This area generally is forested, but it includes a few small savannas, fern lands, and cleared and cultivated areas in the lowlands and on mid-mountain slopes. Tropical palms and broadleaf trees are the dominant plants in the mountain forests on steep slopes. The most common trees are campnosperma, eucalyptus, Honduras mahogany, teak, pandanus, and mangrove. Agroforestry consists of a canopy layer of broadleaf tree species, such as breadfruit and mango as well as coconut and pandanus cultivars, and a lower layer of bananas, kava, cassava, medicinals, and other home-garden shrubs and herbs. Mangrove forests make up most of the coastal intertidal wetlands.

The most common birds in the area are doves, pigeons, kingfishers, swiftlets, terns, herons, gulls, petrels, tropicbirds, and frigate birds. The only native mammals are fruit bats. The surrounding reef systems and open waters have a wide range of coral, anemones, shellfish, and reef and pelagic fish species.

Land Use

Most of this MLRA is tropical hardwood forest and scattered grassland (fig. 195-2). Most of the population lives on the coastal plains. Subsistence farming is practiced in river basins and on lowlands and mid-mountain slopes. Valley bottoms and low-lying areas along the coast are the most productive agricultural lands. Traditional agroforestry systems dominate the landscape. Breadfruit, betel nut, coconut, bananas, cassava, and taro are the principal crops. Wildlife habitat and tourism are other important land uses.

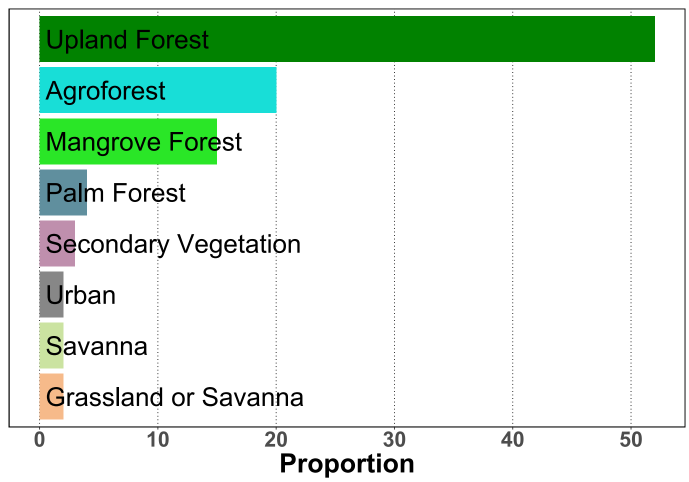

Figure 195-2: Relative proportions (percentages) of land use in MLRA 195.

The major soil resource concern is maintaining the quality and productivity of very infertile soils with a thin topsoil. The most common conservation practices are multistory cropping, forest stand improvement, tree planting, and mulching.

196—Coral Atolls of Micronesia

MLRA 196 (fig. 196-1) consists primarily of coral atolls and some small, low coral islands in the Republic of the Marshall Islands at the eastern end of the Caroline Islands group. It makes up about 10 square miles (30 square kilometers). It is roughly 2,300 miles (3,700 kilometers) southwest of Hawaii. The area is scattered over 502,000 square miles (1.3 million square kilometers) between 4 and 14 degrees north latitude and 160 and 173 degrees east longitude. The MLRA has a southwest boundary with MLRA 195, which consists of the volcanic islands of central and eastern Micronesia.

Figure 196-1: Location of MLRA 196, which covers 2,800 hectares (7,000 acres), within Region Q.

Physiography

This MLRA is in the Pacific Islands province of the Pacific Rim area. It consists of more than 1,225 islands within 29 atolls. The coral atolls consist of low, nearly level, long, narrow islands. Most islets in the Marshall Islands are less than 3,300 feet (1,005 meters) long and 1,650 feet (505 meters) wide. The average island height is about 6 feet (2 meters), and the highest elevation is about 20 feet (6 meters), on Likiep Atoll. Fringing and barrier coral reefs surround these islands. The area has no streams or rivers.

Geology

These islands originated as high volcanic islands, but over time they have been lowered by erosion and tectonic subsidence. Corals grew around the submerged islands, forming atolls and shallow reefs.

Climate

The climate in this area is characterized by high rainfall, high temperatures, and high humidity. The average annual rainfall generally ranges from about 40 to 145 inches (1,015 to 3,685 millimeters). It decreases to the north, and the northern atolls are prone to drought between December and May. January, February, and March are generally the driest months in the southern atolls, which receive 6 to 9 inches (150 to 230 millimeters) of rain annually. The remaining months have a range of 11 to 15 inches (280 to 380 millimeters). The average annual temperature is 81 degrees F (27 degrees C). Variations in temperature are very minimal throughout the year. Typhoons are not common in this area. The MLRA is freeze-free.

Water

Domestic water is supplied by wells and water catchment systems. Crops typically are not irrigated. Wells tap freshwater in solution openings in the limestone or coral deposits that have been raised above sea level.

Soils

The soils in this MLRA are mainly Entisols. They are very deep and somewhat excessively drained. The soil moisture regime ranges from perudic to ustic. All of the mineral soils in the area have an isohyperthermic soil temperature regime and carbonatic mineralogy.

The main soil series:

Majuro series—Udorthents derived from water- and wind-deposited coralline rubble and sand; on beach ridges, beach terraces, and beaches of atolls, karsts, and islands (generally on the oceanside of islands)

Ngedebus series—Udipsamments that formed in water- and wind-deposited coral sand; adjacent to coastal beaches and within interiors of atoll islands

Biological Resources

These islands commonly have atoll-strand forest on the fringes and agroforestry crops in the interior. Coconut trees cover about 60 percent of the land area. Half-flower tree, pandanus, ironwood, and hibiscus also are common. Agroforestry consists of a canopy layer of tree species such as breadfruit, mango, and coconut and a lower layer of bananas and other garden plants.

The most common birds are fruit doves, pigeons, and a variety of sea birds. The area has no native mammals. The surrounding reef systems and open waters have a wide range of coral, anemones, shellfish, and other marine and pelagic fish species.

Land Use

Most of the cropland in this area is used for agroforestry (fig. 196-2), but taro patches also are significant. Much of the land is covered by roads, buildings, swamps, or beaches. The different islands have small areas of subsistence agriculture and urban land.

The major soil resource concern is maintaining the quality and productivity of infertile soils with a thin topsoil. Maintaining the content of soil organic matter is crucial for sustainable agricultural productivity. Water conservation and prevention of ground water and lagoon pollution are additional resource concerns. The most common conservation practices are multistory cropping and mulching.

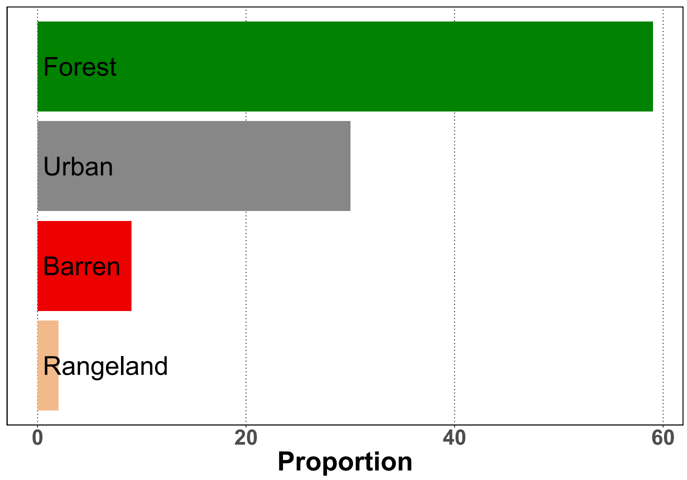

Figure 196-2: Relative proportions (percentages) of land use in MLRA 196.

197—Volcanic Islands of American Samoa

This MLRA (fig. 197-1) consists of the American Samoa islands of Tutuila, Aunu`u, Ofu, Olosega, and Ta`u in the southern Pacific Ocean. It makes up about 77 square miles (199 square kilometers). It is approximately 2,300 miles (3,710 kilometers) south-southwest of Hawaii and 4,150 miles (6,695 kilometers) southwest of California.

Physiography

This area is in the Pacific Islands province of the Pacific Rim area. The islands are characterized by extremely steep, highly dissected volcanic mountains, small valleys, and a narrow coastal plain leading into deep waters offshore. Islands that are not volcanic include Swains Island and Rose Island. Landslide scars are common on the steep mountainsides. More than half of this area has slopes of more than 70 percent. The overall slope of the landscape is due to recent giant landslides and stream erosion. Recent lava flows have built up a broad lava plain on the south side of Tutuila, and there are several cinder cones in this area. The highest elevation, 3,056 feet (931 meters), is on Lata Mountain, on Ta`u. The second highest elevation, 2,142 feet (653 meters), is on Matafao Peak, on Tutuila. Fringing and barrier coral reefs surround these islands. The area has streams but no rivers.

Figure 197-1: Location of MLRA 197, which covers 19,500 hectares (48,400 acres), within Region Q.

Geology

This area consists of volcanic islands made up of Pleistocene-age, basic igneous rocks, mainly basalt and lesser amounts of andesite and trachyte. These rocks are weathered to a considerable depth in some areas. Volcanic ash and cinders have accumulated mostly on young, gently sloping surfaces. Colluvium is common at the base of mountain slopes.

Climate

This MLRA is characterized by a tropical maritime climate with abundant rain and warm, humid days and nights. The average annual precipitation is generally about 125 inches (3,175 millimeters) but is more than 250 inches (6,350 millimeters) in some areas. The amount of rainfall varies greatly over short distances because of the effects of topography. The driest months are June through September (winter), and the wettest are December through March (summer). The average annual temperature is 81 degrees F (27 degrees C). The relative humidity ranges from 73 to 90 percent throughout the year. The prevailing winds throughout the year are easterly trade winds. They are less prevalent in summer than in winter. Typhoons occasionally strike this area. The MLRA is freeze-free.

Water

Fresh ground water is confined by dikes at the higher elevations and is perched on saltwater at the lower elevations. Ground water is pumped to large storage tanks before it is distributed for domestic use. The Leone volcanic rock aquifer supplies almost all of the public and industrial water on Tutuila. The water is hard. An increasing population and increasing urbanization are putting pressure on the ground water supply. Ground water recharge decreases as the area of impervious surfaces increases, and heavy pumping is causing some saltwater intrusion. In addition, fecal coliform contamination has been detected in some wells on Tutuila.

In some areas, water catchment systems that channel water from roofs into cement tanks provide water for domestic use. Because of the abundant rainfall, crops are seldom irrigated. The MLRA has some perennial and intermittent streams.

Soils

Most of the soils on volcanic uplands are Mollisols and Andisols that are shallow to very deep and generally well drained. The dominant soil moisture regime is perudic, and the dominant soil temperature regime is isohyperthermic. The soils generally are fine textured and have mixed, halloysitic, or amorphic mineralogy. The soils on bottom land are Entisols with sandy textures and carbonatic mineralogy and Histosols. They range from shallow to very deep. Nearly level to very steep, mostly well drained Hapludolls are on valley bottoms.

The main soil series:

Iliili series—Hapludands that formed in volcanic ash and are underlain by lava on uplands

Leafu series—Hapludolls that formed in fine textured alluvium derived from weathered basic igneous rock on valley floors

Oloava series—Hapludands that formed in volcanic ash and cinders on uplands

Pavaiai series—Fluvudands that formed in volcanic ash and are underlain by lava on uplands

Puapua series—Hapludands that formed in volcanic ash and are underlain by hard tuff on uplands

Sogi series—Hapludands that formed in volcanic ash and are underlain by hard tuff on uplands

Tafuna series—Udifolists that formed in surface accumulations of organic matter over fragmental `a`a lava on uplands

Biological Resources

Rainforests cover most of this area. Tropical palms and broadleaf trees are the dominant plants on steep slopes in the mountain forests. The most common tree species are maota mea, laga´ali, asi, mamalava, and tava.

The most common birds in the forests are barn owls, tropicbirds, Samoan starlings, white-collared kingfisher, and the many-colored fruit dove. Sea birds include frigate bird, brown booby, gray-backed tern, and white tern. The surrounding reef systems and open waters have a wide range of coral, anemones, shellfish, and other marine and pelagic fish species.

Land Use

Most of this MLRA consists of tropical hardwood forests (fig. 196-2). The interiors of the islands are virtually inaccessible because of very steep mountainous terrain and dense vegetation. Most of the population lives on the coastal plains and in valleys. Subsistence farming is practiced on lowlands and on mid-mountain slopes. Valley bottoms and wet, low-lying areas are the most productive lands for the staple crop of taro. Traditional agroforestry systems dominate the agricultural landscape. Agroforestry consists of a canopy layer of tree species such as breadfruit, coconut, and mango and a lower layer of bananas, kava, cassava, taro, and other garden plants. Coconut, cassava, breadfruit, papaya, bananas, and taro are the principal crops. Wildlife habitat is another important land use.

The major soil resource concern is water erosion on steep slopes. Common conservation practices are multistory cropping, mulching, hillside ditches, contour farming, and cover crops.

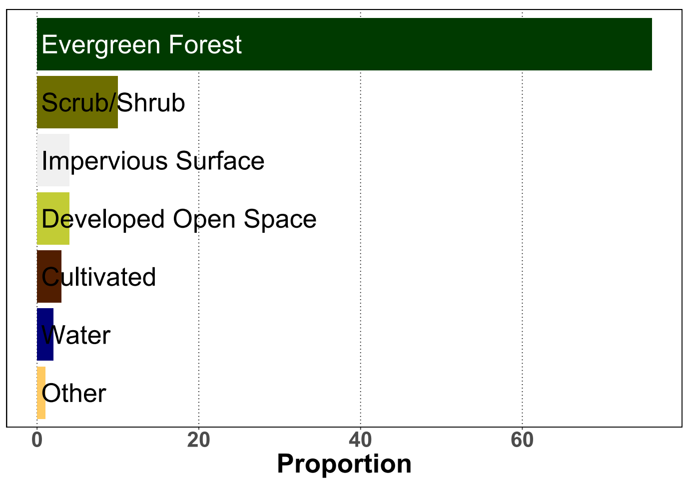

Figure 197-2: Relative proportions (percentages) of land use in MLRA 197.

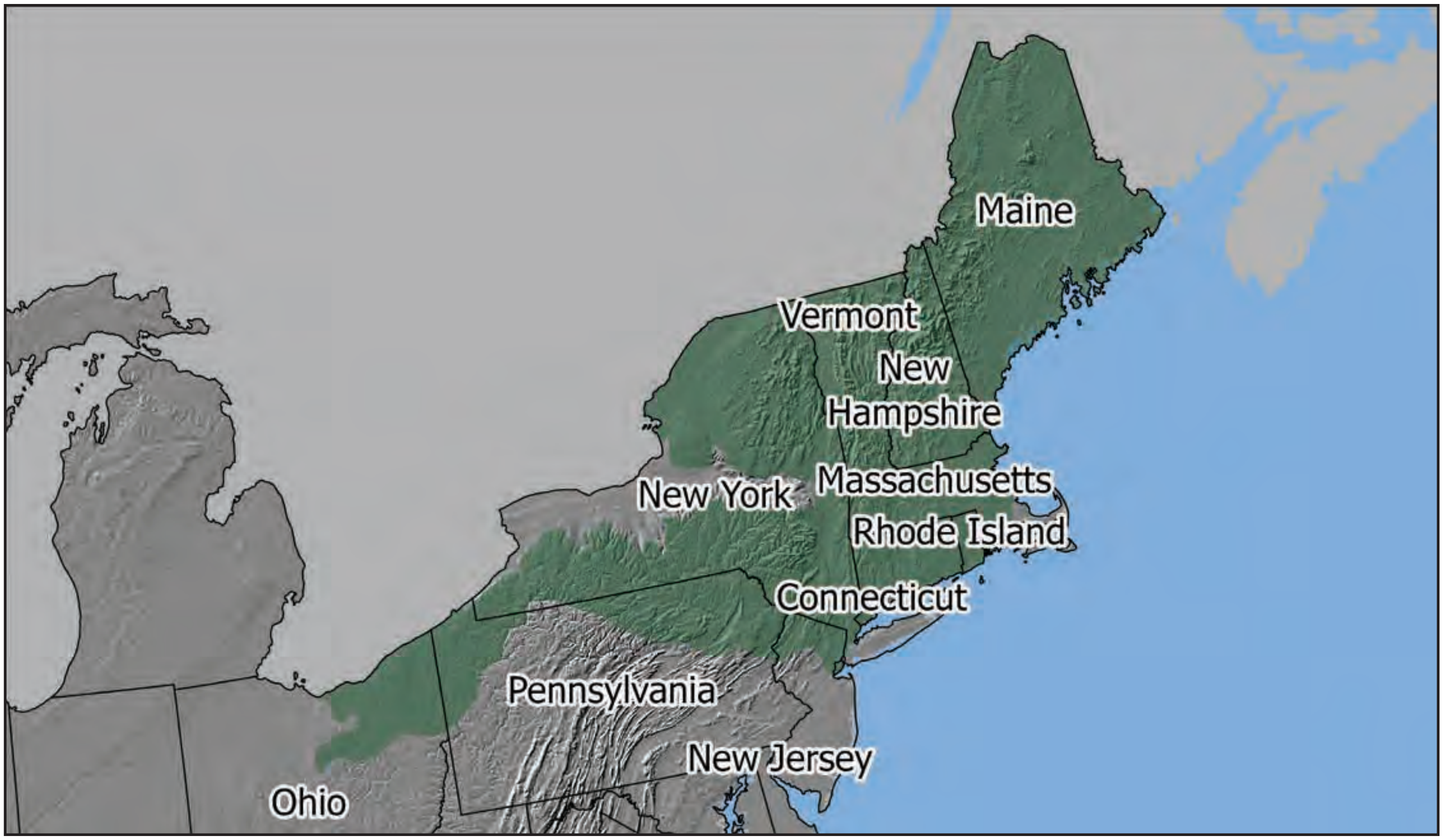

Figure R-1: Location and size of Land Resource Region R, which covers 318,325 square kilometers (122,905 square miles) across New England, northern Pennsylvania, and northeast Ohio.

R—Northeastern Forage and Forest Region

Land Resource Region R (fig. R-1) is the glaciated region of mountains, hills, valleys, dissected plateaus, and coastal areas of New England, northern Pennsylvania, and northeast Ohio. The glacial landscape consists of till plains, outwash, lake deposits, stratified drift, drumlins, eolian deposits, terminal moraines, ablation till, glaciomarine sediments, and alluvial flood plains. These Late Pleistocene deposits vary in thickness over clastic rocks of the Appalachian Plateaus, crystalline Precambrian rocks of the Adirondack Mountains, metamorphic and intrusive igneous rocks of the New England province, and a narrow strip of folded sedimentary rocks of the northern Valley and Ridge. This region contains nine major land resource areas. The extent of these MLRAs and their range in elevation are shown in table R-1.

The boundary between Regions R and L (fig. 1, page 5), which intrudes Region R as the Mohawk Valley in New York, is where an area of dominantly Alfisols on calcareous till (Region L) changes to the forested Spodosols on noncalcareous till to the north, in the Adirondack Mountains, and the wooded Inceptisols to the south, in the Catskill Mountains. The sharp boundary between Regions R and M reflects a change from areas with noncalcareous till over clastic bedrock and Alfisols that have an abundance of fragipans and aquic conditions (Region R) (figs. 2 and 11, pages 6 and 15) to areas with calcareous till overlying limestone and an increase in the extent of Mollisols and cropland (Region M). The boundary between Regions R and N is the limit of Wisconsin glaciation. The Inceptisols with numerous fragipans that formed in glacial deposits, in Region R, contrast with the Ultisols with fewer fragipans that formed in non-glaciated parent material derived from Paleozoic sedimentary bedrock, in Region N (see Introduction, figs. 2, 11, and 12). The boundary between Regions R and S, which also demarks the contact between glacial and non-glacial geology, is where the Valley and Ridge is greatly reduced in width, becoming the narrow north-south-oriented Hudson Valley. Densic material and ortstein are root-restrictive features in some soils of this region (figs. 9 and 11, pages 13 and 16).

Climatically, the region has abundant precipitation, ranging from 39 to 53 inches (995 to 1,360 millimeters). Soil moisture regimes across the entire region are udic and aquic, and numerous perennial streams provide ample supplies of surface and ground water. Annual temperatures range from 39 to 50 degrees F (4.1 to 10 degrees C); the soil temperature regime is frigid in the northern half of the region and mesic in the

Table R-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
139	30,650	11,835	160	540	250	830	340	1,130	460	1,530	680	2,230
140	58,490	22,580	10	30	290	970	450	1,490	620	2,030	1,270	4,170
141	3,035	1,175	110	380	180	590	370	1,220	550	1,810	640	2,110
142	18,305	7,065	0	0	40	140	120	390	330	1,090	830	2,730
143	89,120	34,410	20	80	170	570	400	1,310	650	2,150	1,910	6,270
144A	50,110	19,345	0	0	10	50	110	360	250	840	710	2,350
144B	58,865	22,730	0	0	30	110	150	510	420	1,380	1,160	3,830
145	5,070	1,960	0	0	20	70	70	240	220	720	690	2,280
146	4,690	1,810	70	250	140	460	190	630	260	850	520	1,730

Table R-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
139	6.8	44	7.9	46	9.5	49	10.2	50	11	52	130	147	165/165	187	215
140	4.3	40	6.8	44	7.6	46	8.7	48	10.8	51	110	135	149/150	160	185
141	4.6	40	5	41	6.3	43	7.8	46	8.3	47	115	126	143/140	153	155
142	4.6	40	6.3	43	7	45	7.7	46	8.8	48	115	144	152/155	161	185
143	-1.8	29	3.2	38	4.8	41	6.2	43	8.4	47	90	115	130/130	145	170
144A	6.1	43	8.1	47	9.4	49	10.7	52	13	55	135	151	165/170	195	240
144B	2.3	36	5.5	42	6.8	44	7.6	46	9.1	48	100	130	147/145	162	205
145	4.9	41	7.1	45	9.7	50	10.4	51	11.3	52	120	146	168/165	182	210
146	2.9	37	3.5	38	4.1	39	4.9	41	5.3	42	105	123	131/130	137	145

Table R-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
139	910	36	973	38	1,043/1,065	41/42	1,194	47	1,320	52
140	790	31	924	36	1,091/1,090	43/43	1,247	49	1,780	70
141	1,130	45	1,221	48	1,362/1,360	54/53	1,479	58	1,590	62
142	790	31	903	36	975/995	38/39	1,122	44	1,500	59
143	820	33	1,048	41	1,140/1,180	45/46	1,367	54	2,420	95
144A	940	37	1,087	43	1,225/1,205	48/48	1,285	51	1,450	57
144B	910	36	1,089	43	1,192/1,190	47/47	1,291	51	1,780	70
145	910	36	1,054	41	1,176/1,175	46/46	1,282	50	1,340	52
146	930	37	981	39	1,034/1,030	41/41	1,081	43	1,150	45

southern half. The freeze-free period ranges from 85 days in the higher mountains to 240 days in some areas along the Atlantic Coast. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables R-2 and R-3.

Soils in the southern half of Region R are geologically young and dominantly Inceptisols (fig. 2). Many have fragipans, especially in the Appalachian Plateau area (fig. 11). Fragipans are also common in the Alfisols of northeast Ohio. The northern half of the region is dominated by Spodosols where a combination of climate, parent material, and vegetation (mainly spruce-fir) results in the movement of organic colloids into the subsoil. The region also includes Alfisols in limestone-derived parent materials, Entisols on flood plains and eolian deposits, and Histosols in peat bogs. The soils in Region R generally do not have carbonates, with the exception of soils overlying limestones in northwestern New York and on narrow outcrops in the Hudson and Saint Lawrence Valleys (fig. 5, page 9). Argillic horizons are notably absent as well (fig. 12). Organic carbon is generally higher in this region, especially in the mountains, than in most of the conterminous United States (fig. 14, page 18).

Land use in Region R is primarily forest (fig. R-2 and fig. 8, page 12). Significant amounts of lumber and pulpwood are produced. Locally, Christmas trees and maple syrup are important forest products. Hay, pasture, and grains (especially corn) are the principal crops. Where markets, climate, and soils are favorable, fruits and vegetables are important crops. Wildlife habitat and recreation are other important land uses. Stoniness and steep slopes limit the use of many of the soils, but this area performs important ecosystem services, primarily as a source of potable water for large cities.

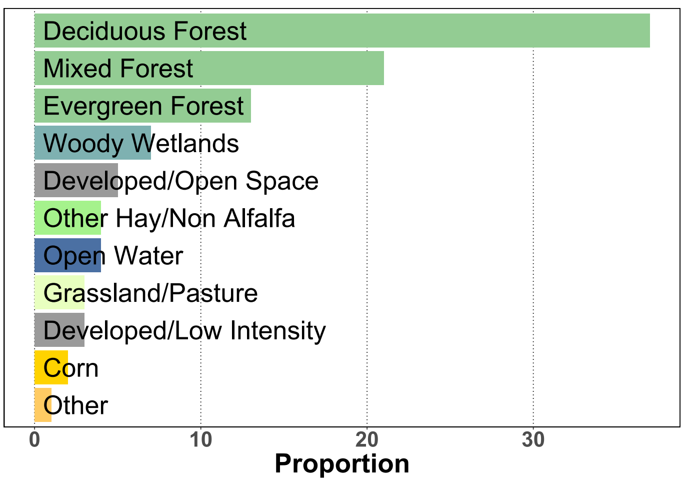

Figure R-2: Relative proportions (percentages) of land use in Land Resource Region R based on 2018 data from the National Agricultural Statistics Service.

139—Lake Erie Glaciated Plateau

MLRA 139 (fig. 139-1) is in Ohio (57 percent), Pennsylvania (34 percent), and New York (9 percent). It makes up about 11,833 square miles (30,648 square kilometers). This MLRA consists of a dissected plateau mantled with various thicknesses of Wisconsin-age glacial deposits. The rolling hills and plains have been shaped and influenced by the action of glacial ice and glacial meltwater. The MLRA is mainly used for general farming and livestock and dairy production.

The eastern boundary of MLRA 139, with MLRA 140 (Glaciated Allegheny Plateau and Catskill Mountains), is

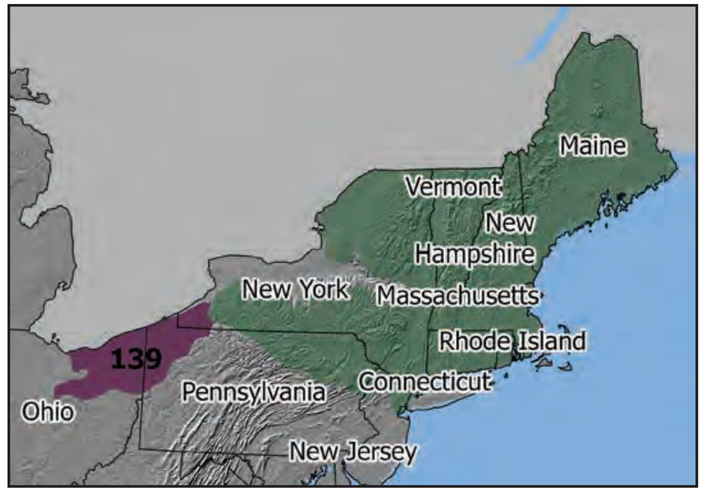

Figure 139-1: Location of MLRA 139, which covers 3,064,800 hectares (7,573,100 acres), within Region R.

diffuse and transitional. The southern boundary is distinct and separates glacial deposits from non-glacial deposits. The western boundary, with MLRA 111 (Indiana and Ohio Till Plain), is diffuse and transitional. The northern boundary is Lake Erie.

Physiography

This area is almost entirely in the Southern New York section of the Appalachian Plateaus province of the Appalachian Highlands. The southern edge of the area is in the Kanawha section of the same province and division. The western suburbs of Cleveland, in the western tip of the area, are in the Till Plains section of the Central Lowland province of the Interior Plains. A narrow band along the shore of Lake Erie is in the Eastern Lake section of the same province and division.

Most of this MLRA is a gently rolling to strongly rolling, dissected glaciated plateau. The narrow band along Lake Erie is relatively flat. Stream valleys are narrow and not deeply incised, but the valley walls are typically steep. In some areas the interfluves are broad and nearly level. Elevation ranges from 660 to 1,000 feet (200 to 305 meters), increasing gradually from north to south. Local relief is about 7 to 50 feet (2 to 15 meters). Most of the rivers in this MLRA flow north to Lake Erie. The headwaters of the Ohio River are in the northeast corner of this area, in Pennsylvania, and some of the headwaters of the Muskingum River are in the central part of the area, in Ohio.

Geology

The bedrock in this area consists mostly of alternating beds of sandstone, siltstone, and shale of Upper Devonian, Mississippian, and Pennsylvanian age. Shale units are dominant closer to the surface along Lake Erie and the western edge of the area. The surface is mantled with glacial till, outwash of unconsolidated sand and gravel, glacial lake sediments, and stratified drift deposits (kames and eskers). The outwash, lake sediments, and stratified drift deposits that fill valleys are important sources of ground water. Younger stream deposits cover the glacial deposits in some of the river valleys.

Climate

The average annual precipitation is 36 to 52 inches (914 to 1,313 millimeters). Rainfall occurs during high-intensity, convective thunderstorms in summer. The seasonal snowfall averages 40 inches (100 centimeters). The average annual temperature is 44 to 52 degrees F (7 to 11 degrees C). The freeze-free period averages 180 days and ranges from 145 to 215 days.

Water

Precipitation and perennial streams provide an abundance of good-quality surface water. Lake Erie and large reservoirs on perennial streams provide water for public supply and industrial use in several of the large cities in the area. On many farms, small constructed ponds provide water for livestock and irrigation and are used for recreation.

Shallow and deep wells are the main sources of water for domestic use and municipal supplies. One source of ground water is the glacial deposits in the valleys. The water from these aquifers is hard or very hard and generally requires softening. This good-quality water is susceptible to contamination from surface activities because the aquifer is often directly recharged from precipitation and runoff on the valley floors.

A second source of ground water in this area is the sandstone bedrock. The water from this aquifer is generally very hard and requires treatment prior to use. At a depth of more than 300 feet, this water is saline. Contamination of the water in this bedrock aquifer is rare.

Soils

The dominant soil order is Alfisols. The soils in the area dominantly have a mesic temperature regime, an aquic or udic moisture regime, and mixed or illitic mineralogy. They are very deep, well drained to poorly drained, and loamy or clayey.

The main soils and their series:

- Epiaqualfs that formed in till on till plains (Mahoning series)
- Fragiaqualfs that formed in till on till plains and moraines (Frenchtown, Platea, Ravenna, Sheffield, Venango, and Wadsworth series)
- Fragiudalfs that formed in till (Canfield and Rittman series) and loess over till (Wooster series) on till plains and moraines
- Hapludalfs that formed in outwash deposits on outwash plains, terraces, kames, and beach ridges (Chili series); that formed in till on till plains (Ellsworth series)

Biological Resources

This area supports mostly beech forest vegetation. American beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), red oak (*Quercus rubra*), white ash (*Fraxinus americana*), and white oak (*Quercus alba*) are the dominant species. Other species include basswood (*Tilia americana*), shagbark hickory (*Carya ovata*), black cherry (*Prunus serotina*), and cucumber tree (*Magnolia acuminata*). American beech and sugar maple are dominant on some poorly drained flatlands. Mixed, mesophytic oak-sugar maple and oak forest types occur in some areas. Major wildlife species include white-tailed deer, cottontail, squirrel, pheasant, and quail.

Land Use

About three-fourths of this MLRA is in farms (fig. 139-2). Feed grains (corn, soybeans, winter wheat, and oats) and forage (grass-legume hay, tall fescue pasture, and alfalfa hay) for dairy cattle are the main crops in the western part of the area. Similar crops are grown in the eastern part, where there are many part-time farms and many rural residences. The MLRA has some cow-calf operations. Some areas are used for potatoes or small fruit crops. A large amount of the milk is locally converted to cheese. The areas of hardwood forest are mainly in farm woodlots. Saw logs for rough construction, firewood, and some high-quality saw logs for specialty uses are harvested from the numerous farm woodlots. Some large holdings are used for watershed protection.

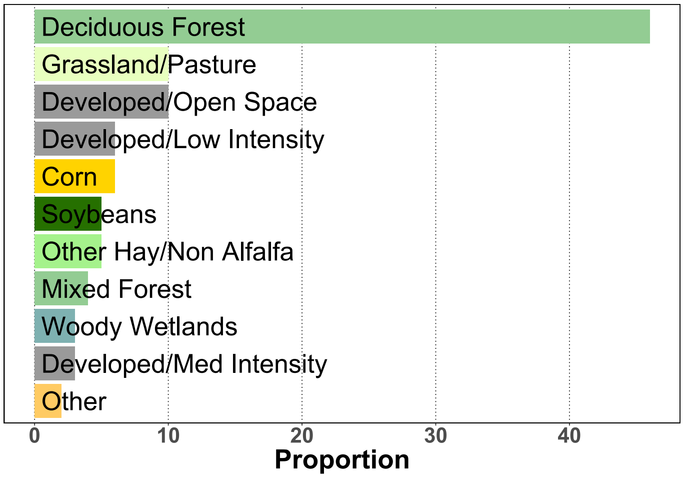

Figure 139-2: Relative proportions (percentages) of land use in MLRA 139.

The major soil resource concerns are sheet and rill erosion, sedimentation by stormwater runoff, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include systems of crop residue management (such as conservation tillage), winter cover crops, grass-legume plantings, contour farming, irrigation water management, compost facilities, nutrient management, manure management, and pesticide management. Excluding livestock from wetlands and watercourses and developing rotational grazing systems help to control erosion and protect water quality. Important conservation practices in community development include critical site planting and urban stormwater management.

140—Glaciated Allegheny Plateau and Catskill Mountains

MLRA 140 (fig. 140-1) is in New York (64 percent), Pennsylvania (35 percent), and New Jersey (1 percent). It makes up about 22,582 square miles (58,488 square kilometers). This MLRA consists of a highly dissected plateau mantled with various thicknesses of Wisconsin-age glacial deposits. Hills and mountains in the area have been modified and shaped by glacial action, and valleys are generally U-shaped. The Catskill Mountains are in the eastern part of this area, in New York State.

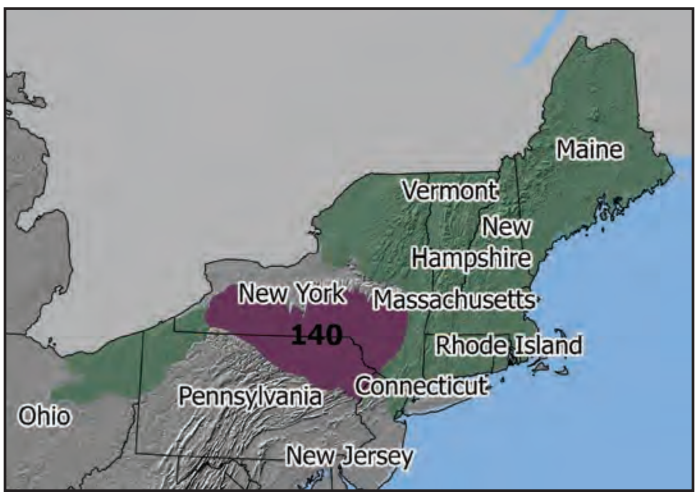

Figure 140-1: Location of MLRA 140, which covers 5,848,800 hectares (14,452,500 acres), within Region R.

The northern boundary of MLRA 140 is gradual and transitional as glacial tills in MLRA 101, with higher carbonate content, grade to the more acid tills of MLRA 140. The eastern boundary (with MLRA 144A) is distinct and marked by the Shawangunk Mountains in New York State and the Kittatinny Mountain in Pennsylvania and New Jersey. The southern boundary (with MLRAs 127 and 147) is distinct and separates glacial deposits from non-glacial deposits. The western boundary, with MLRA 139 (Lake Erie Glaciated Plateau), is diffuse and transitional.

Physiography

This area is primarily in the Southern New York section of the Appalachian Plateaus province of the Appalachian Highlands. The east-central part is in the Catskill section, a small portion of the Allegheny Mountain section is in the south-central part of this MLRA, and the southwest corner of the MLRA is in the Kanawha section, all within the same province and division. The southeast edge and a fingerlike area protruding into the southeast corner of the MLRA are in the Middle section of the Valley and Ridge province of the Appalachian Highlands. The top of the dissected plateau in this MLRA is broad and nearly level to moderately sloping. The narrow valleys have steep walls and smooth floors. The Catskill Mountains have steep slopes. Elevation is typically 650 to 1,000 feet (200 to 305 meters) on valley floors, 1,650 to 2,000 feet (505 to 610 meters) on the plateau surface, and 3,600 feet (1,100 meters) or more in parts of the Catskill Mountains.

This MLRA includes the headwaters of the Susquehanna, Delaware, Genesee, and Allegheny Rivers. The Genesee River, in the southwestern part of this area, is one of the few rivers in the area that flow north.

Geology

The bedrock in this area includes alternating shale and sandstone beds of Devonian age. Some of the Upper Devonian layers have eroded away in the part of the area in New York. Glacial drift mantles the area. Significant deposits of glacial outwash, consisting of unconsolidated sand and gravel, fill most of the valley floors. Some glacial lake sediments and ice-contact and stratified drift deposits occur in most of the valleys. These deposits are the primary aquifers in this area. Younger stream deposits cover some of the glacial deposits on the valley floors.

Climate

The average annual precipitation is 31 to 68 inches (799 to 1,735 millimeters). Rainfall occurs during high-intensity, convective thunderstorms in summer, but most of the precipitation occurs as snow. The average annual temperature is 40 to 51 degrees F (4 to 11 degrees C). The freeze-free period averages 165 days and ranges from 130 to 200 days. The coldest temperatures and the shortest freeze-free periods are in the high-elevation areas in the eastern part of the MLRA.

Water

Precipitation and perennial streams and lakes provide an abundance of good-quality surface water. Soils that have a fragipan are too wet in winter and spring for cultivation and are deficient in moisture during much of the growing season. Irrigation is used sparingly and typically on high-value crops.

The primary source of ground water is the glacial outwash deposits in the valleys. The water in these deposits is hard or very hard and may require softening. This good-quality water is susceptible to contamination from surface activities because the aquifer is often directly recharged from precipitation and runoff on the valley floors. The valleys are the sites of the most intensive land use activities.

A secondary source of ground water, primarily in the southern half of the area, in Pennsylvania, is the sandstone and shale aquifer. Water from this aquifer varies in quality, depending on the source rocks. The water from dominantly sandstone units is soft, and the water from the shale units generally is hard and requires treatment prior to use. Contamination from surface activities is rare.

Soils

The dominant soil order is Inceptisols. The soils in the area dominantly have a mesic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. They are shallow to very deep, well drained to very poorly drained, and loamy or loamy-skeletal.

The main soils and their series:

Dystrudepts that formed in till on hills and dissected plateaus (Arnot, Lordstown, and Oquaga series)

Fragiaquepts that formed in till (dense till in some areas) on hills and till plains (Chippewa, Morris, Norwich, and Volusia series)

Fragiudepts (Bath, Lackawanna, Mardin, Swartswood, Wellsboro, and Wurtsboro series)

Biological Resources

This area supports forest vegetation, particularly hardwood species. Beech-birch-maple and elm-ash-red maple are the potential forest types. The extent of oak species increases from east to west, particularly in areas of shallow and dry soils. Conifers, such as eastern white pine (*Pinus strobus*), are important in some local areas. Aspen (*Populus grandidentata* and *Populus tremuloides*), eastern hemlock (*Tsuga canadensis*), northern white cedar (*Thuja occidentalis*), and black ash (*Fraxinus nigra*) grow on the wetter soils. Sugar maple has potential economic significance in some areas. Major wildlife species include white-tailed deer, cottontail, turkey, pheasant, and grouse.

Land Use

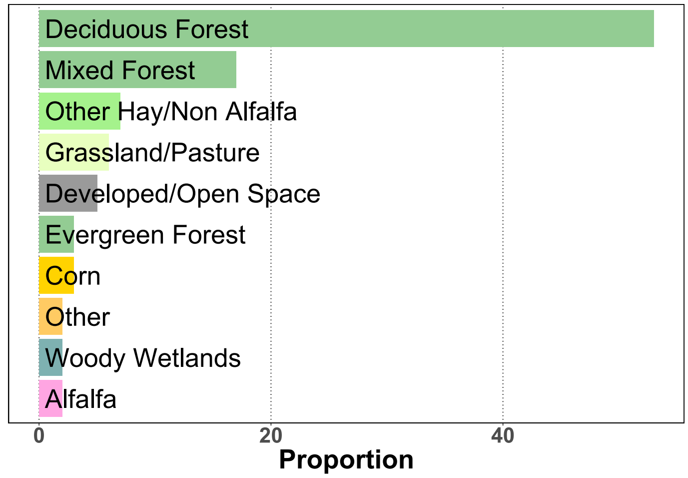

Figure 140-2: Relative proportions (percentages) of land use in MLRA 140.

A large acreage is in second- and third-growth forests of oak and northern hardwoods. Wood products are a major industry in this MLRA. Much of the area is in farms (fig. 140-2). Hay, pasture, and some grain are grown for dairy cattle. Potatoes are an important crop grown on the top of the plateau, and poultry, fruits, and truck crops are produced in many of the narrow valleys. Maple syrup production is important in the upland areas. Abandoned or idle land, which is common in the steeper areas, is reverting to grasses, weeds, shrubs, and trees. Urban development is expanding in some areas. The Catskill Mountains are used mainly for wood products, maple syrup production, and recreation.

The major soil resource concerns are water erosion, soil wetness, and maintenance of the content of organic matter and productivity of the soils. Sedimentation from nonpoint sources, such as agricultural and urban runoff, also is a concern. Conservation practices on cropland generally include conservation tillage, contour stripcropping, crop rotations, crop residue management (mulch-till), cover crops, diversions, and grassed waterways. Conservation practices on forestland generally include forest stand improvement and proper construction, use, and maintenance of skid trails, water bars, access roads, and log landings.

141—Tug Hill Plateau

MLRA 141 (fig. 141-1) is entirely in New York and makes up about 1,173 square kilometers (3,037 square kilometers). It consists of a relatively small but unique upland that lies just off the eastern end of Lake Ontario and west of the Black River Valley and Adirondack Mountain region. It is essentially a north- and east-facing glaciated cuesta scarp and is underlain by thick Wisconsin till and small areas of outwash. Most of the plateau is woodland, so forestry and recreation are the primary uses, but small isolated dairy operations and hobby farms are located around the perimeter.

The area is bordered on the east by the Black River Valley, on the north by the St. Lawrence Lowland, on the west by the Ontario Lowland, and on the south by the Upper Mohawk Valley. The northern and eastern boundaries of MLRA 141 are distinct where they contact the physiographically dissimilar southwestern part of MLRA 142 (St. Lawrence-Champlain Plain). The western and southern boundaries are also distinct where they contact the physiographically dissimilar MLRA 101 (Ontario-Erie Plain and Finger Lakes Region).

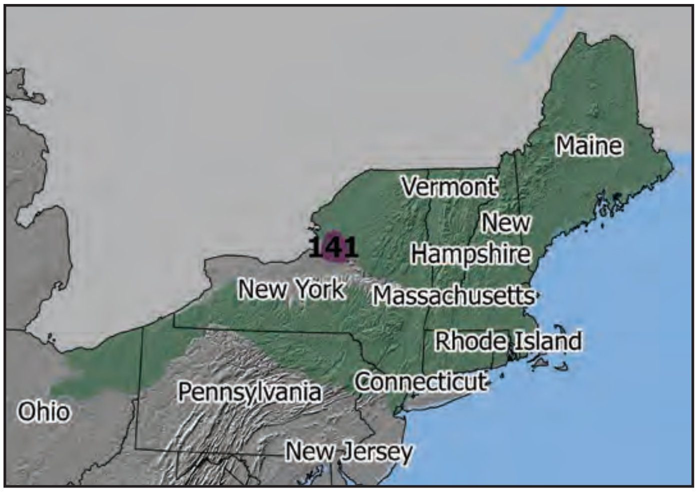

Figure 141-1: Location of MLRA 141, which covers 303,700 hectares (750,500 acres), within Region R.

Physiography

Most of this area is in the Mohawk section of the Appalachian Plateaus province of the Appalachian Highlands. The west and southwest third of the area is in the Eastern Lake section of the Central Lowland province of the Interior Plains. This MLRA is nearly level to gently sloping across the top of the plateau and hilly to steep around the margins. Elevation ranges from 980 feet (300 meters) along the lower margins to 1,970 feet (600 meters) at the top of the plateau. Local relief generally is 15 to 80 feet (5 to 25 meters), but the bordering lowlands are typically about 330 feet (100 meters) below the top of the plateau.

Geology

This area is a plateau underlain mostly by Ordovician- and Silurian-age sandstones, siltstones, and shales. It is mostly underlain by Oswego sandstone and Pulaski siltstone and shale. The Queenston shale occurs in the southwest part of the MLRA and in some small isolated areas of the interior. Most of the area has a relatively thick mantle of till. Some small amounts of outwash deposits occur in the southern part of the MLRA. A small drumlin field is in the east-central part of the plateau.

Climate

The average annual precipitation is 45 to 62 inches (1,142 to 1,571 millimeters). The precipitation is evenly distributed throughout the year. Rainfall occurs during high-intensity, convective thunderstorms in summer. Lake-effect snowfall is heavy from late autumn to early spring. In some areas the seasonal snowfall is as much as 140 inches (355 centimeters). The average annual temperature is 40 to 47 degrees F (4 to 8 degrees C). The freeze-free period averages 115 days and ranges from 90 to 140 days. The lowest temperatures and the shortest freeze-free periods are on the summit of the plateau.

Water

Precipitation and perennial streams provide an abundance of good-quality surface water. The area has few natural ponds or lakes. The available water resources are little used because of the lack of urban centers, mining, industry, or suitable agricultural land. Dense fragipans in most of the soils perch ground water for extended periods in winter and spring.

Shallow and deep wells supply water for livestock and domestic use, the two main uses of water in this MLRA. Stratified glacial drift is a source of ground water in the central and southeastern parts of this MLRA. In nearly level areas consisting mainly of glacial lake sediments, ground water is close to the surface during part of the year. The water from this aquifer is hard or very hard.

A sandstone bedrock aquifer underlies almost all of this area. It has very hard water with the highest levels of chloride of all the aquifers in this area, which are still well below the drinking water standard.

Soils

The dominant soil orders are Spodosols and Inceptisols. The soils in the area have a frigid temperature regime, a udic or aquic moisture regime, and mixed or isotic mineralogy. Many have a fragipan. Most are very deep to bedrock. The soils are loamy or sandy and have varying amounts of gravel. Surface stones and boulders are common. The soils formed mostly in glacial till derived primarily from acid sandstone, siltstone, and shale. The till is compact and dense in many places.

The main soil series:

- Empeyville series—Fragiorthods that formed in loamy acid dense till on till plains
- Fishcreek series—Haplorthods that formed in sandy acid glaciofluvial deposits on outwash plains and terraces
- Rifle series—Haplohemists that formed in neutral organic material in swamps and bogs
- Swancott series—Haplorthods that formed in sandy and gravelly acid glaciofluvial deposits on outwash plains and terraces
- Tughill series—Endoaquepts that formed in loamy acid till on till plains
- Westbury series—Fragiaquods that formed in loamy acid dense till on till plains
- Worth series—Fragiorthods that formed in loamy acid dense till on till plains

Biological Resources

This area supports northern hardwoods. The beech-birch-sugar maple forest type is of primary importance. Sugar maple (*Acer saccharum*) is of particular economic significance. The elm-ash-red maple type also has potential in some parts of the MLRA. Red spruce (*Picea rubens*), balsam fir (*Abies balsamea*), and eastern white pine (*Pinus strobus*) typically grow in mixed stands. Early succession vegetation includes highbush blueberry (*Vaccinium corymbosum*), lowbush blueberry (*Vaccinium angustifolium*), and aspen-birch forest types. As succession approaches climax, sugar maple, American beech (*Fagus grandifolia*), and eastern hemlock (*Tsuga canadensis*) increase in importance. Eastern hemlock, white spruce (*Picea glauca*), American elm (*Ulmus americana*), black ash (*Fraxinus nigra*), and red maple (*Acer rubrum*) grow on the wetter soils. A mixture of moss (*Bryophyta*), Labrador tea (*Ledum groenlandicum*), and fern (*Pteridophyta*) occurs on extremely wet, organic soils. Major wildlife species include white-tailed deer, snowshoe hare, cottontail, and ruffed grouse.

Land Use

Most of this area is forested with mixed hardwoods and conifers (fig. 141-2). Part of the forestland is abandoned cropland that has reverted to forest vegetation. Pulpwood, sawlogs, Christmas trees, and maple syrup are the principal forest products. The cropland is used mainly for forage and some feed grains grown for dairy cattle. A sizable acreage has reverted to unproductive brush and weeds. A small acreage is used for urban development.

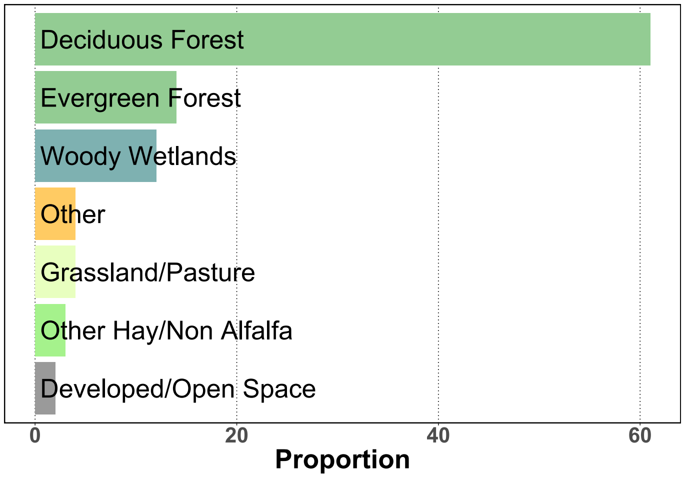

Figure 141-2: Relative proportions (percentages) of land use in MLRA 141.

The major soil resource concerns are water erosion, soil wetness, and maintenance of the content of organic matter and productivity of the soils. Sedimentation from nonpoint sources, such as agricultural and urban runoff, also is a concern. Conservation practices on cropland generally include conservation tillage, contour stripcropping, crop rotations, crop residue management (mulch-till), cover crops, diversions, and grassed waterways. Conservation practices on forestland generally include forest stand improvement and proper construction, use, and maintenance of skid trails, water bars, access roads, and log landings.

142—St. Lawrence-Champlain Plain

MLRA 142 (fig. 142-1) is in New York (75 percent) and Vermont (25 percent). It makes up about 7,067 square miles (18,305 square kilometers). The MLRA is made up of two broad valleys, the St. Lawrence and Champlain, that coalesce to form a broad contiguous lowland underlain by relatively thick Wisconsin till, outwash, lacustrine, and marine deposits. It adjoins Lake Champlain at the New York-Vermont border.

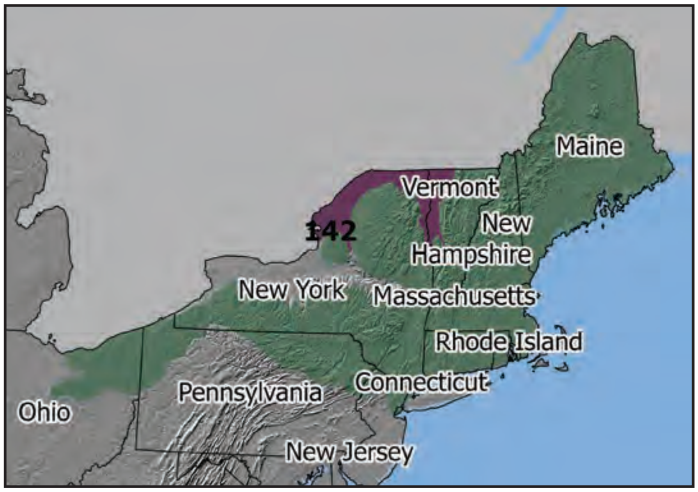

Figure 142-1: Location of MLRA 142, which covers 1,830,500 hectares (4,523,100 acres), within Region R.

MLRA 142 is roughly U-shaped, with the open end to the south. A distinct southern boundary occurs in New York with the physiographically dissimilar Adirondack Mountains part of MLRA 143. The eastern boundary is distinct where it contacts the physiographically dissimilar Green Mountains part of MLRA 143 in Vermont. The southwestern boundary, in New York, is distinct with the physiographically dissimilar Tug Hill Plateau (MLRA 141) but is more diffuse with small parts of MLRA 101. The southeastern part of MLRA 142 forms a relatively diffuse boundary with MLRAs 144A and 144B in New York and Vermont. The northern boundary of the MLRA is the Canadian border and the St. Lawrence River. Lake Ontario is along the western boundary.

Physiography

The northern half of this area is in the Champlain section of the St. Lawrence Valley province of the Appalachian Highlands. Small areas in the northern part of the MLRA are in the Adirondack province of the same division. Most of the southwest corner of the MLRA is in the Eastern Lake section of the Central Lowland province of the Interior Plains. A small area in the southwest corner is in the Mohawk section of the Appalachian Plateaus province of the Appalachian Highlands.

The southeastern extremities of the MLRA are in the Hudson Valley section of the Valley and Ridge province and the Taconic section of the New England province of the Appalachian Highlands.

This MLRA is a glaciated area of low relief dominated by broad expanses of nearly level, sandy deltas and shallow lacustrine and marine basins or plains punctuated by low hills of glacial till. Rivers and streams have cut relatively deep but narrow valleys across the plain. Elevation ranges from 80 to 1,000 feet (25 to 305 meters), increasing gradually from the St. Lawrence River southward and from Lake Champlain to the east and west. Local relief generally is less than 30 feet (10 meters), but glacial till ridges, till plains, and some outwash terraces rise 15 to 80 feet (5 to 25 meters) above the adjacent plains.

Geology

This area was glaciated, and a moderately thick to thin mantle of till covers most of the bedrock. Extensive areas of sandy glacial outwash and thin eolian deposits also occur. Some glacial lake sediments have been deposited over the till. These deposits are thickest in the valleys and thinnest on the ridges and highlands. During the later stages of the Wisconsin glacial period, seawater entered the Champlain Valley and deposited marine sediments that were later covered by thin freshwater sediments in places. The marine deposits are unique to the area. Numerous bedrock outcrops occur in the western half of the area. The bedrock is primarily dolomites, limestones, marbles, and calcareous shales of Ordovician age. To a lesser extent and below these rocks are the Cambrian Potsdam Sandstone and conglomerate. In addition, marbles and gneisses of Middle Proterozoic age occur to a lesser extent in the southwestern part of the MLRA. The limestone units and the Potsdam Sandstone are major aquifers. The carbonate rocks in the part of this area in northwestern Vermont have some quartzite layers.

Climate

The average annual precipitation is 31 to 60 inches (798 to 1,522 millimeters). The precipitation is evenly distributed throughout the year. Most of the rainfall occurs during high-intensity, convective thunderstorms in summer. Snowfall is heavy from late autumn to early spring. The average annual temperature is 40 to 48 degrees F (4 to 9 degrees C). The freeze-free period averages 135 days and ranges from 100 to 170 days. It is longest in a narrow belt around Lake Champlain.

Water

Precipitation and numerous perennial streams provide an abundance of surface water. The St. Lawrence Seaway, which forms the northern border of the area, and Lake Champlain, on the eastern border, are important transportation arteries and are used extensively for recreation. Industry is generally the largest user of both surface water and ground water in the MLRA. The steep terrain provides numerous opportunities for hydropower facilities on rivers. The surface water in the area generally is of excellent quality. Acid rain is a problem. The acidity removes metals, such as aluminum, iron, and mercury, from soils, and these contaminants enter the streams, lakes, and reservoirs and eventually the food chain. Algae growth in Lake Champlain is a local concern.

Ground water is abundant in this MLRA. Deep wells in the stratified glacial drift yield moderate quantities of water for domestic use. In nearly level areas consisting mainly of heavy textured marine and lake sediments, ground water is close to the surface during part of the year. The unconsolidated sand and gravel in alluvial and glacial outwash deposits filling valley floors are a significant aquifer in the part of this area in Vermont. The water from this aquifer is hard or very hard.

Two bedrock aquifers, a carbonate system and the Potsdam Sandstone, occur in the northwestern, north-central, and northeastern parts of this MLRA. The water in the carbonate aquifer is the hardest encountered in New York and Vermont. It is the only water in the area that exceeds the national secondary standard for drinking water for total dissolved solids. The Potsdam Sandstone typically lies beneath the carbonate aquifer, but both aquifers do not always occur in a given area. The sandstone has very hard water with the highest levels of chloride of all the aquifers in this area, which are still well below the drinking water standard.

Soils

The dominant soil orders are Alfisols, Inceptisols, Spodosols, and Entisols. The soils in the area have a frigid or mesic temperature regime, an aquic or udic moisture regime, and mixed or isotic mineralogy. They are shallow to very deep, excessively drained to very poorly drained, and sandy to clayey.

The main soil series:

- Adams series—Haplorthods that formed in frigid sandy acid outwash on deltas and stream terraces
- Covington series—Endoaqualfs that formed in mesic very-fine-family clays on lacustrine or marine plains
- Farmington series—Eutrudepts that formed in mesic loamy calcareous shallow till over limestone on till plains
- Hogansburg series—Eutrudepts that formed in frigid loamy calcareous dense till on till plains
- Limerick series—Endoaquepts that formed in mesic silty neutral alluvium
- Malone series—Epiaquepts that formed in frigid loamy calcareous dense till on till plains
- Muskellunge series—Epiaqualfs that formed in frigid fine-family clays on lacustrine or marine plains
- Nellis series—Eutrudepts that formed in mesic loamy calcareous dense till on till plains
- Schroon series—Dystrudepts that formed in frigid loamy acid till on till plains
- Swanton series—Epiaquepts that formed in frigid loamy over clayey sediments on lacustrine or marine plains

Vergennes series—Hapludalfs that formed in mesic very-fine-family clays on lacustrine or marine plains
Windsor series—Udipsamments that formed in mesic sandy neutral outwash on deltas and stream terraces
Woodstock series—Dystrudepts that formed in frigid loamy acid shallow till over sandstone or gneiss on till plains

Biological Resources

This area typically supports hardwoods. A variation of the beech-birch-sugar maple forest type is the dominant climax forest type on uplands. Associated with this type are basswood (*Tilia americana*), red oak (*Quercus rubra*), shagbark hickory (*Carya ovata*), white ash (*Fraxinus americana*), black cherry (*Prunus serotina*), and white pine (*Pinus strobus*). The aspen-birch type, earlier in succession, is economically important. Species such as tamarack (*Larix laricina*), northern white cedar (*Thuja occidentalis*), fir (*Abies*), and spruce (*Picea*) are on wet soils. This MLRA also supports alvar woodlands (in areas of shallow to limestone bedrock), sandstone pavement barrens, and sandy pine barrens. Trees species in the alvar woodlands are eastern redcedar (*Juniperus virginiana*), bur oak (*Quercus macrocarpa*), and American elm (*Ulmus americana*). Sandstone pavement and pine barren species include jack pine (*Pinus banksiana*) and pitch pine (*Pinus rigida*). Major wildlife species include white-tailed deer, red fox, raccoon, beaver, woodchuck, muskrat, cottontail, ruffed grouse, and woodcock.

Land Use

Most of this area is in forests or farms (fig. 142-2). The forests consist of northern hardwoods and conifers. Sawlogs and pulpwood are the main forest products. Christmas trees and maple syrup also are produced throughout the area. Dairy operations and some beef operations are common. Hay for dairy cattle is the principal crop, but small grain and corn are grown for silage in some areas. Corn for grain, soybeans, and small grains also make up a significant acreage. Potatoes are an important cash crop in some areas, and a few apple orchards are on the slopes along Lake Champlain, but the total acreage of these crops is small. Some areas are used for urban development.

The major soil resource concerns on cropland are sheet, rill, and gully erosion; the content of organic matter and productivity of the soils; and surface compaction (resulting primarily from the harvest of crops under wet conditions). Some erosion results from logging practices. Conservation practices on cropland generally include conservation tillage, contour stripcropping, crop rotations, crop residue management (primarily mulch-till), cover crops, diversions, and grassed waterways. Conservation practices on forestland generally include forest stand improvement and proper construction, use, and maintenance of skid trails, water bars, access roads, and log landings.

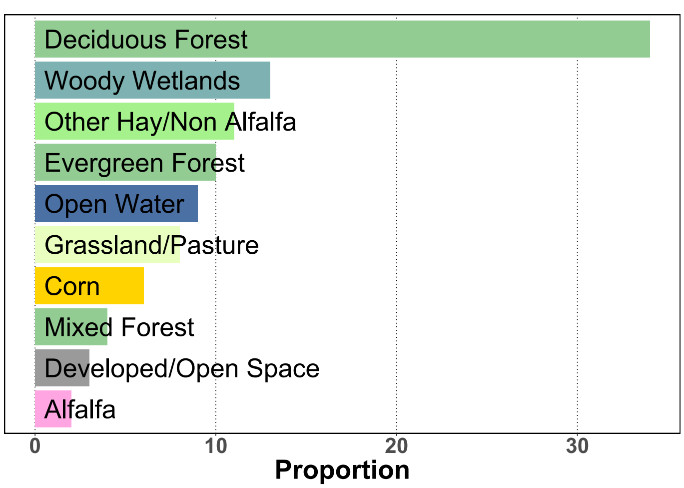

Figure 142-2: Relative proportions (percentages) of land use in MLRA 142.

143—Northeastern Mountains

MLRA 143 (fig. 143-1) is in Maine (51 percent), New York (27 percent), Vermont (13 percent), New Hampshire (7 percent), and Massachusetts (2 percent). It makes up about 34,409 square miles (89,118 square kilometers). The MLRA consists of rolling hills and mountains covered by Wisconsin till. It is in three parts separated by other MLRAs. The western part is in New York (primarily the Adirondack Mountains). The central part is mainly in the Green Mountains in Vermont and the Berkshires in Massachusetts. The eastern part is in New Hampshire and most of northern Maine. The MLRA is used mainly for forestry and recreational purposes.

The western part of MLRA 143 in the Adirondack Mountains has a distinct boundary with the physiographically dissimilar Saint Lawrence-Champlain Plain. The middle part that encompasses the Green Mountains has a diffuse boundary as it blends into the northern part of the New England and Eastern

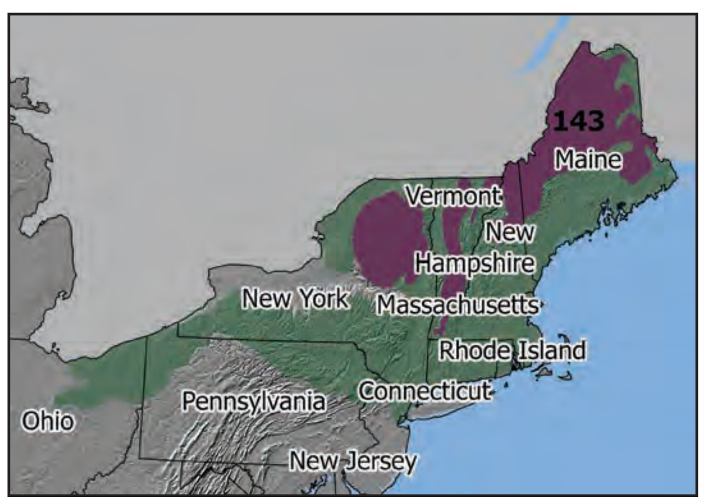

Figure 143-1: Location of MLRA 143, which covers 8,911,800 hectares (22,021,400 acres), within Region R.

New York Uplands on the foothills of the Green Mountains. The southern boundary of the easternmost part of MLRA 143 has the same diffuse boundary. The northern boundary of the MLRA is the Canadian border.

Physiography

The westernmost part of this MLRA is primarily in the Adirondack province of the Appalachian Highlands. A small area in the southern end of the western part is in the Mohawk section of the Appalachian Plateaus province of the same division. The easternmost part, primarily in northern Maine, is in the New England Upland section of the New England province of the Appalachian Highlands. The southwestern half of this part is in the White Mountain section of the same province and division, and the middle part of the MLRA is in the Green Mountain section.

The mountains and foothills in this MLRA are commonly rounded. They are underlain by bedrock and typically covered with thin deposits of till. The more rugged mountain areas are separated by high-gradient streams coursing through steep areas of colluvium or talus-laden valleys. Many glacially broadened valleys are filled with glacial outwash and have numerous swamps and lakes. The mountains and foothills are moderately steep to very steep, and the valleys are nearly level to sloping.

Elevation generally ranges from 1,000 to 4,000 feet (305 to 1,220 meters), but it is more than 5,000 feet (1,525 meters) on a few isolated peaks and less than 1,000 feet (305 meters) in some of the valleys, especially in northeastern Maine. Local relief ranges from moderate in some areas to high in ruggedly mountainous areas.

Geology

The entire area was glaciated by the last continental ice sheet. In addition, evidence on the more rugged mountain peaks indicates that alpine glaciation may have lingered after the retreat of the Wisconsin ice. A thin mantle of till covers most of the bedrock. Sandy glacial outwash has been deposited in many stream valleys, and ice-contact, stratified drift (on kames and eskers) has been deposited on the walls of the valleys. When the European and African continents were pushed up against the North American continent by plate tectonic activity, the mountains in this MLRA were similar in appearance to the present Himalaya Mountains. For the past 500 million years, as the Atlantic Ocean opened up and the European and African continental plates were pushed east, erosion has been the dominant process. Only the roots of those ancient mountains remain in the area today. The bedrock consists primarily of igneous and metamorphic rocks. The metamorphic rocks (gneiss, schist, slate, metanorthosite, marble, and quartzite) are the oldest. The igneous rocks, primarily granite and granodiorite, were intruded into the metamorphic rocks during the Triassic and Cretaceous Periods. The deformation history and the weathering of these rocks have left numerous fractures, joints, bedding plane partings, and cleavage partings that now contain freshwater.

Climate

The average annual precipitation is 33 to 93 inches (848 to 2,350 millimeters). More precipitation generally falls in summer than in winter. Most of the rainfall occurs during high-intensity, convective thunderstorms in summer. Heavy snowfalls are common in winter. The average annual temperature is 30 to 47 degrees F (-1 to 8 degrees C). The freeze-free period averages 100 days and ranges from 30 to 170 days, decreasing in length with elevation.

Water

Precipitation, perennial streams, and lakes provide an abundance of water. In the parts of the MLRA in New York and Vermont, the surface water is used primarily for recreation and the steep terrain provides numerous opportunities for hydropower facilities. The surface water in the part of the MLRA in New Hampshire, Maine, and Massachusetts is used for recreation, light industry (textile and paper mills), and public supply. The surface water throughout the MLRA generally is of excellent quality. Acid rain is a concern. The acidity removes metals, such as aluminum, iron, and mercury, from soils. These contaminants enter the streams, lakes, and reservoirs and eventually the food chain.

Ground water is abundant in deep glacial outwash in valleys but is scarce in the till and bedrock on uplands. Wells in the till yield moderate quantities of water for domestic use. The water from the glacial aquifers can be soft to very hard. The crystalline bedrock throughout this area yields moderately hard ground water of generally excellent quality. The level of total dissolved solids is very low. In the water from some wells, high, naturally occurring levels of iron and manganese can exceed the secondary standards for drinking water. In Maine and New Hampshire, high, naturally occurring levels of radon were a concern in about 5 percent of the wells tested in this aquifer. Wells in granite with high amounts of muscovite and biotite are likely the source of the radon-222.

Soils

The dominant soil orders are Spodosols and, to a lesser extent, Inceptisols. The soils in the area dominantly have a frigid temperature regime, an aquic or udic moisture regime, and isotic or mixed mineralogy. At high elevations (above 3,000 feet, or 915 meters, in the Adirondack and White Mountains), the soil temperature regime is cryic. The soils are shallow to very deep, generally somewhat excessively drained to poorly drained, and loamy.

The main soil series:

Berkshire series—Haplorthods that formed in loamy till on hills, mountains, and plateaus

Burnham series—Humaquepts that formed in dense till in depressions on till plains
Howland series—Haplorthods that formed in dense till on hills and ridges
Lyman series—Haplorthods that formed in loamy till on hills, mountains, and plateaus
Marlow series—Haplorthods that formed in dense till on hills and mountains
Monarda series—Epiaquepts that formed in dense till in depressions on till plains
Peru series—Haplorthods that formed in dense till on hills and mountains
Plaisted series—Haplorthods that formed in dense till on hills and ridges
Telos series—Haplorthods that formed in dense till on hills and mountains
Tunbridge series—Haplorthods that formed in loamy till on hills, mountains, and plateaus

Biological Resources

This area supports northern hardwoods, spruce, and fir. The most common trees are sugar maple (*Acer saccharum*), American beech (*Fagus grandifolia*), yellow birch (*Betula alleghaniensis*), black cherry (*Prunus serotina*), eastern white pine (*Pinus strobus*), balsam fir (*Abies balsamea*), red spruce (*Picea rubens*), eastern hemlock (*Tsuga canadensis*), black spruce (*Picea mariana*), and quaking aspen (*Populus tremuloides*). Sugar maple, yellow birch, American beech, red spruce, and eastern hemlock are dominant on the better drained soils on hills and ridges. Red spruce and balsam fir are dominant on the wetter soils on long, gentle slopes and in depressions. Stunted balsam fir and red spruce are common on many of the high mountaintops. Major wildlife species include moose, black bear, white-tailed deer, snowshoe hare, and ruffed grouse.

Land Use

The forested areas support northern hardwoods, spruce, and fir. Wood for lumber and pulp for the paper industry are the principal forest products. Maple sugar is an important product in many areas. Most farming is a part-time enterprise on isolated farms. Much of the area in the Adirondack Mountains in New York is in a State park, and much of the area in New Hampshire is part of the White Mountain National Forest. Although most of the area in New England is privately owned, a large part is in national forests, State forests, or State parks. This MLRA is widely used for year-round recreation. A small acreage is used for residential development (fig. 143-2).

The major soil resource concerns are related to forestry and recreational development. They include sheet, rill, and gully erosion. Forest management concerns include erosion in scarified areas used as log decks and in areas along logging roads and skidder ruts that focus runoff up and down the slope.

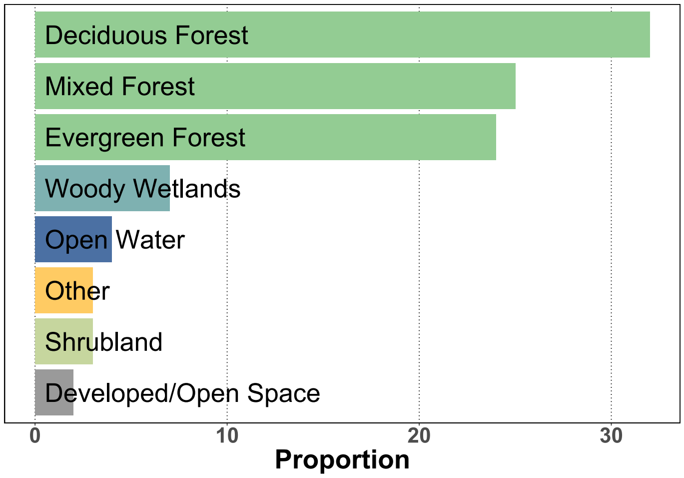

Figure 143-2: Relative proportions (percentages) of land use in MLRA 143.

Construction sites for cottage and housing developments expose soil to the elements. The hazard of erosion becomes severe as the extent of disturbed areas and the slope increase. Erosion also is a severe hazard on ski slopes and in snowboarding areas because of the steepness and length of slopes and the difficulty in establishing stabilizing vegetation. Erosion on logging roads and skid trails is a potentially serious land use limitation. Rill and gully erosion can occur in crop fields.

Conservation practices on forestland generally include forest stand improvement and proper construction, use, and maintenance of skid trails, water bars, access roads, and log landings. Critical area planting and sediment-control measures are needed on construction sites, ski slopes, and recreation trails. Conservation practices on cropland generally include conservation tillage, contour stripcropping, crop rotations, crop residue management (primarily mulch-till), cover crops, diversions, and grassed waterways.

144A—New England and Eastern New York Upland, Southern Part

This MLRA (fig. 144A-1) is in New York (29 percent), Massachusetts (26 percent), Connecticut (20 percent), New Hampshire (8 percent), New Jersey (8 percent), Rhode Island (5 percent), Maine (3 percent), and Vermont (1 percent). It makes up about 19,347 square miles (50,109 square kilometers). It consists of two separate parts, one east of MLRA 145 and one west of MLRA 145. The eastern part of MLRA 144A is primarily in Connecticut, Rhode Island, and Massachusetts, and the western part is primarily in southeastern New York and northern New Jersey.

This MLRA is bordered to the south by water in many areas, including Long Island Sound, and to the east by the Atlantic Ocean. In New Jersey it is bordered by the southern extent of

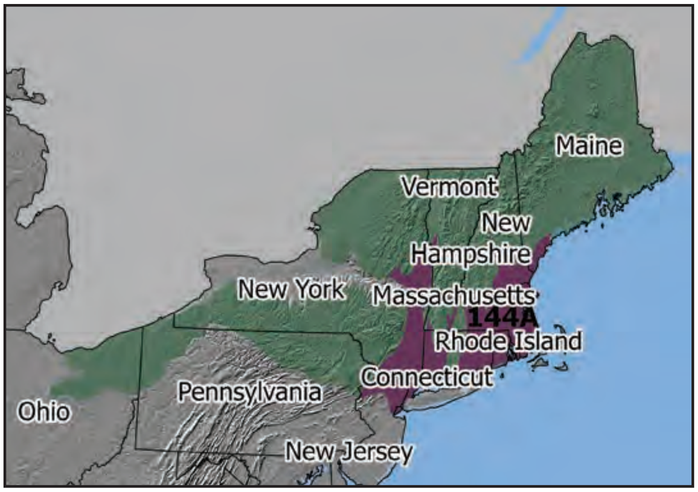

Figure 144A-1: Location of MLRA 144A, which covers 5,010,900 hectares (12,382,100 acres), within Region R.

the Late Wisconsinan ice sheet. To the north it is bordered by higher terrain and frigid soil temperature regimes. It is bordered on the west primarily by the Kittatinny Ridge in New Jersey and the Catskill Mountains, the foothills of the Adirondack Mountains, and Mohawk Valley in New York.

Physiography

The eastern half of the eastern part of this MLRA is in the Seaboard Lowland section of the New England province of the Appalachian Highlands. The western half of the eastern part and the southeastern half of the western part are in the New England Upland section of the same province and division. The northwestern half of the western part is in the Hudson Valley section of the Valley and Ridge province of the Appalachian Highlands.

This MLRA has rolling to hilly uplands that are broken by many gently sloping to level valleys that terminate in coastal lowlands. Elevation ranges from sea level to 1,000 feet (0 to 305 meters) in much of the area but it is 2,000 feet (610 meters) on some hills. Relief is mostly about 6 to 65 feet (2 to 20 meters) in the valleys and about 80 to 330 feet (25 to 100 meters) in the uplands.

The Hudson River flows south through the center of the long, narrow western part of this MLRA in New York. The Wallkill River, eastern part of the Mowhawk River, the Hoosic River, and Kinderhook Creek are also in the part of the MLRA in New York and comprise the greater Hudson River watershed area. The Housatonic and Connecticut Rivers are in the part of the MLRA in Connecticut. The Pawtuxet, Pawcatuck, Blackstone, and Wood Rivers are in the part in Rhode Island. The Blackstone, Hoosic, Housatonic, Merrimack, Nashua, Mystic, and Charles Rivers are in the part in Massachusetts. The Raritan and Passaic Rivers, their tributaries, and the Wallkill River headwaters are in the part in New Jersey.

Geology

This MLRA was glaciated and consists almost entirely of till hills, drumlins, and bedrock-controlled uplands with a thin mantle of till. It is dissected by narrow glacio-fluvial valleys. The southernmost boundary of the area marks the farthest southward extent of Wisconsinan glaciation on the Eastern Seaboard. The river valleys and coastal plains are filled with glacial lake sediments, marine sediments, and glacial outwash. The bedrock in the eastern half of the MLRA consists primarily of igneous and metamorphic rocks of Early Paleozoic age. Granite is the most common igneous rock, and gneiss, schist, and slate are the most common metamorphic rocks. In the parts of the MLRA in eastern and southeastern New York, Devonian- to Pennsylvanian-age sandstone, shale, and limestone are dominant. Carbonate rocks, primarily dolomite and limestone, are the dominant kinds of bedrock in the part of this MLRA in northwestern Connecticut.

Climate

The average annual precipitation is 39 to 47 inches (980 to 1,443 millimeters). The precipitation generally is evenly distributed throughout the year. It is slightly lower in summer near the coast and slightly higher in spring and fall in inland areas. Rainfall occurs during high-intensity, convective thunderstorms in summer. In winter, most of the precipitation occurs as moderate-intensity storms (northeasters) that produce large amounts of rain or snow. The average annual temperature is 43 to 55 degrees F (6 to 13 degrees C), increasing from north to south. The freeze-free period averages 190 days and ranges from 145 to 240 days, increasing in length to the south.

Water

This MLRA ranks eighth among all of the MLRAs in total amount of water used. The abundant precipitation, many perennial streams, and many natural lakes and ponds are important sources of surface water. Many large and small reservoirs provide municipal and industrial water to urban areas that may not have sufficient water. For example, aqueducts that divert water from reservoirs in the basin of the Merrimack River provide half of the public water for Boston and many of its suburbs in eastern Massachusetts. The surface water in the area is suitable for almost all uses.

Some ground water is pumped for domestic use from the glacial till that covers most of this area. The quality of the ground water in the till is the same as that of the water in the stratified drift and valley fill aquifer. The stratified drift and glacial outwash deposits that fill the river valleys throughout this MLRA are the primary sources of most of the public water supply. Water from these units is very fresh. It has not remained in this shallow aquifer for a very long period, and almost all of the unconsolidated sediments consist of quartz and feldspars, which offer few minerals for dissolution in water. The water is typically soft, but it can be hard in local areas where the drift has more soluble minerals, for example, in western Connecticut where glaciers eroded the carbonate bedrock. High, naturally occurring levels of iron and manganese can occur, but the median levels of these metals generally are below the national and State primary standards for drinking water. Ground water in the valley fill generally is acidic. Corrosion of iron, lead, and concrete water lines is common in this area.

Many wells provide good-quality ground water from fractures, bedding planes, and joints in the crystalline igneous and metamorphic bedrock underlying almost all of the MLRA. This aquifer provides water mainly for domestic use but also for public supply and industrial uses. This ground water is slightly alkaline. It has a low level of total dissolved solids. In some areas the water has high levels of naturally occurring iron and manganese that exceed the national and State secondary standards for drinking water. Water from wells that penetrate granite with high amounts of muscovite and biotite can contain high levels of a naturally occurring radionuclide, radon-222. This radionuclide can produce an odorless and inert gas that can cause health problems for humans when it collects in showers, bathrooms, and basements of residences.

Some younger carbonate and sandstone bedrock units are aquifers in the parts of this MLRA in eastern New York, northwestern Connecticut, and northwestern Pennsylvania. Water from the sandstone units commonly is soft, and water from the carbonate units typically is very hard. Water from the carbonate units in eastern New York is the only water from aquifers in the area that exceeds the national secondary standard for drinking water for total dissolved solids. The water from both types of bedrock is slightly alkaline. Because of a shallow depth to water and the openings in the rocks, all of the aquifers in this MLRA are susceptible to contamination from surface activities.

Soils

The dominant soil orders are Entisols, Histosols, and Inceptisols. The soils in the area dominantly have a mesic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. They generally are very deep, somewhat excessively drained to poorly drained, and loamy or sandy.

The main soils and their series:

- Aquepts that formed in till in depressions on hills and in drainageways (Leicester and Ridgebury series)
- Dystrudepts that formed in till, loamy sediments over till, and dense till on till plains, hills, and ridges (Canton, Charlton, Chatfield, Gloucester, Hollis, Montauk, Paxton, Scituate, Sutton, and Woodbridge series) and in glaciofluvial deposits on outwash plains and terraces (Merrimac series)
- Fragiudalfs that formed in till on hills in the southwestern part of the MLRA (Boonton series)
- Fragiudults that formed in till on hills in the southwestern part of the MLRA (Rockaway series)
- Frasiwassents (permanently submerged soils) that formed in freshwater environments (Aquapaug and Burlingame series)
- Haplosaprists that formed in organic material in depressions on uplands and outwash plains (Catden, Freetown, Natchuag, and Swansea series)
- Psammowassents (permanently submerged soils) that formed in sandy estuarine and marine deposits along the coast (Nagunt and Rhodesfolly series)
- Sulfiwassents (permanently submerged soils) that formed in estuarine and marine deposits along the coast (Anguilla, Fort Neck, and Pishagqua series)
- Udipsamments that formed in glaciofluvial deposits on outwash plains, terraces, kames, and eskers (Windsor series) and in human-transported material in urban areas (Bigapple and Fortress series)
- Udorthents that formed in glaciofluvial deposits on outwash plains, terraces, kames, and eskers (Hinckley series) and in human-transported material in urban areas (Greenbelt, Ladyliberty, Laguardia, and Secaucus series)

Biological Resources

Most of the area was cleared for agriculture in colonial times. The agricultural land was abandoned at the turn of the 19th century and then naturally reforested. The area is currently undergoing suburban and rural development. Historic vegetation included forests dominated by American chestnut and some open understories as a result of periodic burning by indigenous people.

Today, ecological sites within natural areas support a mixture of northern and central hardwoods. Sugar maple (*Acer saccharum*), sweet birch (*Betula lenta*), and American beech (*Fagus grandifolia*), as well as several types of oaks (*Quercus*) and hickories (*Carya*), are the major species. Eastern white pine (*Pinus strobus*) is the dominant conifer, with eastern hemlock (*Tsuga canadensis*) in lesser amounts due to mortality from the woolly adelgid. Pitch pine (*Pinus rigida*) and red pine (*Pinus resinosa*) grow on sandy soils that formed in outwash. Red maple (*Acer rubrum*) grows on the wetter sites. Atlantic white cedar (*Chamaecyparis thyoides*) reaches its northern limit in bogs along the coast. The non-native, invasive plants include Japanese barberry (*Berberis thunbergii*), Asiatic bittersweet (*Celastrus orbiculatus*), and Norway maple (*Acer platanoides*). The most common understory plants are moosewood (*Acer pensylvanicum*) and hobblebush (*Viburnum lantanoide*s) in the northern part of the MLRA and flowering dogwood (*Cornus florida*) in the southern part. Abandoned agricultural land is dominated by eastern white pine and paper birch (*Betula papyrifera*) in the northern part of the area and eastern redcedar (*Juniperus virginiana*) and gray birch (*Betula populifolia*) in the southern part.

Numerous unique habitats are in scattered areas throughout this MLRA. Maritime habitats include coastal grasslands, heaths, and dunes; tidal wetlands of estuaries; and freshwater tidal reaches of the major rivers. Away from the coast are inland forests and woodlands, freshwater marshes, swamps, peatlands, flood plains, lowlands, sand barrens, rocky summits, limestone fens, and glades.

Black bear, beaver, fisher, wild turkey, vultures, and forest songbirds are increasing in population in wooded areas of this MLRA. Animals that are tolerant of human settlement also are increasing in population. Examples are white-tailed deer, opossum, skunk, raccoon, and coyote. The at-risk species that are decreasing in population are animals that inhabit more open areas, such as woodchuck, vole, and red fox, and birds such as bobolinks, meadowlarks, whippoorwills, and nighthawks. Fish species include brook trout, brown trout, rainbow trout, largemouth bass, chain pickerel, flounder, bluefish, and striped bass.

Land Use

About one-half of the MLRA is in hardwood and pine forests (fig. 144A-2). Most of the forests are in small holdings. Some are State forests or other large holdings. The forests are used for wood products and for hunting and other kinds of recreation. The acreage used for urban development is increasing rapidly. Agriculture is dominated by dairy, nursery, and greenhouse stock, much of which is driven by the increase in residential development and the demand for landscaping materials. Some forage crops for dairy cattle are still grown, and truck crops, small fruits, and apples are grown on some farms, mainly near the larger towns and cities. Many farmsteads are used as rural residences, and the residents earn their living from nonfarm occupations.

The major soil resource concerns on cropland and forestland are sheet and rill erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Stormwater runoff and subsequent erosion and sedimentation are the primary concerns in areas of urban expansion.

Conservation practices on cropland generally include systems of crop residue management, especially conservation tillage; winter cover crops; rotations of annual crops and grasses and legumes; contour farming; irrigation water management; compost facilities; and nutrient, manure, and pesticide management. Excluding dairy cattle from wetlands and watercourses and developing rotational grazing systems help to control erosion and protect water quality. Stormwater management and erosion- and sediment-control practices are needed in the rapidly expanding urban areas.

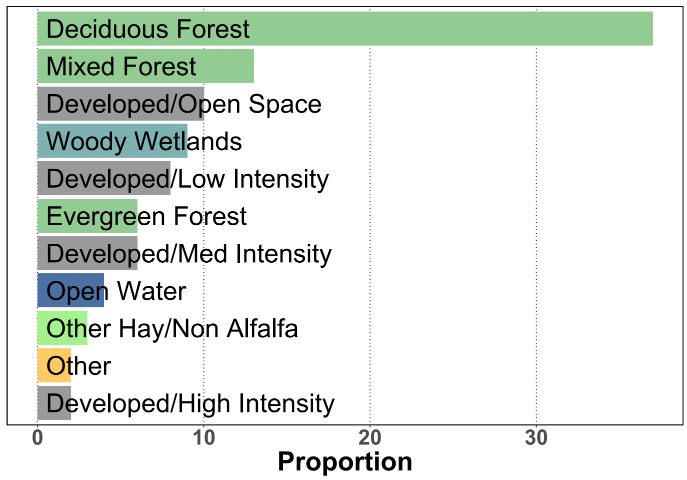

Figure 144A-2: Relative proportions (percentages) of land use in MLRA 144A.

144B—New England and Eastern New York Upland, Northern Part

MLRA 144B (fig. 144B-1) is in Maine (56 percent), New Hampshire (22 percent), Vermont (14 percent), Massachusetts (6 percent), Connecticut (1 percent), and New York (1 percent). It makes up about 22,728 square miles (58,864 square kilometers). The MLRA consists of a relatively young landscape shaped by the Laurentide Ice Sheet, which covered the region from 35,000 to 10,000 years ago. Rolling hills of dense basal till converge on ridges of shallow bedrock that were scoured by glacial ice. River valleys that were flooded by melting glacial water or seawater house large expanses of glacial outwash and stratified drift in inland areas and, to a lesser extent, glaciomarine and glaciolacustrine sediment deposits in coastal areas. Organic bogs, ablation till, and alluvial flood plains make up the remaining portions of the MLRA.

MLRA 144B is the easternmost MLRA in the United States. It has a distinct eastern boundary where it meets the Atlantic Ocean and a distinct western boundary where it meets the Connecticut River Valley and the Green Mountains. There is an

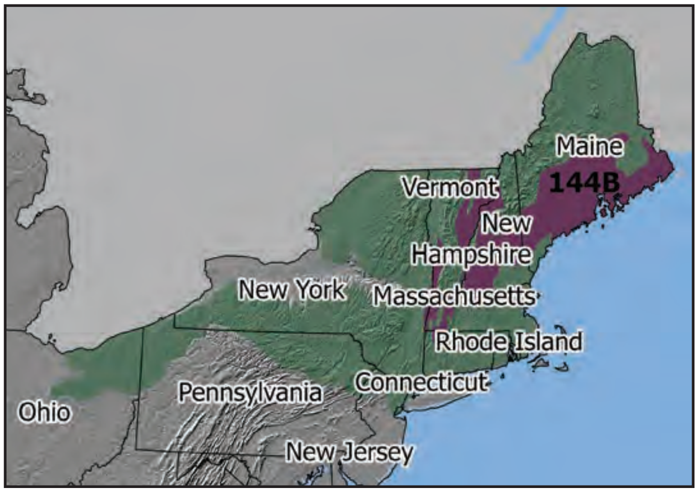

Figure 144B-1: Location of MLRA 144B, which covers 5,886,400 hectares (14,545,600 acres), within Region R.

island of the MLRA to the southwest of the Green Mountains that is less apparent than most of the western border. The boundaries to the south and north are less apparent. The south is marked by a change in the soil temperature regime, from mesic to frigid (MLRA 144A). The north is marked by a landscape that becomes more mountainous, and the bordering area is comprised mostly of commercial forestry land with minimal agricultural and urban development.

Physiography

This area is the New England province of the Appalachian Highlands. The separate western part of the area is in the Taconic section, and the rest of the area is mostly in the New England Upland section. The part in southeastern Maine is in the Seaboard Lowland section. This MLRA includes the coastal zone of Maine north and east of Casco Bay and extends inland along the major river valleys. Most of the area is characterized by rolling to hilly uplands. The area has some isolated mountain peaks. In the part of the area in southeastern Maine, gently sloping to level valleys terminate in coastal lowlands.

Elevation ranges from sea level to 1,000 feet (0 to 305 meters) in much of the area. It is 2,000 feet (610 meters) on some hills and 2,950 feet (900 meters) on a few isolated peaks. Local relief is mostly low or moderate. It generally is highest in the northern part of the area and decreases as sea level is approached. An exception is the Taconic Mountains along the New York-Massachusetts border, where relief is substantial. Relief is mostly about 5 to 65 feet (2 to 20 meters) in the valleys and about 80 to 330 feet (25 to 100 meters) in the uplands.

Geology

Most of this MLRA is characterized by till-mantled, rolling to hilly uplands. The northern and eastern parts of the area are underlain mostly by granite, gneiss, and schist bedrock. Limestone, dolomite, and marble beds interspersed with basalt flows occur in the southern and western parts. A seam of limestone-interbedded phyllite extends through central Maine where calcareous soils that are considered prime farmland formed. Stratified drift deposits of unconsolidated sand and gravel, primarily glacial outwash, fill most of the narrow river valleys. Some marine sediments occur at the lower end of the valleys that terminate in the coastal lowlands in southeastern Maine. Some glacial lake sediments occur on valley bottoms. The areas of marine and glacial lake sediments are not extensive but are important agricultural areas.

Climate

The average annual precipitation is 33 to 45 inches (840 to 1,145 millimeters). The precipitation generally is evenly distributed throughout the year. Near the coast, it is slightly lower in summer. In inland areas, it is slightly higher in spring and fall. Rainfall occurs during high-intensity, convective thunderstorms in summer. In winter, most of the precipitation occurs as moderate-intensity storms (northeasters) that produce large amounts of rain or snow. Heavy snowfalls commonly occur late in winter. The average annual temperature is 39 to 48 degrees F (4 to 9 degrees C). The freeze-free period averages 160 days and ranges from 120 to 195 days. Temperatures and the length of the freeze-free period increase from north to south and closer to the coast.

Water

MLRA 144B has abundant precipitation. Many perennial streams, and many natural lakes and ponds are important sources of surface water. Many large and small reservoirs provide municipal and industrial water. The surface water in the area is of good quality and suitable for almost all uses with no or minimal treatment. Acid rain and municipal and industrial waste discharges are the primary sources of contamination of the surface water.

Ground water is scarce on the till-mantled uplands but is abundant in the deep outwash deposits in the valleys. Most of the ground water used for public supplies and industries is obtained from the stratified drift aquifer in the river valleys. The water from this aquifer is soft to very hard, is acidic, and has very low levels of total dissolved solids. The aquifer is only about 100 feet (30 meters) thick, and the water table is typically at a depth of 30 feet (10 meters). As a result, water in the aquifer is very susceptible to contamination from surface activities.

Water for domestic use, some public supply, and light industry is obtained from wells drilled in the granite, gneiss, and schist bedrock under the uplands in Vermont, New Hampshire, and Maine. This water has slightly more total dissolved solids and generally is harder than the water in the valley fill aquifers. In addition, there are more cases of iron concentrations exceeding the national and State secondary standard in water from the crystalline bedrock aquifer. High levels of radon-222 occur in wells drilled into granite that has high amounts of muscovite and biotite.

Industrial and domestic wells pump water from a carbonate aquifer on the western edge of Massachusetts, in the northeast corner of Connecticut, and along the eastern border of New York. This aquifer consists of beds of limestone, dolomite, and marble interspersed with beds of schist and quartzite. The water from this aquifer is very hard and has levels of total dissolved solids that exceed the national secondary standard for drinking water.

Soils

The dominant soil orders are Inceptisols, Spodosols, Histosols, and Entisols. The soils in the area have a frigid temperature regime, an aquic or udic moisture regime, and isotic, illitic, or mixed mineralogy. They are very shallow to very deep and very poorly drained to excessively drained. They are dominantly loamy but range from sand to clay.

The main soil series:
- Adams series—Haplorthods that formed in glaciofluvial deposits on eskers and outwash plains
- Buxton series—Eutrudepts that formed in glaciomarine deposits on slopes in coastal lowlands or river valleys
- Colonel series—Haplorthods that formed in dense till on till plains and base slopes of hills
- Hermon series—Haplorthods that formed in ablation till on hills, uplands, and till plains
- Lyman series—Haplorthods that formed in shallow till on ridges, hills, and mountaintops
- Marlow series—Haplorthods that formed in dense till on slopes of hills and mountains
- Peru series—Haplorthods that formed in dense till on till plains and hillslopes
- Scantic series—Epiaquents that formed in glaciomarine deposits on flats and depressions in coastal lowlands and river valleys
- Tunbridge series—Haplorthods that formed in moderately deep till on ridges, hills, and mountain slopes

Biological Resources

This area supports northern hardwoods. American beech (*Fagus grandifolia*), paper birch (*Populus papyrifera*), yellow birch (*Betula alleghaniensis*), sugar maple (*Acer saccharum*), and eastern hemlock (*Tsuga canadensis*) are dominant on the better drained soils. Balsam fir (*Abies balsamea*), northern white cedar (*Thuja occidentalis*), red maple (*Acer rubrum*), and red spruce (*Picea rubens*) are dominant on the wetter soils. Balsam fir and red spruce are prevalent on the shallow ridgetops and hilltops. The northern aspects of hill and ridge slopes support spruce and fir, and the southern aspects support northern hardwoods. Eastern white pine (*Pinus strobus*) is common on abandoned farmland, in river valleys, and on outwash plains.

Major wildlife species include white-tailed deer, beaver, snowshoe hare, muskrat, mink, and ruffed grouse. Fish species include trout, salmon, alewife, striped bass, smelt, and eel.

Land Use

Most of this MLRA is in small holdings of private land comprised of hardwood and conifer forests (fig. 144B-2). Some areas are in State forests or in other large holdings. Sawlogs and pulp for paper mills are the principal products, but maple syrup and Christmas trees are produced on some sites. The forests are widely used for hunting and other kinds of recreation. A significant acreage of the forestland is used for residential and leisure home developments. Forage crops for dairy cattle are grown on most of the cropland. Truck crops, small fruits, and apples are grown on some farms, mainly near the larger towns and cities. Native lowbush blueberries are produced in an area in the extreme eastern part of this MLRA. This is the largest blueberry production area in the world. Many farmsteads are used as rural residences, and the residents earn their living from nonfarm occupations. Urban development is increasing in this populous MLRA.

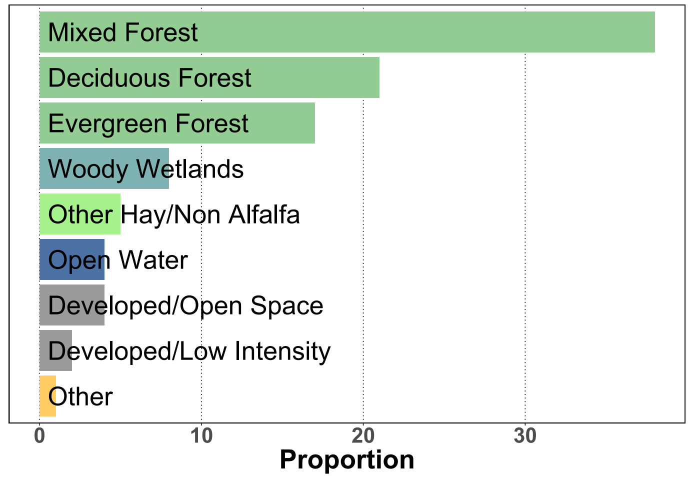

Figure 144B-2: Relative proportions (percentages) of land use in MLRA 144B.

The major soil resource concerns are sheet, rill, and gully erosion on cropland, logging roads, and forest landings and sedimentation in urban areas during periods of construction. Other resource concerns on cropland include nutrient management, maintenance of the content of soil organic matter, maintenance of soil quality, and the loss of important farmland.

Conservation practices on cropland generally include crop residue management (no-till), diversions, grassed waterways, cover crops, and filter strips. They also include management of the storage and utilization of all sources of nutrients on farms. Conservation practices on forestland generally include riparian buffer zones, sediment control on roads and in ditches, and proper stream crossings, which prevent sedimentation and help to maintain water quality.

145—Connecticut Valley

This MLRA (fig. 145-1) is on the floor of the Connecticut River Valley for nearly the entire length of the valley within the United States. It is in Connecticut (49 percent), Massachusetts (28 percent), New Hampshire (18 percent), and Vermont (5 percent). It makes up about 1,958 square miles (5,071 square kilometers). The MLRA is bordered on the south by Long Island Sound, on the east and west by higher terrain dominated by metamorphic bedrock, and on the north by areas with a frigid soil temperature regime.

Physiography

This area is in the New England Upland section of the New England province of the Appalachian Highlands. The nearly level floor of the Connecticut River Valley makes up most of the area. Nearly level to sloping lowlands are at the outer edges of

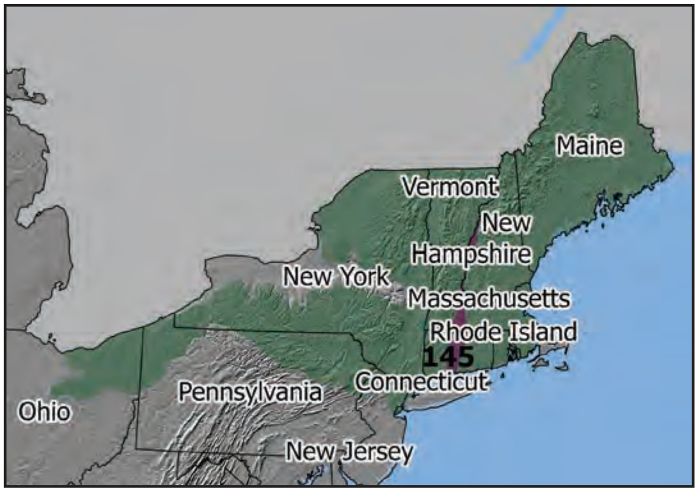

Figure 145-1: Location of MLRA 145, which covers 507,100 hectares (1,253,100 acres), within Region R.

the river valley. These lowlands are broken by isolated, north-to-south-trending, trap-rock ridges that are hilly and steep. Elevation ranges from sea level to 330 feet (100 meters) in the lowlands and from 650 to 1,000 feet (200 to 305 meters) on ridges. Local relief is typically 0 to 65 feet (0 to 20 meters) in the lowlands and about 160 to 330 feet (50 to 100 meters) on ridges. The Connecticut River empties into Long Island Sound in the southeast corner of the area.

Geology

Recent alluvium has been deposited on the nearly level flood plain along the Connecticut River since the glacial retreat about 10,000 to 12,000 years ago. These deposits created some of the most productive agricultural soils in New England. Glacial lake deposits, outwash, and recent alluvial deposits dominate the part of the valley north of Rocky Hill, Connecticut. A great freshwater glacial lake, Lake Hitchcock, extended from Rocky Hill northward to Lyme, New Hampshire. For many thousands of years, this lake received sediments from the contributing uplands. The sediments included very thick deposits of varved clay, silt, and very fine sand. Today, these deposits are as much as 200 feet thick. Water flowing off the higher hills along the valley created great delta deposits of sand and gravel. Outwash deposits along the valley walls occurred where ice blockage prevented sand and gravel from reaching the lake. These kame terraces appear as linear deposits along the valley. After the glacial retreat, winds deposited fine sand on the lake deposits and over much of southern New England. The result was dune deposits on the lake bottom and a loess cap throughout much of southern New England.

Late Triassic and Early Jurassic bedrock lies beneath the glacial sediments. Rift valleys developed in this area during the migration of the continents to their present locations. These large basins were filled with a basalt-sandstone rock sequence locally known as the Newark Supergroup. These rocks occur from Nova Scotia to South Carolina. The bedrock in the Connecticut Valley consists of this sandstone, shale, and conglomerate sequence. Basalt flows along the rift zones periodically spread across these shallow freshwater sediments. Today, these igneous rocks form many of the landmarks throughout the upper valley, such as Mount Tom, Mount Holyoke, and Mount Sugarloaf.

Climate

The average annual precipitation is 36 to 52 inches (911 to 1,324 millimeters). The precipitation is evenly distributed throughout the year. Rainfall occurs during high-intensity, convective thunderstorms in summer. In winter, most of the precipitation occurs during moderate-intensity storms (northeasters) that produce large amounts of rain or snow. The seasonal snowfall averages 40 inches (100 centimeters). The average annual temperature is 41 to 52 degrees F (5 to 11 degrees C). The freeze-free period averages 180 days and ranges from 140 to 220 days. Temperatures and the length of the freeze-free period increase from north to south.

Water

Precipitation, perennial streams, and lakes provide an abundance of good-quality surface water. Water for municipal and industrial needs is stored in reservoirs in this MLRA and adjoining MLRAs. The surface water is of good quality, but it commonly requires some treatment prior to use as drinking water. Progress has been made in cleaning up municipal and industrial waste discharges into the Connecticut River and its tributaries.

Public supply, municipal, and industrial water is obtained from the glacial outwash and alluvial valley fill along the major rivers. The ground water in this aquifer is abundant. It is acidic and soft to very hard and has very low levels of total dissolved solids. This aquifer is typically less than 100 feet (30 meters) thick, and the water table is commonly at a depth of 30 feet (10 meters). As a result, the water in the aquifer is highly susceptible to contamination by surface activities. Some public supply, municipal, and industrial water is obtained from the marine sediments in the parts of this area in Massachusetts and Connecticut. The water in this aquifer is generally moderately hard; it is very hard in the lower part of the aquifer. This aquifer has some deposits of copper, lead, zinc sulfides, and uranium minerals. Water pumped from areas with ore deposits needs to be treated before it can be used for drinking water or industrial purposes.

Many shallow domestic wells obtain ground water from the till deposits that cover the bedrock in the lowlands on each side of the flood plain along the Connecticut River. The water in the till is very similar in quality to the water in the valley fill aquifer. Some public supply and light industry water is obtained from wells drilled in the igneous and metamorphic rocks under the till in the lowlands. This water has slightly more total dissolved solids and generally is harder than the water in the valley fill and till aquifers. In addition, there are more cases of iron concentrations exceeding the national and State secondary standard for drinking water. High levels of radon-222 occur in wells drilled into granite that has high amounts of muscovite and biotite.

Soils

The dominant soil orders in this MLRA are Entisols and Inceptisols. Some Spodosols are in the northern part of the area. The soil temperature regime generally is mesic but is frigid in the northern part of the area. The soils in the area dominantly have an aquic or udic moisture regime and mixed mineralogy. They generally are very deep, excessively drained to poorly drained, and clayey, loamy, or sandy.

The main soils and their series:

- Dystrudepts that formed in outwash deposits on outwash plains and terraces (Agawam and Merrimac series); that formed in dense till on hills and drumlins (Ludlow and Wethersfield series); that formed in till on hills, traprock ridges, and mountains (Cardigan, Cheshire, Dutchess, Holyoke, and Kearsarge series)
- Endoaquepts that formed in glaciolacustrine material on terraces (Scitico series)
- Udifluvents that formed in alluvium on flood plains (Hadley series)
- Udipsamments that formed in outwash on outwash plains, kames, terraces, and eskers (Deerfield, Penwood, and Windsor series)
- Udorthents that formed in outwash on outwash plains, kames, terraces, and eskers (Manchester series)

Biological Resources

Historic vegetation included forests dominated by American chestnut and, as a result of periodic burning by indigenous people, some open understories. Today, ecological sites within natural areas support primarily central hardwoods. Some northern hardwoods are at the northern extent of the MLRA. Habitat loss and fragmentation are widespread throughout the lower part of the Connecticut River Valley as a result of development. Attempts to cultivate infertile sandy areas were unsuccessful and have contributed to the barren appearance of the sand plains and the dominance of pitch pine (*Pinus rigida*) in those areas. The major tree species in the rest of the forested areas are sugar maple (*Acer saccharum*), birch (*Betula*), American beech (*Fagus grandifolia*), oaks (*Quercus*), and hickory (*Carya*). Eastern white pine (*Pinus strobus*) with eastern hemlock (*Tsuga canadensis*) in lesser amounts, due to mortality from the woolly adelgid, are the dominant conifers, but pitch pine and red pine (*Pinus resinosa*) are more common on sandy soils. Red maple (*Acer rubrum*) grows on the wetter sites. Japanese knotweed (*Polygonum cuspidatum*) is a pernicious non-native, invasive plant that hinders the growth and development of the more desirable plants in the area. The most common understory plants are moosewood (*Acer pensylvanicum*) and hobblebush (*Viburnum lantanoides*) in the northern part of the area and flowering dogwood (*Cornus florida*) in the southern part. Abandoned agricultural land is dominated by eastern white pine and paper birch (*Betula papyrifera*) in the northern part and eastern redcedar (*Juniperus virginiana*) and gray birch (*Betula populifolia*) in the southern part.

Important upland habitats include trap-rock ridges and sand plains. Oak woodlands and cedar glades are common on the ridges. Black oak savannas mixed with pitch pine and varying amounts of little bluestem (*Schizachyrium scoparium*) are common on the sand plains. Other habitats of significance include wetlands associated with the Connecticut River, freshwater marshes, swamps, flood plains, and lowlands. The dominant trees on the flood plains are black willow (*Salix nigra*), cottonwood (*Populus deltoides*), silver maple (*Acer saccharinum*), and sycamore (*Acer pseudoplatanus*).

Land Use

The hardwood and pine forests are used for residential development, recreation, wildlife habitat, and esthetic purposes (fig. 145-2). The agricultural land is used mainly for nursery and greenhouse stock, truck crops such as fruits and vegetables, and tobacco. The extent of industrial and residential development is increasing. The Connecticut Valley is one of the most productive and valuable areas in the Northeast because of the long growing season and the proximity to cities and towns. Urban and industrial expansion, however, is causing a rapid loss of agricultural land. Many of the current agricultural fields predate the arrival of Europeans. Archaeological evidence indicates that these fields and the associated anadromous fishery in the lower reaches of the valley were used by Native Americans during the Woodland

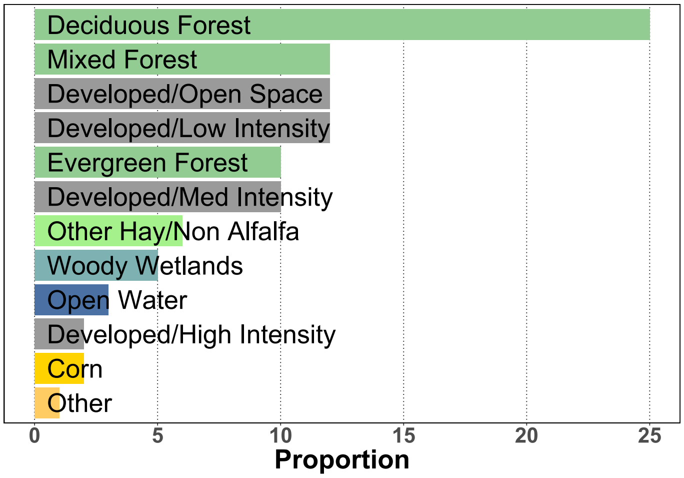

Figure 145-2: Relative proportions (percentages) of land use in MLRA 145.

Period. As a result, later settlement of the area by Europeans was simplified.

The major soil resource concerns are sheet and rill erosion, erosion and sedimentation caused by stormwater runoff, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. The protection of agricultural land from encroaching development is a serious resource concern.

Conservation practices on cropland generally include systems of crop residue management (such as conservation tillage), winter cover crops, rotations of annual crops and grasses and legumes, contour farming, irrigation water management, compost facilities, nutrient management, manure management, and pesticide management. Excluding livestock from wetlands and watercourses and developing rotational grazing systems help to control erosion and preserve water quality. Conservation practices important in areas of community development include critical site planting and urban stormwater management.

146—Aroostook Area

MLRA 146 (fig. 146-1) is entirely in Maine and makes up about 1,810 square miles (4,688 square kilometers). It consists of a relatively young landscape shaped by the Laurentide Ice Sheet, which covered the region 35,000 to 10,000 years ago. Gently sloping expanses of calcareous till converge on gradual ridges of shallow bedrock that were scoured by glacial ice. The river valleys in the region were flooded by melting glacial water and have areas of glacial outwash, glacial lake and marine sediments, alluvial deposits, and stratified drift. Lodgment till, organic bogs, and ablation till make up the remaining portions of the MLRA. MLRA 146 has vast areas of agriculture and minimal urban development.

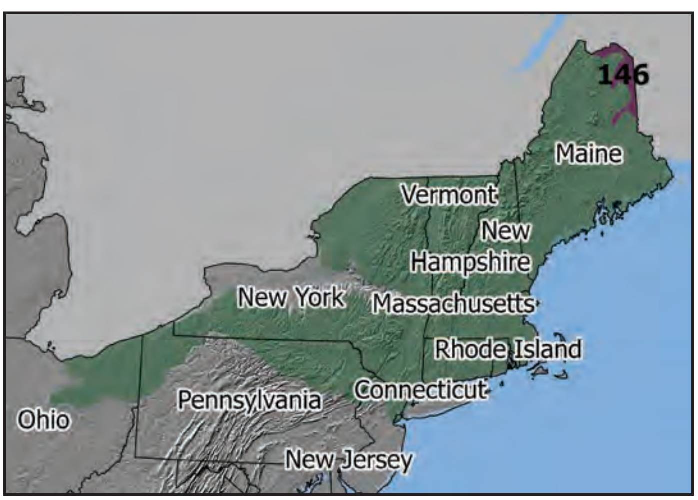

Figure 146-1: Location of MLRA 146, which covers 468,800 hectares (1,158,400 acres), within Region R.

MLRA 146 is the northernmost MLRA in the conterminous United States. It has distinct northern and eastern boundaries with Canada. The boundaries to the south and west are less apparent. They are based on the agricultural land use and the extent of the Carys Mills Formation, which is the source of the fertile calcareous soils that are prevalent throughout the MLRA.

Physiography

This area is in the New England Upland section of the New England province of the Appalachian Highlands. It is mostly a nearly level to sloping lowland. Rolling hills are common in the north-central part of the area. The lowland is broken by isolated, north-to-south-trending, trap-rock ridges (basalt and diabase dikes) that are hilly and steep. These ridges are more common in the far northern parts of the area, near the Canadian border. Elevation ranges from sea level to 330 feet (0 to 100 meters) in the lowlands and from 650 to 1,000 feet (200 to 305 meters) on the ridges. Local relief ranges from less than 5 feet to 65 feet (1 to 20 meters) on the lowlands. The ridges are about 165 to 330 feet (50 to 100 meters) above the lowlands.

Geology

Almost all of this area is mantled with a mixture of glacial till, outwash, stratified drift, and glacial lake and marine sediments. The till is more prominent on the uplands, and the other surficial deposits are more common in the valleys and lowlands. Numerous basalt and diabase dikes occurring as north-to-south-trending ridges cut across this area. Most of the eastern half of the area is underlain by the Carys Mills Formation, a bluish gray limestone with some dark gray calcareous shale and siltstone layers. The rest of the area is underlain by a variety of igneous and metamorphic rocks. The most common igneous rocks are granite, gabbro, diorite, granodiorite, and pegmatite. The metamorphic rocks include schist, gneiss, quartzite, slate, phyllite, and argillite. Recent deposits of river alluvium (unconsolidated sand and gravel) cover the flood plains along the major rivers.

Climate

The average annual precipitation is 37 to 45 inches (931 to 1,141 millimeters). The precipitation is evenly distributed throughout the year. Rainfall occurs during high-intensity, convective thunderstorms in summer. Seasonal snowfall averages 40 inches (100 centimeters). The average annual temperature is 37 to 41 degrees F (3 to 5 degrees C). The freeze-free period averages 140 days and ranges from 120 to 155 days.

Water

The area's abundant precipitation, many perennial streams, and many natural lakes and ponds are important sources of surface water. The many large and small reservoirs provide municipal and industrial water. The surface water in the area is of good quality and suitable for almost all uses with no or minimal treatment. Acid rain is the primary source of contamination of the surface water.

The ground water used in this area typically comes from the glacial outwash and stratified drift aquifers on the valley floors along the St. John and Aroostook Rivers or from carbonate bedrock on the east edge of the area. Water from both aquifers is of very good quality. The water from the carbonate rocks is very hard and requires treatment for this. The water from the glacial aquifers is soft. Because of the shallow depth to the water table in the glacial aquifers and the openings in the carbonate rock connected to the surface, both of these aquifers are susceptible to contamination from agriculture, urbanization, and industry.

Homeowners in the western half of this MLRA and in the uplands above the river valleys typically use ground water from either the glacial till or the igneous and metamorphic bedrock. The water from these aquifers is of very good quality, but well yields are typically much lower than those from wells in the more water-rich outwash, stratified drift, and carbonate aquifers.

Soils

The dominant soil orders in this MLRA are Spodosols and Inceptisols. The soils in the area dominantly have a frigid temperature regime, a udic or aquic moisture regime, and mixed or isotic mineralogy. They are very shallow to very deep and very poorly drained to excessively drained. They are dominantly loamy but range from sand to clay.

The main soil series:

- Burnham series—Humaquepts that formed in dense till in depressions on till plains
- Caribou series—Haplorthods that formed in calcareous till on slopes of hills and uplands
- Howland series—Haplorthods that formed in dense till on till plains and hillslopes
- Monarda series—Endoaquepts that formed in dense till on toeslopes and footslopes of till plains
- Plaisted series—Haplorthods that formed in dense till on slopes of hills and uplands
- Thorndike series—Haplorthods that formed in shallow skeletal till on ridges and hilltops

Biological Resources

The native vegetation consists of both coniferous and deciduous trees. Areas that are forested on the calcareous Carys Mills Formation are dominated by northern hardwoods, including sugar maple (*Acer saccharum*), white ash (*Fraxinus americana*), and yellow birch (*Betula alleghaniensis*) as well as basswood (*Tilia americana*) and hophornbeam (*Ostrya virginiana*). These areas can also have a strong component of northern white cedar (*Thuja occidentalis*) that is not restricted to the wet bottoms. Areas that are not as fertile tend to include sugar maple, American beech (*Fagus grandifolia*), quaking aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), and yellow birch without the basswood and hophornbeam component. The softwoods include red spruce (*Picea rubens*), balsam fir (*Abies balsamea*), eastern white pine (*Pinus strobus*), northern white cedar, and tamarack (*Larix laricina*). Tree plantations have been established since the 1960s on many farms. The typical species on these plantations are white spruce (*Picea glauca*), Norway spruce (*Picea abies*), and red pine (*Pinus resinosa*). Major wildlife species in this area include black bear, moose, white-tailed deer, red fox, eastern coyote, snowshoe hare, and ruffed grouse.

Land Use

Most of this area is forested or is cropland reverting to forest (fig. 146-2). The forest products are used mainly in the paper industry and for lumber. The cropland is used mainly for potatoes, but broccoli, oats, canola, and barley also are grown.

The major soil resource concerns are sheet, rill, and gully erosion caused by rainfall, intensive cropping, and outdated methods of irrigation; soil condition and tilth, surface compaction, and sediment deposition in areas used as cropland; and erosion and sedimentation along the forest roads used by the logging industry. Many agricultural fields have been cultivated for so long that much of the upper solum has eroded downslope and farmers are now planting into the substratum.

Conservation practices on cropland generally include crop rotations (especially where potatoes are grown), grassed waterways in areas of concentrated flow, stripcropping, cover crops, nutrient management, proper row direction, and irrigation water management. Conservation practices on forestland generally include forest stand improvement and proper construction, use, and maintenance of water bars, culverts, stream crossings, and access roads.

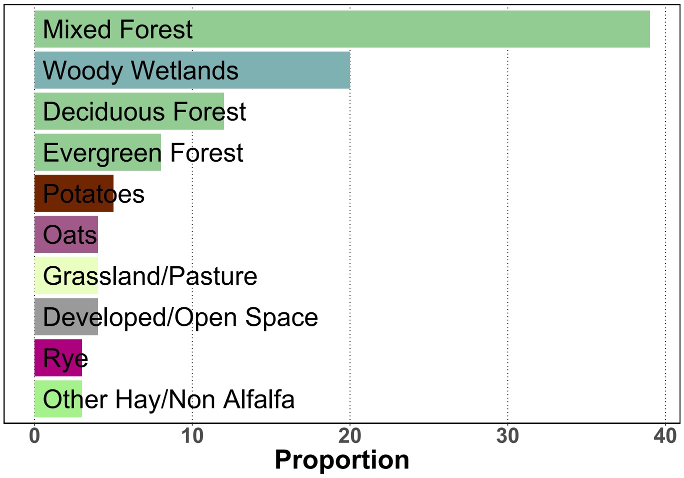

Figure 146-2: Relative proportions (percentages) of land use in MLRA 146.

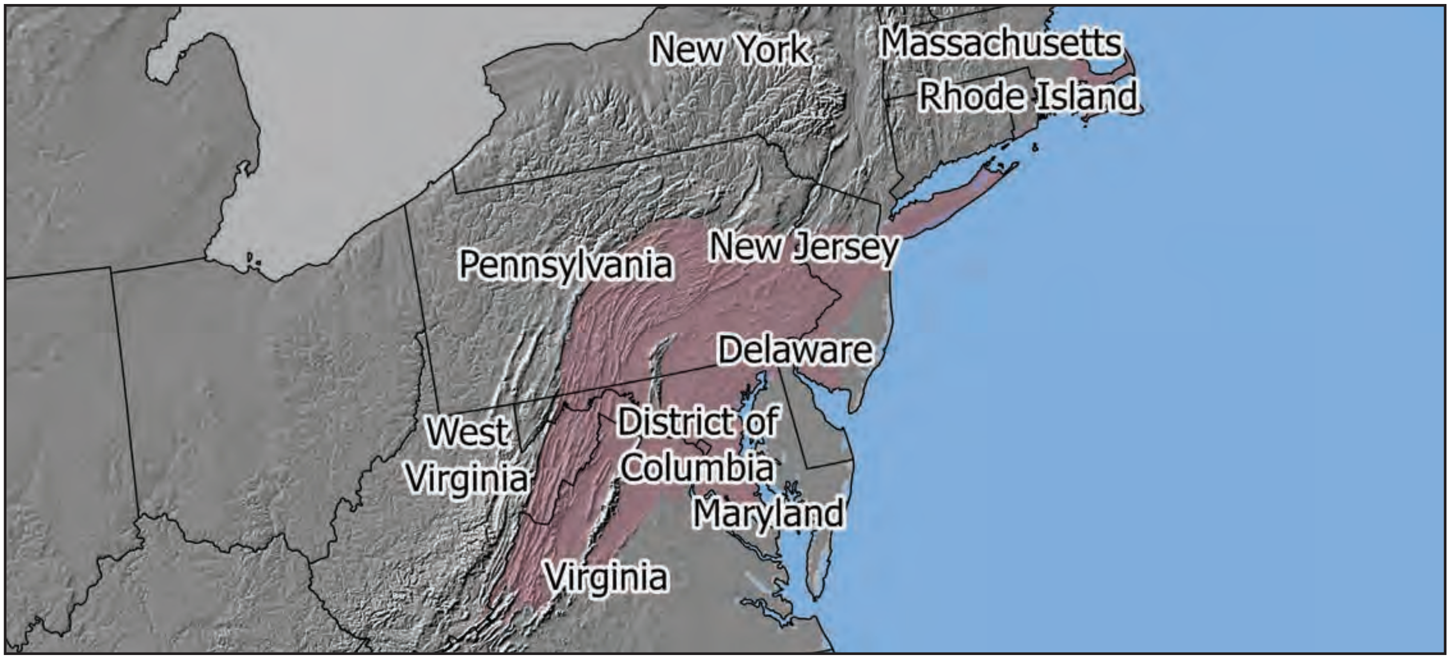

Figure S-1: Location and size of Land Resource Region S, which covers 105,600 square kilometers (40,770 square miles).

S—Northern Atlantic Slope Diversified Farming Region

Land Resource Region S (fig. S-1) is the most urban and densely populated land resource region as well as the region with the most physiographic provinces. It comprises the northern Valley and Ridge province, crosses a narrow band of the Piedmont province, and continues eastward to include the northern Coastal Plain province as well as the glacial drift of Long Island and Cape Cod. The contact between the Piedmont and Coastal Plain is the fall line, where Washington D.C., Baltimore, and Philadelphia were founded. This region contains four major land resource areas. The extent of these MLRAs and their range in elevation are shown in table S-1.

Region S's boundary to the west with Region N (fig. 1, page 5) is the physiographic contact between the Allegheny Plateau, which has clastic sedimentary shales and sandstones and Ultisols, and the Valley and Ridge, which have folded and thrust-faulted Paleozoic rock (including limestone) and Alfisols and Inceptisols. Its boundary to the south with Region N occurs in the Valley and Ridge where the predominance of ridges (Region S) gives way to the predominance of valleys (Region N). Region S's other southern boundary, with Region P, is in the Piedmont section and is based on the mesic-thermic boundary—the soil temperature regime is mesic in Region S and thermic in Region P. Region S's eastern boundary with Region T in New Jersey demarks the increase in forest, Entisols, and large areas of tidally flooded marshes. Region S's boundary with Region R coincides with the boundary between non-glacial and glacial influence and is where the Valley and Ridge greatly narrows to the north-south-oriented Hudson Valley.

Climatically, precipitation extremes range from 31 to 58 inches (781 to 1,463 millimeters) in most of the region and are highest in its northeast corner. The amount of precipitation is slightly higher during spring and summer. Temperature extremes range from 44 to 58 degrees F (7 to 15 degrees C). The mean freeze-free period ranges from 175 to 210 days. It is shortest in the mountains and longest along the Atlantic Ocean and the Chesapeake Bay. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables S-2 and S-3.

The soils of the region reflect the geology. The Valley and Ridge, with its folded and thrust-faulted Paleozoic rock, has weather-resistant ridges with forests on Inceptisols and narrow intervening valleys of limestone with agriculture on Alfisols. The mafic, metamorphic and intrusive igneous rocks of the Piedmont produce Alfisols, and the felsic rocks produce Ultisols. Ultisols are also common on the Coastal Plain segments, while Inceptisols and Entisols are dominant on the glaciated deposits of Long Island and Cape Cod. Hydraquents, Sulfaquents, and Sulfihemists are in tidal marshes along the

Table S-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
147	53,270	20,565	0	0	160	520	320	1,070	630	2,080	1,390	4,580
148	31,085	12,000	0	0	70	230	130	440	220	720	850	2,810
149A	14,405	5,560	0	0	0	0	20	70	50	170	150	490
149B	6,840	2,640	0	0	0	0	10	40	40	140	110	390

Table S-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
147	6.9	44	9	48	10.4	51	11.9	53	13.6	56	130	158	174/175	189	210
148	8.5	47	11.1	52	12	54	13.2	56	14	57	155	182	196/195	207	230
149A	11.6	53	12.2	54	13.1	56	14	57	14.7	58	175	196	211/210	224	240
149B	9.7	49	10.1	50	11	52	12.1	54	12.9	55	165	182	209/205	223	240

Table S-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
147	780	31	959	38	1,047/1,060	41/42	1,196	47	1,470	58
148	1,000	40	1,058	42	1,121/1,135	44/45	1,230	48	1,340	53
149A	1,040	41	1,074	42	1,117/1,125	44/44	1,197	47	1,240	49
149B	1,020	40	1,140	45	1,207/1,205	48/47	1,266	50	1,320	52

Chesapeake Bay and the Atlantic Ocean. Psamments are of major extent on the Long Island-Cape Cod coastal lowland and of minor extent on the coastal plains. Many soils in the northern and western parts of Region S have root-restrictive lithic and paralithic contacts (fig. 9, page 13) and fragipans (fig. 11, page 15). Although some of the soils formed in limestone, soil carbonates are largely absent in this region (fig. 5, page 9). Argillic horizons are common in areas of geomorphic stability (fig. 12, page 16). Most of the organic carbon in Region S occurs in the wetlands along the coast (fig. 14, page 18).

Land use in Region S is dominated by forest and urban land (fig. S-2). In addition, the region has a significant area of highly diversified farming (fig. 8, page 12). Truck crops, fruits, and poultry are important sources of income, particularly on the coastal plains. Forage crops, soybeans, and grain for dairy and beef cattle also are important. Many large-scale corporate farms on the coastal plains are associated with the canning and frozen food industries. Many farms are operated part-time by people who earn most of their living in the cities. Rural residences are on many sites that are less favorable for farming. Throughout the region, urban areas are encroaching on farmland. Steep slopes, which are mainly forested, are used for timber production and recreation.

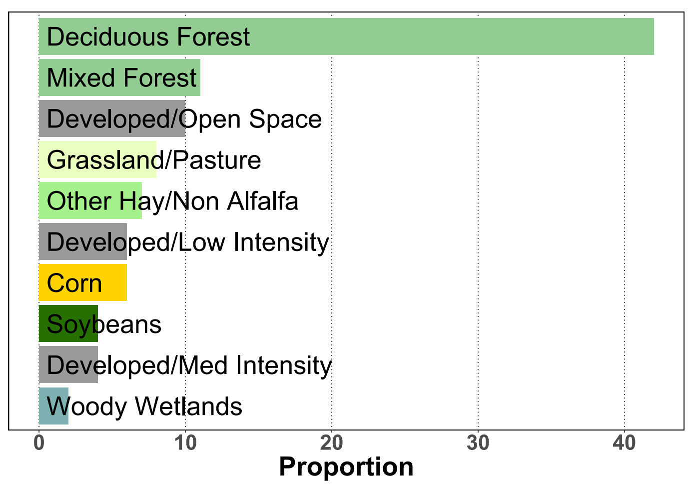

Figure S-2: Relative proportions (percentages) of land use in Land Resource Region S based on 2018 data from the National Agricultural Statistics Service.

147—Northern Appalachian Ridges and Valleys

This MLRA (fig. 147-1) is characterized by a distinct pattern of sandstone ridges separated by limestone valleys that trend northeast to southwest from the Delaware Water Gap, in its northeasternmost corner at the border of Pennsylvania and New Jersey, to southeast of White Sulphur Springs, West Virginia. The Great Valley is a salient feature of the eastern portion and runs the entire length of the MLRA. This MLRA is in Pennsylvania (56 percent), Virginia (25 percent), West Virginia (15 percent), and Maryland (4 percent). It makes up about 20,567 square miles (53,269 square kilometers).

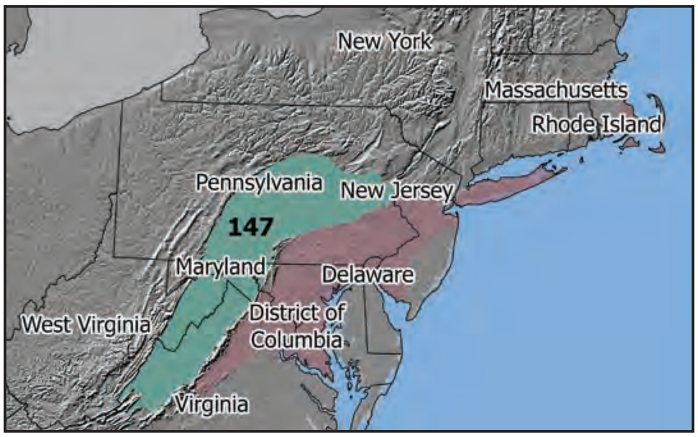

Figure 147-1: Location of MLRA 147, which covers 5,326,900 hectares (13,162,900 acres), within Region S.

MLRA 147 has a distinct boundary based on physiography with MLRAs 130A (Northern Blue Ridge) and 148 (Northern Piedmont), where the underlying bedrock changes from sedimentary geology to metamorphic, and with MLRA 127 (Eastern Allegheny Plateau and Mountains), where bedrock, tilted in MLRA 147, becomes flat-lying with deeply dissected valleys.

MLRA 147 has a less apparent boundary with MLRAs 128 (Southern Appalachian Ridges and Valleys), 140 (Glaciated Allegheny Plateau and Catskill Mountains), and 144A (New England and Eastern New York Upland, Southern Part). In these adjoining MLRAs, glaciation has smoothed the landscape (in the north) and the valley and ridge patterns become narrow (to the south).

Physiography

This area is in the Middle section of the Valley and Ridge province of the Appalachian Highlands. It is a folded and faulted area of parallel ridges and valleys that are carved out of anticlines, synclines, and thrust blocks. Parallel sandstone and shale ridges are separated by narrow to moderately broad limestone and shale valleys. The ridges are strongly sloping to extremely steep and have narrow, rolling crests, and the valleys are mainly level to strongly sloping. The western side of the area is dominantly hilly to very steep and is rougher and much steeper than the eastern side, much of which is rolling and hilly. Elevation generally ranges from 330 to 985 feet (100 to 300 meters) in the valleys and from 1,310 to 2,625 feet (400 to 800 meters) on the ridges and mountains. It is as high as 2,955 feet (900 meters) on some mountain crests and is nearly 4,430 feet (1,350 meters) on a few isolated, linear mountain ridges. Local relief in the valleys is about 15 to 165 feet (5 to 50 meters). The ridges rise about 660 feet (200 meters) above the adjoining valleys. The Susquehanna, Potomac, Greenbrier, New, Clinch, and James Rivers are the major streams that drain this MLRA.

Geology

This area is underlain by Paleozoic sediments ranging in age from Cambrian to Pennsylvanian. Parts of the northernmost section of the MLRA were subjected to Pre-Illinoian glaciation (more than 770,000 years ago). The resistance of the sediments to erosion varies greatly and has a major effect on the topography. The ridge crests are made up primarily of resistant sandstones and conglomerate bedrock. The valleys are underlain by less resistant shales and limestone. Anthracite coal underlies some areas in the north and has been mined since the 1700s. The topographic orientation of the Valley and Ridge province is dominantly northeast to southwest. The streams follow the less resistant rock types and cut through the more resistant rock types at an angle of 90 degrees, forming water gaps, most of which are along zones of intensive fracturing. As a result of this process, a trellis drainage pattern characterizes this MLRA.

Climate

The average annual precipitation in most of this area is 31 to 45 inches (785 to 1,145 millimeters). It is typically 45 to 52 inches (1,145 to 1,320 millimeters) in the northern end of the area, in Pennsylvania. The maximum precipitation occurs from late winter through early summer, and the minimum occurs in fall. About 21 to 26 inches (535 to 660 millimeters) falls during the growing season. The average annual snowfall ranges from 16 to more than 51 inches (40 to 130 centimeters). The average annual temperature is 44 to 57 degrees F (7 to 14 degrees C). The freeze-free period averages 180 days and ranges from 140 to 220 days. The cooler temperatures and the shorter freeze-free periods are at the higher elevations and the more northern latitudes.

Water

In most years the supply of moisture is adequate for maximum crop production and other needs. Short dry periods early in summer occasionally reduce crop yields. Springs, farm ponds, reservoirs, and streams are the principal sources of water in this area. Streams, some ponds, and springs provide water for livestock. Springs also provide some domestic drinking water. The many rivers crossing this area are sources of public supply and industrial water. Most of the surface water is of good quality and suitable for most uses with minimal treatment.

The abundance of ground water depends largely on landscape and geology. The most abundant water sources are in coves and valleys underlain by carbonate rocks. For example, the Valley and Ridge aquifers in Virginia consist of limestone and dolomite. The water in these aquifers is low in total dissolved solids but is very hard. This aquifer is called the Cambrian-Ordovician Carbonate aquifer in Tennessee, and it includes layers of sandstone and shale as well as carbonates. Similar rock types are used as aquifers in the parts of this MLRA in Maryland and Pennsylvania. These aquifers all have water of similar quality, and they provide domestic water for rural landowners, for industry, and for communities. The water is in fractures, joints, and bedding planes in the sandstone and shale layers as well as in solution openings in the limestone and dolomite layers. Most wells are 300 feet (90 meters) or less deep. Because of the shallow depth to water, the concentration of agriculture, the urban areas, the industrial plants on the valley floors, and the solution openings in the carbonate layers, the ground water is susceptible to contamination from human activities.

Soils

The dominant soil orders are Inceptisols, Ultisols, and Alfisols. The soils in the area dominantly have a mesic soil temperature regime, a udic soil moisture regime, and mixed or siliceous mineralogy. They are shallow to very deep, generally excessively drained to moderately well drained, and loamy or clayey.

The main soils and their series:

- Dystrudepts that formed in sandstone, siltstone, and shale on ridges and upper side slopes of mountains (Hazleton series) and hills (Weikert series)
- Dystrudepts that formed in alluvium along flood plains and drainageways (Basher series)
- Endoaquepts that formed in alluvium along backswamp areas of flood plains (Holly and Atkins series)
- Fragiudults that formed in colluvium on the lower footslopes of the ridges and in the valleys (Buchanan and Ernest series)
- Hapludalfs that formed in residuum in the limestone valleys (Hagerstown series)
- Hapludults that formed in residuum on middle slopes of the ridges and in the valleys (Leck Kill series)
- Paleudults that formed in residuum on lower footslopes and low hills in the limestone valleys (Frederick series)

Biological Resources

This area supports hardwoods. White oak, red oak, black oak, hickories, and associated upland hardwoods are the major species. Scarlet oak, chestnut oak, hickories, and scattered Virginia pine, pitch pine, shortleaf pine, and eastern white pine are common on the shallower soils and on south aspects, especially in the southern part of the area. Yellow-poplar, red oak, red maple, and other species that require more moisture grow in sheltered coves and on footslopes and north aspects.

Major wildlife species in this area include white-tailed deer, wild turkey, gray squirrel, cottontail rabbit, raccoon, red fox, gray fox, ruffed grouse, and woodchucks. Smallmouth bass, rock bass, sunfish, catfish, and suckers are in the larger warm-water streams. Suitable cold-water streams are stocked with trout. Native brook trout inhabit many of the smaller streams.

Land Use

Most of this area is in farms (fig. 147-2). The cropland is used for a wide variety of crops, mainly corn, small grains, and forage for dairy and beef cattle. Other important crops are potatoes, soybeans, apples, peaches, and some tobacco and vegetables. Dairy farms, beef production, and poultry farms are major enterprises. The hardwood forests are mainly small or medium-size holdings, but some are larger tracts of national and State forests, game lands, or parks. A significant acreage in the area is used for urban development or consists of land altered by urbanization. Much of the prime farmland in the valleys has been developed for urban uses.

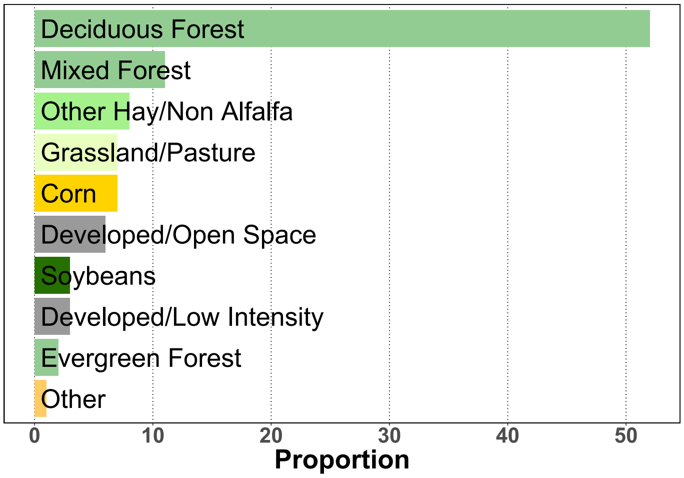

Figure 147-2: Relative proportions (percentages) of land use in MLRA 147.

The major soil resource concerns are water erosion, sedimentation, and maintenance of the content of organic matter and productivity of the soils. Conservation practices on cropland generally include conservation tillage (especially no-till systems), cover crops, contour farming, return of crop residue to the soil, and nutrient management.

148—Northern Piedmont

This MLRA (fig. 148-1) stretches from north-central New Jersey to central Virginia. It is between the flat coastal plain to the east and the northern Blue Ridge Mountains to the west. The

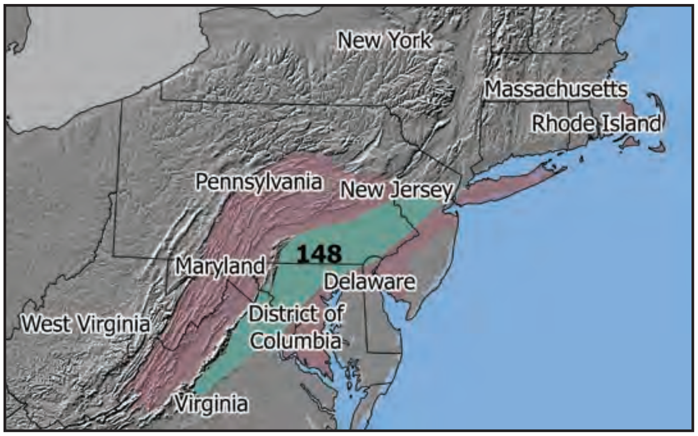

Figure 148-1: Location of MLRA 148, which covers 3,108,600 hectares (7,681,400 acres), within Region S.

igneous and metamorphic bedrock of this area has been eroded into a dissected landscape consisting of moderately steep to steep rolling hills that are covered with mixed hardwoods and small farms. Adequate precipitation and fertile soils make the area desirable for grain crops and livestock production. This area is in Pennsylvania (40 percent), Virginia (28 percent), Maryland (21 percent), New Jersey (10 percent), and Delaware (1 percent). It makes up about 12,002 square miles (31,086 square kilometers).

MLRA 148 has a clear boundary with MLRAs 149A and 133A along the fall line. The fall line separates residual igneous and metamorphic bedrock from the lower elevation, fluviomarine terrace associated with coastal plain sediments. To the north, MLRA 148 has a clear boundary with MLRA 144A where glacial outwash overlies the soils. It has an abrupt geologic boundary with the hilly sedimentary sandstone, shale, and limestone bedrock of MLRA 147. Its boundary with MLRA 136, which has similar geology is not apparent; it is where the mesic soil temperature regime (in the north) transitions to the thermic soil temperature regime (in the south). This transition is tens to hundreds of miles wide. MLRA 148 has a topographically abrupt boundary with MLRA 130A, although the two areas have only slightly different soil parent materials.

Physiography

Most of this area is in the Piedmont Upland section of the Piedmont province of the Appalachian Highlands. The southwest end and the northwest portion of the southwest half of this MLRA and the southeast portion of the northeast half are in the Piedmont Lowlands section of the same province and division. The northwest portion of the northeast half of the MLRA is in the New England Upland section of the New England province of the Appalachian Highlands. Most of this area is an eroded part of the Piedmont Plateau. This MLRA is mostly gently sloping or sloping. Intrusive dikes and sills form sharp ridges that interrupt the less steep terrain. Differential erosion dependent on hardness of rocks has created low and high areas. The steeper slopes generally are on ridges at the higher elevations or are on side slopes adjacent to drainages. In general, this MLRA ranges from 82 to 1,148 feet (25 to 350 meters) in elevation. Isolated peaks and ridges of Blue Ridge geologic material and Valley and Ridge geologic material can be identified at elevations from 1,148 to 1,650 feet (350 to 505 meters) throughout the MLRA.

Rivers and creeks in this MLRA include the Schuylkill, Octoraro, Patuxent, Monocacy, and Rappahannock Rivers and Goose and Deer Creeks. The Delaware River separates Pennsylvania and Delaware from New Jersey in this area. The Susquehanna River crosses the northern end of the area, and the Potomac River separates the District of Columbia and Maryland from Virginia at the southern end of the area.

Geology

This area is above the fall line on the East Coast and below the Blue Ridge and Appalachian Mountains. The fall line is the boundary between coastal plain sediments and the crystalline bedrock of the interior uplands. The eastern third of the area is underlain mainly by Lower Paleozoic to Precambrian sediments and igneous rocks that have been metamorphosed. The typical rock types in this part of the MLRA are granite, gabbro, gneiss, serpentinite, marble, slate, and schist.

The central part of the area is a crustal trough or basin that formed during the Triassic Period. This basin represents the ancestral Atlantic Ocean that formed when the European-African continental plate began its movement westward from the North American Plate. Many of the rocks in this part of the MLRA are the same as those in the western British Isles, since they were deposited at a time when the North American, Eurasian, and African Plates were all one landmass. The rocks deposited in the basins include Triassic sandstone, shale, and conglomerate. These ancient basins have been uplifted and are now in the uplands in this MLRA. Numerous Jurassic diabase and basalt dikes and sills cut the sedimentary rocks in the basins.

The far western part of this MLRA is underlain mostly by Cambrian to Silurian limestone. The northern boundary of the MLRA marks the southernmost extent of the Wisconsin glaciers. Earlier periods of glaciation extended farther south in north-central New Jersey and in eastern Pennsylvania. Unconsolidated stream alluvium (primarily sand and gravel) fills the major river valleys.

Climate

This MLRA has four distinct seasons. Winter is cold and moist, spring and fall are cool and wet, and summer is hot and humid with short periods of drought, which may be interrupted by intense thunderstorms. The maximum precipitation occurs during high-intensity, convective thunderstorms in spring and early summer. Brief periods of bitter cold may occur during winter when the jet stream dips to the Deep South. Snowfall occurs in winter. The occasional northeaster can deposit up to several feet of snow. In general, the climate is hotter and drier in the south part of the MLRA and cooler and wetter in the north part.

The average annual precipitation is 40 to 53 inches (1,010 to 1,335 millimeters). Droughts of 10 to 14 days are common in summer. The average annual temperature is 47 to 57 degrees F (8 to 14 degrees C). The freeze-free period averages 205 days and ranges from 170 to 240 days.

Water

Precipitation and perennial streams are the primary sources of water. The surface water is suitable for most uses if properly treated. Before the 1972 Clean Water Act, the lower Delaware River, many New Jersey rivers, and the Potomac River were degraded for many years by sedimentation from agriculture and waste discharges from cities and industrial sites. Water for urban areas is supplied largely by municipal reservoirs.

Springs and shallow wells are common in this area and provide water for many rural residents and agricultural practices. Wells located in igneous and metamorphic rocks along joints, fractures, and cleavage planes supply a limited quantity of excellent soft water. Water from the Triassic red shale and sandstone (Neward Group) is slightly harder than that in the crystalline bedrock aquifers. An abundance of water can be sourced from the carbonate rocks located in several limestone valleys throughout this MLRA. This very hard water occurs in solution channels, fractures, and partings in the rock. All three aquifer types are susceptible to contamination from agricultural and urban activities. Stormwater runoff from agricultural activities and heavy urbanization is closely monitored and regulated to improve the water quality of Chesapeake Bay for the fragile shellfish and aquaculture habitat.

Soils

Ultisols are the dominant soil order in this MLRA, but Alfisols and Inceptisols are also widespread and locally dominant. Entisols occur locally in high-energy fluvial and colluvial settings. The soils in the area are in a mesic temperature regime and a udic moisture regime and have mixed, micaceous, or kaolinitic mineralogy. In general, they are moderately deep to very deep, moderately well drained or well drained, and loamy or loamy-skeletal. Anthroportic soils occur throughout the area and are a result of cut-and-fill activities associated with construction and urbanization.

The main soils and their series:

- Dystrudepts that formed in residuum on eroded slopes (Manor, Parker, and Mt. Airy series)
- Fragiudalfs that formed in fertile residuum on footslopes and in drainageways (Readington series)
- Fragiudults that formed in acidic colluvium on footslopes and in drainageways (Glenville series)
- Hapludalfs that formed in fertile residuum on uplands (Duffield, Neshaminy, and Penn series)
- Hapludults that formed in acidic residuum on hills and ridges (Chester, Elioak, Gladstone, and Glenelg series)

Biological Resources

This MLRA is part of the Eastern Broadleaf Forest Province and is dominated by a drought-resistant oak-hickory forest association. Because of slight climatic differences between the northern and southern reaches of MLRA 148, vegetative communities vary with latitude. In general, common overstory tree species include white oak (*Quercus alba*), northern red oak (*Quercus rubra*), southern red oak (*Quercus falcata*), black oak (*Quercus velutina*), bitternut hickory (*Carya cordiformis*), and shagbark hickory (*Carya ovata*). The area has well developed understories of dogwood (*Cornus* spp.), sassafras (*Sassafras albidum*), and hornbeam (*Carpinus* spp. and *Ostrya* spp.). American elm (*Ulmus americana*), tuliptree (*Liriodendron tulipifera*), and sweetgum (*Liquidambar styraciflua*) are common on somewhat richer sites (Bailey, 1995). Soils on these richer sites are slightly more fertile and have a higher available water-holding capacity. Virginia pine and tulip-poplar are common early successional forest pioneers. The composition of the more mature forest stands tends to vary depending on soils, topography, and succession. Tree growth and wood production are considerably less extensive in the Triassic basins than elsewhere in the area.

Upland mesic sites on alkaline soils support an oak-hickory forest cover. Hickories commonly are on sites that have a higher base saturation; they are common in both the overstory and understory of the more basic oak-hickory types. Overall species richness also tends to be higher on these sites. Common components include an overstory of shagbark hickory (*Carya ovata*), white ash (*Fraxinus americana*), and eastern redbud (*Cercis canadensis* var. *canadensis*) with understories dominated by flowering dogwood (*Cornus florida*), mapleleaf viburnum (*Viburnum acerifolium*), and dry-mesophytic herbaceous generalists.

Upland mesic sites on acidic soils are dominated by an oak-heath forest community with a common overstory of northern red oak (*Quercus rubra*) and black oak (*Quercus velutina*). Sites on similar submesic soils have chestnut oak (*Quercus montana*), scarlet oak (*Quercus coccinea*), and southern red oak (*Quercus falcata*) while the most drought-prone sites support post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica Münchh* var. *marilandica*). These forest communities tend to have an understory dominated by red maple (*Acer rubrum*), blackgum (*Nyssa sylvatica*), and plants unsuited to alkaline soils, such as early lowbush blueberry (*Vaccinium pallidum*), black huckleberry (*Gaylussacia baccata*), and other heathers (VA DCR, 2016). Eastern redcedar is common in many areas of abandoned cropland.

In cool, moist ravines with acidic soils, a mesic mixed hardwood forest of American beech (*Fagus grandifolia*) is common. This forest community is replacing upland oak-hickory forests in many areas where fire has been excluded for long periods or where oak recruitment has declined for other reasons (Zimmerman et al., 2012). In cool, moist ravines with more mafic or calcareous substrates, similar mesic mixed hardwood forests also commonly include white ash (*Fraxinus americana*), bitternut hickory (*Carya cordiformis*), basswood (*Tilia americana*), chinquapin oak (*Quercus muehlenbergii*), sugar maple (*Acer saccharum*), and dense species-rich understories where overstory shade is not extreme.

Riparian forests and flood-plain forests grow widely across the Northern Piedmont. Along the larger rivers, these forests tend to be dominated by flood-tolerant trees, such as silver maple (*Acer saccharinum*), sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), eastern boxelder (*Acer negundo*), common hackberry (*Celtis occidentalis*), and river birch (*Betula nigra*). In areas with high-energy flooding, these flood-plain forests are commonly broken by flood-scoured deposition bars, outcrops, and early successional vegetation communities. Along stretches that do not flood as deeply, hydrophytic oaks—such as pin oak (*Quercus palustris*), swamp white oak (*Quercus bicolor*), willow oak (*Quercus phellos*), overcup oak (*Quercus lyrata*), and swamp chestnut oak (*Quercus michauxii*)—may dominate the overstory and sedges (*Carex*) may dominate the understory and form large, dense communities.

Major wildlife species include white-tailed deer, fox, raccoon, muskrat, opossum, gray squirrel, cottontail, weasel, pheasant, ruffed grouse, and mourning dove. The black bear population is increasing in the less densely populated portions of this MLRA.

Land Use

Approximately one-third of this area is in farms, and one-third is urban or being urbanized rapidly (fig. 148-2). The farms are intensively cropped in Maryland, in Pennsylvania, and in most of New Jersey. They are mostly in pasture or woodland in the northern parts of New Jersey and in Virginia. Forage crops, soybeans, and grain for dairy cattle make up the largest acreage of cropland. Hog, beef cattle, dairy cattle, and poultry production is significant in this MLRA. Some areas are used for horticultural production, such as landscaping trees and shrubs and Christmas trees. Horse and hobby farms have become more numerous, particularly near the rural-suburban fringe. Recreational uses, such as parks, athletic fields, and golf courses, are common in or near urban or suburban developments.

The major soil resource concern is the conversion of non-urban land, especially prime farmland, to urban and suburban uses. Erosion and the resultant degradation of stream quality commonly occur during construction activities associated with urbanization. Other concerns are erosion and degradation of soil quality in areas used for grain crops year after year.

The important conservation practices on cropland are those that reduce the hazard of erosion. They include contour farming, stripcropping, diversions, grassed waterways, crop rotations, cover crops, and crop residue management. Critical area planting, water- and sediment-control basins, and urban stormwater management are important in areas of urban development.

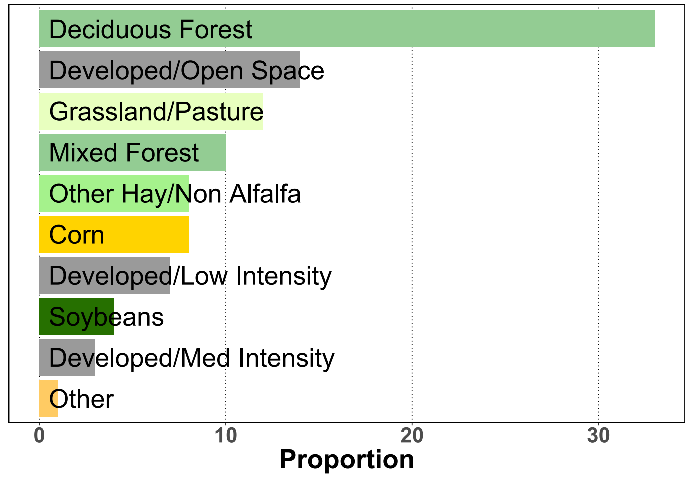

Figure 148-2: Relative proportions (percentages) of land use in MLRA 148.

149A—Northern Coastal Plain

This MLRA (fig. 149A-1) is along the western edge of the Chesapeake Bay in Maryland and extends north to central New Jersey. The embayed area was subject to changes in sea level, which created a dissected coastal plain landscape with nearly level to rolling terrain. Nearshore fluviomarine deposits from the Late Cretaceous seas have been eroded by high winds during the last glaciated period. MLRA 149A is in Maryland (48 percent), New Jersey (41 percent), Pennsylvania (4 percent), Delaware (3 percent), Virginia (3 percent), and the District of Columbia (1 percent). It makes up about 5,562 square miles (14,406 square kilometers).

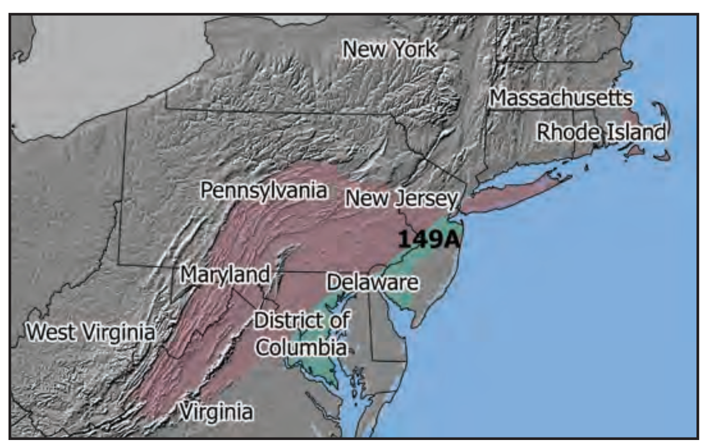

Figure 149A-1: Location of MLRA 149A, which covers 1,440,600 hectares (3,559,700 acres), within Region S.

This MLRA has a distinct boundary, consisting of cobbly and stony glacial outwash, with MLRA 144A to the north. In New Jersey, it has a distinct boundary, marked by drastically different land use and resource concerns, with the wet lowland landscapes of northern MLRA 153D. Its boundary with MLRA 153C, which has similar use and management, is diffuse due to an intermingling of thin bands of eolian silt and fine sand with alluvial sands. MLRA 149A has an abrupt boundary with MLRA 133A based on distinctly dissected fluviomarine terraces and a warmer (thermic) soil temperature regime. To the west, it has an abrupt boundary with MLRA 148 based on the Atlantic Seaboard Fall Line, which is an escarpment characterized by residual soils derived from metamorphic and igneous bedrock.

Physiography

This area is in the Embayed section of the Coastal Plain province of the Atlantic Plain. It is a nearly level to rolling, dissected coastal plain that has been subjected to episodes of rising and falling sea levels. During low sea levels, eroding streams dissected the area, forming a series of terraces across the landscape. The Raritan, Delaware, and Chesapeake Bays are classic drowned river valleys. Elevation ranges from sea level to 330 feet (100 meters). It is less than 165 feet (50 meters) in most of the MLRA. Local relief is mostly 6 to 35 feet (2 to 10 meters), but it is 100 feet (30 meters) or more in a few areas.

The Delaware River separates Pennsylvania and Delaware from New Jersey in this MLRA. It empties into Delaware Bay. In this area, the Susquehanna River empties into the northern tip of the Chesapeake Bay. Raritan Bay marks the northern limit of the MLRA. The Potomac River separates the District of Columbia and Maryland from Virginia at the southern tip of the area.

Geology

Most of this area is underlain by unconsolidated alluvial sediments of sand, silt, and clay deposited in the nearshore environment of Late Cretaceous seas. The rise and fall of the sea level resulted in sand deposits separated by layers of clay and silt. High winds during periods of maximum glacial advance redeposited some of the sandy and silty sediments downwind. In addition, these sediments were sorted downwind from coarsest to finest and from thickest to thinnest.

The northwest boundary of this MLRA almost parallels the fall line on the Eastern Seaboard. The fall line separates the bedrock of the interior uplands and the Coastal Plain. The coastal plain sediments are a source of ground water for the large cities located below the fall line in this MLRA. Southeast Maryland and New Jersey are covered by unconsolidated gravel deposited in the Tertiary Period and reworked by Quaternary seas and erosion. This reworking left a pebble line as a pedisediment marker that separates the older deposits from the more recent eolian deposits.

Glauconite is a common mineral in many of the unconsolidated sediments in the Northern Coastal Plain. Some gabbro, serpentine, Precambrian metamorphic rocks, and Triassic red shale are exposed along the extreme western edges of this MLRA. Because the fall line is irregular, some of the crystalline rocks that occur west of the fall line also occur in this area.

Climate

The average annual precipitation is 40 to 47 inches (1,015 to 1,195 millimeters). Near the coast, most of the precipitation falls as high-intensity, convective thunderstorms in midsummer. Occasionally, extreme weather events, such as northeasters and late summer and fall tropical storms and hurricanes, produce large amounts of precipitation and destructive winds. The seasonal snowfall ranges from little or none in the southern part of the area to 30 inches (75 centimeters) in the northern part.

The average annual temperature is 52 to 58 degrees F (11 to 14 degrees C). The freeze-free period averages 220 days and ranges from 190 to 250 days. Temperatures and the length of the freeze-free period decrease from south to north and from the coast inland.

Water

Rainfall, perennial streams, and underlying aquifers provide an abundance of freshwater for domestic, municipal, and industrial uses. The rivers and streams that flow into estuaries throughout the area supply quality water that supports a diverse and sensitive biome. Agricultural practices in low-lying areas require extensive artificial drainage, while sandy uplands commonly require irrigation water, supplied by wells, during periods of drought. The surficial aquifer extending throughout the MLRA is highly susceptible to contamination from agricultural and urban activities. Near the coastline, the surface water is brackish.

All of the ground water used in the urbanized corridor running along the north and west edges of this area comes from the unconsolidated sand and gravel in the Coastal Plain aquifer system. The aquifers include the Potomac, Raritan, Magothy, Englishtown, and Kirkwood-Cohansey. Domestic supplies are obtained mainly from shallow wells, but large supplies are obtained from deep wells. Generally, very little treatment is required before the water from this aquifer system is used. The water is typically soft, but it can be moderately hard to very hard in some areas. The level of iron may exceed the drinking water standard in some places. Water from wells drilled closer to the ocean may have high levels of chloride because of seawater intrusion. Reservoirs on the tributary streams of the Potomac River and Upper Chesapeake Bay supply water to the District of Columbia. The reservoirs on the Upper Chesapeake Bay also supply Baltimore and its suburbs with drinking water.

Soils

The dominant soil order in this MLRA is Ultisols. Some Entisols, Inceptisols, Spodosols, and Histosols also occur. The soils in the area have a mesic temperature regime, an aquic or udic moisture regime, and mixed, siliceous, or glauconitic mineralogy. They are very deep, excessively drained to very poorly drained, and primarily loamy or sandy. The study of subaqueous soils is of increasing importance along nearshore coastal waters. Anthroportic soils throughout the area are a result of cut-and-fill activities associated with construction and urbanization.

The main soils and their series:

- Fragiudults that formed in old alluvium on hills and relict stream terraces (Aura series); that formed in silty deposits on broad flats (Beltsville series)
- Hapludults that formed in fluviomarine deposits on terraces and flats (Grosstown, Marr, Sassafras, and Woodstown series); that formed in nearshore marine deposits containing glauconite on uplands (Adelphia, Freehold, Collington, and Holmdel series); that formed in sandy eolian deposits (Galestown and Tinton series)
- Sulfiwassents (subaqueous soils) that formed in low- to moderate-energy estuarine deposits on lagoon bottoms along the Atlantic coastline (Rhode River, Sellman, and Contees Wharf tentative series)

Biological Resources

This area supports pine and hardwoods. Loblolly pine, Virginia pine, shortleaf pine, southern red oak, black oak, scarlet oak, pin oak, willow oak, northern red oak, black walnut, yellow-poplar, sweetgum, and red maple are the dominant species. Major wildlife species include white-tailed deer, cottontail, squirrel, waterfowl, and songbirds.

The Chesapeake and Delaware Bays provide habitat for diverse populations of terrestrial and aquatic animal species. The subaquatic vegetation (SAV) in these coastal lagoon areas consists of eelgrass and widgeongrass. These SAV species provide critical habitat and cover for many juvenile fin and shellfish. The estuaries are also an integral part of the Atlantic Flyway and host numerous migratory waterfowl throughout the year.

Land Use

Five major metropolitan cities or suburbs (Baltimore, New York, Philadelphia, Washington D.C., and Wilmington) are partially located within this MLRA and have dramatically altered the natural landscape in more than one-third of the area. Agricultural land is under intense pressure due to rapid urbanization, but many specialty crops are still cultivated on the remaining farms (fig. 149A-2). The major crops are vegetables, corn, soybeans, small grains, and fruits. Tobacco is a specialty crop in Maryland. Highbush blueberries are a common specialty

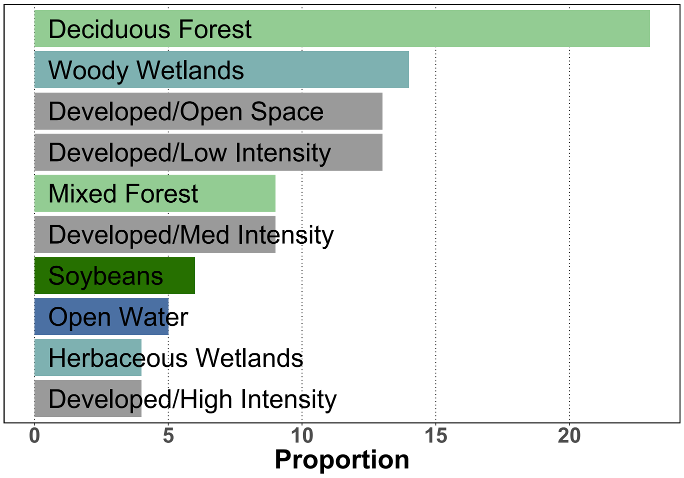

Figure 149A-2: Relative proportions (percentages) of land use in MLRA 149A.

crop in New Jersey. Forage crops and grains for dairy cattle are important locally. Poultry, nursery stock, and sod farms also are important locally. Most of the woodland is in farm woodlots, but some is in large holdings. Pine pulpwood and hardwood lumber are the principal forest products. State forests and parks are extensive in some areas. A narrow band along the coast is intensively developed for resorts and recreation.

The major soil resource concern is the conversion of land, especially prime farmland, to urban and suburban uses. Erosion and the resultant degradation of stream quality commonly occur during construction activities associated with urbanization. Other concerns are erosion and degradation of soil quality in areas used exclusively for grain crop production. Improved drainage is needed on almost one-fourth of the farmland.

Important conservation practices on cropland are those that reduce the hazard of erosion. They include crop residue management (including no-till and minimum tillage systems), conservation cover crops, nutrient management, grassed waterways, filter strips, and riparian buffers. Where livestock or poultry are part of the farm operation, management of animal waste, including its storage, is important. Farmland preservation programs are vital to maintaining the agricultural resources in the MLRA. Critical area planting, water- and sediment-control basins, and urban stormwater management are important in the areas used for urban development.

149B—Long Island-Cape Cod Coastal Lowland

This area (fig. 149B-1) is in New York (64 percent), Massachusetts (34 percent), and Rhode Island (2 percent). It makes up about 2,640 square miles (6,838 square kilometers). The MLRA is bordered on the south and east by the Atlantic Ocean and on the north and west by glaciated areas that are not terminal moraine landscapes.

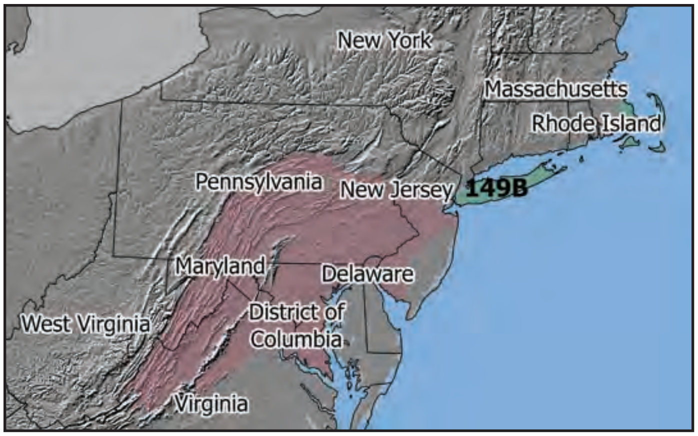

Figure 149B-1: Location of MLRA 149B, which covers 683,800 hectares (1,689,800 acres), within Region S.

Physiography

This area is in the Embayed section of the Coastal Plain province of the Atlantic Plain and the Seaboard Lowland section of the New England province of the Appalachian Highlands. It is part of the submerged coastal plain of New England. It is mostly an area of nearly level to rolling plains, but it has some steeper hills (glacial moraines). Ridges border the lower plains. Elevation generally ranges from sea level to 80 feet (0 to 25 meters), but it is as much as 330 feet (100 meters) in a few areas. Local relief is mainly 3 to 30 feet (1 to 10 meters) but it is as much as 65 feet (20 meters) in the hillier areas. The Peconic and Carmans Rivers are on the eastern end of Long Island. The parts of this area in Massachusetts and Rhode Island have no major rivers.

Geology

This entire area is made up of deep, unconsolidated glacial outwash deposits of sand and gravel. A thin mantle of glacial till covers most of the surface. Some moraines form ridges and higher hills in this area of generally low relief. Sand dunes and tidal marshes are extensive along the coastline.

Climate

The average annual precipitation is 40 to 52 inches (1,023 to 1,320 millimeters). The precipitation is fairly evenly distributed throughout the year. Rainfall occurs during high-intensity, convective thunderstorms in summer. Seasonal snowfall is moderate to low in winter. Extended periods when there is no snow cover can be expected in winter because of relatively moderate temperatures. The average annual temperature is 49 to 55 degrees F (9 to 13 degrees C). The freeze-free period averages 220 days and ranges from 195 to 240 days.

Water

Most of the water used in this area is for the urban population on Long Island. The area has only a few perennial streams, rivers, and lakes, so ground water supplies are used for most needs. In most years precipitation is adequate for crops. High-value vegetable crops grown on the drier sandy soils usually require irrigation for optimum yields. The surface water is generally of good quality.

The deep sand and gravel deposits underlying most of this area are excellent aquifers and are good sources of irrigation water and drinking water. The Magothy Formation and Lloyd Sand make up the Coastal Plain aquifer in Massachusetts and Rhode Island and in the middle and east end of Long Island. This aquifer does not occur on the west end of Long Island, where most of the urban population resides. The water from this aquifer is soft. Some of the water has high levels of iron and manganese, but the median level of these constituents is below the primary and secondary standards for drinking water. The level of nitrates is somewhat high. Encroachment of saltwater from the surrounding ocean is an ongoing hazard in these freshwater aquifers. The ground water on Cape Cod and the offshore islands is acidic and may cause corrosion of metal pipes and concrete.

Soils

The dominant soil orders in this area are Inceptisols and Entisols. The dominant suborders are Udepts and Psamments. The soils in the area have a mesic temperature regime, a udic moisture regime, and mixed mineralogy. They are deep, moderately coarse textured or coarse textured, nearly level to sloping, and well drained. Sand dunes and tidal marshes are extensive along the coastline.

The main soils and their series:

Dystrudepts that formed in glaciofluvial deposits (Haven and Riverhead series) and till (Montauk series)

Psammowassents (permanently submerged soils) that formed in sandy estuarine and marine deposits along the coast (Nagunt and Rhodesfolly series)

Quartzipsamments that formed in glaciofluvial deposits and melt-out till (Carver and Plymouth series); that formed in Holocene coastal dune deposits (Hooksan series)

Sulfihemists that formed in organic material in saltmarshes (Ipswich and Pawcatuck series)

Biological Resources

This MLRA supports hardwoods and softwoods. Extensive areas of oak-pitch pine forest are on droughty, sandy soils. Oak and beech-birch-sugar maple are two other potential forest types. Eastern white pine (*Pinus strobus*) and red pine (*Pinus resinosa*) grow in many areas. Japanese barberry (*Berberis thunbergii*) and lowbush blueberry (*Vaccinium angustifolium*) are common early succession types in burned-over areas. Non-native, invasive honeysuckle (*Lonicera*) and Japanese barberry are common in disturbed areas. In areas of sand dunes, American beachgrass (*Ammophila breviligulata*) can occur on foredunes and a mixture of bayberry, sassafras (*Sassafras* *albidum*), and American holly (*Ilex opaca*) can occur on the more protected dunes.

Major wildlife species include white-tailed deer, fox, raccoon, cottontail, gray squirrel, pheasant, woodcock, bobwhite quail, and waterfowl. Aquatic species include marine fish and shellfish.

Land Use

Almost half of this MLRA is used for urban development, and urban expansion is ongoing (fig. 149B-2). Almost one-fifth is forested, mostly in farm woodlots but also in large holdings. Pine pulpwood and hardwood lumber are the principal forest products. Some areas have extensive State forests and parks. A narrow band along the coast is intensively developed for resorts and recreation. On cropland, cash crops and vegetables, such as potatoes, cauliflower, and cabbage, are particularly important. In a few areas duck and poultry farms are important enterprises.

The major soil resource concern is the conversion of non-urban land, especially prime farmland, to urban and suburban uses. Erosion and the resultant degradation of stream quality commonly occur during construction activities associated with urbanization. Other concerns are erosion and degradation of soil quality in areas used for grain crops year after year. Improved drainage is needed on almost one-fourth of the farmland.

Important conservation practices on cropland are those that reduce the hazard of erosion. They include crop residue management (including no-till and minimum tillage systems), conservation cover crops, nutrient management, grassed waterways, filter strips, and riparian buffers. Where livestock or poultry are part of the farm operation, management of animal waste, including its storage, is important. Farmland preservation programs are vital to maintaining the agricultural resources in the MLRA. Critical area planting, water- and sediment-control basins, and urban stormwater management are important in areas of urban development.

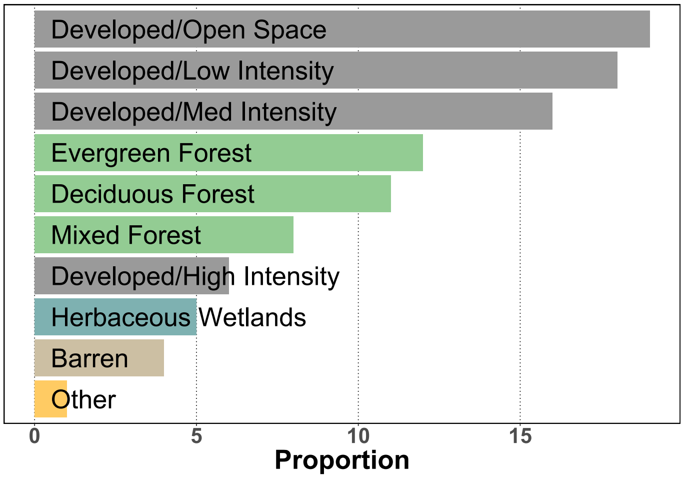

Figure 149B-2: Relative proportions (percentages) of land use in MLRA 149B.

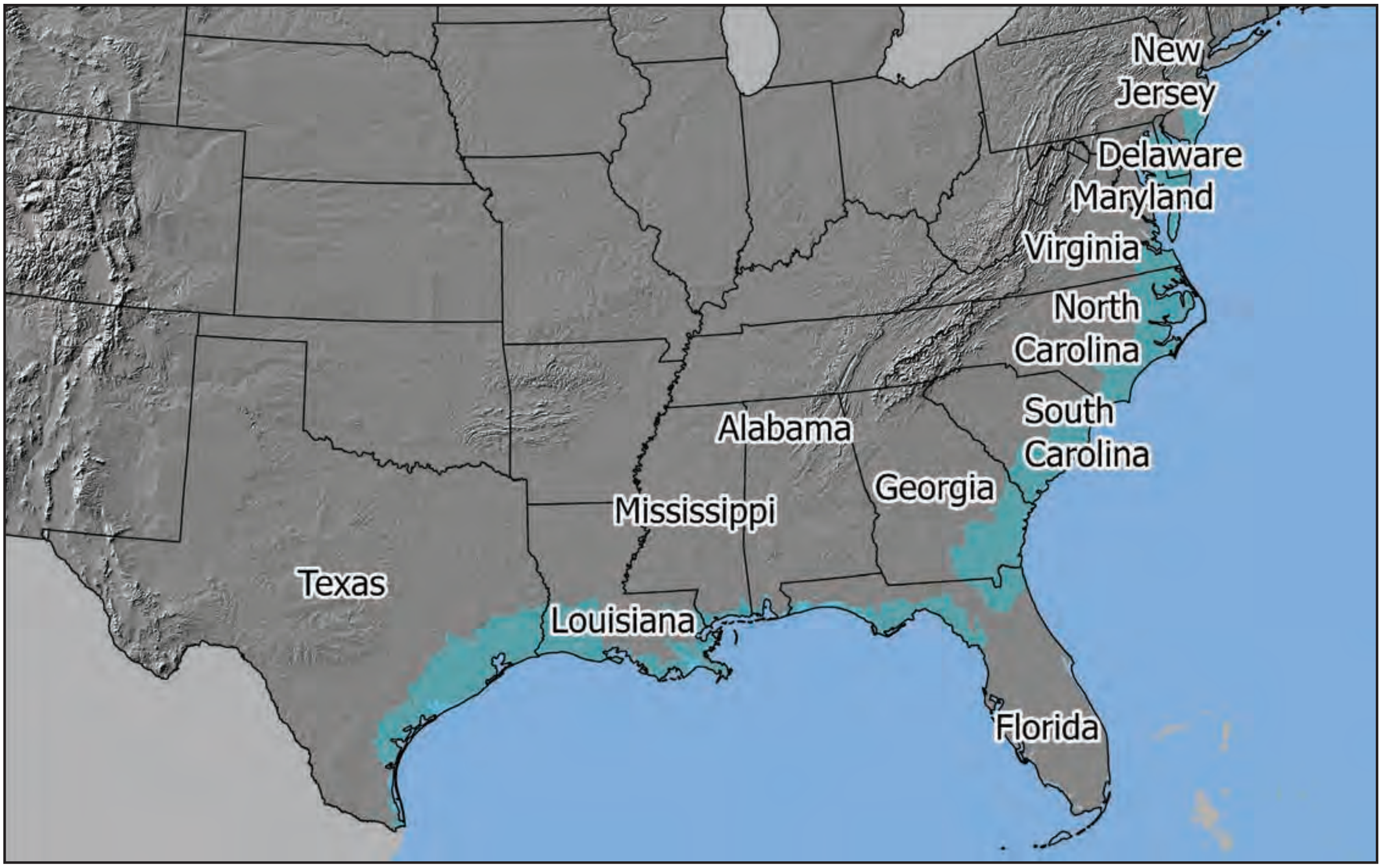

Figure T-1: Location and size of Land Resource Region T, which covers 239,470 square kilometers (92,460 square miles) along the Gulf and Atlantic Coasts from Texas to New Jersey.

T—Atlantic and Gulf Coast Lowland Forest and Crop Region

Land Resource Region T (fig. T-1) is the high water table region of the Coastal Plain bordering the sea. It is also the section with the lowest elevations and youngest Coastal Plain geology. Its broad, shallow valleys with meandering streams, tidal marshes, swamps, estuaries, drowned valleys, sea islands, beaches, and Mississippi River Delta are all features of the Late Quaternary. The soils of this region contain high stocks of organic carbon (fig. 14, page 18). The region has nine major land resource areas. The extent of these MLRAs and their range in elevation are shown in table T-1.

Region T's boundaries with Regions P, J, and I (fig. 1, page 5) are marked by the extent of the aquic soil moisture regime (that occurs almost everywhere in Region T), which promotes the tupelo, gum, bald cypress, and pine forests and restricts use of areas as cropland. Its boundary with Region U reflects the unique conditions in Florida, including a reduced number of streams, an increased abundance of lakes, karsts, and the dominance of Spodosols and Entisols.

Climatically, Region T is the region in the United States most affected by hurricanes. It has some of the highest amounts of annual rainfall, commonly exceeding 65 inches (1,650 millimeters) along the Louisiana, Mississippi, and Alabama coastlines (fig. 6, page 10). The average annual precipitation is 39 to 62 inches (980 to 1,580 millimeters). The region is generally driest at the northern end along the Atlantic Coast and wettest at the southern end. The amount of precipitation is slightly higher during fall and winter. Snowfall occurs in the northern third of the region. The average annual temperature is 56 to 74 degrees F (13 to 23 degrees C). The mean freeze-free period ranges from 210 to 355 days, increasing in length to the south. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables T-2 and T-3.

Soils in the Texas portion of Region T are dominantly Vertisols but include Alfisols, Ultisols, and small dispersed areas of Mollisols (fig. 2, page 6). Eastward into Louisiana, Alfisols and Ultisols occur in higher areas away from the coast and form a boundary with Histosols on the coast. Ultisols become dominant farther east along the gulf and north along the

Table T-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
150A	44,085	17,020	0	0	0	0	10	40	40	150	100	350
150B	8,310	3,210	0	0	0	0	0	0	0	10	20	70
151	19,635	7,580	0	0	0	0	0	0	0	0	40	160
152A	25,580	9,875	0	0	0	0	0	20	20	70	60	210
152B	14,675	5,665	0	0	0	20	20	80	40	150	90	290
153A	78,525	30,320	0	0	0	10	10	60	40	150	90	290
153B	28,885	11,150	0	0	0	0	0	0	0	10	50	170
153C	5,365	2,070	0	0	0	0	10	40	20	60	50	180
153D	14,410	5,565	0	0	0	0	0	20	20	90	80	260

Table T-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
150A	19.2	67	20	68	20.9	70	21.9	71	22.5	73	260	292	307/310	340	365
150B	20.1	68	21	70	21.9	71	23.1	74	23.4	74	310	331	365/355	365	365
151	19.5	67	19.9	68	20.4	69	20.9	70	21.3	70	280	312	324/325	344	365
152A	18.8	66	19.5	67	19.9	68	20.4	69	21.2	70	245	263	283/285	305	345
152B	19	66	19.3	67	19.7	67	20.1	68	20.8	69	260	266	276/280	296	320
153A	15	59	16.2	61	18.2	65	20.1	68	21.1	70	205	215	247/250	278	335
153B	14.1	57	15.1	59	17	63	19.5	67	20.8	70	210	227	259/260	298	330
153C	12.8	55	12.9	55	13.4	56	13.9	57	14.2	58	200	204	211/215	227	240
153D	11.8	53	12.2	54	13.6	57	14.3	58	15	59	185	191	205/210	229	245

Table T-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
150A	660	26	845	33	1,206/1,220	47/48	1,533	60	1,600	63
150B	620	25	673	26	995/980	39/39	1,314	52	1,520	60
151	1,170	46	1,515	60	1,590/1,580	63/62	1,642	65	1,710	67
152A	1,260	50	1,401	55	1,539/1,535	61/60	1,671	66	1,740	68
152B	1,230	49	1,356	53	1,496/1,480	59/58	1,562	62	1,600	63
153A	1,140	45	1,193	47	1,248/1,260	49/50	1,336	53	1,480	58
153B	970	39	1,125	44	1,259/1,255	50/49	1,373	54	1,510	59
153C	1,040	41	1,092	43	1,106/1,110	44/44	1,129	44	1,150	45
153D	940	37	1,091	43	1,136/1,130	45/45	1,171	46	1,210	48

Atlantic Coast, together with areas of Spodosols and Entisols. The dominant suborders are Uderts, Aqualfs, Udalfs, Aquults, Udults, Aquents, Psamments, Aquods, and Saprists. Carbonates only occur in the semiarid portion of Region T in Texas (fig. 5, page 9). Restrictive zones are uncommon but do occur in some soil profiles as abrupt textural changes and natric horizons (figs. 9 and 11, pages 13 and 15). Argillic horizons occur throughout the region, except in areas of organic soils near the coast (figs. 12 and 14, pages 16 and 18).

Land use is dominated by wetlands, forests, and grasslands or pasture (fig. T-2; and fig. 8, page 12). Other uses are open water and developed or open space. The main crops are cotton, especially in Texas, and corn (fig. 8). The native vegetation in most of this region is a mixture of pines and hardwoods, but it is typically grass in the southwestern end. Most of the land is in large holdings and used for the production of lumber and pulpwood. The acreage of cropland is limited primarily because of a high water table and the frequency of flooding. Recreation is a major industry in this coastal region. Significant deposits of salt in domes, natural gas, and petroleum are buried beneath the surface all along the Gulf Coast. The Atlantic Coast and parts of the Gulf Coast are very populous. The loss of wetlands, cropland, and forestland to urban development is a resource concern near these high-population zones. Wind erosion, water erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture, salinity, and coastal flooding also are major resource concerns.

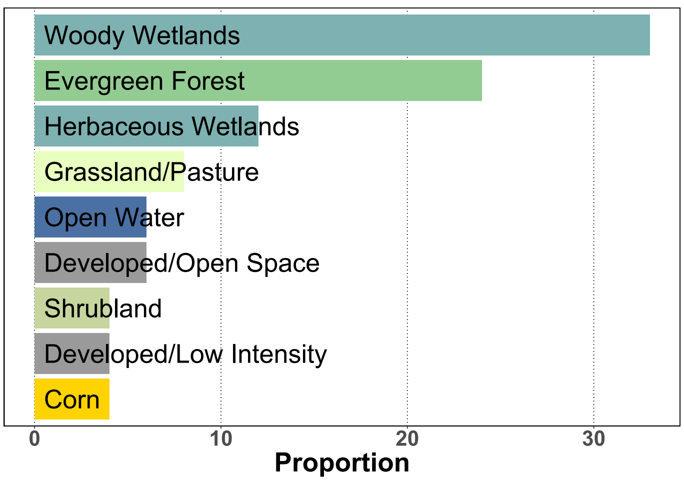

Figure T-2: Relative proportions (percentages) of land use in Land Resource Region T based on 2018 data from the National Agricultural Statistics Service.

150A—Gulf Coast Prairies

This area (fig. 150A-1) is characterized by very deep soils that formed mostly in loamy or clayey fluviomarine deposits of Pleistocene age, on nearly level prairie with low local relief. It is in Texas (84 percent) and Louisiana (16 percent). It makes up about 17,022 square miles (44,086 square kilometers).

MLRA 150A has a gradual boundary with MLRAs 152B and 150B. MLRA 152B has different land use: prairie and farmland rather than forest. MLRA 150B has lower elevations, different vegetation due to soil salinity, different land use (no farming), and tidal flooding in the lower portions.

Physiography

This area is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. It is characterized by nearly level plains that have low local relief and are dissected by rivers and streams that flow toward the Gulf of Mexico. Elevation ranges from sea level to about 165 feet (0 to 50 meters) along the interior margin.

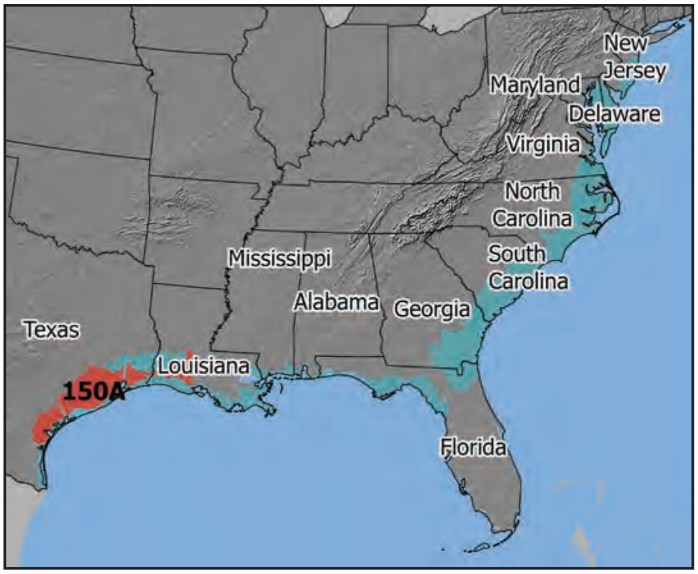

Figure 150A-1: Location of MLRA 150A, which covers 4,408,600 hectares (10,893,700 acres), within Region T.

The Beckwith and Calcasieu Rivers are in the eastern end of this area, in Louisiana. The Sabine River forms the boundary between Texas and Louisiana. From north to south, the Neches, Trinity, San Jacinto, Brazos, San Bernard, Navidad, Lavaca, Guadalupe, San Antonio, Nueces, and Agua Dulce Rivers cross the part of this area in Texas.

Geology

This MLRA mostly consists of a strip of land about 50 to 80 miles (80 to 130 kilometers) wide that runs along the Gulf of Mexico. The sedimentary rocks at the surface are of Pleistocene age. They were laid down during the last 2 million years. The deposits are deltaic and lagoonal clays and loams derived from older rocks to the west. At the western edge of the MLRA, mostly within Texas, the sediments are older and more weathered and contain more sands. At the eastern edge, mostly within Louisiana, a cap of mixed loess and alluvium occurs in most areas. The loess was derived from the flood plain along the Mississippi River. Some Tertiary deposits occur along the interior edge of this MLRA. The weight of the recent deposits has caused them to tilt towards the Gulf of Mexico, so successively older deposits crop out from the coastal edge to the interior edge of the MLRA. Salt domes, natural gas, and petroleum deposits are commonly below the surface throughout this area. Recent deposits of alluvial sand fill the valleys of the Brazos and Trinity Rivers and the other large rivers.

Climate

The average annual precipitation in the northern two-thirds of this area is 45 to 63 inches (1,145 to 1,600 millimeters). It is 28 inches (710 millimeters) at the extreme southern tip and 30 to 45 inches (760 to 1,145 millimeters) in the southwestern third. Precipitation is fairly evenly distributed, but it is slightly higher in late summer and midsummer in the western part of the area and slightly higher in winter in the eastern part. Rainfall typically occurs as moderate-intensity, tropical storms that produce large amounts of rain during winter. The average annual temperature is 66 to 72 degrees F (19 to 22 degrees C). The freeze-free period averages 325 days and ranges from 290 to 365 days, increasing in length to the southwest.

Water

Rainfall and perennial streams provide abundant water that is suitable for almost all uses. Water for irrigating rice is often obtained from streams. The surface water also is used for municipal and industrial supplies and for cooling thermoelectric power plants. Treated sewage effluent from upstream sources makes up a significant portion of the low flow in the San Antonio River in this MLRA. Urbanization and industrial wastes are impacting the surface and ground water supplies in the Houston area. Most of the soils need to be drained for optimum growth of general farm crops.

Ground water is abundant in the Gulf Coast aquifer system in this area. The water from this system typically is moderately hard. This system provides much of the domestic, public supply, and irrigation water used in the MLRA.

Soils

The dominant soil orders in this MLRA are Alfisols, Mollisols, and Vertisols. The soils in the area have a hyperthermic soil temperature regime in the southwestern part of the area and a thermic soil temperature regime in the northeastern part. They generally have an ustic soil moisture regime and smectitic mineralogy. The soils range from well drained in very gently sloping and gently sloping convex areas to very poorly drained in enclosed depressions. Soils that formed in Early Pleistocene sediments, generally occurring north of Interstate 10, are very deep and have a loamy surface layer and subsoil and siliceous mineralogy. Soils that formed in Late Pleistocene sediments, generally occurring south of Interstate 10, are very deep and have a loamy or clayey surface layer and a clayey, very slowly permeable subsoil. Aqualfs and Udalfs (Crowley, Aris, and Vidrine series) are dominant in Louisiana and southeastern Texas. Uderts and Udalfs (League, Lake Charles, Laewest, Hockley, Katy, and Telferner series) are dominant in the eastern and central parts of the MLRA. Usterts and Ustolls (Banquete, Cranell, Orelia, and Victoria series) are dominant in the western and southwestern parts.

Biological Resources

This area was originally a natural grass prairie with hardwood trees along rivers and streams. Little bluestem, Indiangrass, switchgrass, and big bluestem are the dominant species. A few groves of live oak dot the landscape.

Major wildlife species include white-tailed deer, raccoon, opossum, rabbit, fox, coyote, squirrel, armadillo, nutria, quail, and mourning dove. Migratory waterfowl, such as ducks and geese, and neotropical migratory songbirds winter in this area. Fish species include bass, channel catfish, and bream.

Land Use

Most of this area is in farms (fig. 150A-2). Rice, soybeans, grain sorghum, cotton, corn, and hay are the chief crops. About two-fifths of the MLRA is rangeland or pasture. The forested areas, consisting chiefly of hardwoods, border rivers and streams. Urban development is rapidly expanding onto agricultural land throughout the MLRA.

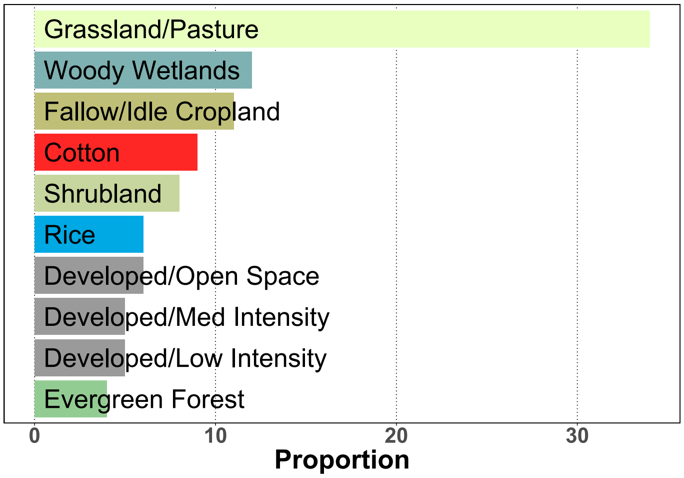

Figure 150A-2: Relative proportions (percentages) of land use in MLRA 150A.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of soil organic matter and tilth, and management of soil moisture. Increasing salinity is a concern in some areas. Conservation practices on cropland generally include systems of crop residue management, which help to control erosion and maintain the content of soil organic matter. Timely tillage and planting helps to maintain tilth and the supply of soil moisture. Conservation practices on pasture and rangeland generally include prescribed grazing, fences, watering facilities, and nutrient and pest management.

150B—Gulf Coast Saline Prairies

This MLRA (fig. 150B-1) is characterized by very deep soils that formed mostly in sandy or clayey fluviomarine deposits of Pleistocene age on nearly level to gently sloping coastal lowland plains. The soils are potentially inundated by high tides at lower elevations and by storm tides at some higher elevations in unprotected areas. The MLRA is entirely in Texas and makes up about 3,209 square miles (8,312 square kilometers).

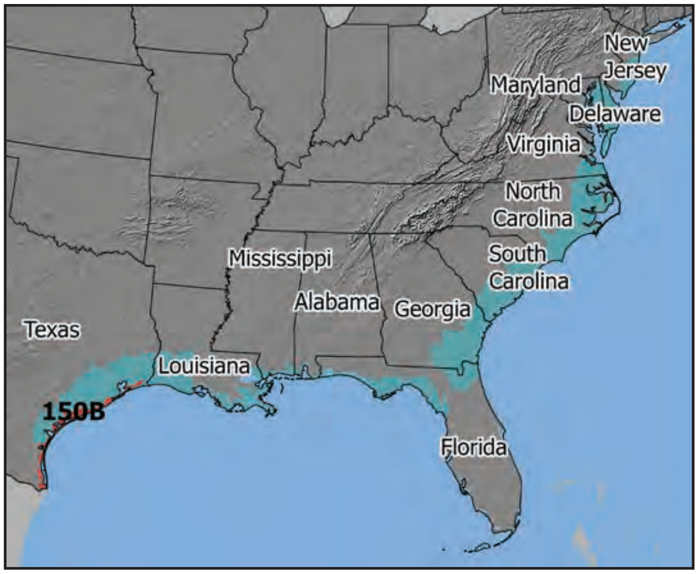

Figure 150B-1: Location of MLRA 150B, which covers 831,200 hectares (2,053,900 acres), within Region T.

MLRA 150B has a gradual boundary with MLRA 150A, which has higher elevations and different land use due to higher levels of soil salinity (resulting from tidal and storm flooding). It has a distinct southern boundary with the Gulf of Mexico. The Rio Grande forms the international boundary between Texas and Mexico at the southwestern end of this area.

Physiography

This MLRA is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. The nearly level to gently sloping coastal lowland plains are dissected by rivers and streams that flow toward the Gulf of Mexico. Barrier islands and coastal beaches are part of this MLRA. The lowest parts of the area are covered by high tides, and the rest are periodically covered by storm tides. Parts of the MLRA have been worked by wind, and the sandy areas have gently undulating to irregular topography because of low mounds or dunes. Broad, shallow flood plains are along streams flowing into the bays. Elevation generally ranges from sea level to about 10 feet (3 meters), but it is as much as 25 feet (8 meters) on some dunes. Local relief is mainly less than 3 feet (1 meter).

Many other major rivers besides the Rio Grande empty into the bays along the Gulf of Mexico in the area. They include the Agua Dulce, Nueces, Lavaca, Navidad, San Bernard, Brazos, San Jacinto, and Neches Rivers. The Trinity River enters Galveston Bay just outside this area. The Guadalupe and San Antonio Rivers join just before emptying into San Antonio Bay in the area. The Sabine River empties into Lake Sabine just outside the northeastern tip of the area.

Geology

This MLRA is underlain entirely by unconsolidated fluvial and marine sediments (Beaumont Formation). Most of the surface is covered by Pleistocene-age sand that has been reworked by the wind into mounds and dunes. Recent deposits of clay, silt, and fine sand form deltas where major rivers empty into saltwater bays. Salt domes, natural gas, and petroleum deposits are deep beneath the surface.

Climate

The average annual precipitation is 45 to 57 inches (1,145 to 1,450 millimeters) in the northeastern half of this MLRA, 26 inches (660 millimeters) at the extreme southern tip, and 30 to 45 inches (760 to 1,145 millimeters) in the rest of the area. Precipitation is abundant in spring and fall in the southwestern part of the area and evenly distributed throughout the year in the northeastern part. Rainfall typically occurs during moderate-intensity, tropical storms that produce large amounts of rain in winter. The average annual temperature is 68 to 74 degrees F (20 to 23 degrees C). The freeze-free period averages 340 days and ranges from 315 to 365 days.

Water

Rainfall is the source of water for pasture and range. A few freshwater streams and rivers flow into the area from the north, and many bays and small entrapments of salty water are throughout the area. Much of the surface water is not suitable for most uses because of mixing with seawater. Freshwater for urban uses is typically piped in from outside the area.

This area has little fresh ground water. Water for livestock comes mainly from dugout ponds or very shallow wells. The only freshwater is very near the surface in places where sandy soils are high enough on the landscape to escape tidal inundation and yet are recharged by rainfall. Strata close to the surface in these soils can store the ground water and release it to wells. The water in the Gulf Coast aquifer system under this area is salty because of the intrusion of seawater.

Soils

The dominant soil orders are Alfisols, Entisols, Inceptisols, Mollisols, and Vertisols. The soils in the area have a hyperthermic soil temperature regime. In the eastern and central parts of the area they have an aquic or udic soil moisture regime, and in the western part they have an aquic or ustic soil moisture regime. Mineralogy is mixed or siliceous in sandy soils, mixed or siliceous in loamy soils, and smectitic in clayey soils. The soils are very deep. They range from excessively drained (Psamments) to very poorly drained (Aqualfs and Aquents). Many of the soils are appreciably saline.

The main soils and their series:
- Fluvaquents (Veston series)
- Halaquepts (Barrada series)
- Haplaquolls (Harris series)
- Typic Hapluderts (Francitas series)
- Sodic Haplusterts (Victine series)
- Typic Natraqualfs (Dietrich, Livia, Matagorda, and Narta series)
- Typic Natraquerts (Franeau series)
- Psammaquents (Mustang series)
- Quartzipsamments (Daggerhill and Greenhill series)
- Udipsamments (Galveston series)

Biological Resources

This area supports grassland vegetation. The more saline soils support a plant community dominated by gulf cordgrass and smaller amounts of little bluestem, switchgrass, seashore saltgrass, inland saltgrass, bushy sea-oxeye, marshhay cordgrass, rushes, sedges, and pickleweed. The less saline, sandy soils support a plant community dominated by little bluestem and lesser amounts of switchgrass, gulfdune paspalum, and marshhay cordgrass.

Major wildlife species include white-tailed deer, alligator, javelina, raccoon, skunk, opossum, jackrabbit, cottontail, armadillo, turkey, bobwhite quail, ducks, geese, and mourning dove. Fish species include channel catfish, yellow catfish, blue catfish, largemouth bass, red fish, speckled trout, and flounder.

Land Use

Most of the coastal part of this MLRA is areas of lowlands that are inundated daily by tides. This part is used primarily for recreation (fig. 150B-2). The inland part of the MLRA is characterized by a natural grass prairie with hardwood trees along the rivers and streams. Nearly all of the inland area is in ranches or used for recreation. More than 75 percent of the inland area is native rangeland that supports mainly salt-tolerant plant species. A small acreage is used for coastal Bermudagrass pasture for beef cattle or for rice or grain sorghum. Urban and recreational developments are expanding, especially along the barrier islands in the central and southern parts of the area.

The major soil resource concerns are wind erosion, water erosion, maintenance of the content of soil organic matter and tilth, and management of soil moisture. Salinity and coastal flooding preclude crop production in most of the MLRA. Conservation practices on rangeland generally include prescribed grazing, fences, nutrient management, pest management, pasture and hay planting, management of upland wildlife habitat, and watering facilities. Conservation practices on cropland generally include systems of crop residue management, which help to control erosion and maintain the content of soil organic matter. Timely tillage and planting can help to maintain tilth and the supply of soil moisture.

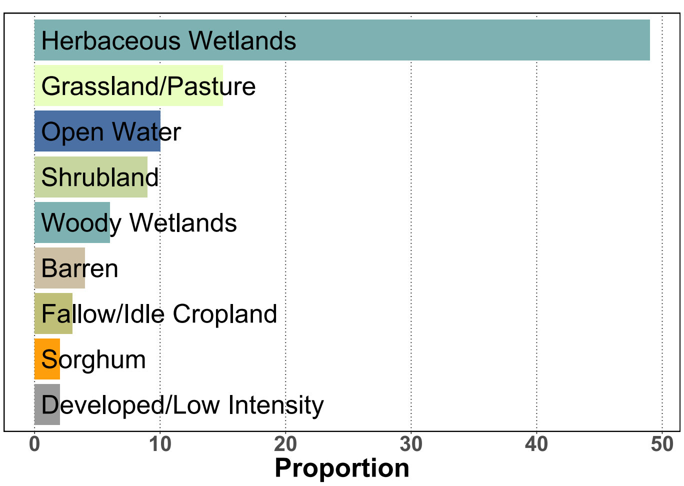

Figure 150B-2: Relative proportions (percentages) of land use in MLRA 150B.

151—Gulf Coast Marsh

This area (fig. 151-1) formed by dynamic deltaic processes where the Mississippi River reached the Gulf of Mexico. An ever-shifting river system created major delta complexes, which produced an abundance of lakes, bayous, and tidal channels. Most of this MLRA is uninhabited because it is very poorly drained and has a water table at or above the surface during most of the year. As a fertile ecosystem, however, the area is crucial to the productive estuarine complex that supports marine life in the Gulf of Mexico. This area is in Louisiana (94 percent), Texas (5 percent), and Mississippi (1 percent).

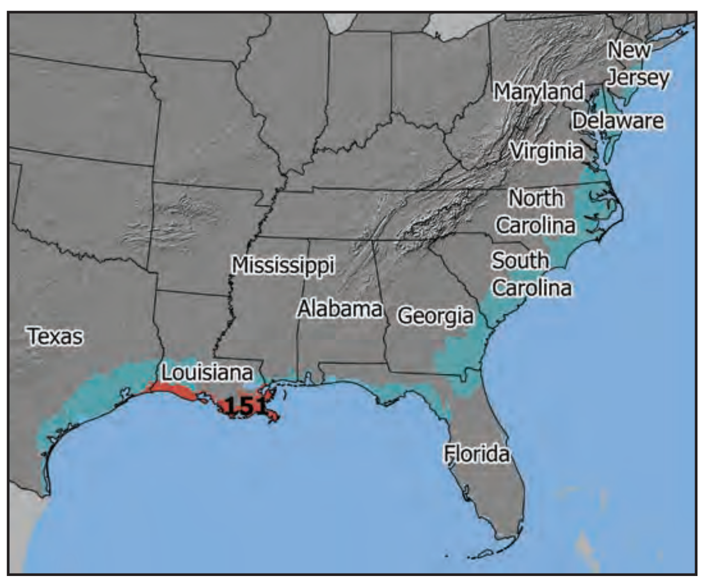

Figure 151-1: Location of MLRA 151, which covers 1,963,700 hectares (4,852,400 acres), within Region T.

It makes up approximately 7,582 square miles (19,637 square kilometers).

MLRA 151 has a diffuse boundary, created by episodic deltaic processes, along the north-central portion with MLRA 131A (Southern Mississippi River Alluvium). It also has a diffuse boundary to the northeast with MLRA 150A (Gulf Coast Prairies) and to the northwest with MLRA 150B (Gulf Coast Saline Prairies). A slight increase in elevation creates a gradual boundary with MLRA 152A (Eastern Gulf Coastal Flatwoods) to the northeast. Localized watersheds of adjacent MLRAs contribute significant runoff containing nutrient and sediment loads, which form the MLRA 151 landscape. To the south, the MLRA is bordered by the Gulf of Mexico.

Physiography

This MLRA is greatly affected by changes in hydrology over time, due to both natural and anthropogenic forces. The landscape was built by flooding of the Mississippi River and influences of the entire drainage basin. The geologic development of the southern extent of this MLRA is closely related to shifting Mississippi River courses. The river changed its course multiple times throughout the Holocene age, developing six major delta complexes, two that are prograding and four that are degrading. Events related to the shifting river courses formed the landscape and led to the identification and characterization of the deltaic cycle. The deltaic cycle is a dynamic and episodic process in which periods of seaward progradation of deltas (regressive deposition) alternate with the subsequent landward retreat of deltaic headlands, as deltas are abandoned, reworked, and submerged by marine waters (transgressive deposition) (US ACE, 2004). Because of these shifts in land building and subsiding, there is a gradual transition between the alluvial landscape of MLRA 131A and the marsh landscape of MLRA 151.

Vermilion Bay divides this area into an eastern half and a western half. The eastern half is in the Mississippi Alluvial Plain section of the Coastal Plain province of the Atlantic Plain. The western half is in the West Gulf Coastal Plain section of the same province and division. The land east of Vermilion Bay, part of the Mississippi River Delta, has a ragged shoreline, while the land west of this bay has a smoother shoreline. Low, narrow sandy ridges characterize much of the area. There are many rivers, lakes, bayous, tidal channels, and manmade canals. Elevation generally ranges from sea level to about 7 feet (2 meters). It is as much as 10 feet (3 meters) on beach ridges, canal spoil banks, and natural levees and as much as 165 feet (50 meters) on salt dome islands. Some areas protected by levees have subsided below sea level.

The Sabine River forms the boundary between Texas and Louisiana in this area, and the Beckwith and Calcasieu Rivers are at the western end of the area, in Louisiana. Other rivers in the part of the area in Louisiana include the Bayou Nezpique, Mermentau, Vermilion, Bayou Teche, Atchafalaya, and Mississippi Rivers.

Geology

The surface of this area is primarily Mississippi River clay, silt, and fine sand that was deposited over the past 2 million years. The eastern half of the area, part of the Mississippi River Delta, is underlain by a mixture of Recent alluvial material and Pleistocene-age marine sediments. The area west of Vermilion Bay is underlain by older alluvial and marine sediments. Salt domes, natural gas, and petroleum deposits are below the surface.

Climate

The average annual precipitation is 60 to 65 inches (1,525 to 1,650 millimeters) in most of the eastern half of this area and 49 to 60 inches (1,245 to 1,525 millimeters) in most of the western half. About 70 percent of the precipitation occurs during the growing season. Rainfall typically occurs as post-frontal precipitation in winter and heat-convection showers and thundershowers in spring and summer. In addition, tropical storms can bring large amounts of rainfall. The average annual temperature is 67 to 69 degrees F (19 to 21 degrees C). The freeze-free period averages 325 days and ranges from 290 to 365 days, increasing in length from north to south.

Water

Most of the water used in this MLRA is for public supply and industry in the northeast corner. The area's many rivers, lakes, bayous, tidal channels, and manmade canals are subject to flooding in populated as well as unpopulated areas. About one-half of the marsh is fresh, and one-half is salty. Tidal channels allow free movement of salty water from the Gulf of Mexico into the parts adjacent to it. Most of the area is susceptible to flooding either by freshwater drained from lands adjacent to the marsh or by saltwater from the gulf. Daily tides flood some areas. High tides and storm surges resulting from hurricanes or tropical storms can be as much as 10 feet (3 meters) above sea level and can flood most of the MLRA.

River water in this area is generally of poor quality and requires treatment prior to human consumption. The level of contamination by fecal coliform bacteria is high in some rivers, and contamination by sediment from nonpoint sources and industrial wastes can occur in all of the rivers.

Ground water is scarce east of Vermilion Bay, in the Mississippi Delta. Fresh ground water is available in moderate to large quantities from the Gulf Coast (Texas) and Chicot (Louisiana) aquifer systems west of Vermilion Bay. The water from these Pleistocene-age river deposits is hard. Iron concentrations exceed the national secondary standard for drinking water.

Soils

The dominant soil orders are Entisols and Histosols. The soils in the area dominantly have a hyperthermic temperature regime, an aquic moisture regime, and smectitic mineralogy. They generally are very deep and clayey. Most of the soils are very poorly drained, having a water table at or above the surface most of the time.

The main soils and their series:

- Haplosaprists that formed in organic deposits over alluvium (Allemands, Clovelly, and Lafitte series); that formed entirely in organic deposits (Kenner and Timbalier series)
- Hydraquents that formed in clayey sediments in coastal marshes (Bancker, Creole, Larose, and Scatlake series)

Biological Resources

This area supports freshwater and saltwater marsh vegetation consisting of grasses, sedges, rushes, and other plants. Alligatorweed, spikerush, maidencane, cutgrass, and bulltongue arrowhead characterize the freshwater vegetation. Roseau cane, common reed, bulltongue arrowhead, and marshhay cordgrass characterize the intermediate-water vegetation. Marshhay cordgrass, saltgrass, and Olney bulrush characterize the brackish water vegetation. The saltwater vegetation includes saltgrass and marshhay cordgrass as well as smooth cordgrass and black needlerush.

Major wildlife species include white-tailed deer, alligator, nutria, raccoon, otter, muskrat, swamp rabbit, cottontail rabbit, mink, mottled duck, bobwhite quail, mourning dove, meadowlark, lark bunting, and crawfish.

Land Use

Much of the area is uninhabited. Most of it supports marsh vegetation and is used for wildlife habitat (fig. 151-2). The area is almost treeless. It is in the fertile and productive estuarine complex that supports the marine life of the Gulf of Mexico. It provides wintering ground for millions of migratory ducks and geese and habitat for many fur-bearing animals and for alligators. A significant acreage west of Vermilion Bay is grazed by cattle in winter. A small acreage of freshwater marsh is drained by pumping systems and used for pasture or rice.

The major resource concerns are determined by land use and marsh type. The concerns in areas of native marsh include maintenance of the salinity level in soils, ingress and egress of freshwater or saltwater, and the content of soil organic matter. The concerns on pasture and cropland include maintenance of the content of soil organic matter and control of the salinity level in soils. Erosion caused by overland water from high rainfall or a storm surge in the gulf is a concern where the native vegetation has been altered.

Conservation practices on cropland include systems of crop residue management, which help to control erosion and maintain the content of soil organic matter. Timely tillage and planting can help to maintain tilth and the supply of soil moisture and control salinity. Conservation practices on pasture include prescribed grazing, brush and pest management, prescribed burning, and watering facilities. Management of upland and wetland wildlife habitat is needed.

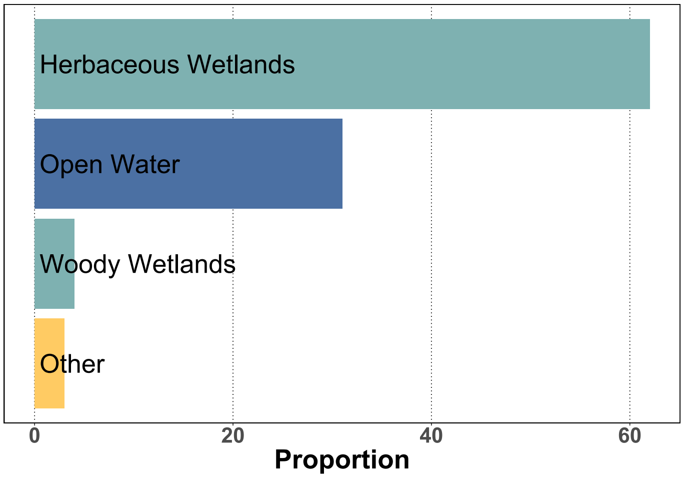

Figure 151-2: Relative proportions (percentages) of land use in MLRA 151.

152A—Eastern Gulf Coast Flatwoods

This MLRA (fig. 152A-1) is a nearly level, low coastal plain crossed by many large streams. It is naturally dominated by pine savanna flats intermingled with slight rises and low ridges. The pine savannas were historically managed by random fires, which perpetuated a natural habitat of strongly acidic soils low in nutrients and organic matter. This area is in Florida (73 percent), Mississippi (11 percent), Louisiana (10 percent), and Alabama (6 percent). It makes up about 9,877 square miles (25,581 square kilometers).

Figure 152A-1: Location of MLRA 152A, which covers 2,558,100 hectares (6,321,200 acres), within Region T.

MLRA 152A has a gradual boundary, defined by an increase in elevation, with the Southern Coastal Plain (MLRA 133A) and Gulf Coastal Plain (MLRA 133C) to the north. It has a gradual boundary to the southwest with the Gulf Coast Marsh (MLRA 151) and Southern Mississippi River Alluvium (MLRA 131A), which are at a slightly lower elevation. Along the coastal reaches of MLRA 152A, sporadic estuaries dissect the sandy beach that comprises the Gulf of Mexico shoreline.

Physiography

Almost all of this area is in the East Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. The extreme southeastern tip is in the Floridian section of the same province and division. The part of the area in Florida has many lakes and ponds. Elevation ranges from sea level to 98 feet (0 to 30 meters). Local relief is generally 10 to 20 feet (3 to 6 meters).

The Pearl River forms the boundary between Louisiana and Mississippi in this MLRA. The Escatawpa River joins the Pascagoula River just before it empties into the Gulf of Mexico in the part of this area in Mississippi. The Tombigbee and Alabama Rivers join just outside this area to form the Mobile River in Alabama. The Perdido River forms the boundary between Alabama and Florida in this area. The major rivers that cross the part of this area in Florida on their way to the Gulf of Mexico are the Escambia, Yellow, Choctawhatchee, Apalachicola, Ochlockonee, and Suwannee Rivers.

Geology

Pleistocene-age terraces consisting of ancient Mississippi River deposits of unconsolidated fine sand, which grade to coarser sand and gravel at depth, are at the surface in the western end of this MLRA, in Louisiana and Mississippi. The Citronelle Formation is at the surface in most parts of this area in Mississippi, Alabama, and the western panhandle of Florida. This formation is a thin layer of silt, sand, and gravel deposited by an ancient predecessor of the Mississippi River during the Pliocene Epoch. A thin veneer of Pleistocene-age sand covers the surface of this area farther to the east in Florida. Limestone and dolomite of the Floridan aquifer lie just beneath the sand in the rest of the area in Florida. Karst topography is common in Florida. Recent silt, sand, and gravel deposits fill the valleys along most of the major rivers in the area.

Climate

The average annual precipitation is 50 to 68 inches (1,264 to 1,737 millimeters). The minimum precipitation usually occurs in the early and middle parts of autumn, increasing moderately in winter and early spring. Lesser amounts occur in May. The maximum precipitation usually occurs in summer. At the eastern end of this area, in Florida, rainfall usually occurs during high-intensity, convective thunderstorms in summer. In the rest of the area, it typically occurs during moderate-intensity, tropical storms that produce large amounts of rain in winter. The average annual temperature is 66 to 70 degrees F (19 to 21 degrees C). The freeze-free period averages 300 days and ranges from 250 to 350 days. It is longer nearer the Gulf of Mexico and to the south in Florida.

Water

The abundant rainfall and the many perennial streams are important sources of water. Generally, river water is suitable for most uses with some treatment. Surface water has been polluted by municipal and industrial wastewater discharges and fecal coliform bacteria. Water quality has improved somewhat as communities and industries strive to clean their wastewater before discharging it into nearby rivers and lakes. Most of the surface water is used for municipal and industrial supply and for cooling thermoelectric power plants.

Ground water is plentiful in this MLRA but is affected by salt in many areas near the coast. Soft ground water is obtained from the Pleistocene terraces in Louisiana, Mississippi, and Alabama. This water is generally low in total dissolved solids, but it may be contaminated by septic systems. Where faults occur, brine from salt-dome deposits can move up into the surface aquifers, making the water too salty for most uses. Where the ground water is not suitable, better quality water can be obtained from river valley alluvium. River flows tend to recharge these aquifers annually, so this water is usually suitable for most uses with some treatment. Ground water is plentiful in the Citronelle and Floridan aquifers, in the middle and eastern parts of this MLRA. This water is soft and hard, respectively, and suitable for most uses. Since these aquifers are close to the Gulf of Mexico, intrusion of seawater is a concern.

Soils

The dominant soil orders are Alfisols, Ultisols, Entisols, Spodosols, and Histosols. The soils in the area dominantly have a thermic or hyperthermic temperature regime, an aquic or udic moisture regime, and siliceous mineralogy. They generally are deep or very deep, somewhat poorly drained to very poorly drained, and loamy, mucky, or sandy.

The main soils and their series:

- Alaquods that formed in sandy marine sediments on flats and in depressions (Chaires and Leon series)
- Albaqualfs that formed in loamy marine sediments on flats and flood plains and in depressions (Tooles series)
- Endoaqualfs that formed in loamy marine sediments on flats and flood plains and in depressions (Meadowbrook and Wekiva series)
- Haplosaprists that formed in organic deposits in swamps and depressions (Dorovan and Pamlico series) or in marshes and swamps (Maurepas series)
- Hydraquents that formed in alluvium on flood plains (Arat series)
- Paleaquults that formed in loamy and sandy sediments on marine terraces (Bayou series)

Psammaquents that formed in sandy marine sediments on flats and in depressions (Scranton series) or on dunes and in interdunal swales on barrier islands (Duckston series)
Quartzipsamments that formed on dunes and in interdunal swales on barrier islands (Newhan and Corolla series)
Sulfaquents that formed in saltwater and brackish water marshes (Axis series)
Sulfihemists that formed in saltwater and brackish water marshes (Handsboro series)

Biological Resources

This area supports pine forest vegetation and freshwater, brackish water, and saltwater marsh vegetation. Longleaf pine and slash pine are the major trees. Chalky bluestem, Indiangrass, and several species of panicum make up the understory. Palmetto, gallberry, and wax myrtle are the dominant woody shrubs. Roseau cane, common reed, bulltongue arrowhead, maidencane, cutgrass, and alligatorweed characterize the freshwater and intermediate-water vegetation. Marshhay cordgrass, saltgrass, and Olney bulrush characterize the brackish water vegetation. The saltwater vegetation also includes saltgrass and marshhay cordgrass as well as smooth cordgrass and black needlerush.

Major wildlife species include white-tailed deer, feral hog, gray fox, red fox, bobcat, raccoon, skunk, opossum, otter, rabbit, squirrel, turkey, bobwhite quail, and mourning dove. Fish species include largemouth bass, channel catfish, bullhead catfish, bluegill, redear sunfish, spotted sunfish, warmouth, black crappie, chain pickerel, gar, bowfin, sucker, spotted trout, croaker, striped mullet, flounder, and red drum.

Land Use

This area is dominantly forested (fig. 152A-2). Much of it is in large holdings owned by pulp and paper companies. Pulpwood and lumber are the principal forest products. Some of the forestland is grazed. Some areas are in State and national forests or are used as game refuges or military training sites. Only a very small acreage is cropped or pastured. Corn, peanuts, tobacco, and soybeans are the major crops.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, surface compaction, and management of soil moisture. Conservation practices on forestland generally include forest stand improvement, forest trails and landings, prescribed burning, riparian forest buffers, forest site preparation, bedding, establishment of trees and shrubs, and management of upland wildlife habitat. The most important conservation practice on pasture is prescribed grazing. Overseeding of pastures with small grains or legumes, or both, during winter commonly supplements forage production. Haying also provides additional feed during the long winters. Conservation practices on cropland generally include systems of crop residue management, cover crops, crop rotations, water disposal, subsoiling or deep tillage, pest management, and nutrient management. Critically eroding areas and areas where animals congregate need to be monitored regularly and treated promptly.

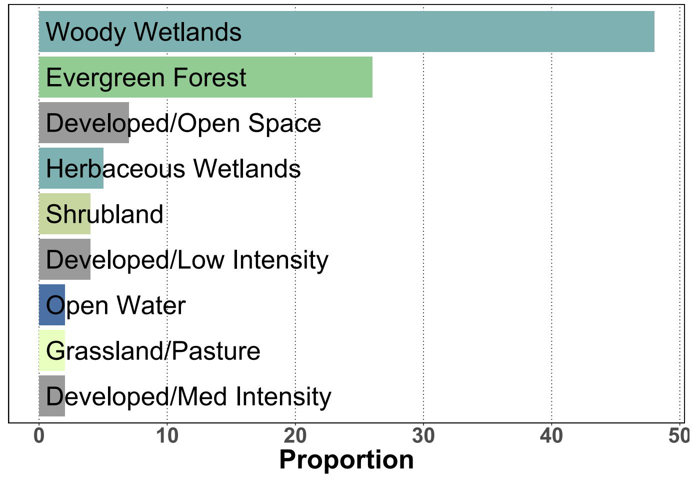

Figure 152A-2: Relative proportions (percentages) of land use in MLRA 152A.

152B—Western Gulf Coast Flatwoods

This area (fig. 152B-1) is characterized by very deep soils that formed mostly in loamy and clayey fluviomarine deposits of Pleistocene age. It is covered by coniferous and deciduous forests. It is in Texas (60 percent) and Louisiana (40 percent). It makes up about 5,665 square miles (14,673 square kilometers).

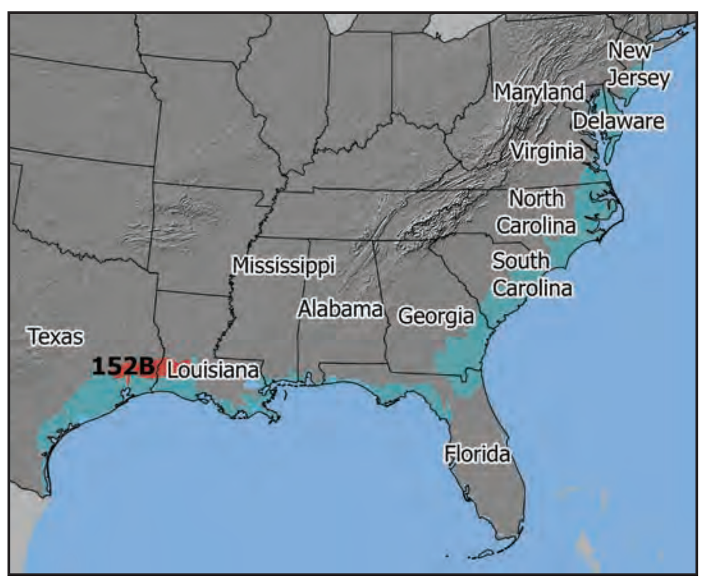

Figure 152B-1: Location of MLRA 152B, which covers 1,467,300 hectares (3,625,800 acres), within Region T.

MLRA 152B has a distinct boundary with MLRA 133B based on a slope increase in the latter. Its boundary with MLRA 150 is gradual in most places but diffuse in others due to forest encroachment. MLRA 152B is dominantly used for timber production, while MLRA 150 is dominantly used for cropland and pasture.

Physiography

This area is in the West Gulf Coastal Plain section of the Coastal Plain province of the Atlantic Plain. It is nearly level to gently sloping and has low local relief. Elevation ranges from 80 to 330 feet (25 to 100 meters).

This area is bisected by many small streams and rivers that run toward the Gulf of Mexico. From west to east, these include the San Jacinto, Trinity, Neches, Sabine, Beckwith, Calcasieu, and Mermentau Rivers.

Geology

The entire area is underlain by unconsolidated clay, silt, sand, and gravel deposited by ancient rivers in the Late Tertiary and Quaternary Periods. Recent silt, sand, and gravel deposits fill the valleys along most of the major rivers in the area.

Climate

The average annual precipitation generally ranges from 46 to 60 inches (1,170 to 1,525 millimeters), increasing from west to east. It is as much as 64 inches (1,625 millimeters) in the extreme northeast corner of the area. The precipitation is evenly distributed throughout the year but is slightly higher in the eastern part during winter. Rainfall usually occurs during moderate-intensity, tropical storms that can produce large amounts of rain in fall and winter. The average annual temperature is 66 to 68 degrees F (19 to 20 degrees C). The freeze-free period averages 290 days and ranges from 265 to 320 days.

Water

Rainfall, perennial streams, and aquifers provide an abundance of water. Most of the soils need to be drained for optimum growth of farm crops. Reservoirs on the San Jacinto River provide industrial and public supply water to the eastern end of the MLRA. Water diverted from the Sabine, Calcasieu, and Mermentau Rivers is used for irrigating rice, for cooling thermoelectric power plants, and for industrial purposes in the suburbs of Lake Charles, Louisiana. Because of high levels of fecal coliform bacteria, the Calcasieu River is one of Louisiana’s most polluted rivers.

The unconsolidated sediments are the primary sources of ground water. The water is used as drinking water and for industry and irrigation. The Gulf Coast aquifer system in Texas has moderately hard water. Soft water can be reached in this aquifer in wells deeper than 500 feet (150 meters). The Chicot aquifer in Louisiana is made up of numerous beds of unconsolidated sand and gravel separated by layers of clay. The water in this aquifer is hard. Because of high iron levels, this water may require treatment before it is used for public supply.

Soils

The dominant soil orders are Alfisols and Ultisols. The soils in the area dominantly have a thermic soil temperature regime, an aquic or udic soil moisture regime, and siliceous or smectitic mineralogy. They generally are very deep, moderately well drained to very poorly drained, and loamy or clayey.

The main soils and their series:

- Glossaqualfs that formed in loamy and clayey sediments on stream terraces (Caddo and Evadale series); that formed in loamy marine sediments on uplands (Waller series); that formed in alluvium on flood plains and stream terraces (Guyton series)
- Glossudalfs that formed in loamy marine sediments on mounds and ridges (Messer series)
- Hapluderts that formed in alluvium on flood plains (Kaman series)
- Paleudults that formed in loamy marine sediments on uplands (Kirbyville and Malbis series)
- Vermaqualfs that formed in old alluvium on uplands (Sorter series)

Biological Resources

This area supports pine-hardwood forest vegetation characterized by longleaf pine. Sweetgum, blackgum, post oak, blackjack oak, and southern red oak are the principal hardwood species. Hawthorns, myrtle, and shining sumac make up the woody understory. Mid and tall grasses are dominant in open areas. Little bluestem, pinhole bluestem, big bluestem, switchgrass, and Indiangrass are the principal grasses. Longleaf uniola, Virginia wildrye, Florida paspalum, beaked panicum, and several low-growing panicums and paspalums are the principal grasses in shady areas. Lespedezas, tickclover, wildbeans, and several composites are the principal forbs.

Major wildlife species include white-tailed deer, coyote, fox, nutria, raccoon, skunk, cottontail, gray squirrel, fox squirrel, mink, armadillo, woodrat, white-footed mouse, eastern harvest mouse, cotton mouse, golden mouse, hispid cotton rat, hispid pocket mouse, marsh rice rat, turkey, quail, and mourning dove. Other major species are cottonmouth moccasin, broad-banded water snake, coral snake, hognose snake, canebrake rattlesnake, pigmy rattlesnake, copperhead, Louisiana milk snake, speckled kingsnake, rough green snake, buttermilk snake, five-lined skink, broad-headed skink, green anole, smooth softshell turtle, three-toed box turtle, red-eared turtle, Mississippi mud turtle, marbled salamander, smallmouth salamander, Fowler’s toad, East Texas toad, spring peeper, eastern tree toad, northern cricket frog, northern leopard frog, and bullfrog. Fish species include spotted bass, largemouth bass, crappie, catfish, bullhead, carp, and bluegill.

Land Use

The forestland in this area consists principally of pine and pine-hardwood forests. Much of the forested acreage is owned by large corporations, and lumber and pulpwood are the main forest products. Cleared areas are used mostly for pasture (fig. 152B-2). The major pasture grasses are bahiagrass and coastal Bermudagrass. Only a few small areas are used for crops. Many small subdivisions are being developed throughout the MLRA, especially in the vicinity of Houston and Beaumont, Texas.

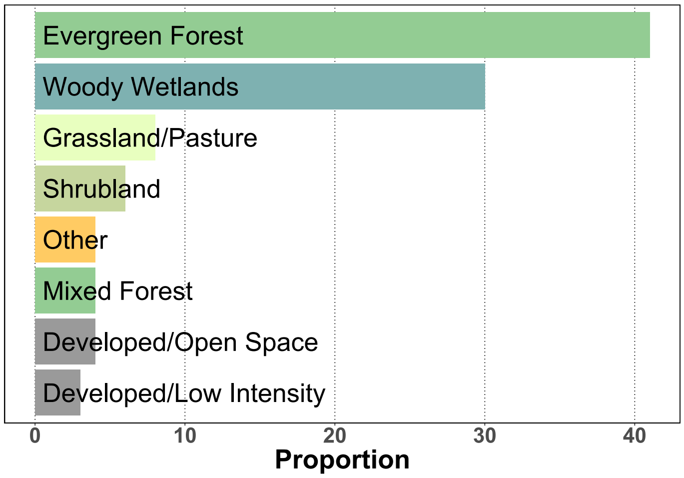

Figure 152B-2: Relative proportions (percentages) of land use in MLRA 152B.

The major soil resource concerns are water erosion, maintenance of the content of organic matter and productivity of the soils, and soil moisture management. When sloping areas are bare following a tree harvest, water erosion is a hazard. Conservation practices on forestland generally include forest stand improvement, forest trails and landings, prescribed burning, riparian forest buffers, forest site preparation, bedding, establishment of trees and shrubs, and management of upland wildlife habitat.

The soils in this MLRA have a low content of organic matter and low productivity. Measures that increase the content of organic matter are needed. Applications of lime in areas of low pH help to maintain or improve productivity. Many of the soils remain wet or have a high water table for some or most of the time during the year. Measures that improve drainage or adapt the land use to the wet conditions are needed.

153A—Atlantic Coast Flatwoods

The defining attribute of this MLRA (fig. 153A-1), also known as the Lower Coastal Plain, is the predominance of the aquic soil moisture regime. The MLRA extends from the northeastern corner of Florida to central Virginia and parallels the Atlantic coastline approximately 10 to 30 miles inland.

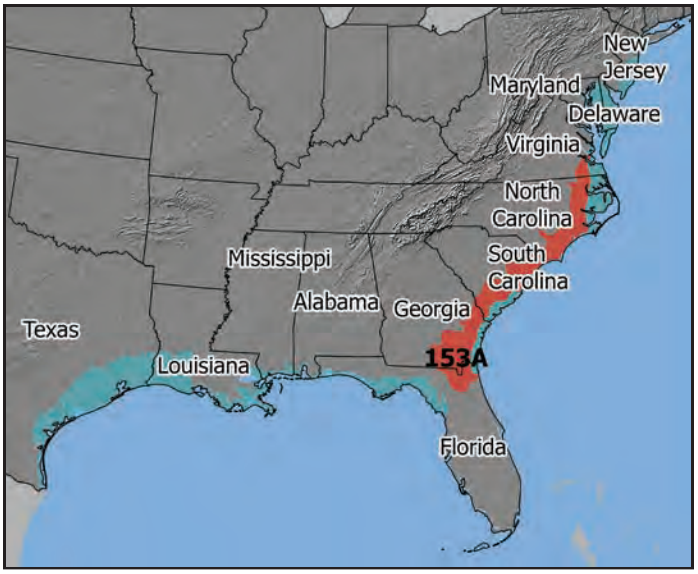

Figure 153A-1: Location of MLRA 153A, which covers 7,852,700 hectares (19,404,300 acres), within Region T.

Mostly unconsolidated fluviomarine sediments formed a relatively flat landscape that is crossed by broad, shallow valleys with widely meandering stream channels. This area is dominated by pine uplands with water tupelo and other hydrophytic vegetation in wetlands. It is in Georgia (30 percent), South Carolina (28 percent), North Carolina (28 percent), Florida (10 percent), and Virginia (4 percent). It makes up about 30,319 square miles (78,527 square kilometers).

This area has a clear boundary with MLRAs 133A and 138 as it occurs on a higher and more dissected fluviomarine terrace. In addition, MLRA 138 is underlain by limestone bedrock, which can influence use and management and vegetative communities. MLRA 153A has a distinct boundary with MLRA 153B, which is based on its younger, lower lying marine terrace that borders the Atlantic Ocean. To the south, it has a distinct boundary with MLRAs 154 and 155, which have shallow underlying limestone bedrock on significantly younger landscapes.

Physiography

This area is in the Coastal Plain province of the Atlantic Plain. While the majority of the central part of this MLRA in the Sea Island section of the province, the northern portion is in the Embayed section and the extreme southern portion is in the Floridian and East Gulf Coastal Plain sections. The valleys consist of mixed alluvium primarily from areas upstream—MLRAs 133A, 136, and 148. Some short, steep slopes border the stream valleys. Elevation ranges from 25 to 295 feet (8 to 90 meters). Local relief is mainly less than 35 feet (10 meters).

Many streams and rivers that flow through this area to the Atlantic Ocean have headwaters that originate to the west in the Upper Coastal Plain and Piedmont regions. The major rivers that cross this area en route to the ocean include, from north to south, the Blackwater, Nottoway, Chowan, Roanoke, Tar, Pamlico, Neuse, Cape Fear, Little Pee Dee, Pee Dee, Lynches, Black, Santee, Cooper, Edisto, Combahee, Coosawhatchie, Savannah, Ogeechee, Altamaha, Big Satilla, Satilla, and Suwanee Rivers.

Geology

Unconsolidated fluviomarine terrace sediments of Tertiary to Quaternary age occur at the surface throughout the area. These young alluvial sediments of clay, silt, sand, and gravel are a mixture of marine sediments and ancient river-laid sediments on terraces, flood plains, and deltas. They have kaolinitic and mixed mineralogy. The nearshore area from central North Carolina to Florida is underlain by Cretaceous marine shale, sandstone, and limestone deposits. The landscapes near the coast associated with present-day river valleys are extremely flat and of great extent. The water table is typically close to the surface in these broad river valleys.

Climate

The average annual precipitation is 45 to 58 inches (1,148 to 1,478 millimeters). The maximum precipitation occurs in summer. Rainfall is usually of moderate intensity. Occasionally, extreme weather events, such as northeasters and late summer and fall tropical storms and hurricanes, produce large amounts of precipitation and destructive winds. On rare occasions snowfall occurs in the northern third of the area.

The average annual temperature is 59 to 70 degrees F (15 to 21 degrees C), increasing to the south. The freeze-free period averages 290 days and ranges from 210 to 365 days, increasing in length to the south.

Water

Rainfall, perennial streams, and aquifers provide an abundance of water. Many of the soils require artificial drainage before they can be used for crops, and some of the sandy soils require irrigation during droughty periods. The numerous rivers have good-quality water that is suitable for most uses with minimal treatment.

Water for domestic and some municipal and industrial uses is obtained primarily from wells in the unconsolidated sediments of the Coastal Plain aquifer system in the northern end of this MLRA. This water is moderately hard or hard but is suitable for all uses. From central North Carolina to Florida, the principal source of ground water is Cretaceous marine sediments. Water from shale and sandstone aquifers is typically soft, and water from limestone aquifers (the Castle Hayne aquifer in South Carolina and the Floridan aquifer in South Carolina, Georgia, and Florida) is hard or very hard. Since the water in all of these aquifers is typically near the surface, contamination is a concern. Naturally high levels of fluoride and iron occur in some of the ground water throughout the MLRA.

Soils

The dominant soil orders are Spodosols and Ultisols. The soils in the area have a thermic temperature regime, an aquic or udic moisture regime, and siliceous mineralogy. They generally are very deep, well drained to very poorly drained, and loamy or clayey.

The main soils and their series:

- Alaquods that formed in marine sediments on flats and terraces and in depressions (Leon and Mascotte series)
- Albaquults that formed in mixed alluvium and marine sediments on flats and terraces (Leaf series)
- Haplosaprists that formed in organic deposits over mixed marine and fluvial deposits on the coastal plain (Croatan series)
- Paleaquults that formed in marine sediments on flats and in depressions on the coastal plain (Lynchburg, Pantego, and Pelham series)
- Paleudults that formed in marine sediments on uplands (Goldsboro series)

Biological Resources

This area supports pine-oak forest vegetation. Because of slight climatic differences between the northern and southern reaches, vegetative communities vary with latitude. Loblolly pine, longleaf pine, sweetgum, red maple, blackgum, and oaks are dominant in the uplands. Water tupelo, swamp blackgum, bald cypress, sweetgum, and red maple are dominant on the bottom land. Longleaf uniola, cutover muhly, toothache grass, panicums, little bluestem, and associated grasses and forbs characterize the understory vegetation.

Major wildlife species include white-tailed deer, feral hog, gray fox, red fox, bobcat, raccoon, skunk, opossum, otter, rabbit, armadillo, squirrel, turkey, and bobwhite quail. Fish species include largemouth bass, channel catfish, bullhead catfish, bluegill, redear sunfish, spotted sunfish, warmouth, black crappie, chain pickerel, gar, bowfin, and sucker. Threatened and endangered species, such as the gopher tortoise, inhabit the southern portion of this MLRA. This area provides crucial habitat for migratory waterfowl along the Atlantic Flyway.

Land Use

This area consists of vast acres of pine forest that are used for industrial, wildlife refuge, and recreational purposes (fig. 153A-2). The majority of the forestland is in farm woodlots and large commercial holdings, which are of great economic importance to the area. Pulpwood production is the main commodity, but lumber and other wood products are also significant. Grain crops (corn, soybeans, and wheat) and truck crops (vegetables, melons, and sweet potatoes) are of significant economic importance. Cropland is more extensive in the northern portion of the MLRA than in the southern portion.

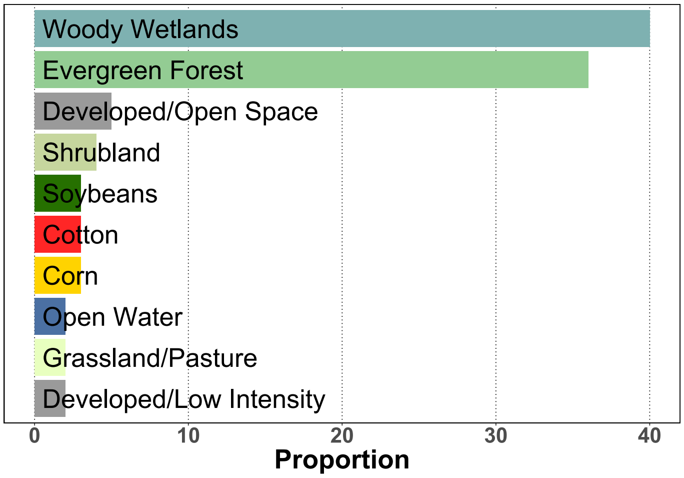

Figure 153A-2: Relative proportions (percentages) of land use in MLRA 153A.

The ground water table is lowered on much of the agricultural land by an elaborate network of ditches. Poultry farming is an important enterprise in the northern part of the area and in some parts in Florida. Swine operations are of moderate importance in the parts of this MLRA in North Carolina and Virginia.

The major soil resource concerns are wind erosion and diminished soil health resulting from surface compaction and a low content of organic matter in cultivated areas. Many areas of poorly drained and very poorly drained soils on uplands have been restored to wetland conditions. Wetland restoration improves water quality and provides wildlife habitat.

Conservation practices on forestland generally include forest stand improvement, forest trails and landings, prescribed burning, riparian forest buffers, forest site preparation, bedding, establishment of trees and shrubs, and management of upland wildlife habitat. Conservation practices on cropland generally include crop residue management, establishment of field borders, vegetative wind barriers, and nutrient and pest management.

153B—Tidewater Area

This MLRA (fig. 153B-1) consists of tidal marshes and estuaries encompassing a narrow band of barrier sea islands to the east and a beach ridge system to the west that stretches from northern Florida to Virginia along the Atlantic coastline. It is used extensively for wood products and, to a lesser extent, for agricultural purposes. Sea level fluctuation due to tidal activity and climatic variations has created tidal marshes along much of the coastline. The tidal marshes and estuaries provide an abundance of critical habitat for coastal wildlife and migratory waterfowl. Aquatic recreational activities, shellfish, and commercial fishing are of great economic importance. This area is in North Carolina (42 percent), Virginia (21 percent), South Carolina (20 percent), Georgia (14 percent), and Florida (3

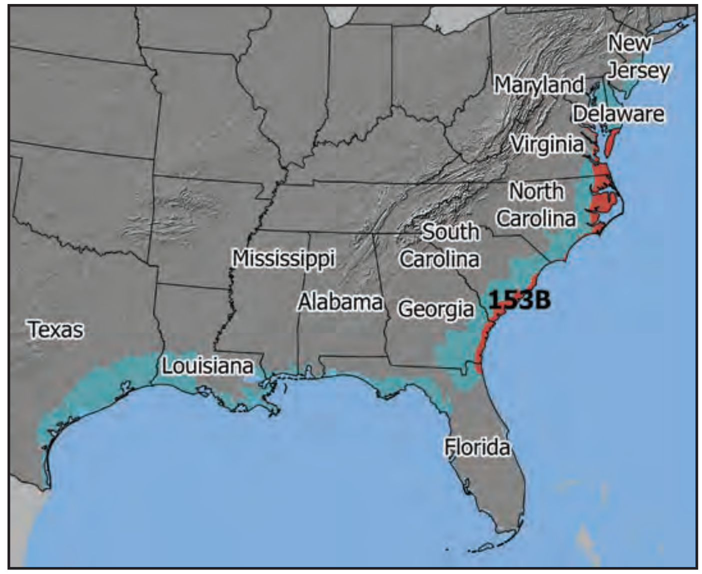

Figure 153B-1: Location of MLRA 153B, which covers 2,888,400 hectares (7,137,300 acres), within Region T.

percent). It makes up about 11,152 square miles (28,884 square kilometers).

MLRA 153B has an abrupt boundary with MLRA 133A in its northernmost reaches, at the much higher fluviomarine terrace of MLRA 133A. It has a distinct boundary with MLRA 153A, which is on a slightly higher (more than 8 meters) fluviomarine terrace west of the Suffolk Scarp and has distinct use and management characteristics. MLRA 153B has a slight transition to MLRA 153D, which has significantly less relief and many farm fields with adjacent drainage ditches.

Physiography

Most of this area is in the Sea Island section of the Coastal Plain province of the Atlantic Plain. The northern quarter is in the Embayed section of the same province and division. The barrier islands extend from the eastern shore of the Chesapeake Bay in Virginia to north of Charleston, South Carolina. The portion in North Carolina is referred to as the Outer Banks. Large bodies of brackish water, such as Pamlico and Albemarle Sounds, are on the inland side of the barrier islands. The sea islands extend from north of Charleston, South Carolina, to Jacksonville, Florida. The Suffolk Scarp is the upper (western) limit of this area and marks a point where the ocean shore extended prior to the Wisconsin period of glaciation.

The coastal marine sediments are crossed by many broad, shallow valleys formed by meandering streams and rivers that originated to the west in the Piedmont and Upper Coastal Plain. The stream valleys terminate at the Atlantic Ocean, in areas with many environmentally sensitive estuaries. Elevation ranges from sea level to less than 25 feet (0 to 8 meters). Local relief is mainly about 3 feet (1 meter) or less.

The major rivers that cross this area en route to the Atlantic Ocean include, from north to south, the Rappahannock, York, Rivanna, and Nottoway Rivers; the Chowan and Roanoke Rivers (Albemarle Sound); the Pamlico and Neuse Rivers (Pamlico Sound); and the Cape Fear, Pee Dee, Black, Santee, Cooper, Edisto, Combahee, Coosawhatchie, Savannah, Ogeechee, Altamaha, Satilla, and St. Marys Rivers. The headwaters of the St. Johns River are in this MLRA. The Great Dismal Swamp is in the parts of the MLRA in Virginia and North Carolina.

Geology

The mostly unconsolidated coastal plain sediments of Tertiary to Quaternary age occur at the surface throughout this MLRA. These young fluviomarine sediments of sand, silt, clay, and gravel were deposited over old riverbeds and on terraces when ocean levels were significantly higher. Sea level rise since the last period of continental glaciation has submerged the mouths of estuaries. From central North Carolina to Florida, Cretaceous marine, nearshore shale, sandstone, and limestone deposits are beneath the surface. Present-day broad, flat river valleys that dissect this area are being actively carved by meandering streams and contain more recent alluvial deposits. This recent alluvium is being deposited along active flood plains and in deltas. Fluctuating ocean levels, along with wave and wind activity, rework sand deposits that comprise the ever-changing barrier sea islands and coastline in this MLRA. The water table typically is close to the surface in the river valleys.

Climate

The average annual precipitation is 39 to 59 inches (982 to 1,508 millimeters). The maximum precipitation occurs in summer, and the minimum occurs in autumn. Rainfall usually is of moderate intensity. Occasionally, extreme weather events, such as northeasters and late summer and fall tropical storms and hurricanes, produce large amounts of precipitation and destructive winds. Snowfall may occur in the northern end of the area. The average annual temperature is 57 to 70 degrees F (14 to 21 degrees C). The freeze-free period averages 295 days and ranges from 230 to 360 days.

Water

The underlying bedrock in the aquifer system in this area gradually dips to the east, resulting in thicker unconsolidated coastal sediments towards the Atlantic Ocean. Rainfall, perennial streams, and underlying aquifers provide an abundance of freshwater for domestic, municipal, and industrial uses. The rivers and streams that flow into estuaries throughout the area supply quality water that supports a diverse and sensitive biome. The surficial aquifer in the area is highly susceptible to contamination from agricultural and urban activities. Near the coastline, the surface water is brackish.

The majority of wells from Virginia to North Carolina originate in the unconsolidated sediments of the Yorktown aquifer. Water in this aquifer ranges from soft to hard and is suitable for all uses. Sea and barrier islands in this area rely on this surficial aquifer for quality water. Deeper wells or wells that are excessively pumped provide water that can have high levels of total dissolved solids because of the encroachment of seawater. From central North Carolina to Florida, the principal source of ground water in this MLRA is Cretaceous marine sediments. Water from shale and sandstone aquifers is typically soft, and water from limestone aquifers (the Castle Hayne aquifer in South Carolina and the Floridan aquifer in South Carolina, Georgia, and Florida) is hard or very hard. Since the water in all these aquifers is typically near the surface, nitrate contamination is a concern. Naturally high levels of fluoride and iron occur in some of the ground water throughout this MLRA.

Soils

The dominant soil orders are Alfisols and Entisols. Histosols are of lesser extent. The soils in the area are characterized by restricted drainage, a thermic temperature regime, and an aquic moisture regime. The soils in the northern part of the area dominantly have mixed mineralogy, and those in the southern part dominantly have mixed clay and siliceous sand mineralogy. The study of subaqueous soils is of increasing importance along nearshore coastal waters.

The main soils and their series:

- Endoaqualfs that are very deep and loamy to clayey (Acredale and Stockade series)
- Endoaquults that are very deep and loamy to clayey (Dragston, Nimmo, and Tomotley series)
- Haplosaprists in large areas in North Carolina and Virginia, in the Great Dismal Swamp and in broad upland wetlands known as pocosins (Belhaven, Ponzer, and Pungo series)
- Hapludults in the higher areas where drainage is better but somewhat restricted (Bojac, Coosaw, and Munden series)
- Psamments (Corolla, Fripp, Newhan, and Wando series)
- Sulfaquents, which are extensive throughout the brackish tidal marshes protected by the barrier and sea islands (Bohicket, Capers, and Chincoteague series)
- Sulfiwassents (subaqueous soils) that formed in low- to moderate-energy estuarine deposits on lagoon bottoms along the Atlantic coastline
- Umbraquults that are very deep and loamy to clayey (Deloss, Hyde, and Portsmouth series)

Biological Resources

Because of slight climatic differences between the northern and southern reaches of this MLRA, vegetative communities vary with latitude. Loblolly pine and some oaks are dominant in the uplands, and blackgum, sweetgum, oaks, water tupelo, and bald cypress are dominant on the bottom land. Longleaf pine and slash pine are dominant in the southern part of the area. Longleaf uniola, switchcane, panicums, little bluestem, inkberry, large gallberry, greenbrier, wax myrtle, cabbage palm, and associated grasses and forbs characterize the understory.

Major wildlife species include black bear, white-tailed deer, fox, raccoon, opossum, otter, muskrat, rabbit, mink, squirrel, quail, and mourning dove. The red wolf, an endangered species, is being reintroduced in several parts of the MLRA.

The nearshore estuaries of the Chesapeake Bay and Atlantic Ocean provide habitat for diverse populations of terrestrial and aquatic animal species. The subaquatic vegetation in these coastal lagoon areas provides critical habitat and cover for many juvenile fin and shellfish. The estuaries host numerous migratory waterfowl throughout the year and are an integral part of the Atlantic Flyway.

Land Use

Estuaries and open water make up the majority of the area and provide pristine habitat for an abundance of permanent and migratory wildlife (fig. 153B-2). Much of this land is owned, regulated, and managed by government, commercial, and conservation groups as parks and wildlife preserves. The refuges also play a vital role in local economies in the form of commercial and recreational gaming and tourism. Most of the woodlands are in large commercial holdings, although some smaller farm woodlots exist. Pine pulpwood and hardwood lumber are the principal forest products. The majority of agriculture occurs in the northern parts of this MLRA. Common crops are corn, soybeans, and various truck crops. Low-lying areas require an extensive drainage network to lower the ground water table for most crop production, while sandy uplands are prone to drought conditions and require irrigation. Urbanization is occurring at an accelerated rate and includes expansion of cities, construction of vacation homes, and recreation associated with coastal life. A narrow band along the coast and on islands is intensively developed for vacation homes and recreational activities.

The major soil resource concerns are a seasonal high water table, flooding, and sea-level rise. Measures that maintain drainage systems are needed. Conservation practices on cropland generally include crop residue management and control of the water table. In much of the area, the water table can be controlled by flashboard risers, which preserve water quality and use ground water rather than irrigation.

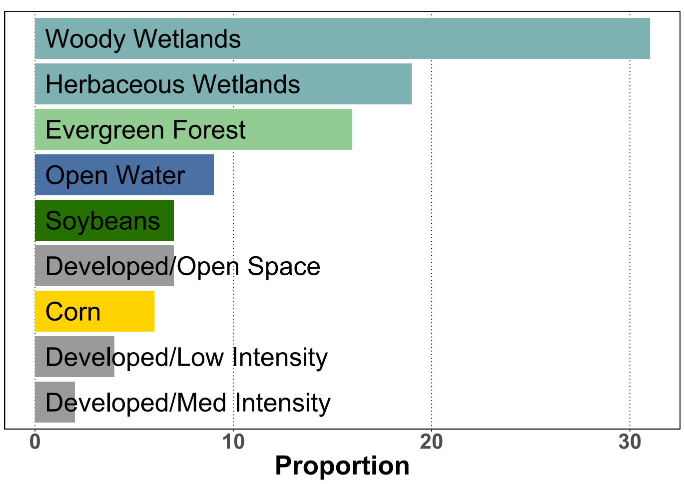

Figure 153B-2: Relative proportions (percentages) of land use in MLRA 153B.

153C—Mid-Atlantic Coastal Plain

This MLRA (fig. 153C-1) is characterized by nearly level to gently sloping inland landscapes consisting of loess-covered, unconsolidated fluviomarine deposits. Its shoreline consists of a network of tidal marsh and open water along the Chesapeake and Delaware Bays. This area is in Maryland (63 percent) and Delaware (37 percent). It makes up about 2,071 square miles (5,364 square kilometers).

This MLRA has a clear boundary with MLRA 149A, which has soils with a lower silt content due to no eolian cap or a thin one. It has a slight transition to MLRA 153D, which has significantly less relief and many farm fields with adjacent drainage ditches.

Physiography

This area is within the Embayed section of the Coastal Plain province of the Atlantic Plain. A layer of eolian (silty) sediments blown from the west covers fluviomarine sediments laid down during the last glaciation. Upland landscapes are nearly level

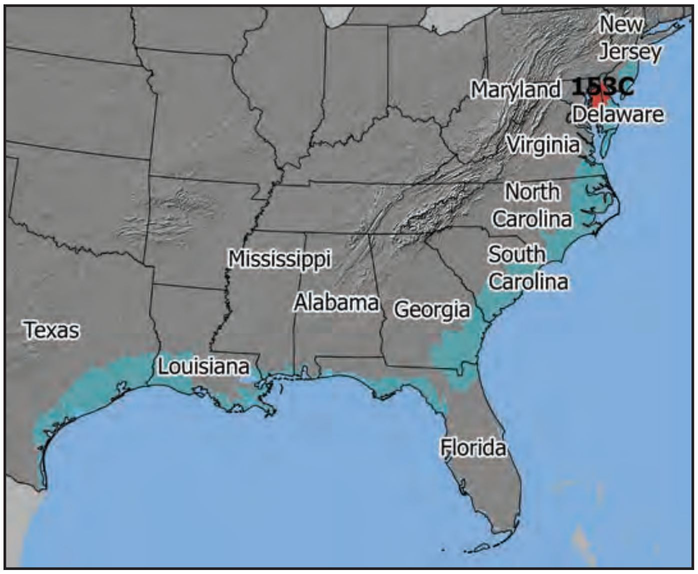

Figure 153C-1: Location of MLRA 153C, which covers 536,400 hectares (1,325,400 acres), within Region T.

to gently sloping, while low-lying areas are flat with shallow water tables. Landscapes become increasingly flat near the shoreline, where vast estuaries are influenced by tide waters. The broad flats of marine and fluvial origin are drained by wide, meandering, slow-moving streams.

Elevation ranges from sea level to about 98 feet (0 to 30 meters). Local relief is only 6 to 15 feet (2 to 5 meters) even where flood plains or coves from the bay are incised. In this MLRA, the Chester and Choptank Rivers flow freely into the Chesapeake Bay, and the Smyrna, Leipsic, Murderkill, and St. Jones Rivers feed estuaries in Delaware Bay.

Geology

This area is characterized by loess over unconsolidated fluviomarine deposits of sand, silt, and clay from the Late Cretaceous Period. Underlying these deposits is unexposed metamorphic bedrock that gradually dips to the east, creating a wedge with sediments thicker towards the Atlantic Ocean. Repeated fluctuations in sea level due to glacial periods resulted in the stratified silty and clayey alluvial sediments and sandy marine sediments. The loess material that caps this MLRA was deposited during the last glacial period when strong westerly winds carried sand and silt material from the area of present-day MLRA 149A over the unconsolidated sediments. These winds sorted the material from coarsest to finest and from thickest to thinnest, resulting in 1 to 5 feet (less than 2 meters) of loess over the fluviomarine sediments.

Fluctuating ocean levels, along with wave and wind activity, rework sand deposits that constitute the ever-changing dunes, barrier islands, and coastline in this area. These low-lying tidal marshes are accreting and moving inland along the Chesapeake and Delaware Bays, particularly at the mouths of rivers.

Climate

The average annual precipitation is 41 to 45 inches (1,046 to 1,146 millimeters). Convective summer thunderstorms provide a large amount of the total precipitation, but precipitation is relatively evenly distributed throughout the year. Occasionally, extreme weather events, such as northeasters and late summer and fall tropical storms and hurricanes, produce large amounts of precipitation and destructive winds. The average annual snowfall is typically about 6 inches (15 centimeters). The average annual temperature is 55 to 58 degrees F (13 to 14 degrees C). The freeze-free period averages 220 days and ranges from 205 to 235 days. It is shorter inland and longer along the bays.

Water

Rainfall, perennial streams, and underlying aquifers provide an abundance of freshwater for domestic, municipal, and industrial uses. The rivers and streams that flow into estuaries throughout the MLRA supply quality water that supports a diverse and sensitive biome. The surficial aquifer is highly susceptible to contamination from agricultural and urban activities throughout the MLRA. Near the coastline, the surface water is brackish.

Wells are generally confined to near-surface unconsolidated alluvial deposits of Quaternary and Tertiary age. As part of the Chesapeake Group, the Rancocas aquifer provides quality water that is used for domestic, municipal, and extensive irrigation purposes in eastern Maryland and southern Delaware. This water has low levels of total dissolved solids, but iron concentrations typically exceed the secondary standard for drinking water and make the water hard or very hard. The overpumping of wells near the shorelines of the Chesapeake and Delaware Bays may result in well contamination from the intrusion of seawater.

Soils

The dominant soils in this MLRA are Ultisols. Entisols and Inceptisols are of lesser extent. The soils in the area have an aquic or udic moisture regime, a mesic temperature regime, and mixed or siliceous mineralogy. They are very deep, dominantly well drained to poorly drained, and generally loamy or sandy in the mineral horizons. The soils generally formed in loamy or sandy coastal plain sediments. Small areas of sandy soils that formed in sandy terrace deposits or ancient dunes associated with rivers are throughout the MLRA. The study of subaqueous soils is of increasing importance along nearshore coastal waters.

The main soils and their series:

- Endoaquults that are poorly drained and in low-lying areas (Fallsington and Carmichael series); that formed in 1 to 3 feet (1 meter or less) of loess over sandy and loamy, stratified coastal plain deposits (Othello and Elkton series)
- Hapludults that are well drained, loamy, and on broad uplands (Reybold, Hambrook, Unicorn, and Ingleside series); that are moderately well drained and in intermediate landscape positions (Pineyneck series); that formed in 1 to 3 feet (1 meter or less) of loess over sandy and loamy, stratified coastal plain deposits (Matapeake, Nassawango, and Mattapex series)
- Sulfaquents that are very poorly drained and in tidal marshes along the Chesapeake and Delaware Bays (Broadkill series)
- Sulfiwassents (subaqueous soils) that formed in low- to moderate-energy estuarine deposits on lagoon bottoms along the Atlantic coastline
- Umbraquults that are very poorly drained, loamy, and in low-lying areas (Corsica series)

Biological Resources

The natural vegetation consists mostly of white oak, red oak, hickory, blackgum, red maple, black oak, scarlet oak, chestnut oak, blackjack oak, sweetgum, loblolly pine, beech, Virginia pine, scrub oak, highbush blueberry, sweet pepperbush, greenbrier, sassafras, lowbush blueberry, holly, and mountain laurel. Major wildlife species include white-tailed deer, turkey, quail, raccoon, rabbit, squirrel, wading shore birds, and numerous species of ducks and geese.

The Chesapeake and Delaware Bays provide habitat for diverse populations of terrestrial and aquatic animal species. The subaquatic vegetation (SAV) in these coastal lagoon areas consists of eelgrass and widgeongrass. These SAV species provide critical habitat and cover for many juvenile fin and shellfish. The estuaries are also an integral part of the Atlantic Flyway and host numerous migratory waterfowl throughout the year.

Land Use

Productive dry uplands and drained lowlands are routinely cultivated by corporate farms for grains and truck and specialty crops. Agriculture is the primary land use, with nearly one-half of this area farmed (fig. 153C-2). Extensive irrigation or ditching networks, or both, are required for most agricultural production. Agricultural practices in low-lying areas require extensive artificial drainage, while sandy uplands commonly require irrigation water, supplied by wells, during periods of drought. Many large-scale corporate farms produce a diverse range of grain crops (soybeans and corn), fruit crops (apples and peaches), truck crops (watermelons and spinach), and various horticultural crops. Poultry farming and soil farms are of significant importance to the local economy, and poultry production exceeds general farming in some counties. Native mixed pine and hardwood forests remain in large tracts or in areas of protected public lands in State forests and parks. Many large tracts of loblolly pine in areas of the wetter soils are managed for pulpwood and lumber. The seafood industry is significant to the economy of the counties bordering the two bays.

The most significant resource concern is the rapid reduction in the acreage of farmland and forestland due to urban and suburban development. Increased runoff and erosion associated with urban development and agricultural practices commonly causes stream degradation through downcutting and widening and the subsequent deposition of sandy material along streambanks and in estuaries. Development of residential lagoons along shorelines can severely impact the adjacent wetlands and estuaries.

Farmland preservation programs are vital to maintaining the agricultural resources in the area. Maintenance or improvement of water quality for recreation and fishing is critical to local economies, particularly for the shellfish habitat areas in the Chesapeake and Delaware Bays. Conservation practices on cropland generally include systems of crop residue management (especially no-till and minimum tillage), conservation cover crops, nutrient management, grassed waterways, filter strips, irrigation water management, and riparian buffers. Where livestock or poultry are part of the farm operation, management of animal waste, including its storage, is critical.

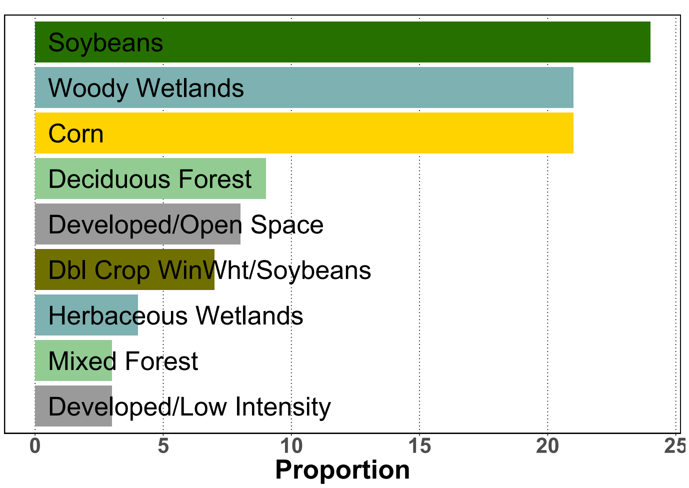

Figure 153C-2: Relative proportions (percentages) of land use in MLRA 153C.

153D—Northern Tidewater Area

This MLRA (fig. 153D-1) is characterized by nearly level to gently sloping inland landscapes consisting of loess-covered, unconsolidated fluviomarine deposits. Its shoreline consists of a vast network of tidal marsh and open water that occurs between the numerous barrier islands and the mainland along the Chesapeake Bay, Delaware Bay, and Atlantic Coast.

This area is in New Jersey (44 percent), Maryland (38 percent), and Delaware (18 percent). It makes up about 5,563 square miles (14,408 square kilometers). The Chesapeake Bay and the Atlantic Ocean border this area. Delaware Bay divides the area nearly in half.

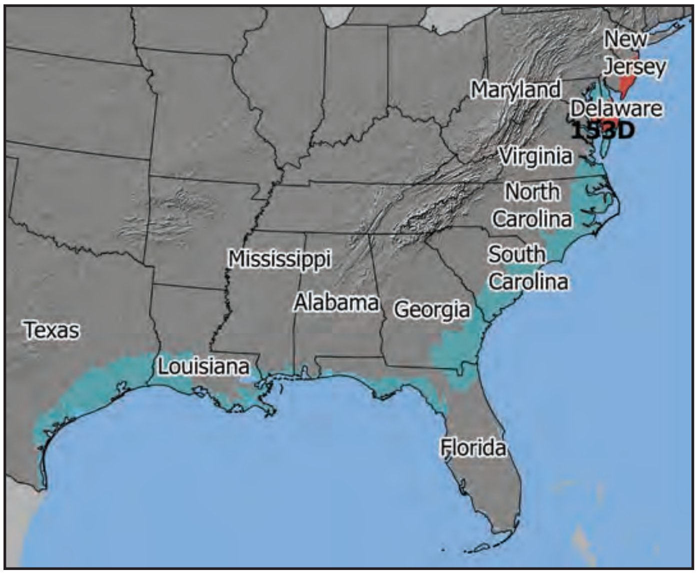

Figure 153D-1: Location of MLRA 153D, which covers 1,440,800 hectares (3,560,300 acres), within Region T.

MLRA 153D has a clear boundary with MLRA 153C, which has a rolling landscape and thicker eolian deposits that favor agriculture. It has a distinct boundary with MLRA 149A, which is used for farming and intense urbanization. It has an indistinct boundary with MLRA 153B, which has soils with similar properties but a thermic rather than a mesic soil temperature regime. The thermic regime allows the production of such crops as tobacco and cotton.

Physiography

This area is within the Embayed section of the Coastal Plain province of the Atlantic Plain. A layer of eolian (silty) sediments blown from the west covers fluviomarine sediments laid down during the embayment period. Upland landscapes are nearly level to gently sloping, while low-lying areas are flat with shallow water tables. Landscapes become increasingly flat near the shoreline, where vast estuaries are influenced by tide waters. The broad flats of marine and fluvial origin are drained by wide, meandering, slow-moving streams. A beach ridge system with numerous barrier islands protects tidal marsh areas on both the ocean and bay sides of the MLRA. Elevation typically ranges from sea level to about 80 feet (0 to 25 meters). In the Barnegate Bay watershed in the northern part of the MLRA, remnants of old coastal plain deposits have a maximum elevation of more than 213 feet (65 meters). Local relief is only 6 to 15 feet (2 to 5 meters), even where flood plains or coves from the bay are incised.

From north to south, the major rivers in the area are the Shark, Manasquan, Toms, Yellow, Oswego, Wading, Mullica, Tuckahoe, Great Egg Harbor, and Maurice Rivers in New Jersey and the Mispillion, Broadkill, Gravelly, Indian, Nanticoke, Broad, Wicomico, Dividing, and Pokomoke Rivers in Delaware and Maryland.

Geology

This area is characterized by loess over unconsolidated fluviomarine deposits of sand, silt, and clay from the Late Cretaceous Period. Underlying these deposits is unexposed metamorphic bedrock that gradually dips to the east, creating a wedge with sediments thicker towards the Atlantic Ocean. Repeated fluctuations in sea level due to glacial periods resulted in stratified silty and clayey alluvial sediments and sandy marine sediments. The loess material that caps the surface was deposited during the last glacial period when strong westerly winds carried sand and silt material from the area of present-day MLRA 149A over the unconsolidated sediments. These strong winds sorted the material from coarsest to finest and from thickest to thinnest, resulting in loess 1 to 3 feet (1 meter or less) thick over the fluviomarine sediments.

Fluctuating ocean levels, along with wave and wind activity, rework sand deposits that constitute the ever-changing dunes, barrier islands, and coastline in this area. This process has formed major spits at the southern margin of both the New Jersey and Delmarva peninsulas at elevations of less than 20 feet (6 meters). These low-lying tidal marshes are accreting and moving inland along the Chesapeake and Delaware Bays and the Atlantic Ocean, particularly at the mouths of rivers.

Climate

The average annual precipitation in most of this area is 38 to 47 inches (962 to 1,206 millimeters). Convective summer thunderstorms provide a large amount of the total precipitation, but precipitation is relatively evenly distributed throughout the year. Occasionally, extreme weather events, such as northeasters and late summer and fall tropical storms and hurricanes, produce large amounts of precipitation and destructive winds. The average annual snowfall is typically about 6 inches (15 centimeters). The average annual temperature is 53 to 59 degrees F (12 to 15 degrees C). The freeze-free period averages 220 days and ranges from 190 to 255 days. It is shorter in inland areas and longer along the Atlantic Ocean and the Chesapeake and Delaware Bays.

Water

Rainfall, perennial streams, and underlying aquifers provide an abundance of freshwater for domestic, municipal, and industrial uses. The rivers and streams that flow into estuaries throughout the area supply quality water that supports a diverse and sensitive biome. The surficial aquifer throughout the area is highly susceptible to contamination from agricultural and urban activities. Near the coastline, the surface water is brackish.

Wells in this MLRA are generally confined to near-surface unconsolidated alluvial deposits of Quaternary and Tertiary age. As part of the Chesapeake Group, the Columbia, Unconfined, and Kirkwood-Cohansey aquifers supply quality water that is used for domestic, municipal, and irrigation purposes on the Delmarva Peninsula (Delaware, Maryland, and Virginia). This water is soft to hard with low levels of total dissolved solids, but iron concentrations typically exceed the secondary standard for drinking water and make the water hard or very hard. The overpumping of wells near the shorelines of the Atlantic Ocean, Chesapeake Bay, and Delaware Bay can result in well contamination from the intrusion of seawater.

Soils

The dominant soil order in this MLRA is Ultisols. Entisols, Histosols, Spodosols, and Inceptisols are of lesser extent. The soils in the area have a mesic temperature regime, an aquic or udic moisture regime, and mixed or siliceous mineralogy. They are very deep, have subaqueous drainage or are very poorly drained to excessively drained, and are generally loamy or sandy in the mineral horizons. A strip of coastal beach dunes extends along the Atlantic Ocean in most of the MLRA. The parts of the MLRA in Maryland and Delaware have significant areas of Hapludults and Endoaquults that formed in 1 to 3 feet (1 meter or less) of loess over sandy and loamy, stratified coastal plain deposits. Large areas of sandy soils that formed in sandy coastal plain sediments or ancient dunes are throughout the MLRA. The study of subaqueous soils is of increasing importance along nearshore coastal water.

The main soils and their series:

- Alaquods that are poorly drained and very poorly drained, are sandy, and formed in sandy coastal plain sediments or ancient dunes (Atsion and Berryland series)
- Endoaquults that are poorly drained and generally formed in loamy or sandy coastal plain sediments (Hurlock series); that formed in 1 to 3 feet (1 meter or less) of loess over sandy and loamy, stratified coastal plain deposits (Othello and Elkton series)
- Haplosaprists that are very poorly drained on flood plains, in freshwater swamps, and on low-lying flats (Manahawkin and Puckum series)
- Hapludults that are well drained, loamy, and on broad uplands (Downer series); that are moderately well drained and in intermediate landscape positions (Hammonton series); that are somewhat poorly drained to excessively drained, are sandy, and formed in sandy coastal plain sediments or ancient dunes (Cedartown series)
- Humaquepts that are very poorly drained and on flood plains, in freshwater swamps, and on low-lying flats (Mullica series)
- Quartzipsamments that are somewhat poorly drained to excessively drained, are sandy, and formed in sandy coastal plain sediments or ancient dunes (Evesboro, Runclint, Lakehurst, Lakewood, and Klej series); that are along the Atlantic Ocean, on a broken line of barrier islands consisting of primarily coastal beaches and dunes (Hooksan series)
- Sulfaquents that are very poorly drained on tidal marshes along the Chesapeake and Delaware Bays and between the barrier islands and the mainland (Appoquinimink, Purnell, and Boxiron series)
- Sulfihemists that are very poorly drained and on tidal marshes along the Chesapeake and Delaware Bays and between the barrier islands and the mainland (Honga, Transquaking, Bestpitch, and Mispillion series)
- Sulfiwassents (subaqueous soils) that formed in low- to moderate-energy estuarine deposits on lagoon bottoms along the Atlantic coastline (Figgs and Tingles series); that have subaqueous drainage in estuarine and coastal lagoon areas in Delaware, Maryland, and New Jersey along the Atlantic Ocean (Cottman and Herring Creek series)
- Udipsamments along the Atlantic Ocean, on a broken line of barrier islands consisting of primarily coastal beaches and dunes (Acquango and Brockatonorton series)

Biological Resources

The natural terrestrial vegetation consists mostly of pitch pine, blackgum, red maple, black oak, scarlet oak, chestnut oak, blackjack oak, Atlantic white cedar, sweetgum, white oak, hickory, shortleaf pine, Virginia pine, scrub oak, highbush blueberry, sheep laurel, sweet pepperbush, gallberry, greenbrier, sassafras, lowbush blueberry, holly, and mountain laurel. Major wildlife species include white-tailed deer, turkey, quail, raccoon, rabbit, squirrel, wading shore birds, and numerous species of ducks and geese.

The nearshore estuaries of the Atlantic Ocean provide habitat for diverse populations of terrestrial and aquatic animal species. The subaquatic vegetation in these coastal lagoon areas provides critical habitat and cover for many juvenile fin and shellfish. The estuaries are also an integral part of the Atlantic Flyway and host numerous migratory waterfowl throughout the year.

Land Use

Wetland, estuaries, and open water make up the majority of the area and provide pristine habitat for an abundance of permanent and migratory wildlife (fig. 153D-2). Native mixed pine and hardwood forests remain in large commercial tracts and on protected public lands. Numerous national wildlife refuges, State forests, State parks, and wildlife management areas occur throughout the MLRA. These refuges play a vital role in local economies in the form of seasonal recreation and tourism. Seasonal tourism is a large part of the local economy, particularly along or near the barrier islands where heavy urbanization has taken place. Large tracts of loblolly pine in wet, low-lying areas are managed for pulp and timber products.

In the north in New Jersey, low relief and shallow water tables limit commercial and private agricultural uses. In the south (Delaware and Maryland), areas are commonly used for

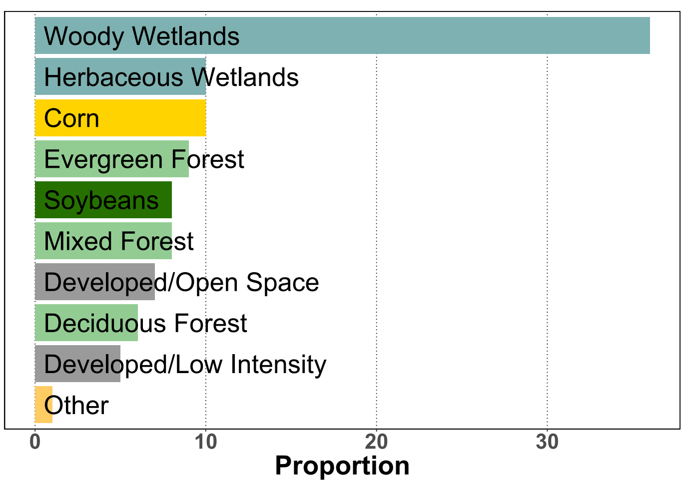

Figure 153D-2: Relative proportions (percentages) of land use in MLRA 153D.

agricultural purposes where extensive irrigation or ditching networks, or both, are installed. Common grain crops (soybeans and corn) and truck crops (watermelons and spinach) are grown in this area. Poultry production exceeds general farming in some counties, and much of the locally grown corn is used for feed. To the north in New Jersey, specialty crops of cranberries and blueberries are of significant economic importance. Aquaculture and shellfish production are expanding throughout the estuarine areas of the MLRA due to increased water quality and ecosystem awareness efforts. Barrier island and bay communities rely on revenue from the seafood industry and seasonal tourism to support local economies.

The most significant resource concern in this area is the rapid reduction in the acreage of farmland and forestland caused by urban and suburban development. The narrow bands of intense development around bay communities and on barrier islands have put pressure on the adjacent ecosystem. Increased runoff and erosion associated with urban development and agricultural practices commonly causes stream degradation through downcutting and widening and the subsequent deposition of sandy material along streambanks and in estuaries. Development of residential lagoons along shorelines can severely impact the adjacent wetlands and estuaries.

Farmland preservation programs are vital to maintaining the agricultural resources in the MLRA. Maintenance or improvement of water quality for recreation and fishing is critical to local economies, particularly for shellfish habitat in the Chesapeake and Delaware Bays. Conservation practices on cropland generally include systems of crop residue management (especially no-till and minimum tillage), conservation cover crops, nutrient management, grassed waterways, filter strips, irrigation water management, and riparian buffers. Where livestock or poultry are part of the farm operation, management of animal waste, including its storage, is critical.

U—Florida Subtropical Fruit, Truck Crop, and Range Region

Land Resource Region U (fig. U-1) is the Florida Peninsula. It is the most recently emerged part of the Coastal Plain, an area of the North American continental platform that remains mostly submerged. The region's recent emergence explains the low relief and elevation, much of which is less than 20 feet, and the many lakes, swamps, and poorly drained soils (except in areas of sandhills and ridges). Distinctive features include a hyperthermic soil temperature regime, the widespread distribution of marine carbonate rocks and karst, and the dominance of wetland vegetation. Only at the higher elevations of northern Florida are caverns commonly above the water table. Region U contains four major land resource areas. The extent of these MLRAs and their range in elevations are shown in table U-1.

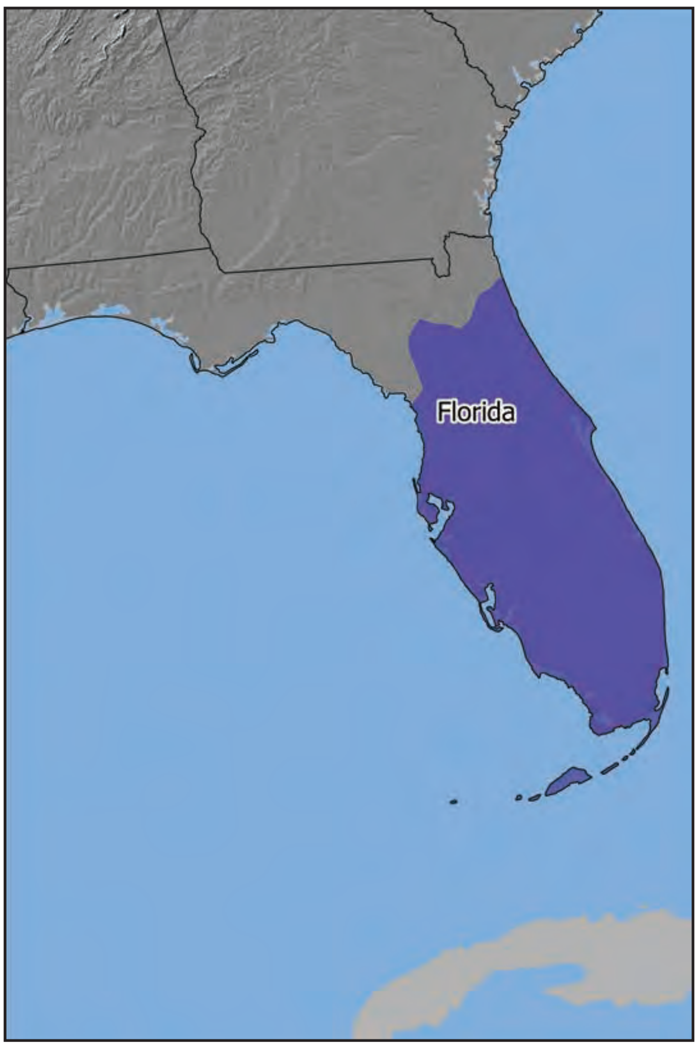

Figure U-1: Location and size of Land Resource Region U, which covers 96,335 square kilometers (37,195 square miles) in Florida.

The boundary between Regions U and T (fig. 1, page 5) is primarily climatic, separating the hyperthermic and thermic soil temperature regimes. This temperature break emphasizes the significance of warmer temperatures, which allow the production of citrus as well as the many truck crops historically sold at winter markets. The boundary between Regions U and P, which also corresponds to the hyperthermic-thermic boundary, separates poorly drained soils (Region U), most of which have an aquic moisture regime, from better drained soils (Region P), most of which have an udic moisture regime.

The climate in Region U is hot and humid. The average annual precipitation is 51 to 53 inches (1,300 to 1,340 millimeters). About 60 percent of the annual precipitation occurs from June through September. Fall and winter are drier. The average annual temperature is 71 to 76 degrees F (22 to 24 degrees C). The freeze-free period ranges from 325 to 365 days. Temperatures and precipitation for this region are shown in figures 6 and 7 in the Introduction. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables U-2 and U-3.

The soils of Region U have many differences based on catena relationships. The combination of sandy soil textures and high water tables has led to an abundance of Spodosols while swampy conditions have led to the formation of Histosols (fig. 2, page 6). Some areas of high ground have soils with illuvial clay, resulting in the formation of Alfisols in the south, where base saturation is higher, and Ultisols in the north, where base saturation is lower. Entisols occur on younger geomorphic surfaces, primarily as Psamments and Aquents. The soils in the region commonly have siliceous mineralogy. Soil carbonates are sparse and associated with shallow limestone (fig. 5, page 9). Restrictive zones in the soils of Region U are mainly lithic and paralithic bedrock (fig. 9, page 13) and ortstein (fig. 11, page 15) in a few areas. The highest amounts of organic carbon accumulation are associated with wetlands (figs. 8 and 14, pages 12 and 18).

Land use is dominated by wetland vegetation (fig. U-2 and fig. 8). Only about 10 percent of the region is cropland, which is used mainly for citrus. Truck crops and sugarcane are important sources of income. Management of the water table is important during summer, and many crops require some irrigation during the generally dry fall and winter. The major resource concerns are wind erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Maintaining the quality of surface water and ground water is a concern in this region because of nitrate and phosphate pollution.

Table U-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10^{th} percentile		50^{th} percentile		90^{th} percentile		High	
	km^2	mi^2	m	ft	m	ft	m	ft	m	ft	m	ft
154	18,670	7,210	0	0	10	40	20	80	40	140	110	370
155	51,730	19,975	0	0	0	0	0	20	20	80	80	270
156A	20,070	7,750	0	0	0	0	0	0	0	10	30	110
156B	5,865	2,265	0	0	0	10	0	10	0	20	60	200

Table U-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10^{th} percentile		50^{th} percentile		90^{th} percentile		High		Shortest	10^{th} percentile	50^{th} percentile/ mean	90^{th} percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
154	20.5	69	20.8	69	21.7	71	22.7	73	23	73	270	292	327/325	349	365
155	20.5	69	21.2	70	22.6	73	23.3	74	24.6	76	280	321	352/345	365	365
156A	23.1	74	23.3	74	24.2	76	24.6	76	25.6	78	365	365	365/365	365	365
156B	22	72	22.3	72	22.8	73	23.3	74	23.8	75	345	352	358/360	365	365

Table U-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10^{th} percentile		50^{th} percentile/mean		90^{th} percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
154	1,150	45	1,260	50	1,304/1,300	51/51	1,343	53	1,410	56
155	970	38	1,195	47	1,308/1,300	51/51	1,395	55	1,570	62
156A	940	37	1,229	48	1,339/1,340	53/53	1,471	58	1,570	62
156B	1,170	46	1,251	49	1,324/1,330	52/52	1,456	57	1,500	59

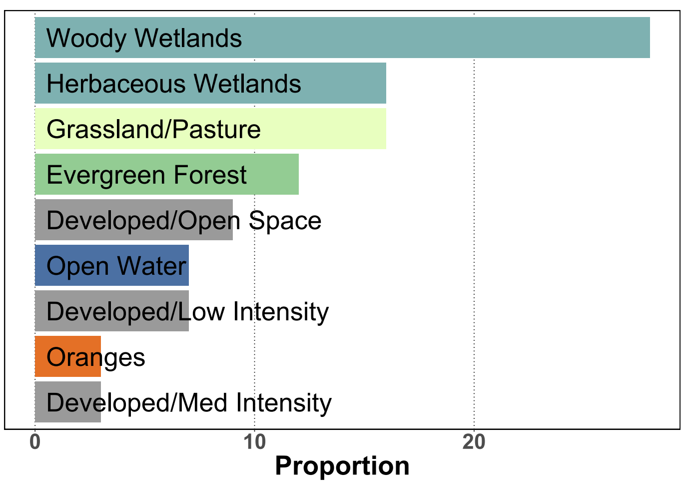

Figure U-2: Relative proportions (percentages) of land uses in Land Resource Region U (National Agricultural Statistics Service, 2018).

154—South-Central Florida Ridge

This MLRA (fig. 154-1) makes up about 7,209 square miles (18,672 square kilometers) and is entirely in Florida. It meanders around the western and central ridge of central Florida, from Gainesville to Lake Placid, and is irregularly shaped. It includes some of the oldest landscapes in peninsular Florida and is dominated by a series of marine sand ridges that mark the remnants of ancient shorelines (dating to the Pleistocene Epoch and earlier). Due to the underlying karst topography and drainage systems, the MLRA has few surficial rivers. Many endemic plant and animal species are associated with the ridges in this area. Livestock, citrus, specialty crops, and timber are important.

MLRA 154 is extensively intertwined with MLRA 155 across the western mid-section of Florida. These two MLRAs differ slightly based on elevation and depth to limestone bedrock. As the depth to limestone bedrock increases, the risk of sinkhole formation and the accumulation of surface water into water bodies decrease. To the north, MLRA 154 borders MLRA 138, which has similar surficial geology but is underlain by limestone. To the northwest and northeast, it has a distinct boundary with MLRAs 152A and 153A marked by a scarp that borders a lower, wetter landscape.

Physiography

This area is in the Floridian section of the Coastal Plain province of the Atlantic Plain. The sand marine terrace is nearly level to moderately steep. The land surface is very irregular

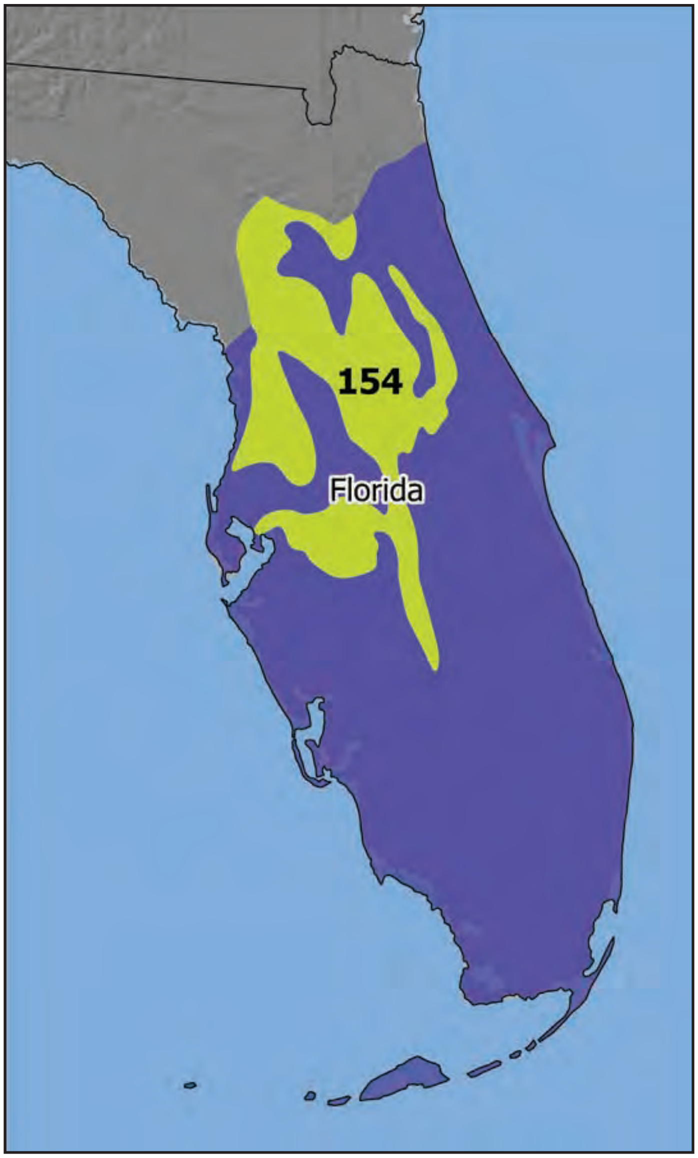

Figure 154-1: Location of MLRA 154, which covers 1,867,200 hectares (4,613,800 acres), within Region U.

because of the many sinkholes that dot the area. Elevation ranges from 10 to 312 feet (3 to 95 meters) throughout the flatwoods of the Wicomico Terrace. The Withlacoochee River is in this area.

Geology

This area is underlain by sediments of the Quaternary Period (present to 2.58 million years ago) that overlie Neogene (2.53 to 23.03 million years ago) and Paleogene (23.03 to 66 million years ago) formations, including those of the Hawthorn Group. The older rocks are exposed in the northern part of this area. The Quaternary sediments are largely undifferentiated marine deposits consisting of fine to coarse sands that are poorly to moderately sorted with variable admixtures of clay and organic material. Quaternary beach ridge and dune sediments, which are mapped based on topographic expression, occur throughout the area, becoming more abundant toward the coast. The Trail Ridge sands are in the north-central part of the MLRA and consist of white to tan, medium to fine quartz, beach ridge sands that are unconsolidated to slightly indurated. They contain an average of 3 percent heavy minerals in some areas.

The Cypresshead Formation of the Pliocene Epoch (2.53 to 5.33 million years ago) overlies the formations of the Hawthorn Group. It is mottled reddish brown and reddish orange to white, unconsolidated to poorly consolidated, fine to very coarse grained, variably clayey to clean quartz sand. Cross-bedded sands are common in this formation. Undifferentiated, reworked Cypresshead sediments are also in this MLRA.

The formations of the Hawthorn Group in the area are, from youngest to oldest, the Coosawhatchie Formation, the Tampa Member of the Arcadia Formation, the Suwannee Limestone, and the Ocala Limestone. The Coosawhatchie Formation is made up of poorly to moderately sorted sandy clay or clayey sand with phosphate grains, limestone, and dolostone. The Tampa Member consists dominantly of fossiliferous limestone with subordinate dolostone, sand, and clay. The Suwannee Limestone is a cream-colored to tan, crystalline, vuggy and muddy, fossiliferous, variably dolomitic carbonate. It has chert nodules in some areas. The Ocala Limestone was deposited during the Eocene Epoch (33.9 to 56 million years ago) and is the oldest rock formation exposed in Florida. It is a white to cream-colored, fossiliferous limestone that includes chert nodules in some areas. Undifferentiated Hawthorn Group sediments in the MLRA consist of poorly to moderately consolidated clayey sands to silty sands and relatively pure clays with little or no phosphate (Evans, III et al., 2004; Green et al., 2005, 2009, 2010, 2011, 2012, 2013, 2014, 2018; Williams et al., 2012).

Climate

The average annual precipitation is 46 to 55 inches (1,161 to 1,404 millimeters). About 60 percent of the precipitation occurs from June through September. Most of the rainfall occurs during moderate-intensity, tropical storms that produce large amounts of rain from late spring through early autumn. Late autumn and winter are relatively dry. The average annual temperature is 69 to 73 degrees F (21 to 23 degrees C). The freeze-free period averages 335 days and ranges from 300 to 365 days.

Water

Rainfall, surface water, and ground water provide an abundance of water for most of the year. The combination of sandy soils and karst topography significantly increases the importance of monitoring surface water runoff in agricultural and urbanized areas. Although this MLRA has few perennial streams, a high ground water table creates a significant risk of contamination. Many lakes have formed in the sinkholes throughout the area.

Almost all domestic, municipal, and irrigation water is obtained from wells in the Floridan aquifer, which is one of the most productive sources of ground water in the United States. This hard, calcium-bicarbonate-type water is of good quality. The aquifer consists of a thick sequence of Tertiary limestone and dolomite. The Eocene Avon Park Formation and Ocala Limestone are the thickest and most productive units in the aquifer system.

Soils

The dominant soil orders are Entisols and Ultisols. The soils in the area dominantly have a hyperthermic temperature regime, a udic moisture regime, and siliceous mineralogy. They generally are very deep, excessively drained to somewhat poorly drained, and sandy and loamy. Anthroportic soils throughout the area are a result of cut-and-fill activities associated with construction and urbanization.

The main soils and their series:

Paleudults that formed in sandy and loamy marine sediments of the Citronelle and Cypresshead Formations on uplands (Apopka, Millhopper, and Sparr series)

Quartzipsamments that formed in mixed sandy eolian and marine sediments on uplands (Astatula, Candler, Lake, and Tavares series)

Biological Resources

This area supports sandhill vegetation. Turkey oak, bluejack oak, sand pine, slash pine, and longleaf pine are the major species. Running oak, gopher apple, and grasses such as bluestems, threeawns, dropseed, Indiangrass, panicums, and goldaster characterize the understory.

Major wildlife species include deer, feral hog, fox, raccoon, rabbit, gray squirrel, fox squirrel, turkey, bobwhite quail, and dove. Fish species include largemouth bass, shellcracker, catfish, bluegill bream, and crappie.

Land Use

Agricultural enterprises in this area include the production of livestock, citrus, and specialty crops (fig. 154-2). Forest products also are important. Pulpwood is the primary forest product, but some woodlands are grazed. Although less than one-tenth of the acreage is used for crops, this area produces a significant amount of citrus in Florida. Many kinds of winter vegetables also are grown. About half of the pastured areas in the MLRA are improved and intensively managed. Beef cattle are the principal livestock, but dairying is an important enterprise near some of the large cities. Urban land makes up a large acreage in the area. Phosphate mines are a prominent feature in the central part of the MLRA.

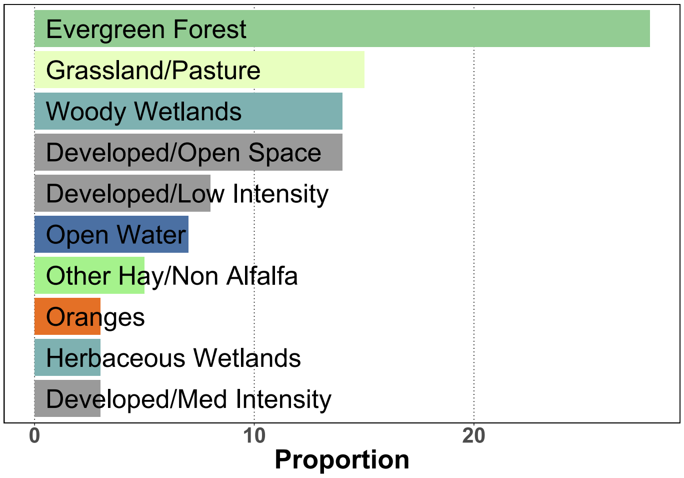

Figure 154-2: Relative proportions (percentages) of land use in MLRA 154.

The major soil resource concerns are wind erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Additional resource concerns are water quality, water quantity (excess amounts), and plant and animal productivity and health. Conservation practices on cropland generally include conservation crop rotations, cover crops, irrigation water management (including micro irrigation systems), nutrient management, and pest management. Conservation practices on pasture and rangeland generally include prescribed grazing, brush management, pest management, prescribed burning, and watering facilities. Conservation practices on forestland generally include forest stand improvement, forest site preparation, prescribed burning, firebreaks, establishment of trees and shrubs, pest management, and management of upland wildlife habitat.

155—Southern Florida Flatwoods

This area (fig. 155-1) makes up about 19,973 square miles (51,731 square kilometers) and is entirely in Florida. It stretches across the mid-section of the State, from the Gulf of Mexico to the Atlantic Ocean, and north and south from the Everglades (MLRA 156A) to Jacksonville. This MLRA consists of a young sandy marine plain of Pleistocene age that is underlain by Tertiary-age limestone bedrock. The terrain is nearly level to gently sloping with large areas of swamp and marsh. Sinkholes affect land use and management.

MLRA 155 is extensively intertwined with MLRA 154 across the western mid-section of Florida. These two MLRAs differ slightly based on elevation and depth to limestone bedrock. As depth to bedrock decreases, sinkhole formation and the accumulation of surface waters into water bodies increase. MLRA 155 surrounds MLRA 156B, which occurs as a pocket of significantly wetter, low-lying wetland with a

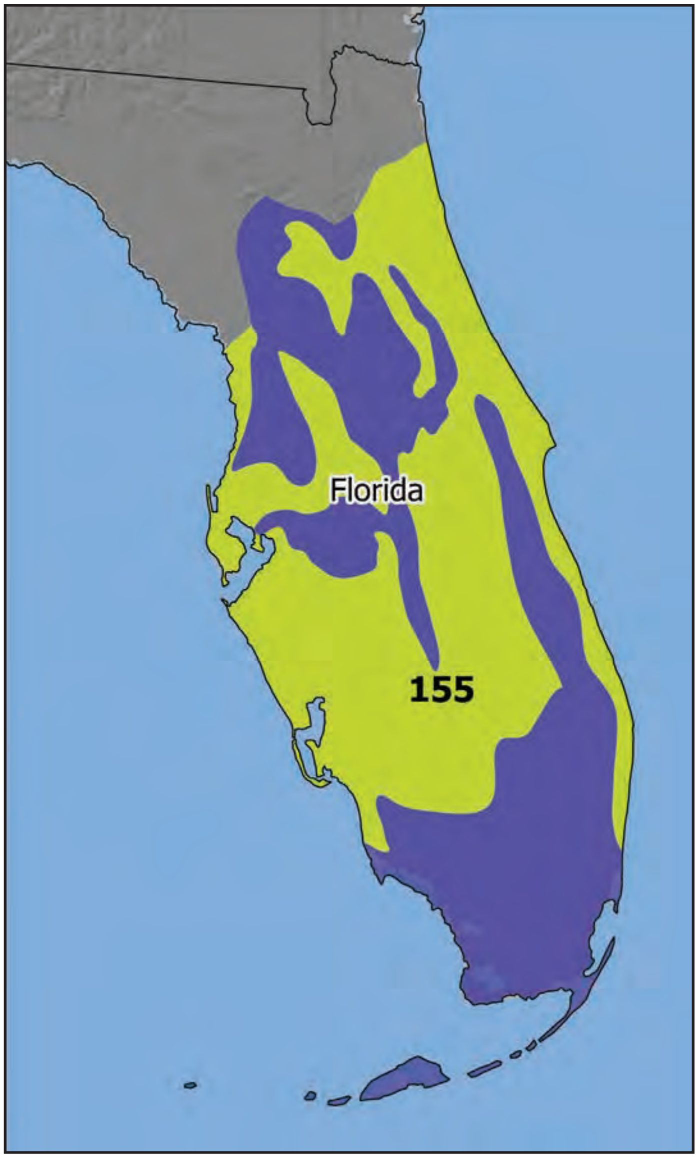

Figure 155-1: Location of MLRA 155, which covers 5,173,100 hectares (12,782,900 acres), within Region U.

diffuse boundary. To the south, MLRA 155 borders MLRA 156A, which has distinctly different use and management and an isohyperthermic soil temperature regime.

Physiography

This area is in the Floridian section of the Coastal Plain province of the Atlantic Plain. The landscape consists of nearly level to gently sloping marine terraces that have large areas of wetlands and marshes. Streams and lakes are common. Low-lying wet areas are flat with some hummocks that rise 3 feet (1 meter) above the general level of the landscape. Coastal areas consist of low beach ridges and dunes that rise 6 to 10 feet (2 to 3 meters) above the lower inland areas. Elevation ranges from sea level to less than 196 feet (60 meters), increasing gradually from the coast to inland areas. The St. Johns, Kissimmee, and Caloosahatchee Rivers are in this MLRA.

Geology

This MLRA is underlain by sediments of the Quaternary Period (present to 2.58 million years ago) which overlie Neogene (2.53 to 23.03 million years ago) and Paleogene (23.03 to 66 million years ago) formations, including those of the Hawthorn Group. The older rocks are exposed in the north-central part of this area. The Quaternary sediments are largely undifferentiated marine deposits consisting of fine to coarse sands that are poorly to moderately sorted with variable admixtures of clay and organic material. Undifferentiated Holocene (present to 0.0117 million years ago) sediments, which include quartz sands, marls, organic material, and minor carbonate sands and mud, are in the northeast part of this MLRA. The sediments may also include freshwater gastropods. Near the southeastern coastline, the Anastasia Formation and Miami Limestone are exposed. The Anastasia Formation is made up of a variably lithified coquina of shells and sands and unlithified fossiliferous sand. The Miami Limestone is white to light gray, variably fossiliferous, oolitic and pelletal with variable percentages of quartz sand, ranging from sandy limestone to calcareous quartz sand (Scott, 1993a, 1993b; Duncan, 1993a, 1993b). Quaternary beach ridge and dune sediments, which are mapped based on topographic expression, occur throughout the MLRA, becoming more abundant toward the coast.

The Cypresshead and Tamiami Formations overlie the formations of the Hawthorn Group. The Cypresshead Formation, which is Pliocene (2.53 to 5.33 million years ago) in age, is a mottled reddish brown and reddish orange to white, unconsolidated to poorly consolidated, fine to very coarse grained, variably clayey to clean quartz sand. It commonly has cross-bedded sands. The MLRA has undifferentiated, reworked sediments of this formation. The Tamiami Formation, which is Late Pliocene to Late Miocene in age (2.6 to 13.06 million years ago), consists of sandy limestones, sands, and marls with variable amounts of phosphate and fossils (Scott, 1993b, 1993c).

The formations of the Hawthorn Group in the MLRA are, from youngest to oldest, the Coosawhatchie Formation, the Peace River Formation, the Tampa Member of the Arcadia Formation, and the Ocala Limestone. The Coosawhatchie Formation is made up of poorly to moderately sorted sandy clay or clayey sand with phosphate grains, limestone, and dolostone. The Peace River Formation is composed of interbedded sands, clays, and carbonates. The sands are generally light gray to olive gray, poorly consolidated, clayey, variably dolomitic, very fine to medium grained, and phosphatic. The phosphate content of the Peace River Formation sands is frequently high enough to be economically mined. The carbonates typically are dolostone in the outcrop area. The dolostone is light gray to yellowish gray, poorly indurated to well indurated, variably sandy and clayey, and phosphatic. These sediments commonly have opaline chert. The Tampa Member consists predominantly of fossiliferous limestone with subordinate dolostone, sand, and clay. The Ocala Limestone was deposited during the Eocene Epoch (33.9 to 56 million years ago) and is the oldest rock formation exposed in Florida. It is a white to cream-colored, fossiliferous limestone that includes chert nodules in some areas. Undifferentiated sediments of the Hawthorn Group in the MLRA consist of poorly to moderately consolidated, clayey to silty sands and relatively pure clays with little or no phosphate (Evans, III et al., 2004; Green et al., 1997, 1999, 2005, 2009, 2011, 2012, 2013, 2014, 2015, 2018; Scott, 1993a, 1993b, 1993e; Williams et al., 2012).

Climate

The average annual precipitation is 38 to 61 inches (973 to 1,559 millimeters). About 60 percent of the precipitation occurs from June through September. Most of the rainfall occurs during moderate-intensity, tropical storms that produce large amounts of rain from late spring through early autumn. Late autumn and winter are relatively dry. The average annual temperature is 69 to 76 degrees F (21 to 24 degrees C). The freeze-free period averages 335 days and ranges from 300 to 365 days.

Water

Rainfall, surface water, and ground water provide an abundance of good water. Canals and ditches control the ground water level for crops and pasture. Excess water is pumped out during the rainy season, and irrigation water is applied during the growing season.

Most of the domestic, municipal, and irrigation water in the area is obtained from wells in the artesian Floridan aquifer, which consists of deep limestone and dolomite beds. This aquifer is one of the most productive sources of ground water in the United States. The water from this aquifer is a calcium-bicarbonate type. It is hard and in some areas has high amounts of total dissolved solids.

A nonartesian aquifer of sand, shells, and limestone occurs in a belt across the southern and central parts of this MLRA and is a source of drinking water. This shallow aquifer provides limited quantities of good-quality water. The water is a calcium-bicarbonate type and hard or very hard. It is highly susceptible to contamination from surface activities.

Soils

The dominant soil orders are Alfisols, Entisols, and Spodosols. The soils in the area dominantly have a hyperthermic temperature regime, an aquic moisture regime, and siliceous mineralogy. They generally are deep or very deep; poorly drained, very poorly drained, or somewhat poorly drained; and sandy or loamy, or both. Anthroportic soils throughout the area are a result of cut-and-fill activities associated with construction and urbanization.

The main soils and their series:

- Alaquods that formed in sandy marine deposits on flats and flood plains and in depressions (Eaugallie, Immokalee, Myakka, Oldsmar, Smyrna, Cassia, and Wabasso series)
- Endoaqualfs that formed in loamy marine sediments on flats and flood plains and in depressions (Holopaw and Malabar series)
- Glossaqualfs that formed in loamy marine sediments on flats and flood plains and in depressions (Pineda series)
- Psammaquents that formed in sandy marine deposits on flats and flood plains and in depressions (Basinger and Valkaria series)

Biological Resources

This area supports flatwood forest vegetation. Slash pine, longleaf pine, loblolly pine, cabbage palm, bald cypress, laurel oak, water oak, and live oak are the main species. Saw palmetto, wax myrtle, gallberry, and grasses such as bluestems, threeawns, maidencane, and wiregrasses characterize the understory.

Major wildlife species include white-tailed deer, feral hog, bobcat, squirrel, snipe, raccoon, skunk, otter, bobwhite quail, woodpecker, and mourning dove. Fish species include black crappie, largemouth bass, bluegill, and catfish.

Land Use

Along the coastline and around the city of Orlando, this MLRA has been heavily urbanized. However, a significant acreage remains in agriculture for the production of citrus, specialty crops, and cattle (fig. 155-2). Surface water runoff from agriculture and urbanization are carefully monitored to help mitigate sinkhole development.

The forestland in this area consists mainly of low-quality pine. It is grazed extensively. More than one-third of the area is improved pasture or native range grazed by cattle. The cropland

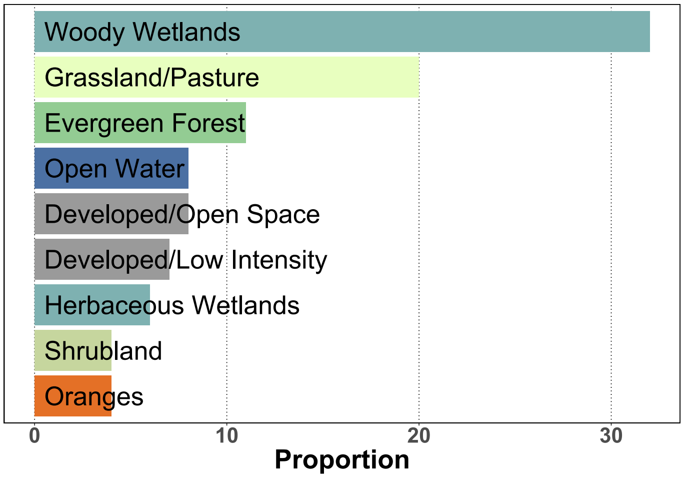

Figure 155-2: Relative proportions (percentages) of land use in MLRA 155.

is reserved for many kinds of winter vegetables. Some citrus fruits are grown. Other subtropical fruits are grown in the southern part of the MLRA.

The major soil resource concerns are wind erosion, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include conservation crop rotations, cover crops, irrigation water management (including micro irrigation systems), nutrient management, and pest management. Conservation practices on pasture and rangeland generally include prescribed grazing, brush management, pest management, prescribed burning, and watering facilities. Conservation practices on forestland generally include forest stand improvement, forest site preparation, prescribed burning, firebreaks, establishment of trees and shrubs, pest management, and management of upland wildlife habitat.

156A—Florida Everglades and Associated Areas

This area (fig. 156A-1) makes up about 7,749 square miles (20,071 square kilometers) and is entirely in Florida. It is located at the southern tip of the State and has shoreline on both the Atlantic Ocean and the Gulf of Mexico. Lake Okeechobee borders the MLRA to the north. Aside from sugar cane plantations in the north, the Everglades National Park, Big Cypress National Preserve, and the Big Cypress Seminole Indian Reservation comprise this area. Historical ditching, berming, and canals prevent natural water flow through this delicate ecosystem. To mitigate this, extensive restoration efforts have been implemented. Urban sprawl from Miami and cities to its north on the Atlantic Ridge has encroached along the eastern boundary of this area. Most of the MLRA has resisted urbanization because of a water table that is at or near the surface, a considerable acreage of unstable organic soils, and its identity as a national treasure.

The boundary between MLRAs 156A and 156B is not apparent and is primarily marked by differing soil temperature regimes. MLRA 156A is isohyperthermic whereas MLRA 156B is hyperthermic. The boundary between MLRAs 156A and 155 is distinct. MLRA 155 has a higher, drier landscape that allows for significantly different use and management.

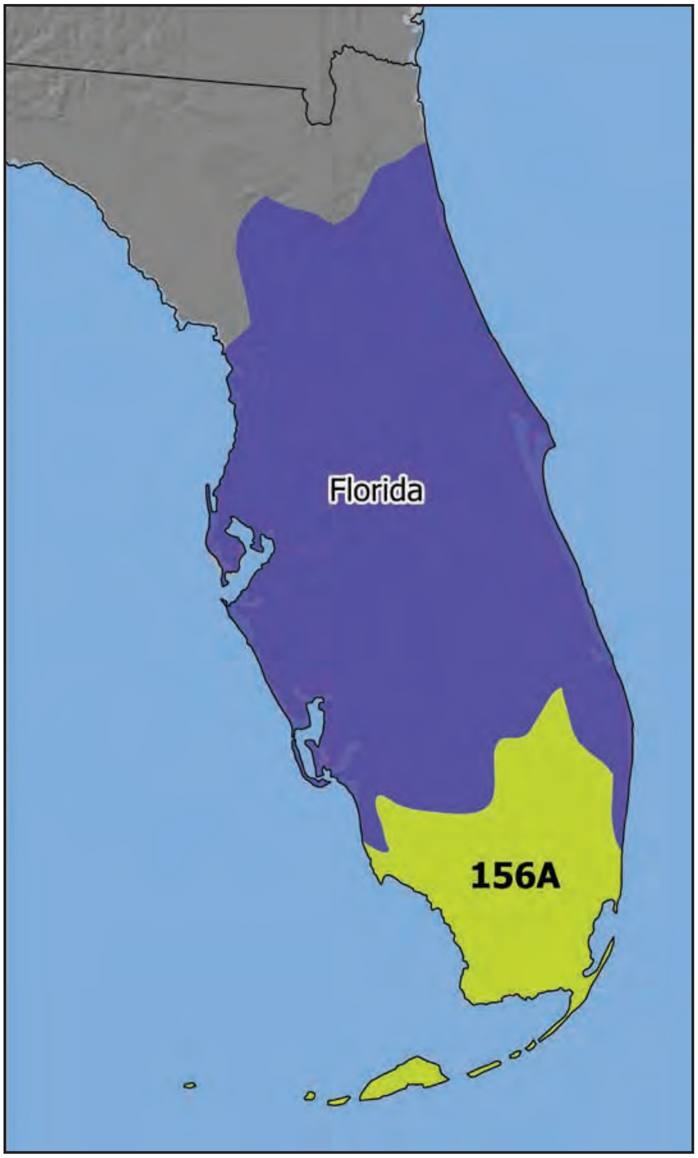

Figure 156A-1: Location of MLRA 156A, which covers 2,007,100 hectares (4,959,500 acres), within Region U.

Physiography

This area is in the Floridian section of the Coastal Plain province of the Atlantic Plain. It is on a level, low coastal plain that has large areas of swamps and marshes. Poorly defined and broad streams, canals, and ditches drain the area to the ocean. Most of the area is flat, but hummocks in the interior rise 3 to 6 feet (1 to 2 meters) above the general level of the landscape and low beach ridges and dunes, mainly in the eastern part of the area, rise 10 to 15 feet (3 to 5 meters) above the adjoining swamps and marshes. Elevation ranges from sea level to less than 26 feet (8 meters). The area has no major rivers, but several canals cross the northern half.

Geology

Most of this MLRA is underlain by sediments and rocks of the Quaternary Period (present to 2.58 million years ago). The area in Palm Beach County and easternmost Hendry County is underlain by undifferentiated Quaternary shell beds, which extend through Broward County into the northern border of Dade County. To the west, the beds follow the western and northern borders of Collier County. The eastern portion of Broward County is underlain by the Miami Limestone. This limestone is white to light gray, variably fossiliferous, oolitic, and pelletal with variable percentages of quartz sand ranging from a sandy limestone to calcareous quartz sand. It extends southward, comprising most of the bedrock in Dade County, and westward, just past the eastern border of Monroe County and the southeast corner of Collier County.

The barrier islands that are east of Biscayne Bay and extend south past Florida Bay are underlain by the Key Largo Limestone. This formation is a white to light gray, highly fossiliferous, coralline limestone consisting of a fossil coral reef facies (Scott, 1993b, 1993e; Duncan, 1993a, 1993b, 1993c, 1993e). The two limestones are overlain by thin soils (Green et al., 1995, 1996). Holocene sediments extend westward along the southern Dade County coastline and underlie the western half of Monroe County (Duncan, 1993e). They consist of quartz sand with minor amounts of organic matter and clay associated with lagoonal deposits and are described as muck and carbonate mud (Green et al., 1995, 1996).

The oldest formation in the MLRA is the Tamiami Formation, which dates to the Neogene Period (2.53 to 23.03 million years ago). It consists of sandy limestones, sands, and clays with variable fossil and phosphate content. The Buckingham marl member contains significant phosphate (Duncan, 1993d). In Collier County, the Tamiami Formation lies between the undifferentiated shell beds to the east and the Holocene sediments to the west along the coastline. It continues to the south, where the undifferentiated shell beds are replaced by the Miami Limestone. It tapers off between the Holocene sediments and the Miami Limestone as it extends southward into Monroe County (Duncan, 1993b, 1993d).

Climate

The average annual precipitation is 37 to 62 inches (950 to 1,565 millimeters). About 60 percent of the precipitation occurs from June through September. The center of the area is the driest. Most of the rainfall occurs during moderate-intensity, tropical storms that produce large amounts of rain from late spring through early autumn. Late autumn and winter are relatively dry. The average annual temperature is 74 to 78 degrees F (23 to 26 degrees C). The freeze-free period averages 355 days and ranges from 345 to 365 days.

Water

Rainfall, surface water, and ground water provide an abundance of quality water. Unless the water level in naturally wet areas is controlled, shallow water covers the surface during much of the rainy season. Canals and ditches control the ground water level for crops and pasture. Excess water is pumped out during the rainy season, and irrigation water is applied during the growing season. Domestic water is obtained mainly from wells in a shallow, nonartesian aquifer of sand, shells, and limestone or from the Biscayne aquifer in the eastern half of the MLRA. The shallow aquifer provides limited quantities of good-quality water. The Biscayne aquifer is a sole source aquifer (the only supply of drinking water) in much of Dade and Broward Counties and parts of Monroe and Palm Beach Counties. It consists of very permeable limestone and has good-quality water. Some high-capacity irrigation wells tap the Biscayne aquifer. All of the ground water is a calcium-bicarbonate type and hard or very hard. The Biscayne aquifer has some saline water issues near the coast. It is also susceptible to contamination from surface activities.

The northern part of the MLRA has abundant surface and ground water of good quality for agriculture. The Floridan aquifer is the primary source of ground water in Brevard County. It consists of deep limestone and dolomite beds. The water in this aquifer is a calcium-bicarbonate type and hard.

Soils

The dominant soil orders are Entisols and Histosols. The soils in the area dominantly have an isohyperthermic temperature regime, an aquic or udic moisture regime, and siliceous or carbonatic mineralogy, or both. They are very shallow to very deep and organic, loamy, or sandy. They are dominantly poorly drained or very poorly drained; minor areas of somewhat poorly drained to moderately well drained soils occur on beach ridges and dunes along the coast. Anthroportic soils throughout the area are a result of cut-and-fill activities associated with construction and urbanization.

The main soils and their series:

- Fluvaquents that formed in marine sediments on flats and in depressions and sloughs (Biscayne and Perrine series)
- Haplosaprists that formed in organic deposits in marshes (Lauderhill series)
- Psammaquents that formed in marine sediments on flats and in depressions and sloughs (Hallandale series)
- Udorthents that formed in residuum on flats (Krome series)

Biological Resources

This area is composed of three broad landscapes: the Atlantic Ridge, the Everglades trough, and the Big Cypress Swamp. These landscapes support many distinctive communities and plants.

The communities and their typical components are:

- Tropical Hardwood Hammocks—poisonwood, gumbo limbo, and pigeon plum
- Pine Rocklands—slash pine, coco plum, and white bully
- Pine Flatwoods—slash pine, gallberry, and saw palmetto
- Dwarf Cypress Savannah—pond cypress, beaksedge, and sawgrass
- Cypress Domes—pond cypress, swamp bay, and buttonbush
- Marl Prairie—pineland croton, threeawn, and hairawn muhly
- Bayhead Swamp—bald cypress, sweet bay, swamp bay, and swamp fern (*Blechnum*)
- Mangrove Swamp—black mangrove, white mangrove, red mangrove, and buttonwood

Sawgrass Marsh—sawgrass, Carolina willow, and Gulf Coast spikerush

Major wildlife species include white-tailed deer, feral hog, snipe, bobcat, raccoon, skunk, otter, squirrel, bobwhite quail, and woodpecker. Alligators, turtles, and wading birds (including wood storks, white ibis, glossy ibis, egrets, and herons) are abundant in the swamps and marshes. Fish species include black drum, red drum, sea trout, sheepshead, snook, tarpon, and largemouth bass.

Land Use

About one-third of this area is in Indian reservations, national parks, game refuges, or other large holdings (fig. 156A-2). Cypress forests are extensive, but mangrove forests are widespread along the eastern and southern coasts. A large part of the area is open marsh. Much of the area is used for hunting, fishing, and other recreational activities.

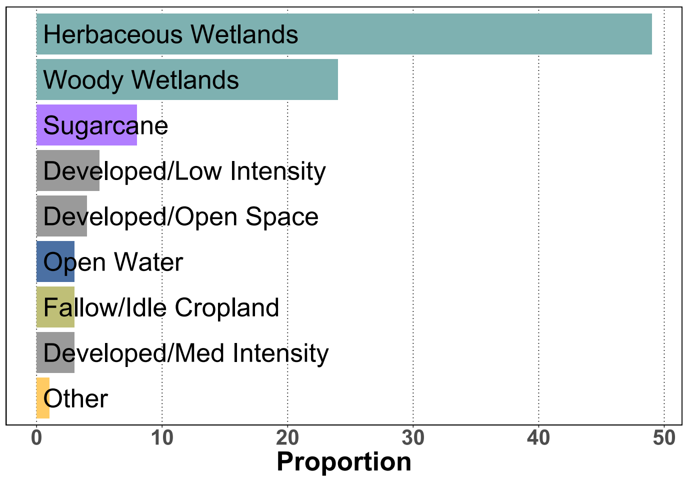

Figure 156A-2: Relative proportions (percentages) of land use in MLRA 156A.

The cropland is used mainly for winter vegetables, but citrus fruits, avocado, and papaya are grown on the better drained soils. Sugarcane is an important crop on the organic soils south of Lake Okeechobee. The acreage of improved pasture is increasing. Beef cattle are the principal livestock, but dairying is an important enterprise locally. Urbanization is extensive along the northeastern edge of this area.

The major soil resource concerns are wind erosion on exposed soil, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture and soil subsidence. Conservation practices on cropland generally include conservation crop rotations, cover crops, nutrient management, pest management, water-control structures, surface drainage systems (field ditches, mains, and laterals), pumping plants, and irrigation water management (including micro, surface, and subsurface irrigation systems). Conservation practices on pasture and rangeland generally include prescribed grazing, brush management, pest management, prescribed burning, and watering facilities. Conservation practices on forestland generally include forest stand improvement, firebreaks, pest management, prescribed burning, and management of upland and wetland wildlife habitat.

156B—Southern Florida Lowlands

This area (fig. 156B-1) makes up about 2,264 square miles (5,864 square kilometers) and is entirely in Florida.

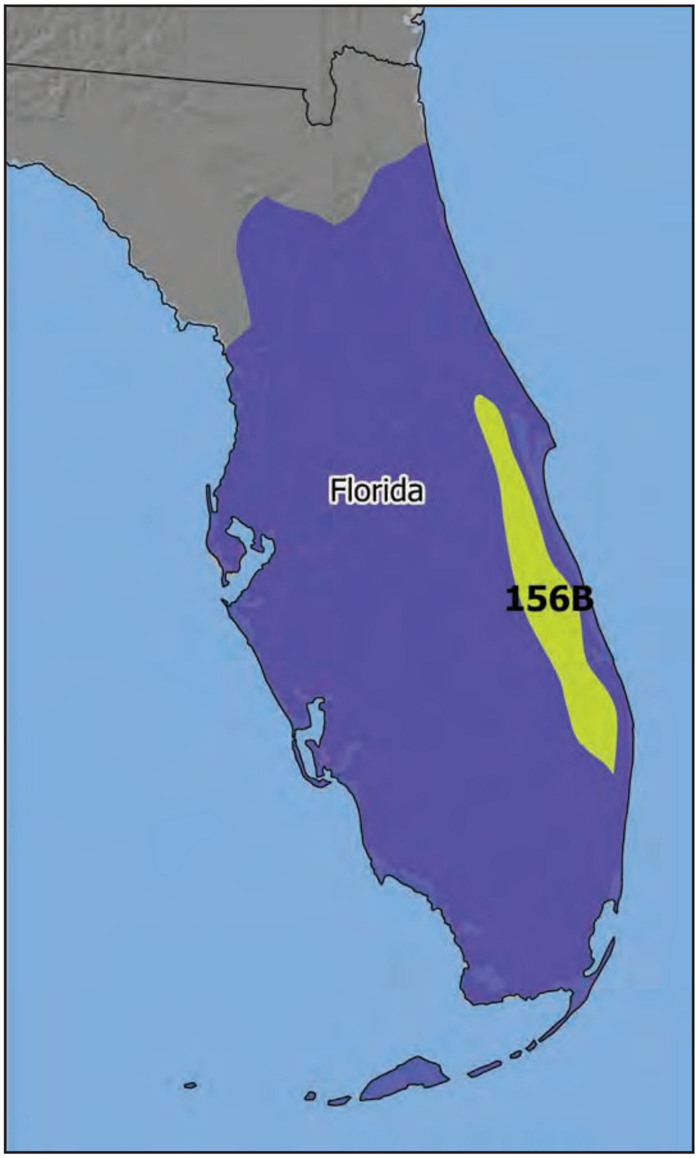

Figure 156B-1: Location of MLRA 156B, which covers 586,400 hectares (1,449,100 acres), within Region U.

It is long and narrow (170 miles by 20 miles) and oriented in a northwest-southeast direction along the Atlantic Coast, extending from the shore inland to Lake Okeechobee. The naturally hummocky landscape serves as the headwaters for both the north-flowing St. Johns River and the Everglades (MLRA 156A) to the south. A significant portion of this area is in agriculture due to an expansive water-control system that drains and irrigates. Urban sprawl from major cities on the Atlantic Ridge has encroached on the eastern boundary of this MLRA. However, the area limits urban growth from the east because of a water table that is at or near the surface and its identity as a national treasure.

The boundary between MLRAs 156B and 156A is not apparent and is primarily marked by differing soil temperature regimes. MLRA 156B is hyperthermic whereas MLRA 156A is isohyperthermic. The boundary between MLRAs 156B and 155 is distinct. MLRA 155 has a higher, drier landscape that allows for significantly different use and management.

Physiography

This area is in the Floridian section of the Coastal Plain province of the Atlantic Plain. It is on nearly level lowlands. A few hummocks rise 3 to 6 feet (1 to 2 meters) above the general level of the landscape. Elevation ranges from near sea level to 26 feet (8 meters).

Geology

This area is underlain by sediments and rocks of the Quaternary Period (present to 2.58 million years ago). The northern portion of the area is underlain by Holocene fluvial and lacustrine sands, clays, marls, and peats along with undifferentiated shell beds (Duncan and Scott, 1993a; Scott, 1992, 1993a, 1993c; Green et al., 2015). The Holocene unit ends just south of the Indian River and the St. Lucie County line. In southern Indian River County, the MLRA expands in width to include the Anastasia Formation. This formation is made up of a variably lithified coquina of shells and sands and unlithified fossiliferous sand (Scott, 1993b; Duncan and Scott, 1993b). The area terminates in eastern Palm Beach County, where it is underlain entirely by the undifferentiated shell beds (Scott, 1993d).

Climate

The average annual precipitation is 49 to 59 inches (1,176 to 1,497 millimeters). About 60 percent of the precipitation occurs from June through September. Most of the rainfall occurs during moderate-intensity, tropical storms that produce large amounts of rain in summer. Spring, fall, and winter are relatively dry. The average annual temperature is 72 to 75 degrees F (22 to 24 degrees C). The freeze-free period averages 360 days and ranges from 360 to 365 days.

Water

Rainfall, surface water, and ground water provide an abundance of quality water. Unless the water level in naturally wet areas is controlled, shallow water covers the surface during much of the rainy season. Canals and ditches control the ground water level for crops and pasture. Excess water is pumped out during the rainy season, and trench or drip irrigation is applied during the growing season.

Domestic water is obtained mainly from wells in a shallow, nonartesian, calcium-bicarbonate-type aquifer. This aquifer provides limited quantities of water that is easily contaminated and hard but generally of good quality. High-capacity irrigation wells are typically drilled down to the artesian Floridan aquifer, which consists of deep limestone and dolomite beds. The water in this aquifer is a calcium-bicarbonate type with high amounts of total dissolved solids. In some areas the artesian water is too salty for direct application on salt-sensitive citrus crops.

Soils

The dominant soil orders in this MLRA are Alfisols, Entisols, and Histosols. The soils in the area dominantly have a hyperthermic temperature regime, an aquic moisture regime, and siliceous mineralogy. They generally are deep or very deep, poorly drained or very poorly drained, and loamy or sandy. Anthroportic soils throughout the area are a result of cut-and-fill activities associated with construction and urbanization.

The main soils and their series:

- Argiaquolls that formed in loamy marine sediments on flats and flood plains and in depressions (Floridana series)
- Glossaqualfs that formed in loamy marine sediments on flats and flood plains and in depressions (Riviera and Canova series)
- Haplohemists that formed in organic deposits in swamps and marshes (Everglades series)
- Haplosaprists that formed in organic deposits in marshes (Terra Ceia series)

Biological Resources

This area is a dominantly wetland ecosystem that has been heavily influenced by human activity. It supports hummock and slough wetland vegetation. Remaining native savanna and scrub areas consist of native grasses, forbs, sedges, and a few scattered pines. Slash pine and cabbage palm are the dominant overstory species. Saw palmetto, cordgrasses, and bluestems make up the understory. Major wildlife species include white-tailed deer, feral hog, gray fox, raccoon, opossum, armadillo, rabbit, tree squirrel, wild turkey, bobwhite quail, mourning dove, Florida mallard, and woodpecker.

Land Use

Water-control systems have allowed extensive agriculture (fig. 156B-2). Citrus and specialty crops are extensively planted in beds between shallow ditches that are part of the water-control system.

The major soil resource concerns are wind erosion on exposed soil, maintenance of the content of organic matter and productivity of the soils, and management of soil moisture. Conservation practices on cropland generally include conservation crop rotations, cover crops, nutrient management, pest management, water-control structures, surface drainage systems (field ditches, mains, and laterals), pumping plants, and irrigation water management (including micro, surface, and subsurface irrigation systems). Conservation practices on pasture and rangeland generally include prescribed grazing, brush management, pest management, prescribed burning, and watering facilities.

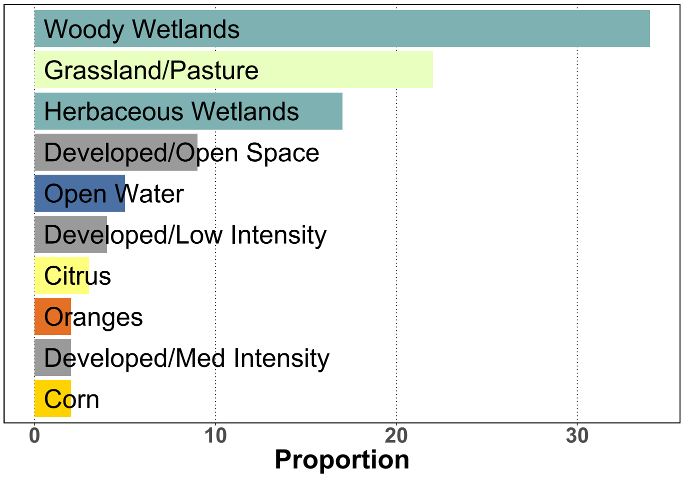

Figure 156B-2: Relative proportions (percentages) of land use in MLRA 156B.

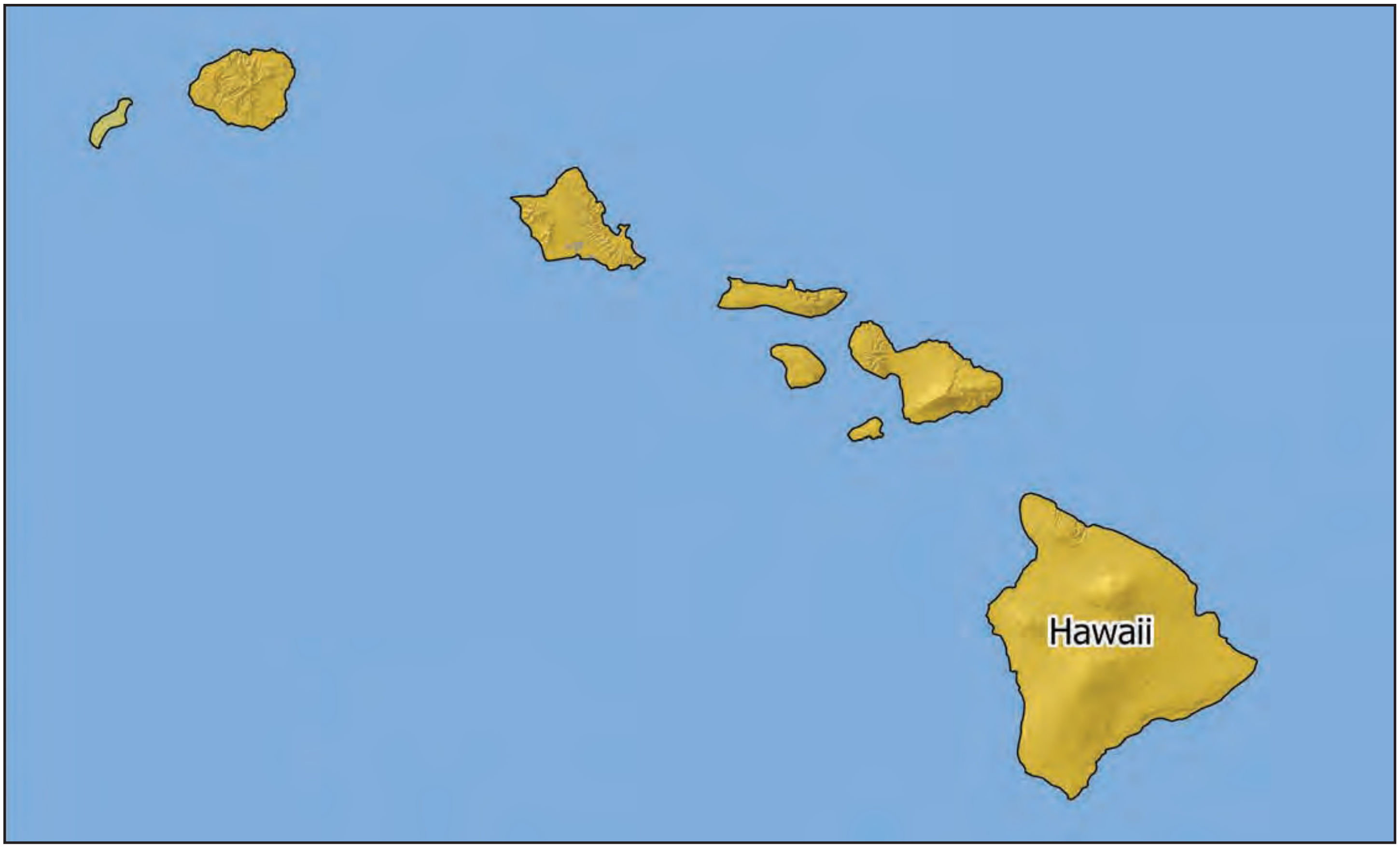

Figure V-1: Location and size of Land Resource Region V, the Hawaiian Islands, which covers 16,655 square kilometers (6,430 square miles), an area about the size of Rhode Island and Connecticut combined.

V—Hawaii Region

Land Resource Region V (fig. V-1) is the north-west-trending chain of eight major basaltic islands in the Pacific Ocean between North America and Asia. These mountainous islands are progressively older to the northwest. They formed as the Pacific tectonic plate moved over a stationary hotspot, which is currently producing the active volcanoes of the Island of Hawaii, the youngest and largest island. These islands consist of coastal plains, upland slopes, mountain ranges, plateaus, and summits. Trade winds blowing from the northeast produce abundant rain on the windward side of the islands, while conditions are semiarid on the leeward side. This rainfall pattern combined with elevations ranging from sea level to greater than 13,000 feet produces a variety of ecosystems and soil types. This region contains 13 major land resource areas. The extent of these MLRAs and their range in elevations are shown in table V-1.

The climate at the lower elevations of the Hawaiian Islands has warm to hot temperatures. Precipitation extremes are typical for each island. The windward (north and northeast) side of the islands receives heavy annual rainfall, especially at higher elevations, mostly from November to March or April, while the leeward side receives less rainfall. The region is subject to kona storms, which come from the leeward side of the islands and provide most of the annual precipitation in many areas. Winters are pleasantly warm. The average annual precipitation ranges from 60 to 220 inches (1,525 to 5,590 millimeters) on the windward side of the islands and from 30 to 60 inches (760 to 1,525 millimeters) on the leeward side. The average annual temperature ranges from 58 to 76 degrees F (14 to 24 degrees C). The freeze-free period is typically 365 days on all of the islands. Freezing temperatures occur annually at the tops of the higher volcanic peaks. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables V-2 and V-3.

Soils in Region V are dominantly Andisols, especially on the younger southeastern islands (fig. 3, page 7). Mollisols, Aridisols, Histosols, Oxisols, and Inceptisols are of lesser extent. The region has a significant area of volcanic rock, which is classified as nonsoil and identified as "Misc. Areas" on figure 3. The dominant suborders are Ustands, Udands, and Ustolls that formed in weathered volcanic ash and basalt

Table V-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
157	715	275	0	0	70	240	450	1,500	970	3,190	1,920	6,320
158	1,420	550	0	0	20	80	140	450	390	1,280	970	3,180
159A	1,385	535	0	0	130	430	630	2,060	1,380	4,540	1,980	6,520
159B	640	245	60	220	410	1,350	1,010	3,330	1,640	5,400	2,120	6,970
160	1,290	500	240	800	890	2,910	1,630	5,360	3,020	9,910	4,200	13,770
161A	4,170	1,610	0	0	100	340	1,800	5,930	3,150	10,340	4,200	13,770
161B	1,025	395	0	0	270	890	910	2,990	1,620	5,310	2,410	7,910
162	1,430	555	0	0	30	110	430	1,430	1,240	4,070	1,940	6,360
163	420	165	0	0	0	0	0	20	60	210	500	1,640
164	1,985	765	0	0	170	550	550	1,800	1,230	4,040	2,700	8,860
165	280	110	0	0	240	790	510	1,700	1,040	3,410	1,280	4,220
166	1,275	490	0	0	10	40	210	700	730	2,410	3,040	9,970
167	610	235	0	0	10	40	150	510	340	1,120	940	3,090

Table V-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set. Dashes indicate data were not available.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
157	13.1	56	17.6	64	20.9	70	23.5	74	24.8	77	---	---	---	---	---
158	17.6	64	21.4	70	23.2	74	24	75	24.5	76	---	---	---	---	---
159A	13	55	15.7	60	19.4	67	22.6	73	24	75	---	---	---	---	---
159B	12.9	55	15	59	17.8	64	21.1	70	23.2	74	---	---	---	---	---
160	3.6	39	8.8	48	14.8	59	17.8	64	22.4	72	---	---	---	---	---
161A	3.6	39	8.2	47	14.3	58	23.1	74	24.9	77	---	---	---	---	---
161B	11.5	53	15.2	59	18.6	65	22.2	72	24.3	76	---	---	---	---	---
162	13.2	56	16.3	61	20.2	68	23.1	74	23.7	75	---	---	---	---	---
163	21.5	71	23.8	75	24.3	76	24.6	76	24.8	77	---	---	---	---	---
164	9.9	50	15.6	60	20	68	22.8	73	24.5	76	---	---	---	---	---
165	14.1	57	15.9	61	20.9	70	22.7	73	24.3	76	---	---	---	---	---
166	8.1	47	18.9	66	22.8	73	24.1	75	24.7	77	---	---	---	---	---
167	17.6	64	21.4	71	22.9	73	24.1	75	24.7	76	---	---	---	---	---

on uplands. Cambids also are common on uplands in the drier areas. Folists are common on wet mountain slopes. Restrictive zones occur in many soil profiles mainly as lithic and paralithic bedrock (fig. 10, page 14). The soils in the region dominantly have an isohyperthermic or isothermic soil temperature regime, an ustic or udic soil moisture regime, and mixed mineralogy.

Land use consists of agriculture and, because of the pleasant climate and the tropical island scenery, recreation for the tourism industry (fig. V-2). Pineapples and coffee are the major exported crops. Macadamia, papaya, and floral products are other important exported crops. Truck crops, mainly tomatoes, cucumbers, head cabbage, lettuce, green peppers, snap beans, and bananas, and specialty crops such as ginger and taro also are important. Cattle ranching is important to the local economy. The forests in the region are used mainly for watershed, wildlife habitat, and recreation. The native vegetation ranges from desert shrubs and grasses to subtropical forest. The most significant resource concern is the invasion of foreign plants and animals. Other concerns include water erosion and nutrient and pesticide runoff and leaching.

Table V-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
157	220	9	345	14	590/610	23/24	903	36	1,590	63
158	330	13	503	20	907/995	36/39	1,603	63	3,550	140
159A	640	26	2,060	81	3,667/3,955	144/156	6,602	260	7,680	302
159B	840	33	1,273	50	1,872/1,855	74/73	2,499	98	2,810	110
160	210	8	527	21	976/1,205	38/47	2,190	86	4,420	174
161A	180	7	392	15	692/910	27/36	1,930	76	3,320	130
161B	370	15	663	26	944/995	37/39	1,431	56	1,760	69
162	1,980	78	2,605	103	3,622/4,010	143/158	5,958	235	7,090	279
163	330	13	488	19	579/635	23/25	922	36	1,760	69
164	650	26	1,479	58	2,948/3,210	116/126	5,275	208	8,970	353
165	600	24	913	36	1,277/1,340	50/53	1,868	74	2,660	105
166	330	13	444	17	640/745	25/29	1,192	47	2,890	113
167	910	36	1,267	50	1,959/2,050	77/81	2,969	117	5,700	224

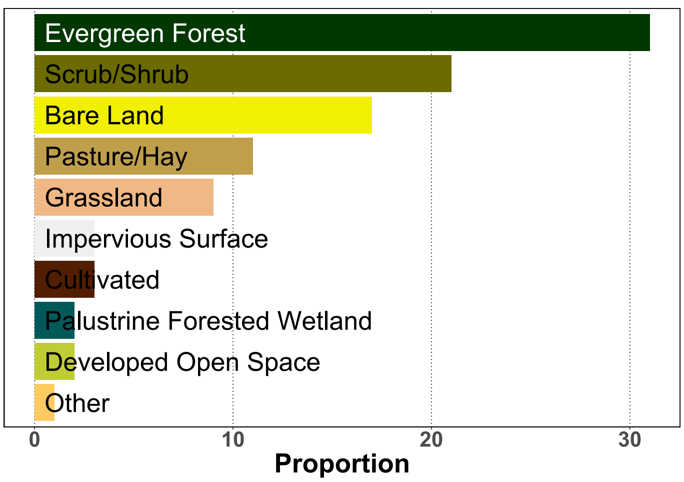

Figure V-2: Relative proportions (percentages) of land use in LRR V.

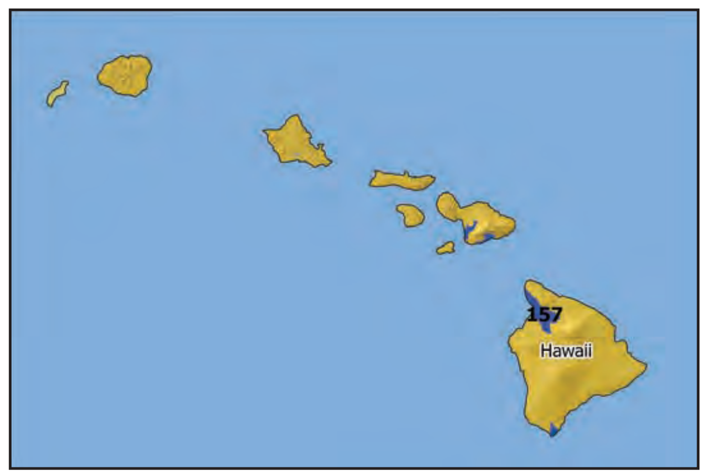

Figure 157-1: Location of MLRA 157, which covers 71,700 hectares (177,100 acres), within Region V.

157—Arid and Semiarid Low Mountain Slopes

MLRA 157 (fig. 157-1) is on shield volcanoes in the Hawaiian Islands. It makes up about 275 square miles (715 square kilometers). It has a distinct boundary where it contacts the lava flows of MLRA 161A. It has a diffuse boundary where it contacts the low mountain slopes of MLRA 158 and the subhumid or humid climate areas of MLRAs 159B and 160.

Physiography

This area is on moderately dissected, gently sloping to steep, leeward mountain slopes on the geologically younger islands of Maui and Hawaii. Elevation ranges from near sea level to 6,000 feet (0 to 1,830 meters). Local relief ranges from 1,500 to 6,000 feet (455 to 1,830 meters). The area has no perennial streams.

Geology

This MLRA is underlain dominantly by \`a\`a (basalt), which is covered by volcanic ash. It has minor areas of weathered andesite and basalt. Olivine sand is mixed with the ash deposits on the south- and east-facing slopes of the coastal uplands.

Climate

The average annual precipitation in most of this area is 10 to 35 inches (255 to 890 millimeters). It can exceed 45 inches (1,145 millimeters) on interior slopes at the higher elevations. Most of the rainfall occurs from October through May. Much of it occurs during kona storms, which occur in winter and usually bring rain for several hours to several days. They are called kona storms because they bring wind from the kona, or leeward, direction on the islands. The average annual temperature is 55 to 76 degrees F (13 to 24 degrees C). The average freeze-free period is 365 days.

Water

The amount of rainfall is not adequate for crop production without irrigation. Because of the lack of perennial streams in this MLRA, water for public supply and almost all irrigation and livestock use is imported into this area from adjacent MLRAs with more plentiful water resources.

All three of the volcanic rock aquifers on the island of Hawaii and the two on Maui are in this area. The ground water away from the Hawaiian coast is of good quality and suitable for almost all uses. Near the coast, however, water quality is lower because of increased levels of salts from the intrusion of seawater. Some rural landowners still use these aquifers for domestic and livestock water, but most of the ground water near the coast is used for irrigation.

Soils

The dominant soil orders are Andisols, Mollisols, and Aridisols. The soils in the area have an isohyperthermic or isothermic temperature regime, an ustic or aridic moisture regime, and dominantly amorphic mineralogy. They generally are moderately deep to very deep, well drained, and loamy. The soils are nonstony to extremely stony. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

The main soil series:

Kamaole series—Haplustolls that formed in material weathered from ash overlying \`a\`a lava on uplands

Kawaihae series—Haplocambids that formed in material weathered from basic volcanic ash over pahoehoe lava, in all hillslope positions of gently sloping to moderately steep ash fields on pahoehoe lava flows 250,000 to 400,000 years old

Oanapuka series—Vitritorrands that formed in material weathered from volcanic ash and cinders over \`a\`a lava on uplands

Pakini series—Haplotorrands that formed in basic volcanic ash, in all hillslope positions of nearly level to very steep lava flows that are greater than 10,000 years old

Puu Pa series—Haplustands that formed in basic volcanic ash in \`a\`a lava, in all hillslope positions of undulating to hilly ash fields and \`a\`a flows that are 65,000 to 250,000 years old

Waikui series—Haplotorrands that formed in basic volcanic ash in \`a\`a lava, on ash fields in summit positions of undulating to hilly \`a\`a flows that are 65,000 to 250,000 years old

Biological Resources

This area is dominated by grass-shrub vegetation. The naturalized vegetation at the lower elevations includes kiawe, Bermudagrass, lantana, fingergrass, and cactus. The native vegetation at the lower elevations includes \`ilima, pili grass, and uhaloa. At the higher elevations, naturalized kikuyugrass, white clover, and rattail grass are common and the native species include the aiea tree, and on Maui, two rare species—ko´oloa ´ula (Chinese lantern) and pua aloalo (delicate yellow hibiscus).

Major wildlife species in the area include introduced game birds, such as pheasant, chukar, dove, and francolin. The upper elevations on Maui are designated as critical habitat for Blackburn’s sphinx moth.

Land Use

Most of this MLRA is rangeland that is grazed primarily during the winter rainy season (fig. 157-2). Forage production is low during the dry summer months, so cattle are usually moved to wetter areas during that part of the year. Irrigated truck crops are grown in small areas at an elevation near 2,000 feet (610 meters). The local climate and soils are suitable for cool-season crops, such as head cabbage, head lettuce, celery, and round onions. Tomatoes are grown throughout the year. Some coastal areas are used for urban or resort development.

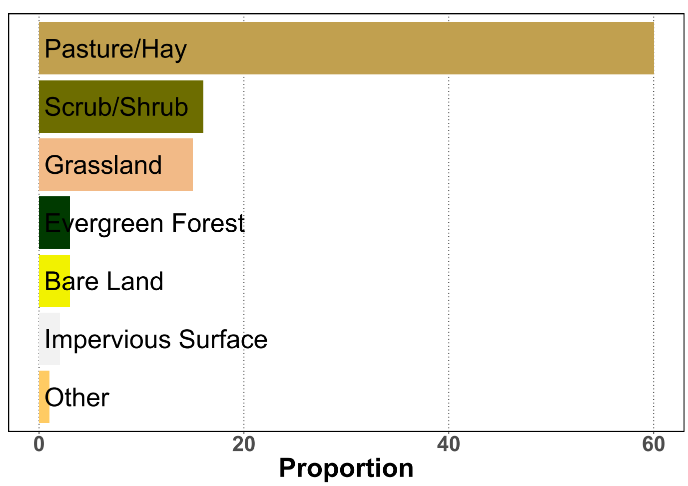

Figure 157-2: Relative proportions (percentages) of land use in MLRA 157.

The major soil resource concerns are water erosion and wind erosion. Conservation practices on rangeland generally include prescribed grazing and brush management. Conservation practices on cropland generally include sprinkler and micro irrigation, windbreaks, crop rotations, contour farming, and nutrient and pest management.

158—Semiarid and Subhumid Low Mountain Slopes

MLRA 158 (fig. 158-1) is on volcanic mountains and shield volcanoes in the Hawaiian Islands. It makes up about 550 square miles (1,420 square kilometers). It has a distinct boundary with MLRA 164, which has highly dissected, steep and very steep mountain slopes. It has a diffuse boundary with MLRA 163, which has alluvial fans and coastal plains; with MLRAs 160 and 167, which have intermediate or high mountain slopes; with MLRAs 157 and 166, which have an arid climate; and with MLRA 159A, which has a humid climate.

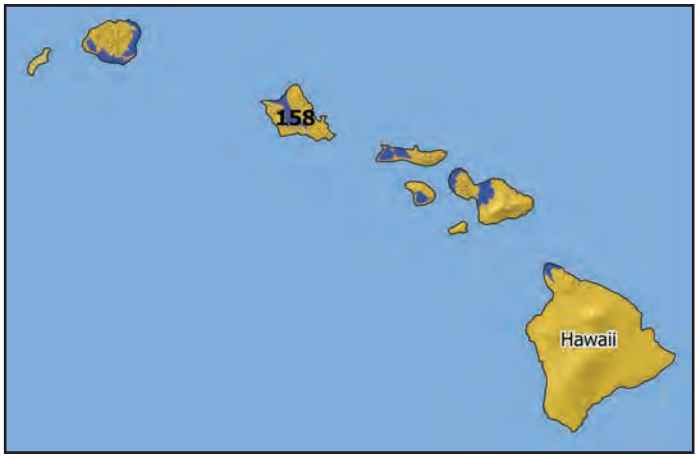

Figure 158-1: Location of MLRA 158, which covers 142,000 hectares (351,100 acres), within Region V.

Physiography

This area primarily lies on the leeward, drier side of the older islands in the Hawaiian Islands chain. It is on nearly level to moderately steep slopes on plains that are dissected in places by gulches. Elevation ranges from near sea level to 1,600 feet (0 to 490 meters). This area has no major rivers but has several perennial streams.

Geology

Most of the surface of this area is covered with highly weathered volcanic ash, which overlies basic igneous rocks. Alluvium derived from basic igneous rocks occurs in some moderately extensive areas of intermediate uplands.

Climate

The average annual precipitation in much of this area is 10 to 30 inches (255 to 760 millimeters). It can exceed 60 inches (1,525 millimeters) on the east and northeast sides of Kauai, in central Oahu, and on the north side of the Big Island. Most of the rainfall occurs from November through March. Much of it occurs during kona storms. The average annual temperature is 69 to 76 degrees F (21 to 24 degrees C). The freeze-free period averages 365 days.

Water

Irrigation is required for the growth of crops in most of this area. Some parts of the MLRA are in high-rainfall (windward) zones on the islands where surface water is plentiful and irrigation is not necessary. Some surface water is trapped in these zones and piped to drier areas for use in irrigation. This MLRA has several perennial streams. The surface water is used primarily for irrigation and for watering livestock. However, on Maui, almost all of the domestic water supply is surface water. The water has good chemical quality, but it typically requires treatment before it can be used as drinking water.

Little surface water is available in the part of this area on Molokai. In the 1960s, when pineapple production was at its height, a tunnel was constructed to bring water from the windward side of the island to the center. The tunnel is still serviceable but currently is not used at full capacity.

Ground water of suitable quality for almost all uses can be obtained from three aquifers on Kauai—the Napali volcanic aquifer, the Koloa and Olokele volcanic aquifer, and the alluvial sediments in the river valleys. The water in the volcanic aquifers is very hard and requires some treatment prior to use for domestic and public supplies.

Good-quality ground water for most uses also can be obtained from three aquifers on Oahu—the Koolau volcanic aquifer, the Waianae and Honolulu volcanic aquifer, and alluvial sediments. The water in the volcanic aquifers is soft, so little treatment is required before it is used as drinking water.

Poor-quality ground water can be obtained from three aquifers on Maui—the Honolua volcanic aquifer, the Kula volcanic aquifer, and the sedimentary material in the isthmus area. The water in the volcanic aquifers is very hard. Because of water-quality concerns, ground water on Kauai and Maui is used primarily for irrigation.

The Kau volcanic rock aquifer on the Big Island has water with the lowest levels of total dissolved solids and the softest water of all the aquifers on all the islands, especially near the center of the island, where recharge occurs. The level of salts in the water may be higher than the median for this aquifer since this MLRA is located on the northwest coast of Hawaii. Pumping tends to increase the level of seawater intrusion into the basal water. Most of the ground water in this area floats as a lens of freshwater on the denser saltwater that occurs at depth in each aquifer. When freshwater is pumped out of the aquifer, the seawater tends to move higher into the aquifer, contaminating the freshwater. Seawater intrusion is most common near the coast, so the ground water may be limited for use as drinking water in this area.

Silica levels in the water from all of the volcanic rock aquifers in the MLRA limit industrial use of the ground water. Silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The dominant soil orders are Oxisols, Mollisols, and Aridisols. The soils in the area have an isohyperthermic temperature regime, an ustic or aridic (torric) moisture regime, and dominantly kaolinitic mineralogy. They generally are very deep, well drained, and very fine textured. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

The main soil series:

Lahaina series—Eutrustox that formed in residuum weathered from basic igneous rock on low-elevation mountain hillslopes

Lihue series—Eutrustox that formed in residuum weathered from basic igneous rock that was influenced by tropospheric dust, on uplands

Makaweli series—Haplustolls that formed in material weathered from basic igneous rock and volcanic ash on uplands

Molokai series—Eutrotorrox that formed in material weathered from basic igneous rock on low-elevation hillslopes

Puhi series—Kandiustox that formed in material weathered from basic igneous rock on uplands

Wahiawa series—Haplustox that formed in residuum and alluvium weathered from basalt on uplands

Biological Resources

Naturalized scrub-shrub and grassland species include koa haole, Bermudagrass, and guineagrass. The native species include `ilima, pili grass, and uhaloa. `Ohai, a rare shrub, grows along the coast of Molokai.

Major wildlife species include non-native game birds, such as francolins and doves. The endangered Hawaiian bat inhabits Maui, Oahu, and Kauai. In areas of reservoirs and wetlands the endangered species include stilts and nene on Maui; stilts, nene, koloa duck, coots, and moorhen on Kauai; and stilts, coots, and moorhen on Oahu. On Kauai, critical habitat has been designated for the endangered cave wolf spider and cave amphipod.

Land Use

Farms and ranches make up nearly all of this MLRA (fig. 158-2). Cultivated areas are used for irrigated sugarcane, pineapples, truck crops, or orchards. In addition, some small areas are used for pasture. Some areas are used for urban development or military installations.

The major soil resource concerns include water erosion, wind erosion, and nutrient and pesticide runoff and leaching. The availability of irrigation water also is a concern. Conservation practices on cropland and grassland generally include nutrient and pest management, crop rotations, crop residue management, windbreaks, and cover crops.

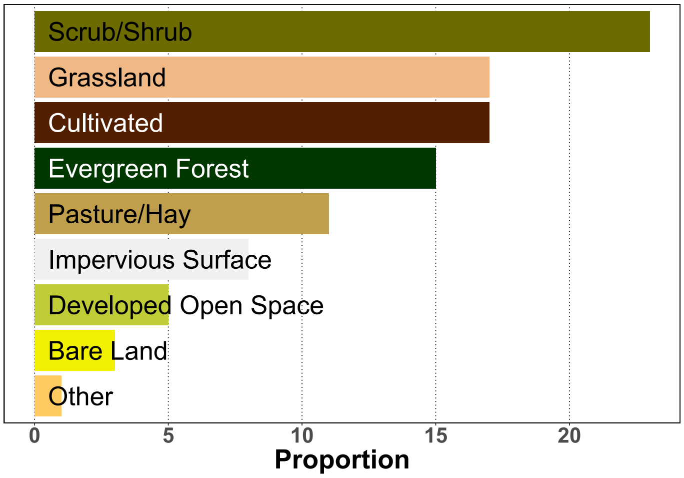

Figure 158-2: Relative proportions (percentages) of land use in MLRA 158.

159A—Humid and Very Humid Volcanic Ash Soils on Low and Intermediate Rolling Mountain Slopes

MLRA 159A (fig. 159A-1) is on Mauna Kea, Mauna Loa, and Haleakala shield volcanoes in the Hawaiian Islands. It makes up about 535 square miles (1,390 square kilometers). It has a distinct boundary with MLRA 164, which has highly dissected steep and very steep mountain slopes. It has a diffuse boundary with MLRA 160, which has high mountain slopes, and with MLRA 157, which has an arid or semiarid climate.

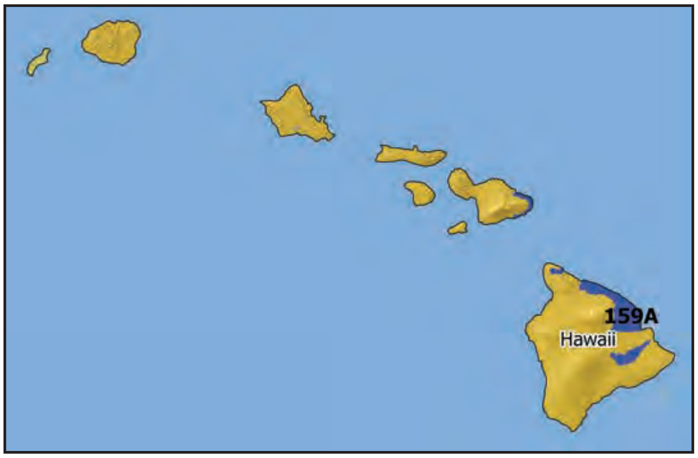

Figure 159A-1: Location of MLRA 159A, which covers 138,700 hectares (342,700 acres), within Region V.

Physiography

This area lies on the windward, wetter side of the islands of Hawaii and Maui. It consists of rolling mountain slopes and steep-sided gulches. Elevation ranges from near sea level to 6,000 feet (0 to 1,830 meters). The MLRA has no major rivers, but a few perennial streams drain the area.

Geology

In most of this MLRA, volcanic ash is underlain by basic igneous rocks. Some areas have volcanic ash over cinders.

Climate

The average annual precipitation in most of this area is 120 to 200 inches (3,050 to 5,080 millimeters). It can be as high as 300 inches (7,620 millimeters) in rainforest zones and as low as 70 inches (1,780 millimeters) in the extreme north and west inland parts of the area. The average annual temperature is 54 to 73 degrees F (12 to 23 degrees C). The freeze-free period averages 365 days.

Water

Almost all of this MLRA is in high-rainfall (windward) areas on the islands, so surface water typically is plentiful and irrigation is not needed. The western part of the Hamakua coast requires supplemental irrigation during the drier season. The MLRA has a few perennial streams but no storage reservoirs or lakes. The surface water is used primarily for irrigation and watering livestock. An exception is surface water on Maui, where it makes up almost all of the domestic water supply. The water typically requires treatment before it can be used as drinking water.

Poor-quality ground water is obtained primarily from the Honolua and Hana volcanic aquifer in the part of this MLRA on Maui. The water is very hard. Since this MLRA is on the coast of Maui, seawater intrusion can be a problem in the volcanic rock aquifer. Because of water-quality problems, the ground water on Maui is used primarily for irrigation.

All three volcanic rock aquifers on the island of Hawaii occur in this area. They include the Kau aquifer; the Puna, Hualalai, Kahuku, and Hamakua aquifer; and the Laupahoehoe and Hawi aquifer. The ground water in the Kau aquifer is soft. It is suitable for almost all uses with little or no treatment. In all of the volcanic rock aquifers, silica levels limit industrial use of the ground water. Silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The dominant soil order is Andisols. The soils in the area have an isothermic or isohyperthermic temperature regime, a udic or perudic moisture regime, and dominantly ferrihydritic mineralogy. They generally are very deep, well drained or moderately well drained, and hydrous.

The main soil series:
- Ainakea series—Hapludands that formed in basic volcanic ash over material weathered from basalt
- Akaka series—Hydrudands that formed in material weathered from volcanic ash on ashfields
- Hilo series—Hydrudands that formed in material weathered from volcanic ash on ashfields
- Honokaa series—Hydrudands that formed in basic volcanic ash on mid-elevation, windward slopes of Mauna Kea
- Kaiwiki series—Hydrudands that formed in material weathered from volcanic ash on ashfields
- Kopua series—Hydrudands that formed in basic volcanic ash over pahoehoe lava
- Ohia series—Hydrudands that formed in material weathered from volcanic ash overlying pahoehoe or `a`a lava; on the lower windward slopes of Mauna Loa
- Ookala series—Hydrudands that formed in basic volcanic ash overlying `a`a lava
- Panaewa series—Hydrudands that formed in material weathered from volcanic ash overlying pahoehoe lava
- Puaulu series—Hapludands that formed in basic volcanic ash deposited over basic lava

Biological Resources

This area supports forest vegetation and naturalized pasture grasses. The naturalized vegetation includes hilograss, California grass, kikuyugrass, and rattail grass as well as eucalyptus and guava. Native forest and remnant patches include `ohi`a lehua, koa, treefern, and uluhe. *Stenogyne scrophulariodes*, a plant species of concern, occurs on the Big Island.

Major wildlife species in the area include invasive feral pigs and mongooses and exotic birds, such as pheasants, chukars, meadowlarks, turkeys, and francolins. Native species on the Big Island include the endangered Hawaiian hawk and the endangered Hawaiian bat. On Maui, the upper elevations around Hana include critical habitat for numerous plant species, including `oha wai.

Land Use

Rangeland and woodland make up most of this MLRA (fig. 159A-2). Some areas are used intensively for orchards, eucalyptus plantations, or cropland. Some small areas are used for ornamentals. Forest reserves are maintained for the protection of rare, threatened, or endangered native plants.

The major resource concerns are water erosion, nutrient and pesticide leaching and runoff, surface compaction, plant disease, and excess moisture. Conservation practices on cropland and rangeland generally include erosion control, nutrient and pest management, and deep tillage.

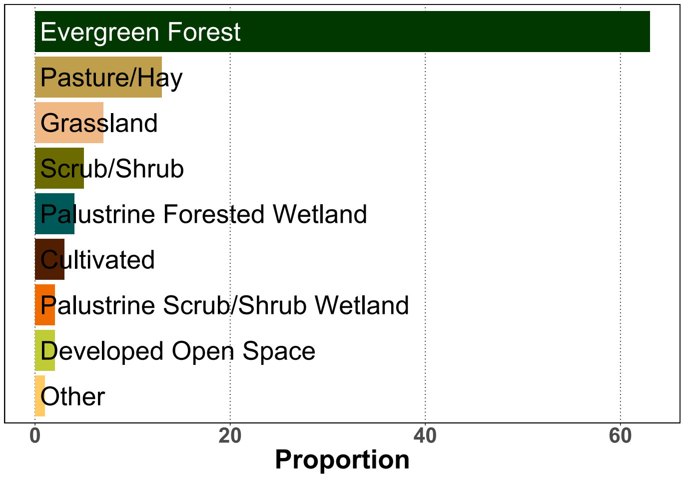

Figure 159A-2: Relative proportions (percentages) of land use in MLRA 159A.

159B—Subhumid and Humid Low and Intermediate Mountain Slopes

MLRA 159B (fig. 159B-1) is in the Kau area, on the Mauna Loa shield volcano on the Island of Hawaii. It makes up about 245 square miles (640 square kilometers). It has a distinct boundary with the lava flows of MLRA 161A. It has a diffuse boundary with MLRA 160, which has high mountain slopes, and with MLRA 157, which has an arid or semiarid climate.

Physiography

This area is on low and intermediate slopes of Mauna Loa. The slopes are moderately dissected and gently sloping to rolling. Elevation ranges from near sea level to 6,000 feet (0 to 1,830 meters). Local relief ranges from 3,000 to 6,000 feet (915 to 1,830 meters).

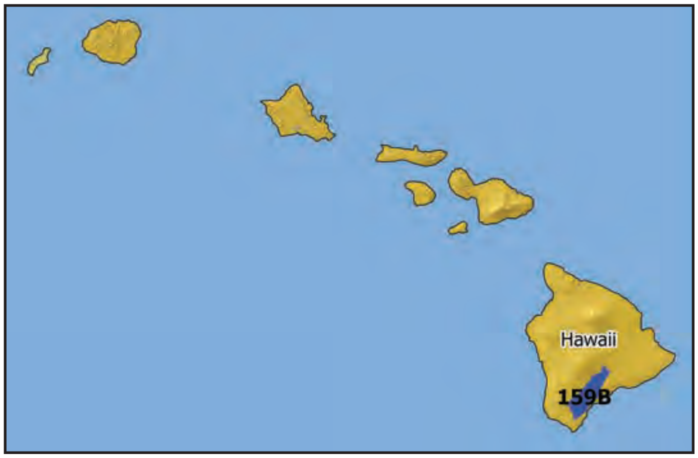

Figure 159B-1: Location of MLRA 159B, which covers 63,800 hectares (157,700 acres), within Region V.

Geology

Basic igneous rocks (basalt) underlie a mantle of basic weathered volcanic ash in this area. There are some alluvial fans. Colluvium, typically a mixture of volcanic ash and cinders, occurs in places.

Climate

The average annual precipitation is 50 to 100 inches (1,270 to 2,540 millimeters). Most of the rainfall occurs from November through March. The average annual temperature is 54 to 73 degrees F (12 to 23 degrees C). The freeze-free period averages 365 days.

Water

The amount of rainfall is generally adequate for crop production without full irrigation, but some small areas of cropland on the less steep slopes are irrigated. The MLRA has few perennial streams. Springs occur in the volcanic rocks. The surface water is typically suitable for irrigation and livestock but not as drinking water.

The Kau volcanic rock aquifer and the Laupahoehoe and Hawi volcanic rock aquifer occur in this area. The Kau volcanic rock aquifer on the Big Island has the lowest levels of total dissolved solids and the softest water of all aquifers on all islands, especially near the center of the island where recharge occurs. The ground water from these aquifers is suitable for almost all uses. Silica levels limit industrial use of the ground water. Silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The soils in this MLRA are mainly Andisols and Histosols. They have an isothermic temperature regime, a udic moisture regime, and euic mineralogy. They are very deep to very shallow, well drained or moderately well drained, and hydrous.

The main soil series:

Akihi series—Hydrudands that formed in basic volcanic ash in \`a\`a lava
Alapai series—Hydrudands that formed in basic volcanic ash
Hilea series—Hydrudands that formed in basic volcanic ash over pahoehoe lava
Honuapo series—Hydrudands that formed in basic volcanic ash over pahoehoe lava
Kuanene series—Hapludands that formed in volcanic ash over pahoehoe lava

Biological Resources

The vegetation consists of rainforest at the upper elevations and mixed trees, shrubs, and grasses at the lower elevations. Naturalized vegetation in the wetter areas includes hilograss, California grass, and guava. Naturalized vegetation in the drier areas includes Christmasberry, guineagrass, Bermudagrass, and Natal redtop. Native forest and remnant patches include `ohi`a lehua, koa, and treefern. Two areas are designated as critical habitat for plant clusters, one consisting of 531 acres (215 hectares) and the other 1,351 acres (545 hectares). Kauila (or kauwila) is one of the keystone endangered plants in these protected areas.

Major wildlife species include feral pigs, mongoose, wild sheep, and exotic game birds. Native wildlife includes the endangered Hawaiian hawk, the endangered Hawaiian bat, and the endangered akepa.

Land Use

Much of the land at the higher elevations is in a forest reserve that provides watershed, habitat, and protection for rare, threatened, and endangered plant species. Most of the land at the lower elevations is rangeland (fig. 159B-2). Some small areas are used intensively for orchards, woodland, or irrigated cropland. A large part of this MLRA was used for nonirrigated sugarcane for about 100 years. Some of the areas once used for sugarcane are now used for cattle ranching, the production of macadamia nuts, trees for biomass, or small truck farms.

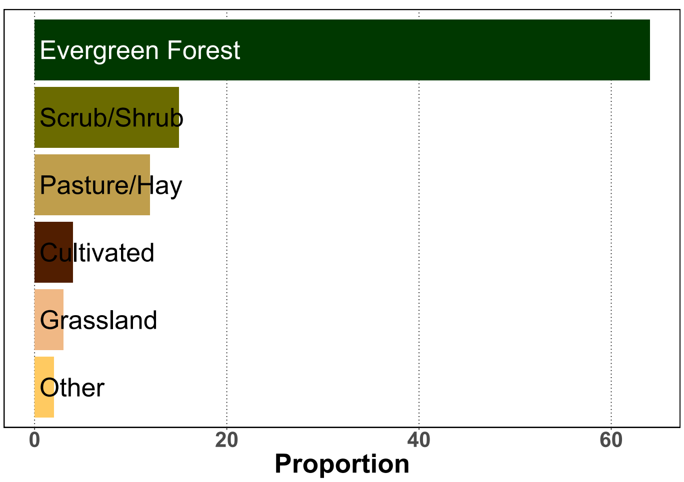

Figure 159B-2: Relative proportions (percentages) of land use in MLRA 159B.

The major resource concerns are water erosion, nutrient and pesticide runoff and leaching, surface compaction, and plant disease. Conservation practices on cropland and rangeland generally include erosion and flood control and deep tillage.

160—Subhumid and Humid Intermediate and High Mountain Slopes

MLRA 160 (fig. 160-1) is on the Mauna Kea and Haleakala shield volcanoes in the Hawaiian Islands. It makes up about 500 square miles (1,290 square kilometers). It has a distinct boundary with MLRA 164, which has highly dissected, very steep mountain slopes, and with MLRA 161A, which has lava flows. It has a diffuse boundary with MLRA 159A, which has intermediate-elevation mountain slopes, and with MLRAs 157 and 158, which have an arid or semiarid climate.

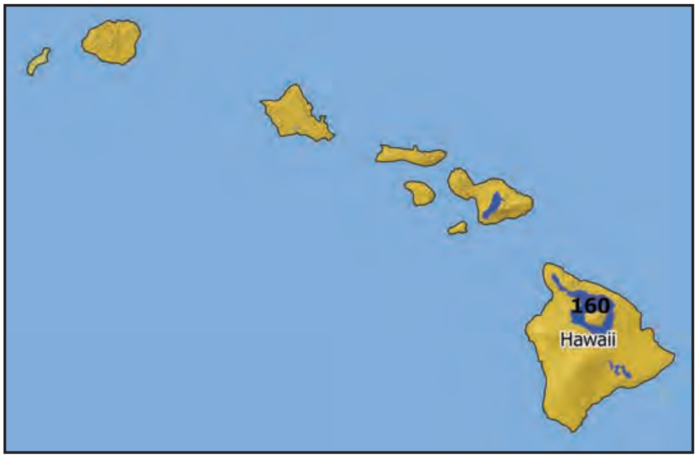

Figure 160-1: Location of MLRA 160, which covers 129,100 hectares (319,000 acres), within Region V.

Physiography

This area is on hilly, intermediate to high slopes of the Mauna Kea, Kohala, and Haleakala Mountains. The topography is gently sloping to hilly, and cinder cones are common. Elevation ranges from 1,000 to 9,000 feet (305 to 2,745 meters). Local relief ranges from 1,000 to 6,000 feet (305 to 1,830 meters).

Geology

Most of this area consists of material weathered from volcanic ash of different ages. At the higher elevations, some areas have common outcrops of `a`a. Some small areas are underlain by andesite or basalt bedrock. Alluvium in the area consists of volcanic sand and gravel.

Climate

The average annual precipitation is 20 to 75 inches (510 to 1,905 millimeters). Most of the rainfall occurs during kona storms from November through March. Some supplemental moisture is derived directly from the clouds that typically occur above 2,000 feet (610 meters). The average annual temperature is 50 to 71 degrees F (10 to 22 degrees C). The freeze-free period averages 365 days.

Water

Some irrigation water is applied in most of the areas used for crops in the MLRA. Much of this water comes from rain catchments with storage tanks, from lined reservoirs, or from sources outside the MLRA. Most domestic and livestock water is from catchments that empty into storage tanks. The headwaters of a few perennial streams are in this area. The surface water is suitable for most uses. Surface water not from catchments requires treatment for use as drinking water.

This MLRA is near drainage divides on Maui and Hawaii. Any ground water at the higher elevations is probably trapped in the subsurface behind or between intrusive dikes. Quantities of available water depend on the geologic structure of a particular area. Poor-quality ground water is obtained from the Honolua and Kula volcanic aquifer in the part of this MLRA on Maui. In other areas where this aquifer occurs, the water is very hard. Because of water-quality concerns, the ground water on Maui is used primarily for irrigation.

The Puna, Hualalai, Kahuku, and Hamakua volcanic rock aquifers and the Laupahoehoe and Hawi volcanic rock aquifer occur in the part of this MLRA on the Big Island. The water in these aquifers typically has low levels of total dissolved solids and is soft. It is suitable for almost all uses with little or no treatment. Silica levels in the water from all of the volcanic rock aquifers limit industrial use of the ground water. Silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The dominant soil order is Andisols. The soils in the area have an isomesic temperature regime, an ustic or udic moisture regime, and dominantly amorphic or ferrihydritic mineralogy. They generally are deep, well drained, and medial in texture. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

The main soil series:

- Kau series—Hydrudands that formed in volcanic ash deposited over \`a\`a lava
- Keamoku series—Hapludands that formed in basic volcanic ashfields deposited on basic \`a\`a lava
- Kemole series—Haplustands that formed in basic volcanic ash in \`a\`a lava
- Lanapohaku series—Ustivitrands that formed in volcanic ash and \`a\`a lava
- Laumaia series—Hapludands that formed in material weathered from volcanic ash
- Palapalai series—Hydrudands that formed from basic volcanic ash over basaltic lava
- Pohakulehu series—Ustivitrands that formed in volcanic ash and \`a\`a lava
- Puu Oo series—Hydrudands that formed in material weathered from volcanic ash
- Umikoa series—Haplustands that formed in basic volcanic ash over \`a\`a lava
- Waimea series—Haplustands that formed in material weathered from volcanic ash underlain by andesite and basalt

Biological Resources

Vegetation consists of temperate grasses, shrubs, and trees. Naturalized vegetation, particularly in the pastured areas, includes Bermudagrass, eucalyptus, gorse, kikuyugrass, Natal redtop, and rattail grass. Native species include koaoha, naio, mamani, pukiawe, a´ali´i, and treefern.

Major naturalized wildlife species include chickens, mongoose, numerous species of game birds, and feral pigs, goats, axis deer (only on Maui), and mouflon sheep (only on the Big Island). Part of the MLRA on the Big Island is designated critical habitat for some rare, threatened, or endangered plants and animals, including the endangered Hawaiian palila, akiapolaau, and Hawaiian hawk. On Maui, the upper elevations include an area designated as critical habitat for Blackburn's sphinx moth.

Land Use

Most of this area is rangeland (fig. 160-2). Some small areas at elevations of 2,000 to 3,000 feet (610 to 915 meters) are used intensively for irrigated truck crops. The local climate and soils at those elevations are suitable for cool-season crops, such as head cabbage, head lettuce, celery, and round onions. The major soil resource concern is water erosion.

Conservation practices on rangeland generally include proper grazing practices and brush management. Conservation practices on cropland generally include irrigation water management, windbreaks, crop rotations, contour farming, nutrient management, and pest management.

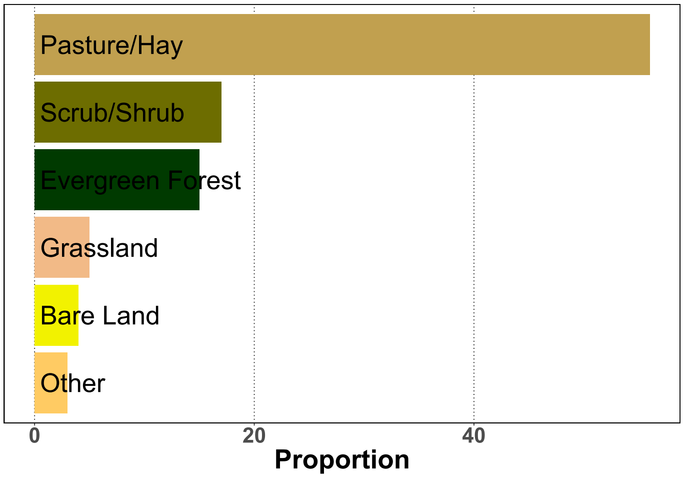

Figure 160-2: Relative proportions (percentages) of land use in MLRA 160.

161A—Lava Flows and Rock Outcrops

This MLRA (fig. 161A-1) makes up about 1,610 square miles (4,170 square kilometers) in the Hawaiian Islands. It has distinct boundaries where it contacts the mineral soils of other MLRAs in the Hawaii Region. It has diffuse boundaries where

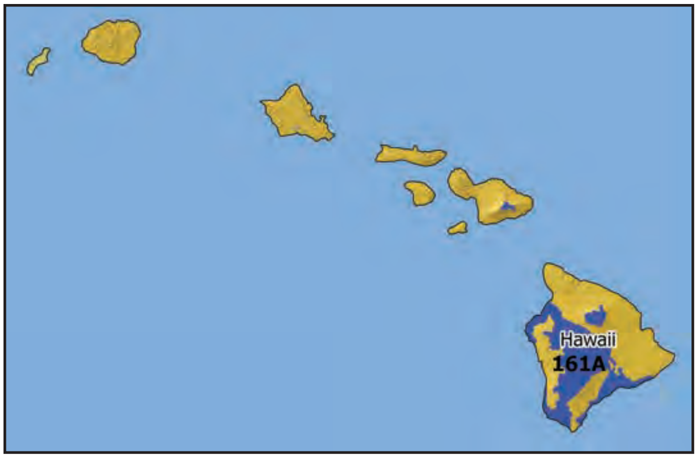

Figure 161A-1: Location of MLRA 161A, which covers 416,700 hectares (1,029,800 acres), within Region V.

it contacts organic soils and lava flows (in MLRAs 161B and 162).

Physiography

This area extends from sea level to the tops of the Mauna Kea, Mauna Loa, Haleakala, Kilauea, and Hualalai Mountains, ranging in elevation to 13,796 feet (0 to 4,206 meters). It is on undulating to hilly, barren lava flows, rocky cliffs, rock outcrops, and steep cinder cones. Mauna Kea is the highest point in Hawaii. Local relief ranges from 3,000 to 13,000 feet (915 to 3,965 meters).

Geology

This area has young \`a\`a and pahoehoe lava that flowed from the top or flanks of shield volcanoes. The surface of the \`a\`a lava is fragmental, jagged, and rough. The surface of the pahoehoe lava is smooth but has many cracks. Cinder cones are near the summits of the volcanoes.

Climate

The average annual precipitation is 10 to 100 inches (255 to 2,540 millimeters), generally increasing with elevation. Most of the rainfall occurs from October through March in most areas and from May through September in the Kona area. The average annual temperature is 38 to 76 degrees F (3 to 25 degrees C). The freeze-free period averages 365 days in most of the MLRA but is shorter at the highest elevations.

Water

Water used in this area is almost entirely surface water. The low rainfall limits agricultural production. Because much of the area is close to the craters of the large volcanoes on Maui and Hawaii, there are few streams. Water for almost all domestic uses and livestock is catchment water stored in tanks. Some resorts and urban areas along the coast of Hawaii rely on imported water from adjacent MLRAs. Very little or no ground water is available for development in this MLRA.

Soils

The dominant soil orders are Andisols and Histosols. The soils in the area have an isohyperthermic to isofrigid temperature regime and an ustic or udic moisture regime. Most of the soils are organic. Mineral soils have medial texture. The MLRA mostly consists of miscellaneous (nonsoil) areas, including lava flows, rock outcrop, and cinder land.

The main soil series:

Pohakulehu series—Ustivitrands that formed in volcanic ash and \`a\`a lava

Biological Resources

Vegetation includes naturalized dryland shrubs and grasses as well as rare dryland tree and shrub communities. It varies considerably, depending on the age of lava flows, rainfall, and elevation. Most areas, including recent lava flows and the tops of volcanoes, have no vegetation or have sparse growth of mosses, lichens, and ferns. The dry areas at low elevations support naturalized plants, such as kiawe, klu, and fountaingrass. The naturalized plants in wet areas include guava and molassesgrass.

Native vegetation in the MLRA includes pili grass, \`i uhaloa, ohia, and pukiawe. The vegetation in much of the area on the Big Island is classified as *Sophora chrysophylla*-bastard sandalwood subalpine dry forest and lovegrass (*Eragrostis atropioides*) subalpine dry alpine vegetation. Two critical habitat areas for multiple plant species have been designated in this MLRA. One consists of about 70,000 acres (28,330 hectares) and the other of about 95,000 acres (38,445 hectares). The protected species include ka\`u silversword in the first area and \`ohai and po´e in the larger area.

Major wildlife species in the area include feral mouflon sheep (on the Big Island) and axis deer (on Maui). Native wildlife includes nene on both islands; the endangered Hawaiian palila, endangered Hawaiian hawk, and endangered Hawaiian bat on the Big Island; and the endangered pueo on Maui. In the area of Pu´u wa´a on the Big Island, critical habitat has been designated for the endangered Blackburn's sphinx moth.

Land Use

Current land uses are dominantly recreation, wildlife habitat, rangeland, and some orchard production (fig. 161A-2). Low-producing grazing land is in the medium rainfall belt. Some coastal areas are used for urban or resort development.

The major resource concerns are wildfire, wind erosion, drought, and flooding. Conservation practices on cropland and rangeland generally include prescribed grazing, firebreaks, and irrigation water management.

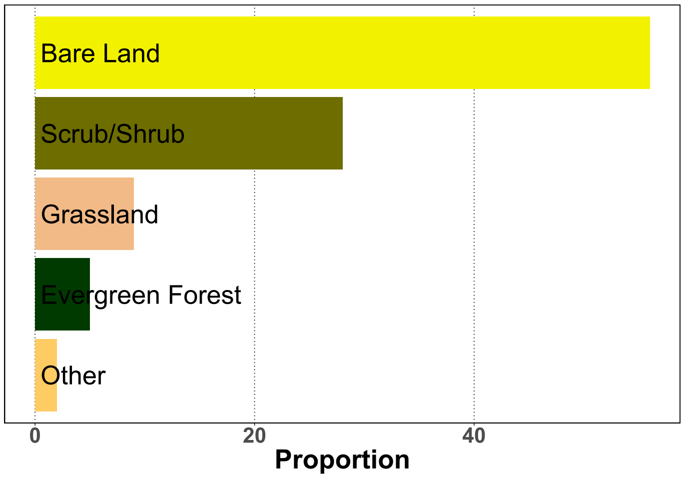

Figure 161A-2: Relative proportions (percentages) of land use in MLRA 161A.

161B—Semiarid and Subhumid Organic Soils on Lava Flows

This MLRA (fig. 161B-1) is on low- to intermediate-elevation, leeward lava flows in the Kona coastal area on the Big Island of Hawaii. It makes up about 385 square miles (1,000 square kilometers). It has a diffuse boundary with the lava flows of MLRA 161A.

Physiography

This area is on the western slopes of the Mauna Loa and Hualalai shield volcanoes. Slopes are undulating to very steep and follow the rugged topography of the lava flows. Elevation ranges from sea level to 6,000 feet (0 to 1,830 meters). Local relief ranges from 50 to 1,000 feet (15 to 305 meters). The MLRA has no perennial streams.

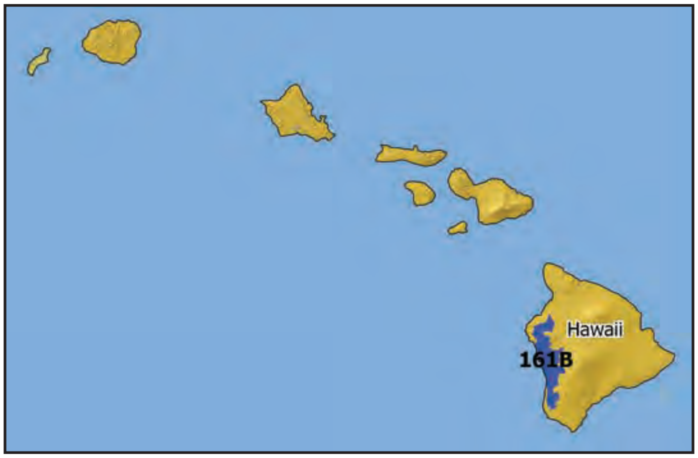

Figure 161B-1: Location of MLRA 161B, which covers 102,500 hectares (253,400 acres), within Region V.

Geology

The surface of this area is dominated by organic material mixed with volcanic ash over \`a\`a and pahoehoe lava.

Climate

The average annual precipitation is 30 to 80 inches (760 to 2,030 millimeters). Most of the rainfall occurs in spring and summer. The average annual temperature is 55 to 75 degrees F (13 to 24 degrees C). The freeze-free period averages 365 days.

Water

This MLRA is a low-rainfall area with no perennial streams. Much of the irrigation water used in the area is imported from adjacent MLRAs. Catchments are used at the higher elevations to trap surface water, which is then piped to lower elevations for livestock use. Much of the public and domestic drinking water supply is distributed through pipelines from a few deep wells.

The Kau volcanic rock aquifer on the Big Island has the lowest levels of total dissolved solids and the softest water of all the aquifers on the islands, especially near the center of the island, where recharge occurs. The level of salts in the water may be higher than the median for this aquifer since much of this MLRA is near the southwestern coast of Hawaii. Pumping tends to increase the level of seawater intrusion into the basal water. Most of the ground water in this area floats as a lens of freshwater on the denser saltwater that occurs at depth in the volcanic rock aquifer. When freshwater is pumped out of the aquifer, the movement of seawater higher into the aquifer can cause contamination. The intrusion of seawater is most common near the coast, so the ground water may be limited for use as drinking water in parts of this area. Away from the coast, the ground water is suitable for almost all uses with little treatment. Silica levels in the volcanic rock aquifer limit the industrial use of the ground water. Silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The dominant soil orders are Histosols and Andisols. The soils in the area have an isohyperthermic to isomesic temperature regime, have an ustic or udic moisture regime, and generally are organic. They are dominantly very shallow to moderately deep and are well drained. Most of the soils are Folists, which are well drained and organic, in areas of \`a\`a or pahoehoe lava. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

The main soil series:

Honuaulu series—Hydrudands that formed in basic volcanic ash in \`a\`a lava

Kamawai series—Haplustands that formed in basic volcanic ash in \`a\`a lava
Kapua series—Ustifolists that formed in organic material mixed with minor amounts of basic volcanic ash in \`a\`a lava
Kekake series—Ustifolists that formed in organic material mixed with minor amounts of basic volcanic ash over pahoehoe lava
Kona series—Udifolists that formed in organic material mixed with minor amounts of basic volcanic ash in \`a\`a lava
Mawae series—Ustifolists that formed in organic material mixed with minor amounts of basic volcanic ash in \`a\`a lava
Napoopoo series—Hydrudands that formed in basic volcanic ash over \`a\`a or pahoehoe lava
Napuu series—Haplustands that formed in basic volcanic ash in \`a\`a lava
Puna series—Udifolists that formed in organic material mixed with minor amounts of basic volcanic ash in \`a\`a lava
Puuiki series—Ustifolists that formed in organic material mixed with basic volcanic ash over pahoehoe lava

Biological Resources

Vegetation consists of shrubs, grasses, and trees. The dominant naturalized vegetation at the lower elevations includes kiawe, Bermudagrass, tobacco tree, fountaingrass, and Natal redtop. A few native herbaceous species, including \`ilima and uhaloa, are dominant. At the high-rainfall, intermediate elevations, naturalized hilograss is interspersed with native ohia and treefern. At the upper elevations, kikuyugrass and rattail grass are the dominant grazed pasture grasses and ohia and koa are the dominant native overstory trees. Five critical habitat areas have been designated within this MLRA for clusters of plants, including haha (both *Cyanea hamatiflora* and *Cyanea stictophylaa*), popolo ku mai, and hau kuahiwi.

Major wildlife species include feral mouflon sheep, feral pigs, and numerous species of game birds. The native wildlife species include the endangered nene, the endangered Hawaiian hawk, and the endangered Hawaiian bat.

Land Use

Most of this MLRA is rangeland, but forest dominates the wetter, higher elevation areas (fig. 161B-2). Coffee, macadamia, avocado, and papaya are grown. Some coastal areas are used for urban or resort development.

The major resource concerns are the irrigation water supply, nutrient and pesticide runoff and leaching, and depletion of soil organic matter. Conservation practices on cropland generally include irrigation water management and nutrient and pest management.

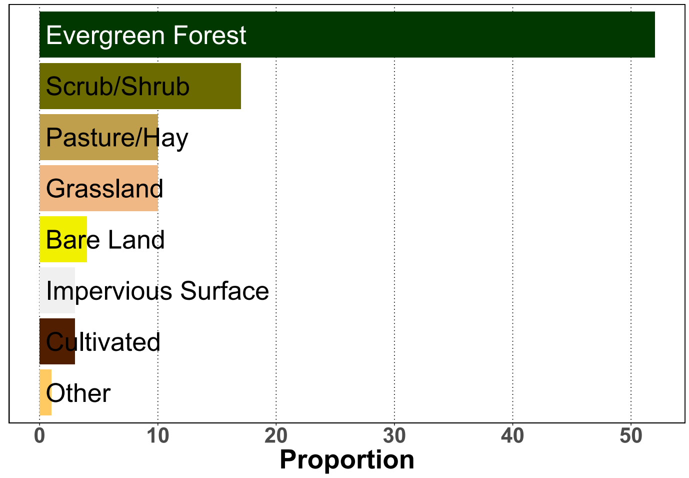

Figure 161B-2: Relative proportions (percentages) of land use in MLRA 161B.

162—Humid and Very Humid Organic Soils on Lava Flows

MLRA 162 (fig. 162-1) is on low- to intermediate-elevation, windward lava flows on the Big Island of Hawaii. It makes up about 550 square miles (1,430 square kilometers). It has a diffuse boundary with the lava flows of MLRA 161A, the high volcanic mountain slopes of MLRA 160, and the humid and very humid climate areas of MLRA 159A.

Physiography

This area is on the southeastern slopes of Mauna Loa and Kilauea. Slopes are undulating to very steep and follow the rugged topography of the lava flows. Elevation ranges from sea level to 4,000 feet (0 to 1,220 meters). Local relief ranges from 20 to 100 feet (6 to 30 meters). The area has numerous streams. The Wailuku River empties into Hilo Bay in this area.

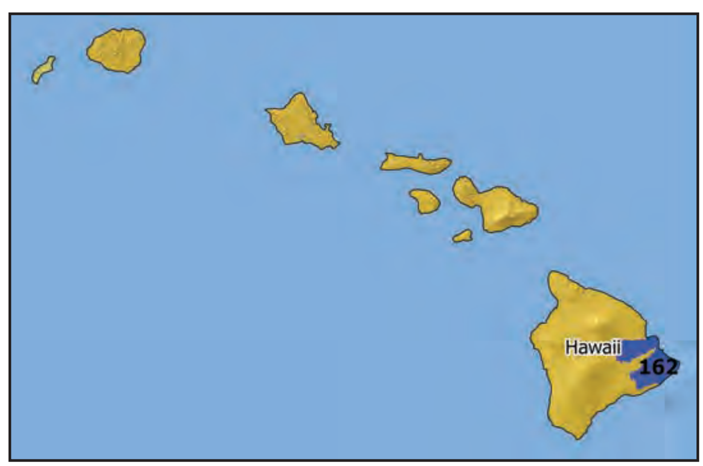

Figure 162-1: Location of MLRA 162, which covers 143,100 hectares (353,800 acres), within Region V.

Geology

This area is covered dominantly by a shallow layer of organic material in or on basaltic `a`a or pahoehoe lava. Volcanic activity has covered some small areas with recent volcanic ash.

Climate

The average annual precipitation is 60 to 235 inches (1,525 to 5,970 millimeters). It is higher in the northern part of the MLRA than in the southern part and increases with elevation. The rainfall occurs from November through April in udic areas and is evenly distributed in perudic areas. The average annual temperature is 54 to 73 degrees F (12 to 23 degrees C). The freeze-free period averages 365 days.

Water

Because of the high amount of rainfall, irrigation is not needed for crop production. The area has several perennial streams. The surface water requires treatment if it is to be used as drinking water.

All three volcanic rock aquifers on the Big Island of Hawaii occur in this area. They include the Kau aquifer; the Puna, Hualalai, Kahuku, and Hamakua aquifer; and the Laupahoehoe and Hawi aquifer. The ground water in the Kau aquifer is soft. In most of the MLRA, this water is suitable for almost all uses with little or no treatment. The level of salts in these aquifers increases near the coast, where the intrusion of seawater can occur if the aquifers are overused. Silica levels in the water from all of the volcanic rock aquifers limit industrial use of the ground water. Silica combines with calcium and magnesium to form a scale that can create problems, especially in boilers and steam turbines.

Soils

The dominant soils in this MLRA are Udifolists that have an isothermic or isohyperthermic temperature regime and a perudic or udic moisture regime. They are shallow over pahoehoe or a layer of `a`a clinkers. The layer of clinkers can extend to a depth of about 3 feet (1 meter). Hard, massive but fractured basalt underlies this layer. In some areas `a`a and pahoehoe lava flows or ash are too young to have obtained enough organic material for the formation of soils.

The main soil series:

Hakuma series—Hydrudands that formed in basic volcanic ash over pahoehoe lava

Keaukaha series—Udifolists that formed in a thin mantle of organic material and small amounts of volcanic ash overlying pahoehoe lava

Keei series—Udifolists that formed in a thin mantle of organic material and small amounts of volcanic ash overlying pahoehoe lava

Kiloa series—Udifolists that formed in organic material over `a`a lava

Opihikao series—Udifolists that formed in a thin mantle of organic material and small amounts of volcanic ash overlying pahoehoe lava

Papai series—Udifolists that formed in organic material over `a`a lava

Biological Resources

This MLRA supports herbaceous plants, shrubs, and trees. Naturalized vegetation includes rose apple tree, African tuliptree, strawberry guava, and banana poka. The vegetation on coastal beaches includes coconut palms, ironwood, and other xerophytic and salt-tolerant plants. Native forests are dominated by ohia. Critical habitat for clusters of plants has been designated in the upper watersheds above Hilo and Saddle Road. The rare or endangered plants in the area include `oha wai (*Clermontia peleana*), haha (*Cyanea platyphylla*), and ha´iwale (*Cyrtandra tintinnabula*).

Major wildlife species include endangered waterfowl in wetlands and streams, such as the Hawaiian stilt, coot, moorhen, and duck. Other endangered species include nene goose, hoary bat, and Hawaiian hawk in pastures, in abandoned areas formerly used for sugarcane, and in unique anchialine pools (pools in marine caves) in lava fields along the coastline. Rare shrimp species also occur in the anchialine pools.

Land Use

Naturalized forest makes up most of this MLRA (fig. 162-2). The forestland is used for grazing, recreation, wildlife habitat, and watershed. Some areas are used for woodland with planted trees or for pasture or orchards.

The major resource concerns are the spread of invasive plant species, depletion of soil organic matter, and contamination caused by fertilizers, pesticides, and rural waste-disposal systems. Conservation practices on cropland and rangeland generally include mulching, crop residue management, and

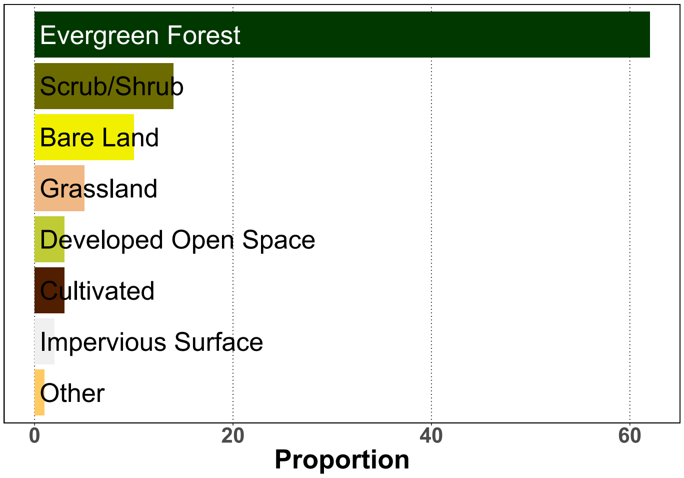

Figure 162-2: Relative proportions (percentages) of land use in MLRA 162.

nutrient and pesticide management. Practices that reduce the extent of invasive species also are important.

163—Alluvial Fans and Coastal Plains

MLRA 163 (fig. 163-1) is on the low-elevation isthmus in the central part of Maui and in coastal areas of older Hawaiian Islands that have been affected by sea-level changes over time. It makes up about 165 square miles (420 square kilometers). It has a distinct boundary with the steep and very steep mountain slopes of MLRA 164 and a diffuse boundary with the low- and intermediate-elevation volcanic mountain slopes in MLRAs 158, 166, and 165.

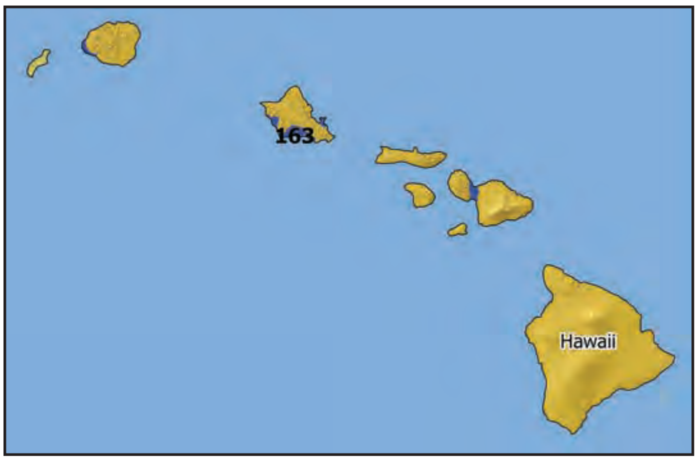

Figure 163-1: Location of MLRA 163, which covers 42,100 hectares (104,200 acres), within Region V.

Physiography

This area is on nearly level and gently sloping coastal plains and the adjacent alluvial fans. Elevation ranges from sea level to 200 feet (0 to 60 meters). Local relief ranges from 50 to 100 feet (15 to 30 meters).

Geology

Alluvial fans and terraces grade into coastal plains throughout this MLRA. Basalt, coral limestone, calcareous sand deposits, volcanic ash, coral sand, and fill lie beneath the unconsolidated sediments. Some small areas on coastal plains are underlain by marly lagoon deposits and marine clays.

Climate

The average annual precipitation is 20 to 30 inches (510 to 760 millimeters). Most of the rainfall occurs from November through March during kona storms that come from the leeward side of the islands. The average annual temperature is 72 to 76 degrees F (22 to 24 degrees C). The freeze-free period averages 365 days.

Water

The amount of rainfall is not adequate for crop production without irrigation. The area has only a few perennial streams. Some surface water is trapped in catchments in the higher and wetter parts of the MLRA and then piped to lower areas, where it is used for watering livestock and irrigation. Some irrigation water is imported from adjacent MLRAs. The surface water generally is not suitable for drinking without treatment.

Most of the water used in this MLRA is ground water, which is better quality than the surface water. Most of the water on Oahu is pumped from alluvial aquifers and the Waianae and Honolulu volcanic rock aquifer. This water typically is moderately hard. Ground water is pumped from sedimentary deposits in the isthmus area of Maui for use in this MLRA. The intrusion of seawater is a potential problem in the aquifers on both Oahu and Maui.

Because of population increases, agricultural land has been converted to urban uses in southern Oahu. The improved drainage system in the urbanized areas carries runoff water away from the recharge areas for the local aquifers. In addition, recharge no longer occurs from the application of irrigation water where agricultural land is developed for urban uses. Because of the lack of recharge and the heavy pumping near the coast, the level of ground water has dropped and the water has become saltier.

Soils

The dominant soil orders are Mollisols, Aridisols, Entisols, and Vertisols. The soils in the area have an isohyperthermic temperature regime, an aquic or arid (torric) moisture regime, and kaolinitic, carbonatic, parasesquic, smectitic, or mixed mineralogy. They are very deep to shallow, excessively drained to poorly drained, and clayey. The MLRA has some miscellaneous (nonsoil) areas.

The main soil series:
- Ewa series—Haplustolls that formed in alluvium weathered from basaltic rock
- Kekaha series—Haplocambids that formed in fine textured alluvium from soils weathered in basic igneous rock
- Lualualei series—Gypsitorrerts that formed in alluvium and colluvium from basalt and volcanic ash
- Mamala series—Haplocambids that formed from alluvium deposited over coral limestone and consolidated calcareous sand
- Puuone series—Torripsamments that formed in material derived from coral seashells

Biological Resources

This area supports herbaceous and shrub vegetation and some trees. The naturalized vegetation consists of fingergrass, kiawe, koa haole, klu, lantana, and Bermudagrass. The vegetation on coastal beaches includes coconut palms, ironwood, and other xerophytic and salt-tolerant plants.

Wetlands support pickleweed, napiergrass, guava, and California grass.

Major native wildlife species inhabiting the wetlands include the endangered stilts, the endangered coot, and the endangered moorhen. The Kaneohe Bay Marine Corps Base on Oahu has a refuge area for the endangered red-footed booby. The naturalized animals in the MLRA include numerous game bird species and chickens.

Land Use

The crops grown in the MLRA include irrigated sugarcane, truck crops, and orchards (fig. 163-2). Some small areas are used for dry-farmed pasture. Some coastal areas are used for resort development. Most of the part of this MLRA on Oahu is in urban areas or military installations.

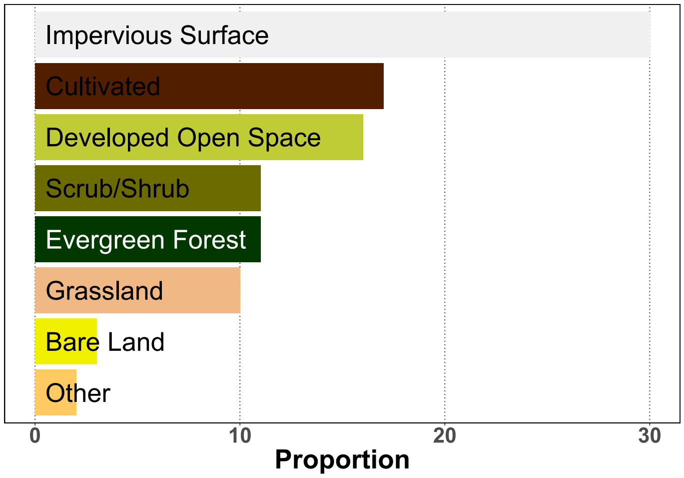

Figure 163-2: Relative proportions (percentages) of land use in MLRA 163.

The major resource concerns are nutrient and pesticide leaching in nearshore environments, invasive plants and animals in wetlands, tillage-induced surface compaction, wind erosion, water erosion, and the supply and efficient use of irrigation water. Conservation practices on cropland and rangeland generally include nutrient and pest management, management of wildlife habitat, proper tillage, subsoiling, properly designed irrigation systems, windbreaks, and cover crops. Urban stormwater management in the heavily urbanized areas and on the military installations helps to protect streams, wetlands, and coastal zones.

164—Humid and Very Humid Steep and Very Steep Mountain Slopes

MLRA 164 (fig. 164-1) is at low to intermediate elevations in the Hawaiian Islands and is highly dissected by gulches and canyons. It makes up about 760 square miles (1,970 square kilometers). It has only a few populated areas. It has a distinct boundary with the arid and semiarid climate areas in MLRAs 158 and 163 and with the rolling volcanic mountain slopes in MLRAs 159A, 160, 165, and 167.

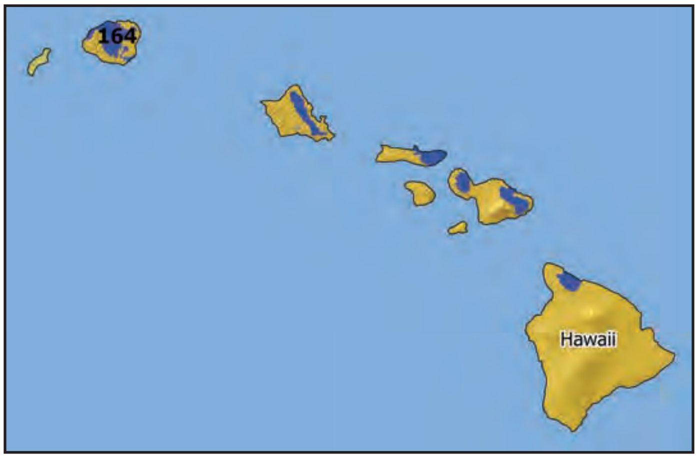

Figure 164-1: Location of MLRA 164, which covers 198,400 hectares (490,400 acres), within Region V.

Physiography

This MLRA consists primarily of the deeply dissected mountainous areas of the older Hawaiian Islands. The topography is steep to precipitous and has many ridges, gulches, and canyons. Plateaus supporting montane bogs occur on Kauai, Molokai, Maui, and Hawaii. Elevation ranges from sea level to 7,000 feet (0 to 2,135 meters). Local relief is mostly 2,000 to 4,000 feet (610 to 1,220 meters).

Geology

This MLRA is underlain by fractured basic igneous rock that is slightly weathered to highly weathered. Most of the bedrock is basalt. Deposits of volcanic ash and tropospheric dust are in some areas. Organic deposits are in wet forests at the higher elevations.

Climate

The average annual precipitation in most of this MLRA is 75 to 250 inches (1,905 to 6,350 millimeters). It can be as low as 30 inches (760 millimeters) in some of the coastal areas below mountains and as much as 450 inches (11,430 millimeters) at the highest elevations. Most of the rainfall occurs from November through April. The average annual temperature is 53 to 75 degrees F (12 to 24 degrees C). The freeze-free period averages 365 days.

Water

All of the water used in this MLRA is surface water. This high-rainfall area has many perennial streams. It is primarily an area of ground water recharge for all of the islands it includes. Most of the water is used for domestic purposes or for watering livestock. Catchments are used to trap water, which is stored in tanks for future use.

Soils

The dominant soil orders are Inceptisols, Andisols, and Spodosols. The soils in the area have an isothermic or isomesic temperature regime, an aquic to ustic moisture regime, and mixed, amorphic, ferrihydritic, or parasesquic mineralogy. They generally are deep, are poorly drained to well drained, and have fine, very fine, medial, and hydrous textures. The soils on plateaus have an organic surface layer. The plateaus have unique montane bogs with perched water caused by an ironstone sheath within the soils. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

The main soil series:

Amalu series—Petraquepts that formed in organic matter over basic volcanic ash and tropospheric dust over residuum weathered from basalt

Honomanu series—Hydrudands that formed in material weathered from volcanic ash overlying fragmented basic igneous rock

Kailua series—Hydrudands that formed in material weathered from volcanic ash overlying basalt

Kehena series—Hydrudands that formed in basic volcanic ash over basaltic lava

Niulii series—Hapludands that formed in material weathered from basic volcanic ash over pahoehoe lava

Biological Resources

This area is dominated by the *Oreobolus furcatus* montane rainforest, which has mixed plant species. Montane bog vegetation is common in the rainforests. The more common plants in the bogs are wet sedges, ohia, na`ena`e (*Dubautia waialealae*), and `uki`uki. This MLRA has numerous areas of critical habitat plant clusters. The rare and endangered plants in the part of the MLRA on Kauai include Domin's club, mapele, heau, *Poa siphonoglossa*, *Alsinidendron viscosum*, and haha (*Cyanea asarifolia*). The plants in the part of the area on Oahu include nanu, alani (*Melicope lydgatei*), `oha (*Delissea subcordata*), `anini or wanini, and nioi. The plants in the part on Molokai include alani (*Melicope reflexa*), haha (*Cyanea grimesiana*), ko`oko`olau, *Lysimachia maxima*, and *Stenogyne bifida*. The plants in the part on Maui include *Pteris lydgatei*, ha`iwale (*Cyrtandra munroi*), `oha wai, and a variety of pauoa and haha species.

Major wildlife species include rare honeycreepers and other native Hawaiian forest birds (particularly on Kauai, which is inhabited by the `Akikiki Kaua´i elepaio, Kaua´i amakihi, `anianiau, and `akeke´e). The endangered animals in this MLRA include Newcomb's snail on Kauai, Blackburn's sphinx moth on Molokai, Oahu elepaio and Oahu tree snails on Oahu, and Achatinellid land snails on Oahu and Maui. The naturalized species include exotic birds, feral pigs, deer, and goats.

Land Use

Most of this area is rangeland (fig. 164-2). Much of the area is naturalized rainforest. The forestland is used mainly for watershed, wildlife habitat, and recreation. Some small areas are used for crops or pasture. The major soil resource concern is water erosion, including mass movement. Conservation practices on forestland include native forest restoration and fencing, which helps to control feral animals.

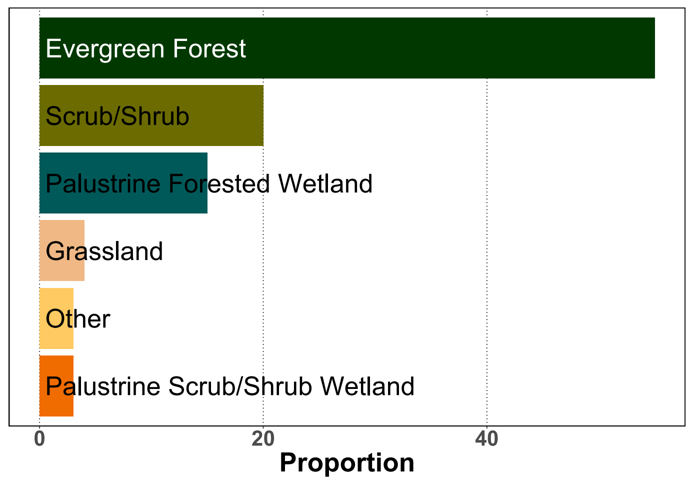

Figure 164-2: Relative proportions (percentages) of land use in MLRA 164.

165—Subhumid Intermediate Mountain Slopes

MLRA 165 (fig. 165-1) is on leeward, volcanic mountain slopes in the Hawaiian Islands and is dissected by gulches. It makes up about 110 square miles (290 square kilometers). It has very few populated areas. It has a distinct boundary with the highly dissected, very steep mountain slopes of MLRA 164. It has a diffuse boundary with the low- and intermediate-elevation, volcanic mountain slopes of MLRA 158.

Physiography

This area is on the leeward, drier, intermediate mountain slopes of the older Hawaiian Islands. Slopes are rolling and are dissected by many steep and very steep gulches. Elevation ranges from 400 to 3,700 feet (120 to 1,130 meters). Local relief ranges from 200 to 1,800 feet (60 to 550 meters).

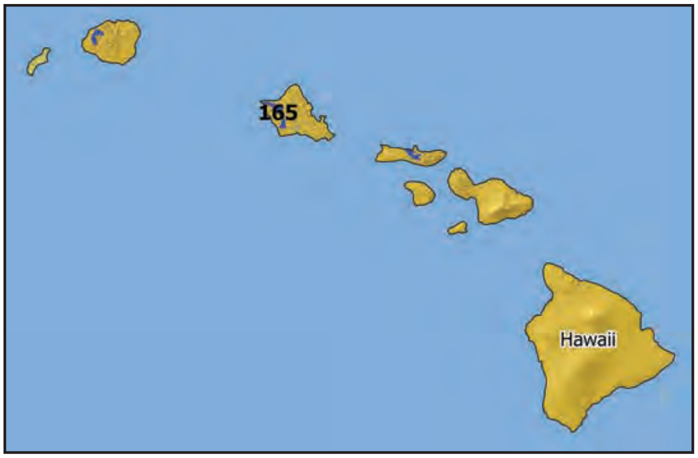

Figure 165-1: Location of MLRA 165, which covers 28,000 hectares (69,400 acres), within Region V.

Geology

This area is dominated by basic igneous rock (primarily basalt). Interfluves are influenced by volcanic ash.

Climate

The average annual precipitation is 25 to 60 inches (635 to 1,525 millimeters). Most of the rainfall occurs from November through March. The average annual temperature is 61 to 74 degrees F (16 to 23 degrees C). The freeze-free period averages 365 days.

Water

The amount of rainfall is not adequate for crop production without irrigation. The streams that feed the Waimea River, the only perennial stream on Kauai, originate in this area. Water for almost all irrigation and livestock use is imported.

The Napali volcanic rock aquifer on Kauai and the Waianae and Honolulu volcanic rock aquifer on Oahu provide good-quality ground water suitable for almost all uses. Rural landowners use these aquifers for domestic and livestock water and for irrigation water. Some public supplies also are obtained from these aquifers.

Soils

The dominant soil orders are Inceptisols, Ultisols, Oxisols, Andisols, and Spodosols. The soils in the area have an isothermic temperature regime, a udic or ustic moisture regime, and parasesquic, ferrihydritic, or mixed mineralogy. They generally are deep, well drained, and fine textured or very fine textured. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

The main soil series:

- Kemoo series—Paleustolls that formed in material weathered from basalt
- Kokee series—Hapludands that formed in material weathered from basic igneous rock
- Mahana series—Haplustox that formed in material weathered from volcanic ash
- Oli series—Haplustands that formed from volcanic ash over residuum from andesite
- Puu Opae series—Palehumults that formed in material weathered from basic igneous rock

Biological Resources

This MLRA supports forest, grassland, and scrub-shrub vegetation. The naturalized vegetation in the areas with lower rainfall includes kiawe, koa haole, klu, lantana, and Bermudagrass. Ohia, treefern, and uluhe dominate the mesic to wet areas. Numerous critical habitat plant clusters occur on each island. On Kauai, the endangered plants that receive special protection include *Abutilon sandwicense*, alani (*Melicope pallida*), *Schiedea hookeri*, different species of haha, and aiea (*Nothocestrum peltatum*). On Oahu, they include kulu´i, nioi, Ma`o hau hele (native yellow hibiscus), *Abutilon sandwicense*, alani (*Melicope pallida*), and various *Schiedea* species. The plants on Molokai include *Mariscus fauriei*, various *Schiedea* species, and *Silene alexandri*.

Naturalized wildlife species include feral pigs, goats, chickens, and game birds. Endangered wildlife species include Blackburn’s sphinx moth, which has designated critical habitat in the part of the MLRA on Molokai. The hoary bat, Oahu tree snail, and Amastid land snail are endangered species in the part of the MLRA on Kauai.

Land Use

Forest and rangeland make up nearly all of this MLRA (fig. 165-2). Most of the MLRA is used as watershed for adjacent MLRAs. Some small areas are used for irrigated coffee or pineapple crops.

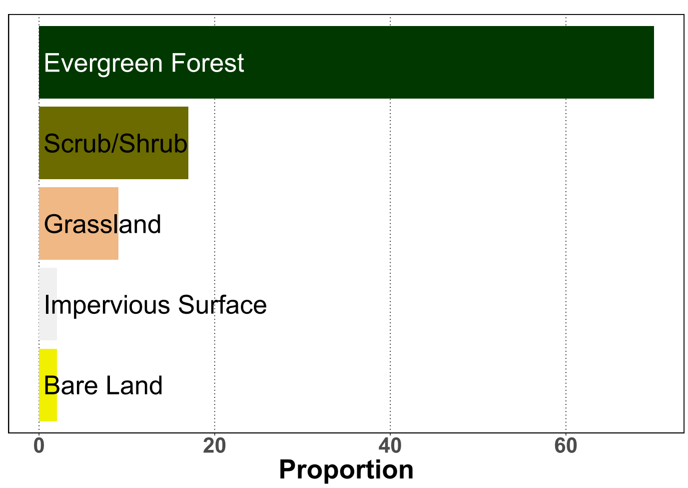

Figure 165-2: Relative proportions (percentages) of land use in MLRA 165.

The major resource concerns are invasive species, feral animals, and water erosion. Conservation practices important to the area generally include restoration of native wildlife habitat, erosion control, and fencing, which helps to control feral animals.

166—Very Stony Land and Rock Land

MLRA 166 (fig. 166-1) is on arid and semiarid, low- to high-elevation, volcanic mountain slopes on the older Hawaiian Islands. It makes up about 490 square miles (1,275 square kilometers). It has diffuse boundaries where it borders MLRAs 158, 163, 164, and 165.

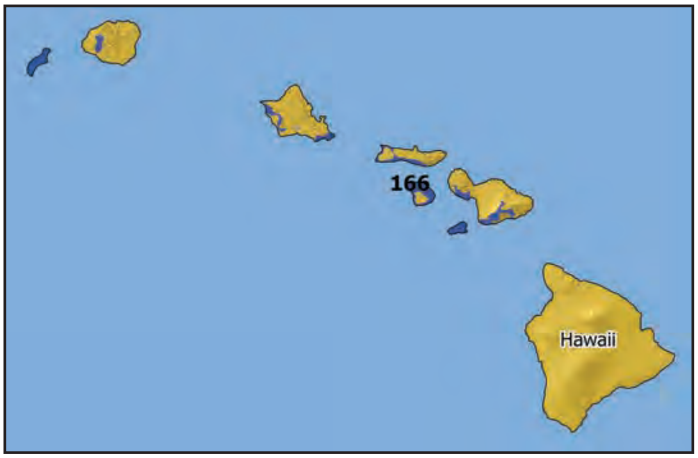

Figure 166-1: Location of MLRA 166, which covers 127,400 hectares (315,000 acres), within Region V.

Physiography

This MLRA encompasses the stony complex slopes and rocky gulches in the arid and semiarid areas of the older Hawaiian Islands. Elevation ranges from sea level to 8,000 feet (0 to 2,440 meters). Local relief ranges from 200 to 2,000 feet (60 to 610 meters). The Waimea River, the only perennial stream on Kauai, is in this MLRA.

Geology

This MLRA is covered by extrusive basic igneous rocks (primarily basalt) that are weathered in some areas. Some interfluves are mantled with weathered volcanic ash.

Climate

The average annual precipitation is 10 to 60 inches (255 to 1,525 millimeters). Most of the rainfall occurs from November through March. Much of it occurs during kona storms. The average annual temperature is 50 to 76 degrees F (10 to 24 degrees C). The freeze-free period averages 365 days.

Water

The amount of rainfall is not adequate for crop production without irrigation. The only perennial stream on Kauai, the Waimea River, is in this area. Water for almost all irrigation and livestock use is imported.

Almost all of the water used in this area is for domestic, public, municipal, or industrial supplies. This water comes from volcanic rock aquifers. All of the volcanic rock and alluvial or sedimentary aquifers on Kauai, Oahu, Molokai, Maui, and the minor islands occur in this MLRA. Some rural landowners use these aquifers for domestic and livestock water and some limited irrigation, but most of the ground water is used for public supply or for municipal or industrial purposes.

Soils

The dominant soil orders are Aridisols, Mollisols, and Entisols. The soils in the area have an isohyperthermic temperature regime, an aridic or ustic moisture regime, and dominantly mixed mineralogy. They dominantly are shallow, well drained, and clayey. They formed in material weathered from basic igneous rocks. The MLRA has a significant acreage of miscellaneous (nonsoil) areas. Rock outcrops or stones cover the surface of about 40 to 50 percent of the MLRA.

The main soil series:

- Lualualei series—Gypsitorrerts that formed in alluvium and colluvium from basalt and volcanic ash
- Makaweli series—Haplustolls that formed in material weathered from basic igneous rock and volcanic ash
- Waiawa series—Haplocambids that formed in colluvium and material weathered from basic igneous rocks

Biological Resources

The lower elevations of all the islands in this MLRA support naturalized grass and scrub-shrub vegetation. This vegetation includes Christmasberry, guineagrass, Bermudagrass, and Natal redtop. Many areas are designated as critical habitat for endangered plants. Critical area plant clusters include *Panicum beecheyi*, *Schiedea spergulina*, \`akoko (*Chamaesyce halemanui*), nehe (*Lipochaeta faurei*), kaula, and *Gouania meyerii* on Kauai; kio´ele, *Bonamia menziesii*, \`awiwi, \`anaunau, and *Silene lanceolata* on Oahu; Wahine noho kula, \`ohai, and ma\`o hau hele on Molokai; *Tetramolopium remyi*, ma\`o hau hele, and \`ohai on Lanai; and ko\`oko\`olau (*Bidens micrantha* spp. *kalealaha*), *Bobea sandwicensis*, *Bonamia menziesii*, and a´e (*Zanthoxylum hawaiiense*) on Maui.

Naturalized game birds, feral pigs, deer, and goats inhabit this MLRA. Many pelagic bird species, such as the Laysan albatross, shearwaters, and petrels, are along the coast and on nearby islets. Major endangered wildlife species include pueo and hoary bat on Oahu and Blackburn's sphinx moth and nene on Maui.

Land Use

Most of this MLRA is used for rangeland, watershed, and wildlife habitat (fig. 166-2). More than one-fifth of the area is forestland. A small acreage is used for urban development.

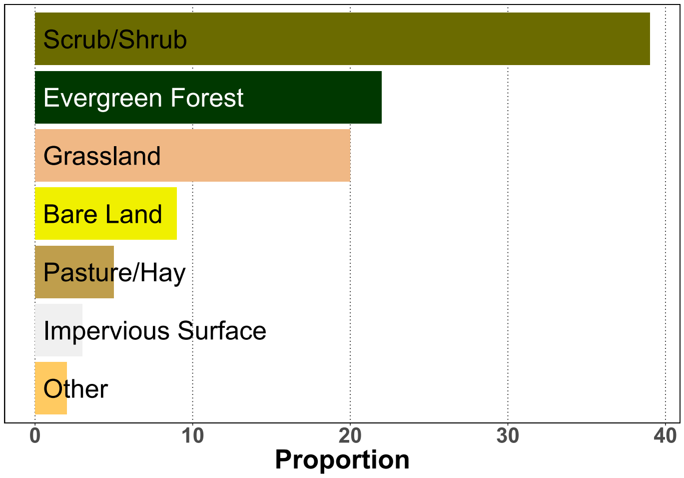

Figure 166-2: Relative proportions (percentages) of land use in MLRA 166.

The major resource concerns are control of flooding, fire, wind erosion, water erosion, and feral animals and restoration of native plant species. Conservation practices on rangeland generally include prescribed grazing, fencing, watering facilities, and firebreaks.

167—Humid Oxidic Soils on Low and Intermediate Rolling Mountain Slopes

MLRA 167 (fig. 167-1) consists of humid oxidic soils on low and intermediate, rolling, volcanic mountain slopes in the Hawaiian Islands. It makes up about 230 square miles (595 square kilometers). It has a distinct boundary with the highly dissected, very steep mountain slopes of MLRA 164. It has a diffuse boundary with the high-elevation mountain slopes of MLRA 160 and the arid and semiarid climate areas in MLRAs 158 and 163.

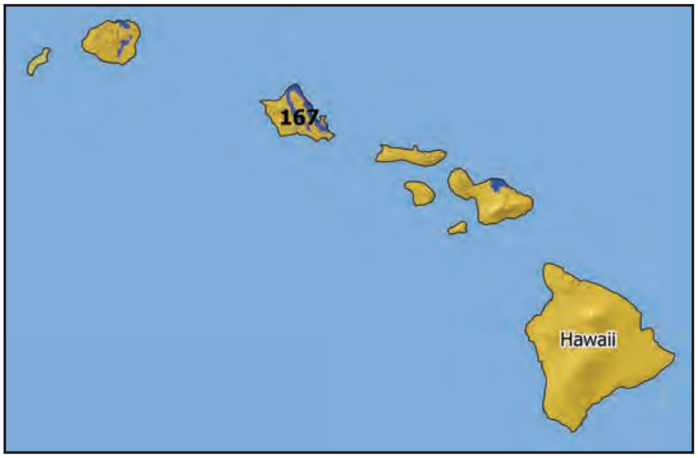

Figure 167-1: Location of MLRA 167, which covers 61,000 hectares (150,800 acres), within Region V.

Physiography

This MLRA is dominantly on windward, low and intermediate mountain and hill slopes of the older Hawaiian Islands. Many steep and very steep gulches dissect the rolling mountain slopes. Elevation ranges from sea level to 2,000 feet (0 to 610 meters). Local relief ranges from 100 to 700 feet (30 to 215 meters). The headwaters of many streams occur in this MLRA.

Geology

This MLRA is covered dominantly by highly weathered ash and basic igneous rock. Alluvial sediments occur on bottom lands and low terraces along streams. In some small areas, the dominant geology is influenced by tropospheric dust.

Climate

The average annual precipitation is 35 to 120 inches (890 to 3,050 millimeters). It increases with elevation. Most of the rainfall occurs from November through April. The average annual temperature is 66 to 76 degrees F (19 to 24 degrees C). The freeze-free period averages 365 days.

Water

The amount of rainfall is not adequate for crop production without irrigation. The MLRA has a few perennial streams but no natural storage areas for surface runoff. Rural landowners use the surface water only for livestock and some irrigation because of contamination.

Almost all of the water used in this MLRA is for domestic, public, municipal, and industrial supplies. Ground water of suitable quality for almost all uses on Kauai can be obtained from the Koloa and Olokele volcanic aquifer and the sedimentary rocks. The water in the volcanic aquifer is very hard and requires some treatment prior to use for domestic and public supplies. Good-quality ground water for most uses can be obtained from the Koolau volcanic aquifer, alluvial sediments, and sedimentary rocks on Oahu. The water in the volcanic aquifers is soft, so little treatment is required before the water can be used as drinking water. Poor-quality ground water can be obtained from the Kula volcanic aquifer on Maui. This water is very hard. Because of the poor water quality, the ground water on Maui is used primarily as livestock and irrigation water.

Soils

The dominant soil orders in this MLRA are Ultisols, Oxisols, and Inceptisols. The soils in the area have an isohyperthermic temperature regime, a udic or ustic moisture regime, and dominantly ferritic, ferruginous, mixed, parasesquic, kaolinitic, or sesquic mineralogy. They generally are very deep, well drained, and very fine textured. The soils on bottom land are well drained to poorly drained. The MLRA has a significant acreage of miscellaneous (nonsoil) areas.

The main soil series:

Haiku series—Palehumults that formed in material weathered from basic igneous rock and influenced by tropospheric dust

Halii series—Acroperox that formed in material weathered from basaltic rock with admixtures of volcanic ash and ejecta

Hanalei series—Endoaquepts that formed in alluvium derived from basic igneous rock

Lolekaa series—Palehumults that formed in alluvium and colluvium

Pauwela series—Kanhaplohumults that formed in material weathered from basic igneous rock

Pooku series—Acrudox that formed in material weathered from basic igneous rock

Biological Resources

This MLRA supports mesic to wet grass and forest vegetation and wetland plants. Naturalized plants include hilograss, California grass, Java plum, and guava. Some areas are designated as critical habitat for endangered plants. Critical area plant clusters include *Awaous guamensis*, *Atyoida bisulcata*, and *Hedyotis littoralis* on Kauai and different species of haha, aupaka (*Isodendrion longifolium*), and *Schiedea kaalae* on Oahu. Critical habitat for asplenium-leaved Diellia is in the part of this MLRA on Maui.

Major wildlife species include hoary bat on all three islands and Oahu elepaio on Oahu. The endangered Hawaiian coot, stilt, and moorhen inhabit wetlands in the parts of this MLRA on Kauai and Oahu. Small colonies of the endangered Newell shearwater and the endangered Hawaiian duck are in the part on Kauai.

Land Use

Rangeland and woodland make up most of this MLRA (fig. 167-2). About one-third of the MLRA is used for bananas, pineapples, sugarcane, pasture, taro, orchards, or other crops. Some coastal areas are used for urban or resort development.

The major resource concerns are the spread of invasive plant species, flooding, and beach and water erosion. Wind erosion is a concern in the Kahuku area on Oahu. Conservation practices on rangeland and cropland generally include nutrient and pest management, restoration of native plants, prescribed grazing, crop rotations, and windbreaks.

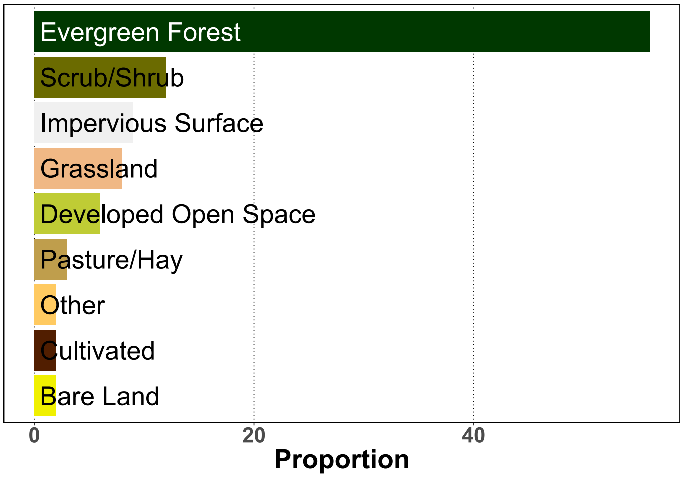

Figure 167-2: Relative proportions (percentages) of land use in MLRA 167.

Figure W1-1: Location and size of Land Resource Region W1, which covers 290,585 square kilometers (112,195 square miles) and is the southern part of Alaska.

W1—Southern Alaska

Land Resource Region W1 (fig. W1-1) is Alaska's warmest, wettest, most densely forested region. Because of the great elevational relief of this earthquake-prone maritime region, there are numerous alpine glaciers on mountains. The glaciers, which are maintained by the high amounts of precipitation and cold temperatures, make the region one of the largest glacial areas in the world outside of the polar ice caps and Greenland. Region W1 includes the arc of coastal lowlands and mountains along the Gulf of Alaska from the Alexander Archipelago in the southeast to Kodiak Island and the southern portion of the Alaska Peninsula, including Unimak Island, in the west. It also includes the lowlands and mountains of Cook Inlet. Rolling hills, glacial moraines, alluvial fans, and large outwash plains extend from the mountains to the typically rugged coastline. All of the rivers in the region drain into the Gulf of Alaska and the North Pacific. Broad flood plains, terraces, and deltas flank the numerous glacial and freshwater drainages. Elevation ranges from sea level along the coast to 20,320 feet (6,195 meters) at the summit of Denali (formerly Mount McKinley). The higher elevations are in areas of rugged mountains with bare rock, talus, glaciers, and ice fields. Some permafrost occurs in small, isolated depressions and on north-facing slopes in the northern portion of the region. This region contains five major land resource areas. The extent of these MLRAs and their range in elevations are shown in table W1-1.

The boundary between Regions W1 and X1 follows the mountain crest and separates the sporadic permafrost region (Region W1) from the discontinuous permafrost region (Region X1). The boundary between Regions W1 and X2 is also the line between sporadic and discontinuous permafrost as well as the boundary separating the mountainous areas (Region W1) from the lowlands (Region X2).

The climate in Region W1 ranges from maritime, at the lower elevations along the coast, to transitional maritime-continental, at the higher elevations and in the northern Cook Inlet Lowlands. The average annual precipitation ranges from about 15 inches (380 millimeters) in the central Cook Inlet Lowlands to more than 275 inches (6,985 millimeters) in the coastal mountains. The average annual snowfall ranges from 30 to 70 inches (75 to 180 centimeters) along the coast and is as much as 800 inches (205 centimeters) in the high mountains. The average annual air temperature ranges from 27 to 46 degrees F (-3 to 8 degrees C). Temperatures are warmer near the coast and in the Cook Inlet Basin. Daily and seasonal temperature variations are highest in the mountains. The freeze-free period ranges from less than 60 days to more than 140 days. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables W1-2 and W1-3.

Soils in Region W1 are dominantly Spodosols and Andisols (fig. 3, page 7). While Spodosols and Andisols intergrade in some areas, Andisols are dominant in the areas closer to

Table W1-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
220	82,350	31,795	0	0	0	0	150	520	650	2,140	1,880	6,170
222	67,205	25,950	0	0	210	710	930	3,070	1,680	5,530	5,470	17,960
223	50,630	19,550	0	0	370	1,220	1,000	3,300	1,760	5,770	6,060	19,890
224	28,400	10,965	0	0	20	70	100	340	410	1,350	1,590	5,210
225	61,995	23,935	0	0	10	40	200	650	740	2,440	2,850	9,350

Table W1-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set. Dashes indicate data were not available.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
220	-5.4	22	2.3	36	4.9	41	6.8	44	8.2	47	---	---	---	---	---
222	-25.4	-14	-4.5	24	-0.7	31	3.2	38	6.5	44	---	---	---	---	---
223	-30.9	-24	-6.2	21	-2.2	28	1.2	34	3.8	39	---	---	---	---	---
224	-4	25	0.5	33	1.6	35	2.6	37	4.1	39	---	---	---	---	---
225	-9.8	14	-0.5	31	2.4	36	4.1	39	5.4	42	---	---	---	---	---

Table W1-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
220	560	22	1,797	71	2,835/2,875	112/113	3,853	152	8,570	337
222	660	26	1,450	57	3,058/3,170	120/125	4,985	196	10,250	403
223	250	10	604	24	1,033/1,265	41/50	2,304	91	5,390	212
224	250	10	450	18	658/685	26/27	980	39	2,340	92
225	400	16	761	30	1,244/1,360	49/54	2,097	83	6,330	249

volcanic sources, such as the Alaska Peninsula, Kodiak Island, the southern Kenai Peninsula, Kruzof Island, and Baranof Island. The region also contains Inceptisols and Entisols. Gelepts and Cryepts occur on steep mountain slopes. Cryods, Cryands, Aquands, and Cryepts occur on the lower slopes, foothills, and moraines. The Cryepts on the younger surfaces include Haplocryepts and Dystrocryepts. Fluvents and Aquents are dominant on flood plains and low terraces. Histosols and Histic subgroups of other orders occur throughout the region, on level and depressional landforms and even on the steeper slopes along the coast and in the southeast. The Histosols include Fibrists, Hemists, Saprists, and Folists. Some soil profiles in Region W1 have restrictive zones, including densic material, ortstein, and abrupt textural changes (fig. 10, page 14). The soils in this region dominantly have a cryic soil temperature regime, an aquic or udic soil moisture regime, and mixed or amorphic mineralogy. The many glaciers in the region are mapped as miscellaneous areas (fig. 3).

Land use in the region is very diverse and includes urban and rural development, agriculture, forestry, commercial fishing, mining, livestock grazing, subsistence hunting and fishing, recreation, and wildlife habitat (fig. W1-2). Native vegetation consists of alpine and subalpine vegetation on the mountain slopes. The vegetation transitions into subalpine grasslands and tall scrub at the lower elevations. The lower elevations of the Cook Inlet Lowlands have mixed forests of white spruce, black spruce, paper birch, and willow. Areas of stunted black spruce grade into scrub and herbaceous communities in fens and bogs. Coastal forests dominated by Sitka spruce are along the northern and northwestern parts of the Gulf of Alaska. Western hemlock and Sitka spruce forests are dominant in the southeastern part of the region, and red cedar and Alaska cedar occur in the southernmost area.

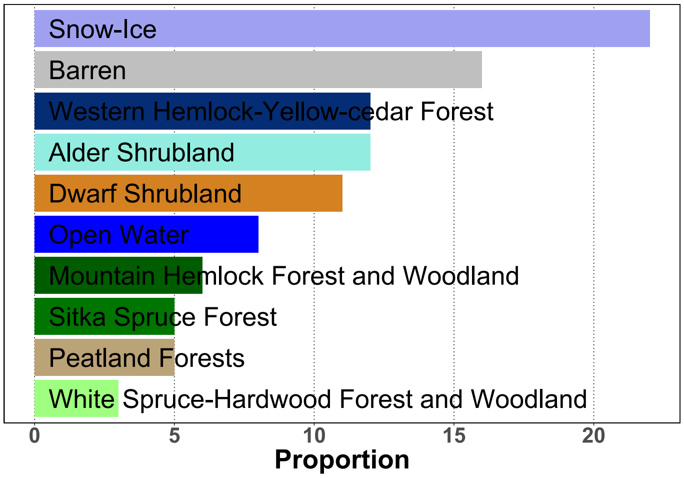

Figure W1-2: Relative proportions (percentages) of land use in LRR W1.

220—Alexander Archipelago-Gulf of Alaska Coast

MLRA 220 (fig. 220-1) includes the narrow arc of islands and low coastal mountains from the Alexander Archipelago in southeastern Alaska, north and west along the coast of the Gulf of Alaska and Prince William Sound, to the southern tip of the Kenai Peninsula, Afognak Island, and the northern tip of Kodiak Island. It makes up about 31,795 square miles (82,350 square kilometers). The area consists primarily of maritime-influenced, lower elevation forested and subalpine zones. Most of this MLRA is surrounded by saltwater. The coastal area defined by this MLRA is influenced by a temperate maritime climate.

On its northeast side, MLRA 220 is bordered by the high-relief Southern Alaska Coastal Mountains of MLRA 222 (occurring in the true alpine zone). To the southwest, it is bordered by the Southern Alaska Peninsula Mountains of MLRA 225 on Kodiak Island (where a relatively distinct vegetation break occurs between spruce forest and non-forested lands) and the Pacific Ocean.

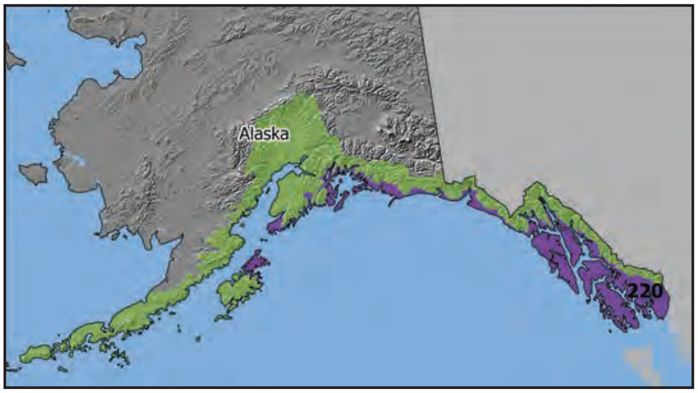

Figure 220-1: Location of MLRA 220, which covers 8,235,000 hectares (20,349,200 acres), within Region W1.

Physiography

This area lies within the Pacific Border Ranges, Coastal Mountains, and Coastal Trough provinces of the Pacific Mountain System. The Alexander Archipelago, Prince William Sound, and the southern Kenai Peninsula have dominantly low to moderate relief and deeply incised mountains. Glaciers, rivers, and streams have cut deep, narrow to broad valleys throughout the area. The broader valleys have nearly level to strongly sloping flood plains and stream terraces. Alluvial and colluvial fans and short footslopes are common in the valleys along the base of the mountains. Rocky headlands and sea cliffs are common along the coast. In the central portion of the MLRA, the terrain consists primarily of strongly sloping to moderately steep outwash plains, alluvial fans, long footslopes, and flood plains. The flood plains in this part of the MLRA were formed by meltwaters of glaciers and ice fields from the adjoining MLRA 222. They are generally broad, have a high gradient, and are braided. Elevation ranges from sea level to 4,665 feet (1,420 meters).

Surface water in this MLRA drains to the Gulf of Alaska and the North Pacific by way of numerous short, high-gradient rivers that originate in glaciers, ice fields, mountain uplands, and the interior of Alaska and British Columbia. The major rivers are the Copper, Alsek, Taku, and Stikine Rivers. Lakes make up less than 2 percent of the area. Glaciers make up less than 1 percent and are limited to the higher elevations on Baranof Island in the Alexander Archipelago.

Geology

During the Late Pleistocene Epoch, the entire area was covered with glacial ice. The numerous fjords of the Alexander Archipelago and Prince William Sound formed along faults or joints, chiefly as a result of glacial scouring and deepening of preglacial river valleys. Most glacial deposits have eroded away or been buried by mountain colluvium and alluvium, which cover about 90 percent of the present landscape. The remaining glacial and glaciofluvial deposits are generally restricted to coastal areas. During the Holocene Epoch, volcanic activity within and adjacent to this MLRA deposited a layer of volcanic ash of varying thickness on much of the landscape in the southeastern and northwestern parts of the area. Paleozoic, Mesozoic, and Lower Tertiary stratified sedimentary rocks and Cretaceous and Tertiary intrusive rocks underlie much of the MLRA and are exposed on steep mountain slopes and ridges.

Climate

Cloudy skies, moderate temperatures, and abundant rainfall characterize the temperate maritime climate of this MLRA. Winter storms, accompanied by heavy rainfall at the lower elevations and snow at the higher elevations, are frequent. Moderate to strong, south and southeast winds are common before and during the storms.

The average annual precipitation in most of the MLRA is 60 to 120 inches (1,525 to 3,050 millimeters). It is 15 to 25 inches (380 to 635 millimeters) at the lower elevations on the small part of the Cook Inlet Lowlands in the southwest corner of the area. It is 23 to 60 inches (585 to 1,525 millimeters) on the small part of the Kodiak Archipelago in the western part of the area. It can be as much as 200 inches (5,080 millimeters) at the highest elevations. The average annual snowfall ranges from about 30 to 70 inches (75 to 180 centimeters) along the coast and can be as much as 200 inches (510 centimeters) at the higher elevations. The average annual temperature at the lower elevations ranges from about 37 degrees F (3 degrees C) in the northwestern part of the area to 46 degrees F (8 degrees C) in the southeastern part. The freeze-free period averages about 120 to 190 days but is much shorter at the higher elevations.

Water

In most years precipitation is adequate for crops, but in some years yields are reduced by short dry periods in summer. Permanent streams, originating in the mountainous regions on the inland side, carry water to nearly all parts of the MLRA. Some outlets for natural lakes in this area have been dammed. The stored water is used for limited irrigation, public supply, pulp mills in Sitka and Ketchikan, and fish-processing plants. The surface water is generally suitable for all uses. Rivers fed by glacial meltwater typically carry high loads of suspended sediment. Flooding from ice dams that form during the spring thaw is a concern.

Ground water is used for some public supply, pulp mills in Sitka and Ketchikan, and fish-processing plants in the central part of the area and in the vicinity of Juneau. The water is pumped primarily from unconsolidated sediments in river valleys (alluvium) or from buried glacial outwash deposits in the river valleys or on uplands. It is hard or very hard but is otherwise of excellent quality. Wells in this aquifer generally are shallow, and the aquifer is constantly recharged with freshwater (rainfall and runoff). The level of iron may exceed the secondary (esthetic) standard for drinking water. The iron can stain ceramic and porcelain and precipitate in pipes. Since this aquifer is close to the surface and water moves through it quickly, it is highly susceptible to contamination from runoff. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along the coast. Small amounts of ground water can be obtained from the bedrock aquifer in the western and eastern parts of this MLRA. This water is similar in quality to that in the unconsolidated sediments.

Soils

The dominant soil orders in this MLRA are Spodosols, Histosols, and Entisols. The soils in the area have a cryic temperature regime. Most have a udic moisture regime and mixed mineralogy. Miscellaneous (nonsoil) areas make up about 23 percent of this MLRA. The most common are chutes, rock outcrop, rubble land, beaches, riverwash, and water.

The main soils and their series:

Cryaquents that are generally deep, are well drained to somewhat poorly drained, and formed in silty, sandy, and gravelly to cobbly alluvium; on flood plains, stream terraces, and outwash plains (Ashmun series)

Cryofibrists that are generally deep, are poorly drained or very poorly drained, and formed in thick deposits of organic material; on footslopes, discharge slopes, and valley floors and in areas directly above the timberline (Staney series)

Cryofluvents that are generally deep, are well drained to somewhat poorly drained, and formed in silty, sandy, and gravelly to cobbly alluvium; on flood plains, stream terraces, and outwash plains (Tonowek series)

Cryofolists that are well drained and on steep mountainsides (McGilvery series)

Cryohemists that are generally deep, are poorly drained or very poorly drained, and formed in thick deposits of organic material; on footslopes, discharge slopes, and valley floors and in areas directly above the timberline (Kina series)

Cryosaprists that are generally deep, are poorly drained or very poorly drained, and formed in thick deposits of organic material; on footslopes, discharge slopes, and valley floors and in areas directly above the timberline (Maybeso series)

Haplocryods that are shallow to deep, are well drained to somewhat poorly drained, and formed in colluvium and glacial till; on mountains and hills (Remedios series)

Humicryods that are shallow to deep, are well drained to somewhat poorly drained, and formed in silty volcanic ash over loamy and gravelly or cobbly colluvium and glacial till, on mountains and hills (Partofshikof and Sitka series); that are shallow to deep, are well drained to somewhat poorly drained, and formed in colluvium and glacial till, on mountains and hills (Tolstoi and Kupreanof series)

Biological Resources

Western hemlock and Sitka spruce are the dominant trees on mountains and hills at the lower elevations. Red cedar and Alaska cedar are more prevalent in the southern part of the MLRA. Black cottonwood and mixed forest types occur on flood plains. Areas of peat and other sites that are too wet for forest growth support sedge-grass meadows and low scrub. Tall alder scrub is on steep mountain slopes and in the subalpine zone. Grasslands of bluejoint reedgrass are common in the subalpine zone. Alpine dwarf scrub, herbaceous communities, and barren ground dominate the landscape at elevations of about 2,500 to 3,000 feet (760 to 915 meters) or more.

Mammals common to the area include brown bear, black bear, Sitka black-tailed deer, Roosevelt elk, moose, wolf, and mountain goat. Many species of migratory waterfowl and shore birds pass through the area. Extensive coastal meadows in the Yakutat area are especially important as resting and feeding sites during migration. Peregrine falcons and bald eagles nest in the MLRA. Southeast Alaska supports the largest concentration of bald eagles in the world. The streams and rivers in the area support healthy populations of wild salmon and freshwater fish.

Land Use

For many decades, logging, commercial fishing, and mining have been the primary enterprises throughout much of the MLRA. In recent years changes in public interests, land use policies, and timber economics have contributed to a significant decline in the timber industry (fig. 220-2). Commercial fishing continues to be an important industry, and most communities support a fleet of boats and fishing-related facilities. Several mines operate in the MLRA, and others have been prospected and proposed. Tourism and wildland recreation are becoming increasingly important. During summer, one or more cruise ships are likely to be docked in Juneau and other ports in the area. Flight-seeing, guided fishing, and other recreational tours are available out of Juneau and other major communities. Less than 1 percent of the MLRA is urban. Juneau and several smaller communities, however, are experiencing significant growth and urban development. Subsistence hunting, fishing, and gathering provide food and a variety of other resources to local residents and remain the principal economy for the residents of remote villages.

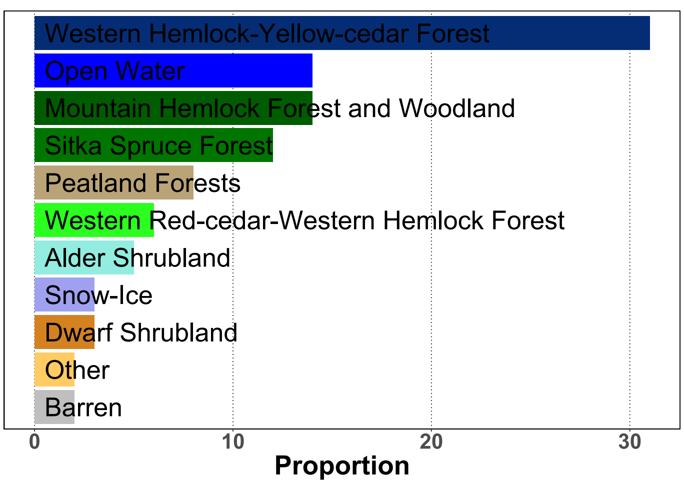

Figure 220-2: Relative proportions (percentages) of land use in MLRA 220.

The major soil resource concerns are water erosion and mass wasting. Mass wasting induced by earthquakes and erosion can take the form of creep, earthflow, rockfall, slump, debris avalanche, and debris flow. It can also result from human activities, such as logging and road construction. Undercutting or overloading of slopes, vibrations from earthquakes, and increased soil moisture content can trigger mass movements. Conservation practices on forestland generally include forest stand improvement and properly constructed roads, landings, and stream crossings.

222—Southern Alaska Coastal Mountains

MLRA 222 (fig. 222-1) includes the higher elevation areas of the Coast, St. Elias, Chugach, and Kenai Mountains. It makes up about 25,950 square miles (67,205 square kilometers). The area is almost entirely undeveloped wildland. Most of it is in the true alpine zone and is influenced by a transitional continental/maritime climate.

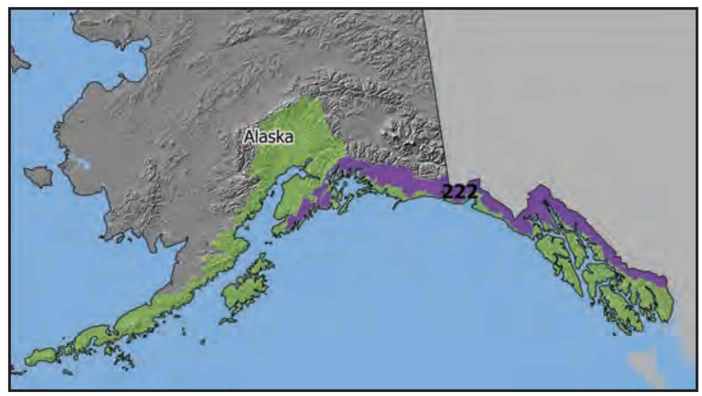

Figure 222-1: Location of MLRA 222, which covers 6,720,500 hectares (16,606,700 acres), within Region W1.

To the south, MLRA 222 borders MLRA 220 (Alexander Archipelago-Gulf of Alaska Coast). The boundary is identifiable by the prominent mountain ranges and distinct subalpine scrub plant communities occurring between the true alpine of MLRA 222 and the subalpine of MLRA 220. Although MLRA 222 is proximal to the maritime climate of MLRA 220, it is more heavily influenced by a continental climate with more consistent snowfall. To the north and west, MLRA 222 has a less apparent boundary with the Cook Inlet Mountains and the Interior Alaska Mountains of MLRAs 223 and 228, where the climate grades from transitional maritime/continental to subarctic.

Physiography

This MLRA lies within the Coastal Mountains and Pacific Border Ranges provinces of the Pacific Mountain System. The terrain consists of steep, rugged, high-relief mountains; massive glaciers; and ice fields. Glaciers and ice fields make up about 54 percent of the area. Numerous arêtes and nunataks are throughout the ice fields. Medial and lateral moraines are common in the glaciers. Unglaciated areas are deeply incised with narrow to broad valleys. Flood plains and stream terraces on valley floors rapidly transition to steep alluvial fans and mountain footslopes. Elevation ranges from sea level at the base of tidewater glaciers and ice fields to 18,008 feet (5,490 meters) at the summit of Mount St. Elias.

Surface water in this area drains to the Gulf of Alaska and North Pacific by way of numerous short, high-gradient rivers that originate in the glaciers, ice fields, and mountainous uplands. Lakes make up less than 1 percent of the area.

Geology

During the Pleistocene Epoch, the area was covered with glacial ice. Most glacial deposits have eroded away or been buried by colluvium and slope alluvium, which cover more than 90 percent of the present unglaciated landscape. The remaining glacial and glaciofluvial deposits and recent fluvial deposits are generally restricted to the bottoms of the larger valleys. Paleozoic, Mesozoic, and Lower Tertiary stratified sedimentary rocks, and in some places Paleozoic intrusive rocks, underlie much of the MLRA and are exposed on steep mountain slopes and ridges.

Climate

Cloudy conditions and moderate to cold temperatures characterize the climate. The precipitation usually is abundant throughout the year in most of the area. At the higher elevations, freezing temperatures are likely to occur during any month of the year.

The average annual precipitation throughout most of this area is 120 to 200 inches (3,050 to 5,080 millimeters). It is 250 inches (6,350 millimeters) or more at the highest elevations. It is 25 to 50 inches (635 to 1,270 millimeters) in small areas northwest of Juneau, which is just outside this MLRA, and around and northeast of Copper Center. The average annual snowfall ranges from about 200 to 800 inches (510 to 2,030 centimeters). It greatly exceeds the annual snowmelt in many places, as evidenced by the abundance and extent of glaciers and ice fields.

Water

This MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers either are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders are Spodosols and Histosols. The soils in the area have a cryic temperature regime or a subgelic soil temperature class, a udic or aquic moisture regime, and mixed or amorphic mineralogy. Miscellaneous (nonsoil) areas make up more than 90 percent of this MLRA. The most common are rock outcrop, rubble land, chutes, and glaciers.

The main soils and their series:

- Cryofibrists that generally are deep, are somewhat poorly drained to very poorly drained, and formed in thick deposits of organic material; on footslopes, discharge slopes, and valley floors
- Cryohemists that generally are deep, are somewhat poorly drained to very poorly drained, and formed in thick deposits of organic material; on footslopes, discharge slopes, and valley floors (Nuka and Koyuktolik series)
- Cryosaprists that generally are deep, are somewhat poorly drained to very poorly drained, and formed in thick deposits of organic material; on footslopes, discharge slopes, and valley floors
- Haplocryods that are shallow to deep, are well drained to somewhat poorly drained, and formed in loamy and gravelly colluvium and glacial till; on mountains and hills
- Humicryods that are shallow to deep, are well drained to somewhat poorly drained, and formed in loamy and gravelly colluvium and glacial till; on mountains and hills (Nanwalek and Tutka series)

Biological Resources

Vegetation consists of a variety of dwarf scrub and herbaceous communities. Low willow scrub is common in drainages. Lichens, scattered herbs, and dwarf shrubs dominate bedrock exposures and very shallow soils. In general, there is little or no plant growth at elevations above about 7,500 feet (2,285 meters). Along the boundary with MLRA 220, there are stringers and inclusions of tall alder scrub and grasslands of bluejoint reedgrass, which are characteristic of the subalpine zone.

Mammals common to the area include brown bear, Dall sheep, mountain goat, moose, wolf, coyote, fox, snowshoe hare, Arctic ground squirrel, and hoary marmot. Ptarmigan, American golden plovers, golden eagles, and a wide variety of other birds are common in many areas.

Land Use

Remote wildland recreation is the principal land use (fig. 222-2). The rugged, high mountains, extensive glaciers and ice fields, and wilderness qualities of the area attract visitors from around the world. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Less than 1 percent of this area is urban. Most of the communities in the area are along the major rivers. There are no major resource concerns.

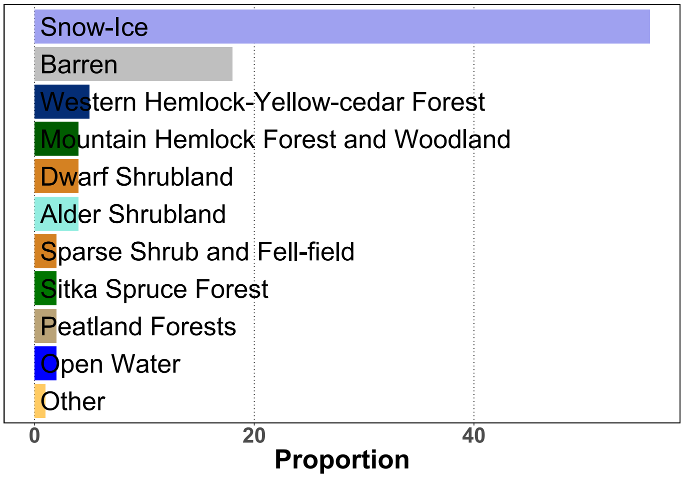

Figure 222-2: Relative proportions (percentages) of land use in MLRA 222.

223—Cook Inlet Mountains

MLRA 223 (fig. 223-1) includes the higher mountains of the Aleutian and Alaska Ranges and the Talkeetna, Kenai, and Chugach Mountains that drain into the Cook Inlet Lowlands (MLRA 224) and Cook Inlet. It makes up about 19,550 square miles (50,630 square kilometers). The area is primarily undeveloped wildland and is sparsely populated. Terrain throughout the area consists primarily of rugged, moderate to high mountains of the Pacific Mountain physiographic system (Wahrhaftig, 1965). For the most part, this MLRA includes only the true alpine zone. The geology is dominated by stratified sedimentary rocks with an overlying admixture of loess and volcanic ash. The MLRA occurs in the transitional maritime/continental climate zone but is influenced by the subarctic climate of the interior.

MLRA 223 is the mountainous region surrounding MLRA 224 (Cook Inlet Lowlands), which is easily recognized by its distinct lower elevation glaciated hills and plains. It has a less apparent boundary with MLRA 225 (Southern Alaska Peninsula Mountains), which has a greater influence of the maritime climate in the Chigmit Mountains of the Aleutian Range (from Iniskin Bay of Cook Inlet, north to the Pile River). Further to the south, MLRA 223 borders MLRA 222 (Southern Alaska Coastal Mountains), which also occurs in the transitional maritime/continental climate zone but does not have the subarctic climate influence. To the north, MLRA 223 borders MLRA 228 (Interior Alaska Mountains), which is distinguishable by its continental subarctic climate and sedimentary, metamorphic, and igneous bedrock geology.

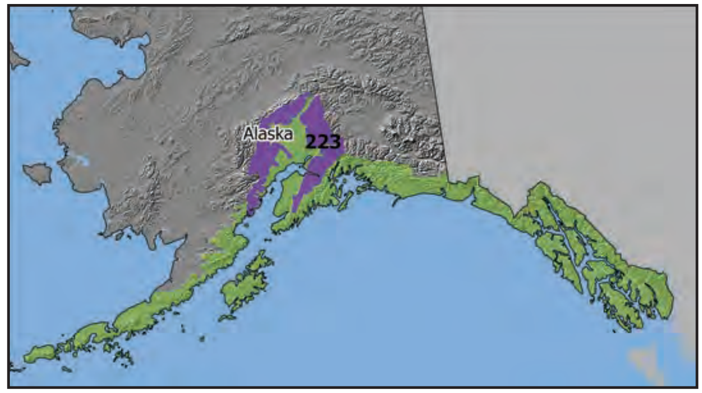

Figure 223-1: Location of MLRA 223, which covers 5,063,100 hectares (12,511,300 acres), within Region W1.

Physiography

All of this MLRA lies within the Pacific Mountain System. The part in the Alaska and Aleutian Ranges lies within the Alaska-Aleutian province, the part in the Kenai and Chugach Mountains lies within the Pacific Border Ranges province, and the part in the Talkeetna Mountains lies within the Coastal Trough province. Massive valley glaciers and ice fields are prominent at the higher elevations. Many of the larger valley glaciers extend down to an elevation of about 1,000 feet (305 meters) and into the upper edge of the Cook Inlet Lowlands. Glaciers and ice fields make up about 15 percent of the MLRA. The mountains throughout the area are deeply incised with narrow to broad valleys that have braided, high-gradient flood plains. Coalescing alluvial fans and long footslopes are common on the lower mountain slopes in broad valleys. Elevation generally ranges from about 2,500 feet (760 meters) along the boundary with the Cook Inlet Lowlands to 20,320 feet (6,195 meters) at the summit of Denali, the highest point in North America. It drops to sea level in small areas along the Turnagain Arm of Cook Inlet.

All of the rivers in the area drain into the Cook Inlet Lowlands and Cook Inlet. The Matanuska, Little Susitna, Knik, Kenai, and Chakachatna Rivers and major tributaries of the Susitna River, including the Yentna, Skwenta, Chulitna, Talkeetna, and Kashwitna Rivers, originate in glaciers and mountainous uplands in this MLRA. The largest lakes are Chakachamna and Chelatna Lakes in the Alaska Range and Eklutna and Kenai Lakes in the Chugach Mountains. Lakes make up about 2 percent of the area.

Geology

The entire area, except for the highest peaks and the steep upper ridges, was covered by glacial ice during the Late Pleistocene Epoch. Most of the glacial deposits have eroded away or been buried by colluvium and slope alluvium during the Holocene Epoch. Colluvial and alluvial deposits cover about 65 percent of the present landscape. Slightly modified to highly modified glacial moraines and outwash deposits are extensive on the lower mountain slopes and in valleys at the lower elevations. Holocene eolian deposits, consisting of an admixture of loess and volcanic ash and ranging in thickness from a few inches to 24 inches (60 centimeters) or more, have accumulated on the mid and lower mountain slopes. Valley bottoms are buried with recent fluvial deposits. The bedrock geology consists primarily of Late Paleozoic and Early Mesozoic stratified sedimentary rocks. Tertiary intrusive rocks are common.

Climate

Cloudy conditions, short summers, and moderate to cold temperatures characterize the climate. The average annual precipitation ranges from about 15 to 30 inches (380 to 760 millimeters) along the boundary with the Cook Inlet Lowlands (MLRA 224) to more than 100 inches (2,540 millimeters) in the highest mountains. Late summer and fall are generally the rainiest periods. The average annual snowfall ranges from about 80 to 400 inches (205 to 1,015 centimeters) or more. The average annual temperature at Puntilla Lake in the Alaska Range is 27 degrees F (-3 degrees C). The freeze-free period averages about 60 to 80 days. At the higher elevations, freezing temperatures can occur during every month.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries a high load of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Spodosols, Inceptisols, Gelisols, and Entisols. The soils in the area have a cryic temperature regime or a subgelic soil temperature class, a udic or aquic moisture regime, and amorphic or mixed mineralogy. Miscellaneous (nonsoil) areas make up about 70 percent of this MLRA. The most common are rock outcrop, rubble land, and glaciers.

The main soils:

- Cryofluvents, Cryorthents, and Cryaquents that are generally deep, range from very poorly drained to excessively drained, and formed in loamy and gravelly alluvium on flood plains
- Haplocryepts and Dystrocryepts that are shallow to very deep, are generally well drained, and formed in gravelly colluvium over fractured bedrock of varied lithology on strongly sloping to steep slopes
- Haplocryods, Humicryods, and Cryaquods that are generally deep, range from well drained to poorly drained, and formed in a surface layer of silty loess and volcanic ash over gravelly glacial drift or colluvium on mid-mountain slopes
- Histoturbels and Aquiturbels that are poorly drained and that have finer textures than the Haplocryepts and Dystrocryepts but are on similar landforms

Biological Resources

Vegetation consists of a variety of dwarf scrub and herbaceous communities. Low willow scrub is common in drainages. Lichens and scattered herbs and dwarf shrubs dominate bedrock exposures and very shallow soils. In general, there is little or no plant growth at elevations above about 7,500 feet (2,285 meters). Along the boundary with the Cook Inlet Lowlands, there are stringers and inclusions of tall alder scrub and grasslands of bluejoint reedgrass, which are characteristic of the subalpine zone.

Mammals common to the area include brown bear, Dall sheep, mountain goat, caribou, moose, wolf, coyote, fox, snowshoe hare, Arctic ground squirrel, and hoary marmot. Ptarmigan, American golden plovers, golden eagles, and a wide variety of other birds are common in many places.

Land Use

Remote wildland recreation is the principal land use (fig. 223-2). The rugged mountains, extensive glaciers, ice fields, and wilderness qualities of the area attract hikers and wilderness enthusiasts from around the world. Every summer, hundreds of climbers attempt to scale Denali and other high peaks. More people visit Denali National Park than any other park in Alaska. Hunters pursue moose, caribou, Dall sheep, brown bear, and black bear. Back-country recreationists and hunters are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. This MLRA has many extractable minerals and other commodities. Mining was historically a major land use that helped to support development on nearby lowlands. Less than 1 percent of this area is urban. Most of the communities are along the major rivers. There are no major resource concerns.

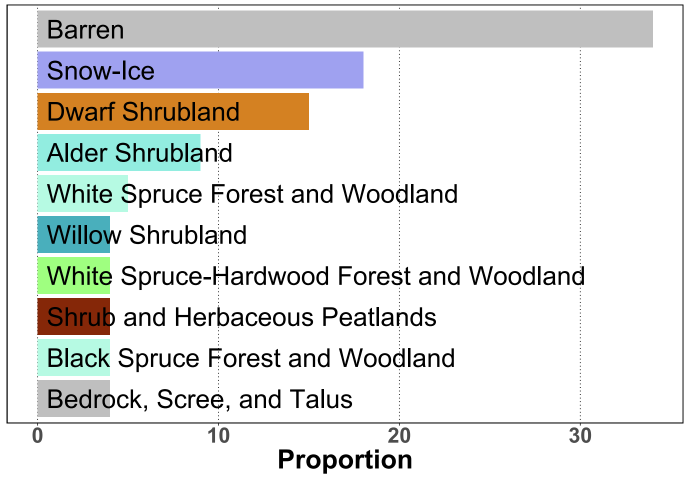

Figure 223-2: Relative proportions (percentages) of land use in MLRA 223.

224—Cook Inlet Lowlands

MLRA 224 (fig. 224-1) consists of the lowlands and lower mountain slopes of the Susitna and Matanuska Valleys, the western Kenai Peninsula, and the west side of Cook Inlet. It makes up about 10,965 square miles (28,400 square kilometers). The terrain is dominantly a broad expanse of gently sloping to rolling plains and low- to moderate-relief hills bordered by the lower slopes of the surrounding mountains. It includes the most densely populated areas of Alaska and the most extensive network of highways and secondary roads in the State. This MLRA primarily includes the lower lying forested and subalpine zones. The climate is transitional from temperate maritime to continental subarctic.

MLRA 224 is bordered on three sides by MLRA 223 (Cook Inlet Mountains), which drains into its lowlands. The boundary between these MLRAs occurs at the sedimentary bedrock-controlled footslopes of the Cook Inlet Mountains where the true alpine plant communities of MLRA 223 begin to transition to the lower lying forested and subalpine zones of MLRA 224.

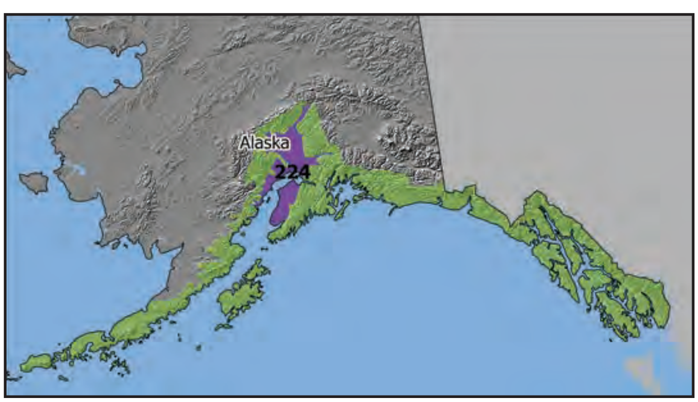

Figure 224-1: Location of MLRA 224, which covers 2,839,900 hectares (7,017,500 acres), within Region W1.

MLRA 224 shares a narrow boundary with MLRA 228 (Interior Alaska Mountains) on the north at Broad Pass (south of Summit Lake) where the transitional climate of MLRA 224 changes to the continental subarctic climate of MLRA 228. MLRA 224 is bordered to the south by waters of Cook Inlet.

Physiography

This area lies within the Coastal Trough province of the Pacific Mountain System. Depressions and shallow basins on plains are dotted with thousands of small and medium-size lakes and interconnecting wetlands. Lakes also are common in low areas between hills. Rivers have relatively high gradients, and braided flood plains and low to high stream terraces are common along the rivers. The area includes the Caribou Hills, Mount Susitna, Beluga Mountain, and the Yenlo Hills. These isolated, low to moderately high, rounded mountains protrude above the surrounding terrain. Coalescing alluvial fans are common on the lower mountain slopes. Elevation ranges from sea level to 4,396 feet (1,340 meters).

Numerous rivers, which originate in the surrounding Cook Inlet Mountains (MLRA 223), pass through the area. All of the rivers and streams drain into Cook Inlet. The major rivers are the Susitna and Yentna Rivers in the Susitna Valley, the Little Susitna River and Matanuska River in the Matanuska Valley, and the Kenai River and Deep Creek on the Kenai Peninsula. Other important rivers or tributaries include the Kustatan River on the west side of Cook Inlet, Ship Creek and Eagle River in the municipality of Anchorage, and Willow Creek, Montana Creek, Lake Creek, and the Deshka River in the Susitna Valley. The largest lakes are Tustumena Lake and Skilak Lake on the Kenai Peninsula and Beluga Lake on the west side of Cook Inlet. Small and medium-size lakes are in scattered areas throughout the rolling plains and hills in the Susitna Valley, the western Matanuska Valley, and the northern Kenai Peninsula. Lakes and other areas of surface water make up about 15 percent of the MLRA.

Geology

This area has a complex history of repeated glaciation. During the Late Pleistocene Epoch, the entire area was covered by glacial ice originating from the surrounding mountains. At times during the Early and Middle Pleistocene Epoch, ice dams at the lower end of Cook Inlet caused much of the area to be covered with a large proglacial lake. Surficial deposits on plains and hills are a complex mixture of glacial till and outwash. Fine textured glaciolacustrine deposits and sand dunes are in a few areas, primarily near the coast in the southern Susitna Valley, in the municipality of Anchorage, and on the western Kenai Peninsula. Recent fluvial deposits cover modern flood plains and stream terraces. During the Holocene Epoch, winds blowing sediments from unvegetated flood plains and volcanic activity in the Alaska and Aleutian Ranges deposited a layer of mixed loess and volcanic ash across much of the area. In the vicinity of the city of Palmer, along the lower Matanuska and Knik Rivers, the layer of loess is many meters thick.

Climate

Most weather systems originate in the North Pacific and the Gulf of Alaska. In winter, particularly in the northern part of the area, arctic weather systems are more common. In the Matanuska Valley, seasonal winds pick up fine-earth material from unvegetated flood plains and create extensive dust clouds that can reach an altitude of 5,000 feet (1,525 meters) or more.

The average annual precipitation ranges from 15 to 60 inches (380 to 1,525 millimeters). It generally is higher on the southern Kenai Peninsula, in the northern Susitna Valley, and at the higher elevations along the mountains. The average annual snowfall is about 60 to 120 inches (150 to 305 centimeters). The average annual temperature is about 27 to 36 degrees F (-3 to 2 degrees C). The freeze-free period averages 65 to 160 days, decreasing in length with elevation.

Water

In most years precipitation is adequate for crops, but in some years yields are reduced by short dry periods in summer. Permanent streams carry water to nearly all parts of the MLRA. Some outlets for natural lakes have been dammed. The stored water is used for limited irrigation, public supply, and the needs of seafood-processing plants. Anchorage obtains supplemental surface water for public supply in developing areas from a pipeline from Lake Eklutna. The surface water generally is suitable for all uses. Rivers fed by glacial meltwater typically carry high loads of suspended sediment, and water in the lakes may require treatment. Flooding from ice dams that form during the spring thaw is a concern.

Ground water is used for public supply and for the needs of seafood-processing plants and a large petrochemical industrial complex on the Kenai Peninsula. It is pumped primarily from the Anchorage, Matanuska-Susitna, and Kenai Peninsula aquifers. These aquifers are either unconsolidated sediments in river valleys (alluvium) or buried glacial outwash deposits in river valleys or on uplands. This water is hard or very hard but is otherwise of excellent quality. Wells in these aquifers generally are shallow, and the aquifers are constantly recharged with freshwater (rainfall and runoff). The level of iron may exceed the secondary (esthetic) standard for drinking water in the Kenai Peninsula aquifer but not in the Matanuska-Susitna aquifer. The iron can stain ceramic and porcelain and precipitate in pipes. Since the aquifers are close to the surface and water moves through them quickly, they are highly susceptible to contamination from runoff. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along Cook Inlet. Small amounts of ground water can be obtained from the bedrock aquifer in the higher parts of this area. This water is typically similar in quality to that in the unconsolidated sediments.

Soils

The dominant soil orders in this MLRA are Spodosols, Histosols, Entisols, and Inceptisols. The soils in the area have a cryic temperature regime, a udic or aquic moisture regime, and dominantly mixed mineralogy. Miscellaneous (nonsoil) areas make up about 15 percent of this MLRA. The most common are beaches, riverwash, and water.

The main soils and their series:

- Cryaquents that are generally deep, are well drained to very poorly drained, and formed in stratified silty and sandy alluvium over gravelly alluvium; on flood plains and stream terraces (Killey series)
- Cryaquepts that are poorly drained or very poorly drained and formed in silty loess and volcanic ash over loamy, sandy, and gravelly glacial till and outwash; on plains and hills (Slikok and Disappear series)
- Cryofibrists that are poorly drained or very poorly drained and formed in thick deposits of organic material; in broad shallow basins and drainageways (Salamatof series)
- Cryofluvents that are generally deep, are well drained to very poorly drained, and formed in stratified silty and sandy alluvium over gravelly alluvium; on flood plains and stream terraces (Niklason series)
- Cryohemists that are poorly drained or very poorly drained and formed in thick deposits of organic material; in broad shallow basins and drainageways (Starichkof series)
- Dystrocryepts that are deep and well drained and formed in silty loess and volcanic ash over loamy, sandy, and gravelly glacial till and outwash; on plains and hills (Smithfha series)
- Haplocryepts that are deep and well drained and formed in silty loess and volcanic ash over loamy, sandy, and gravelly glacial till and outwash; on plains and hills (Bodenburg series)
- Haplocryods that are deep and well drained and formed in silty loess and volcanic ash over loamy, sandy, and gravelly glacial till and outwash; on plains and hills (Estelle and Kenai series)
- Humicryods that are deep and well drained and formed in silty loess and volcanic ash over loamy, sandy, and gravelly glacial till and outwash; on plains and hills (Talkeetna series)

Biological Resources

Vegetation on upland sites is dominated by white spruce, paper birch, and quaking aspen. Lutz spruce is dominant on the southern Kenai Peninsula. On flood plains and in seepage areas on mountain slopes, cottonwood and mixed cottonwood forests are common. Extensive lowlands and areas of peat support stunted white and black spruce, low scrub of ericaceous shrubs and willow, and a variety of sedge and grass meadows. Halophytic sedge and sedge-grass meadows are along the coast of Cook Inlet. At the higher elevations in the subalpine zone, forests gradually transition to grasslands of bluejoint reedgrass, tall alder scrub, and low willow scrub. Dwarf scrub and herbaceous communities characteristic of the alpine zone are above elevations of about 1,800 to 2,500 feet (550 to 760 meters) in the Caribou Hills on the southern Kenai Peninsula, on Mount Susitna and the Yenlo Hills in the Susitna Valley, and along the boundary with the Cook Inlet Mountains (MLRA 223).

Since the mid-1980s, spruce bark beetles have infested tens of thousands of acres of white spruce, Lutz spruce, and mixed spruce forests on the Kenai Peninsula, in the southern Matanuska and Susitna Valleys, and along the west side of Cook Inlet. Across this area, and in particular on the Kenai Peninsula, bark beetles have killed the vast majority of large-diameter spruce trees. On the southern Kenai Peninsula, they have entirely killed off the dominant forest canopy.

Mammals common to the area include moose, brown bear, black bear, wolf, coyote, fox, beaver, and lynx. Caribou are common in a few places. Tundra swans, Canada geese, a wide variety of ducks, and sandhill cranes use the wetlands and lakes in the area for nesting and as stop-over sites during migration. Spruce grouse are common throughout the forests. Bald eagles are seen along rivers and streams throughout much of the year.

Most of the rivers and streams are important spawning grounds for salmon. Thousands of visitors are attracted to the area each year for sport fishing for Chinook, coho, and red salmon. Rivers on the Kenai Peninsula support anadromous steelhead fisheries. Rainbow trout are in many streams and lakes. The Alaska Department of Fish and Game stocks many lakes throughout the area with rainbow trout. Introduced northern pike are in most of the lakes in the Susitna Valley. They are a major predator of small fish and waterfowl.

Land Use

Agriculture has been important in this area since the beginning of European settlement and particularly since 1935, when the Matanuska Colony was established near the city of Palmer. Other agricultural areas in the MLRA are in the Susitna Valley, at Point Mackenzie, and around the cities of Sterling, Soldotna, and Homer on the Kenai Peninsula. The principal crops are hay, potatoes, and other hardy vegetables. A few dairy farms are still operating in the Palmer area, at Point Mackenzie, and on the Kenai Peninsula. Cattle graze native rangeland and pasture on the southern Kenai Peninsula. Logging and personal-use firewood cutting are locally significant. Salvage logging in response to the bark beetle infestation on the Kenai Peninsula and other management activities have resulted in the construction of hundreds of miles of roads and in clear-cut logging on thousands of acres. Other major industries in the area include commercial fishing, fish processing, and oil and gas extraction (fig. 224-2).

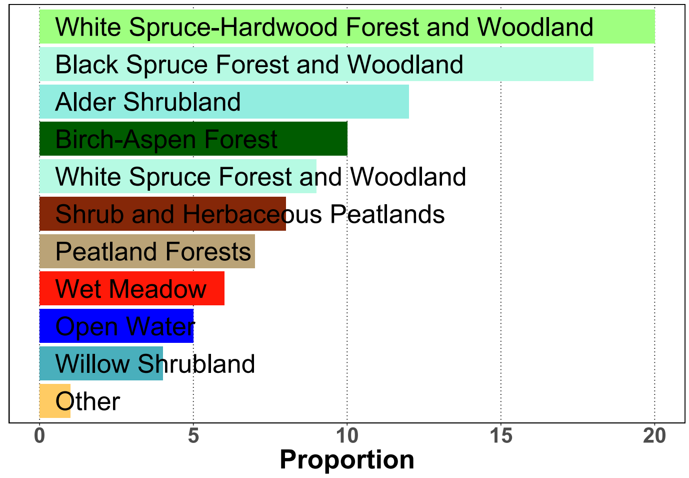

Figure 224-2: Relative proportions (percentages) of land use in MLRA 224.

Tourism and wildland recreation are becoming increasingly important. The recreation and tourism industries include hunting, fishing, back-country guiding, bus tours, and flight-seeing. Many local residents participate in hunting for moose and other game and fishing for salmon, halibut, trout, and northern pike. In winter, snowmobile trails crisscross the Susitna Valley. Extensive ATV trails provide summer and fall access to much of the area. Recreational cabins have been constructed beside many lakes and in other areas. Subsistence hunting, fishing, and gathering provide food and a variety of other resources for many residents.

Urban development, particularly along the road system, is a significant land use. Most of the land available for development within the municipality of Anchorage has already been developed. Rapid urbanization is occurring in the vicinity of Palmer and Wasilla in the lower Matanuska Valley and in the cities of Kenai and Soldotna on the Kenai Peninsula. Throughout the MLRA, agricultural lands are being converted to residential and small industrial developments. Extraction of sand and gravel in support of construction, road building, and road maintenance impacts thousands of acres in the lower Matanuska Valley and in other locations along the road system.

The major resource concerns are water erosion and water quality. Off-road vehicle use is an increasing problem throughout much of the MLRA. It contributes locally to the destruction of the existing vegetation and causes surface compaction, erosion (sheet and rill, concentrated flow, and gully), damage to stream channels and fisheries, and changes in access and land use. Conservation practices that minimize ground disturbance and maintain an adequate plant cover are needed. Conservation practices on forestland generally include forest stand improvement; proper construction of roads, landings, and stream crossings; and road closures. Critical-area stabilization is important in places disturbed or damaged by off-road vehicles.

225—Southern Alaska Peninsula Mountains

MLRA 225 (fig. 225-1) includes most of Kodiak Island and the slopes of the southern Aleutian Mountains on the Alaska Peninsula (including Unimak Island to the west), where drainage is into MLRA 236 (Bristol Bay-Northern Alaska Peninsula Lowlands), lower Cook Inlet, Shelikof Strait, and the North Pacific. It makes up about 23,935 square miles (61,995 square kilometers). The MLRA is mostly undeveloped wildland. The terrain consists primarily of rugged, low to moderately high mountains deeply dissected with narrow, high-gradient valleys. Volcanic activity in Mount Katmai and other volcanoes in the area has deposited a layer of volcanic ash across much of the landscape. The climate is maritime along the coast and transitions to maritime/continental at the higher elevations.

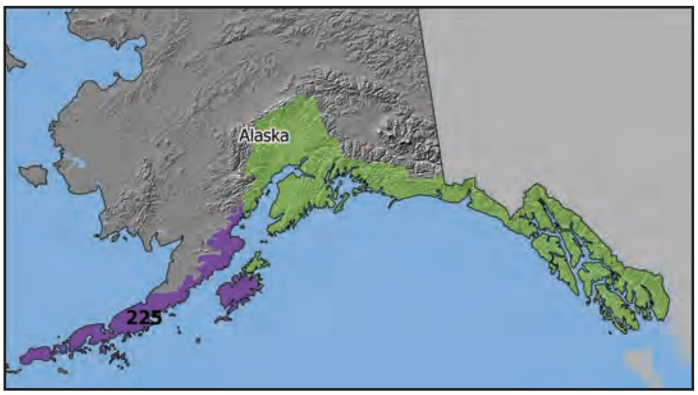

Figure 225-1: Location of MLRA 225, which covers 6,199,600 hectares (15,319,700 acres), within Region W1.

MLRA 225 shares a distinct border with MLRA 220 (Alexander Archipelago-Gulf of Alaska Coast) on Kodiak Island, which is distinguishable by the vegetation break between spruce forest and non-forestland. To the northeast, it has a less apparent boundary with MLRA 223 (Cook Inlet Mountains) from Iniskin Bay to the Chigmit Mountains, which is distinguishable by a transitional maritime/continental climate with subarctic influence. To the northwest, it has a less apparent boundary with MLRA 228 (Interior Alaska Mountains) from the Chigmit Mountains along the Lake Clark National Preserve boundary to Chekok Lake, where the continental subarctic climate is the distinguishing characteristic. To the west, it shares a physiographically distinct border with MLRA 236 (Bristol Bay-Northern Alaska Peninsula Lowlands) from Iliamna Lake to the Bristol Bay lowlands north of Reindeer Creek and the Pacific Ocean (parts of Cook Inlet and Bristol Bay).

Physiography

This area lies within the Pacific Border Ranges province and Alaska-Aleutian province of the Pacific Mountain System. Glaciers and small ice fields are common at the upper elevations on the highest peaks. Glaciers and permanent ice and snow make up about 7 percent of the MLRA. In steep, narrow valleys, coalescing fans and steep footslopes extend down to the stream channel. Flood plains and stream terraces are of limited extent, except in the broader valleys at the lower elevations. A narrow, discontinuous zone of gently sloping to moderately steep outwash plains, flood plains, and low-relief hills is along the coast of Cook Inlet. At the lower elevations, along the boundary with MLRA 236, flood plains and stream terraces are common on valley bottoms. Elevation ranges from sea level along the coast to 9,372 feet (2,857 meters) at the summit of Shishaldin Volcano on Unimak Island. Lakes make up about 5 percent of the area.

Geology

Except for the highest peaks and steep upper ridges, the entire area was covered with glacial ice during the Late Pleistocene Epoch. During the Holocene Epoch, glacial deposits across much of the area eroded away or were buried by mountain colluvium and alluvium, which cover about 60 percent of the present landscape. Slightly modified to highly modified glacial moraines and outwash deposits and recent alluvium are extensive on the lower mountain slopes and in valleys at the lower elevations. Volcanic activity in Mount Katmai and other volcanoes in the area has deposited a layer of volcanic ash across much of the landscape. The dominant geologic formations underlying most of the area are Upper Jurassic, Lower Tertiary, and some Cretaceous stratified sedimentary rocks. Undifferentiated volcanic rocks of Quaternary and Tertiary age are common near Mount Katmai and other volcanoes.

Climate

Cloudy conditions and moderate to cold temperatures characterize the climate. Freezing temperatures are likely to occur during any month of the year, particularly at the higher elevations. The climate is influenced by the maritime conditions of Bristol Bay and the Bering Sea in the western part of the area, by spillover effects from the North Pacific to the southeastern part of the area, and by the orographic effects of the rugged mountainous environment. The precipitation is usually abundant throughout the year.

The average annual precipitation in most of this area is 60 to 90 inches (1,525 to 2,285 millimeters). It ranges from about 30 inches (760 millimeters) in spots along the coast to more than 100 inches (2,540 millimeters) at the higher elevations.

The average annual snowfall is about 50 to 200 inches (125 to 510 centimeters). It greatly exceeds annual snowmelt in many places, as evidenced by the abundance of glaciers and ice fields.

Water

This MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic purposes in this area is probably obtained from private wells.

Small communities and rural landowners can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). A significant area is underlain by the unconsolidated sediment aquifer on the northern side of the part of this MLRA on the Alaska Peninsula. This aquifer may also occur in the valleys along some of the larger streams. Where the aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Andisols, Histosols, and Inceptisols. The soils in the area have a cryic temperature regime or a subgelic soil temperature class, a udic or aquic moisture regime, and dominantly amorphic mineralogy. Miscellaneous (nonsoil) areas make up about 51 percent of this MLRA. The most common are rock outcrop, rubble land, glaciers, riverwash, and beaches.

The main soils:

- Cryaquepts that formed in silty volcanic ash over loamy glacial till and colluvium and that generally are deep and somewhat poorly drained; on valley bottoms, in depressions, and on benches on mountains
- Cryofibrists that formed in thick deposits of organic material and are poorly drained or very poorly drained; on valley bottoms and in depressions
- Haplocryands and Dystrocryepts that formed in a layer of silty volcanic ash of varying thickness over gravelly and loamy colluvium, slope alluvium, and glacial till, that range from shallow to deep, and that generally are well drained; on mountain slopes and hills

Biological Resources

Vegetation at the lower elevations is mostly tall scrub dominated by alder and willow. Balsam poplar forests, with tall shrub and herbaceous understory, are on flood plains and some south-facing mountain slopes. As elevation increases, tall scrub rapidly gives way to low scrub dominated by willow, ericaceous shrubs, and various graminoids and forbs. Grasslands of bluejoint reedgrass are scattered throughout the scrub. Dwarf scrub is the dominant vegetation at the highest elevations and on exposed ridges and steep slopes where the soils are shallow over bedrock. Crowberry, ericaceous shrubs, willow, bryophytes, and lichens generally dominate dwarf shrub communities. Poorly drained areas and areas of peat support low scrub and sedge-grass meadows.

Mammals common to the area include brown bear, Dall sheep, moose, wolf, and coyote. Ptarmigan, American golden plovers, golden eagles, and a wide variety of other birds are common in many places.

Land Use

The principal land use in this MLRA is remote wildland recreation (fig. 225-2). The rugged mountains, extensive glaciers and ice fields, and wilderness qualities of the area attract visitors from around the world. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Most of the communities are along the major rivers. A few communities and recreational lodges are along the coast. Subsistence hunting, fishing, and gathering provide food and a variety of other resources to local residents.

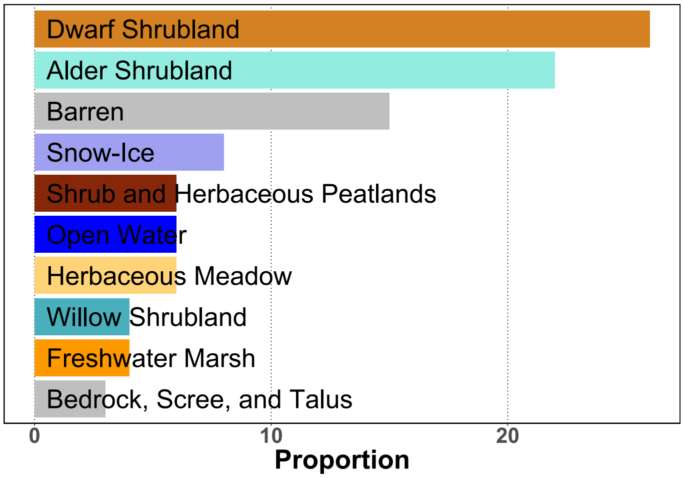

Figure 225-2: Relative proportions (percentages) of land use in MLRA 225.

Figure W2-1: Location and size of Land Resource Region W2, which covers 13,450 square kilometers (5,190 square miles) and stretches over 1,000 miles into the northern Pacific Ocean.

W2—Aleutian Alaska

Land Resource Region W2 (fig. W2-1) is an arc of volcanic islands that includes the Aleutian Islands (except Unimak Island) and the Pribilof Islands. Magma riding atop the subduction zone where the Pacific Plate from the south dives beneath the Arctic Plate to the north produced an igneous terrane that includes many active volcanoes. The region's landforms include steep mountain slopes, rolling hills, steep-walled fjords and sea cliffs, lava flows, and tilted fault blocks of volcanic-derived sediments. The eastern part of the region has been glaciated. Elevation ranges from sea level to more than 4,000 feet (0 to 1,220 meters). Unlike many areas of Alaska, the soils of the islands are not permanently frozen. The treeless islands are almost constantly shrouded by fog. The boundary between Regions W2 and W1 occurs where the Alaskan Peninsula narrows and begins breaking into islands south and west of Unimak Island. Region W2 contains one major land resource area. The extent of this MLRA and its range in elevations are shown in table W2-1.

The climate in Region W2 consists of cool temperatures, strong winds, fog, overcast skies, and precipitation characteristic of a maritime climate. The annual precipitation ranges from about 21 inches to more than 78 inches (535 to 1,980 millimeters). The average annual air temperature ranges from 36 to 39 degrees F (2 to 4 degrees C). The freeze-free period averages about 115 to 140 days. It typically occurs from May to mid-September. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRA in this region is shown in tables W2-2 and W2-3.

The soils are dominantly Andisols, primarily Cryands that formed in volcanic ash or scoria. Bare rock and rubble occur on the steep slopes of volcanic cones, peaks, and high ridges. Histosols, especially Fibrists, are in depressions and on broad valley bottoms. Soil texture grades from coarse scoria and cinders to fine sand as distance from volcanoes increases. The soils in the region have a cryic soil temperature regime, a udic or aquic soil moisture regime, and amorphic or mixed mineralogy.

Land uses in the region are wildlife habitat and subsistence hunting, fishing, and gathering (fig. W2-2). Small communities with fishing operations are located in the few good harbors. A few areas are used for recreation or livestock grazing. Almost 70 percent of the water is used by the seafood industry. The rest is used as public supply or livestock water. This region has no trees. Dwarf scrub vegetation occurs at the higher elevations and in areas exposed to strong winds. The more protected areas support mesic graminoid herbaceous vegetation.

Table W2-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
226	13,450	5,190	0	0	0	0	140	470	550	1,800	2,170	7,130

Table W2-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set. Dashes indicate data were not available.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
226	-6.3	21	1.1	34	3.4	38	4	39	4.5	40	---	---	---	---	---

Table W2-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
226	510	20	802	32	1,233/1,315	49/52	1,950	77	3,980	157

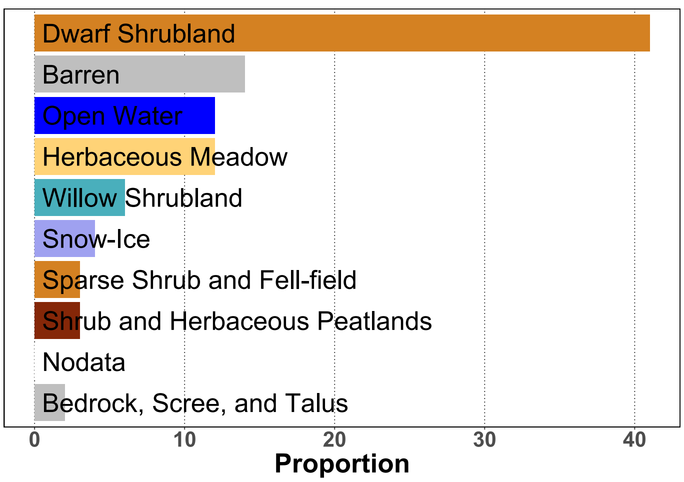

Figure W2-2: Relative proportions (percentages) of land use in LRR W2.

226—Aleutian Islands-Western Alaska Peninsula

MLRA 226 (fig. 226-1) is the only MLRA in the Aleutian Alaska Region. It makes up about 5,190 square miles (13,450 square kilometers). It includes the islands west of Unimak Island to Attu Island, the Pribilof Islands, and the Sanak Islands. The area is dominantly on steep, low to moderately high, rounded mountains and isolated, moderately high volcanic cones. It is bordered on the south by the Pacific Ocean and on the north by the Bering Sea (the Pribilof Islands are bordered on all sides by the Bering Sea).

Physiography

This area lies within the Alaska-Aleutian province of the Pacific Mountain System. At the lower elevations on the larger islands, broad, moderately sloping valleys and rolling uplands bordered by low-relief hills are common. Valley features include gently sloping fans; narrow, meandering flood plains; and shallow basins dotted with small lakes and interconnecting wetlands. The complex, irregular coastline has many prominent headlands, sea cliffs, and narrow, steep-walled bays. Elevation

Figure 226-1: Location of MLRA 226, which covers 1,344,700 hectares (3,323,000 acres), within Region W2.

ranges from sea level to more than 4,000 feet (1,220 meters) on many of the islands.

Surface water in this area is drained into the North Pacific and the Bering Sea by numerous short, steep-gradient rivers and streams. Lakes make up less than 2 percent of the area.

Geology

This MLRA includes more than 50 volcanoes, most of which were active at some time during the Quaternary and Tertiary Periods. It consists primarily of Quaternary and Tertiary volcanic rocks and unconsolidated deposits overlying a mostly submarine ridge of Tertiary sedimentary rocks. During the Pleistocene Epoch, glacial ice covered the eastern part of the area to approximately Umnak Island. To the west, probably only the upper elevations were glaciated. Volcanic activity has mantled most of the area with thick deposits of silty volcanic ash, sandy and gravelly cinders, and volcanic rubble. Some slightly modified or moderately modified glacial landforms and deposits are at the lower elevations. Glaciers make up only about 1.5 percent of the present landscape and are restricted to the upper elevations of the highest volcanoes. Recent coastal and fluvial deposits occur in scattered areas along the coast and on flood plains at the lower elevations.

Climate

The area has a cool maritime climate characterized by cloudy and foggy conditions, moderate temperatures, and abundant rainfall. Gale-force winds, occasionally approaching 100 miles per hour (160 kilometers per hour), are common during storms. The average annual precipitation ranges from 21 to about 78 inches (535 to 1,980 millimeters), generally increasing with elevation. The annual snowfall is 30 to 85 inches (75 to 215 centimeters) at the higher elevations. The average annual temperature is 36 to 39 degrees F (2 to 4 degrees C). The freeze-free period averages about 115 to 140 days.

Water

In most years precipitation is adequate for crops in some areas, but in some years yields are reduced by short dry periods in summer. Some permanent streams, originating in the mountainous regions on the islands and the Alaska Peninsula, carry water to many parts of the MLRA. The surface water generally is suitable for all uses. The rivers fed by glacial meltwater typically carry high loads of suspended sediment.

The ground water used in this MLRA is primarily from unconsolidated sediments in river valleys (alluvium or glacial outwash) but some is from bedrock aquifers. The ground water occurs as a lens of freshwater floating on saltwater near the coast. The ground water is probably hard or very hard but otherwise is of excellent quality. Wells generally are shallow in the unconsolidated sediment aquifer, and this aquifer is constantly recharged with freshwater (rainfall and runoff). As a result, the level of total dissolved solids is fairly low unless there is intrusion of seawater. The level of iron may exceed the secondary (esthetic) standard for drinking water. The iron can stain ceramic and porcelain and precipitate in pipes. The water in the bedrock aquifer generally is very similar in quality to the water in the unconsolidated sediments. Shallow aquifers are highly susceptible to contamination from runoff. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Andisols and Histosols. The soils in the area have a cryic temperature regime, a udic or aquic moisture regime, and amorphic or mixed mineralogy. Miscellaneous (nonsoil) areas make up about 46 percent of this MLRA. The most common are cinder land, rock outcrop, water, riverwash, and beaches. Small valley glaciers are at the upper elevations on a few of the larger islands.

The main soils and their series:

- Cryofibrists that are poorly drained or very poorly drained and formed in thick deposits of organic material, along the margins of streams and lakeshores
- Andic Dystrocryepts where coarse marine sediments underlie volcanic deposits
- Aquandic Dystrocryepts where coarse marine sediments underlie volcanic deposits
- Vitrandic Dystrocryepts where coarse marine sediments underlie volcanic deposits (Tsammana series)
- Haplocryands that are shallow to deep, generally are well drained to excessively drained, and formed in moderately thick or thick deposits of silty to sandy volcanic ash and coarse sandy to gravelly cinders over basalt bedrock (Zolotoi series)
- Vitricryands that are shallow to deep, generally are well drained to excessively drained, and formed in moderately thick or thick deposits of silty to sandy volcanic ash and coarse sandy to gravelly cinders over basalt bedrock (Polovina series)

Biological Resources

At the higher elevations in this area, vegetation consists of a mosaic of dwarf shrub scrub characteristic of the true alpine zone. At the lower elevations, wet and dry grasslands are dominated by mid and tall grasses, sedges, and forbs. In areas of peat, the vegetation consists of low ericaceous shrub scrub. Aleutian shield fern, the only endangered plant species currently listed for Alaska, is on Adak and Attu Islands. The MLRA has no naturally occurring forests.

This MLRA is rich in marine and bird wildlife. Two species native to the Aleutian Islands, the Steller sea lion and the Aleutian

Canada goose, are currently listed as threatened. The area is an important winter habitat for emperor geese and other waterfowl. It provides nesting habitat for a variety of birds, including green-winged teal, rock sandpiper, whiskered auklet, rock ptarmigan, song sparrow, rosy finch, and winter wren. The introduction of dogs, cats, and foxes has severely reduced the population of ground-nesting birds. Rats, coming from ships, also are a danger to these birds. Northern fur seals, Steller sea lions, and sea otters are common along the coast. Pink salmon and sockeye salmon are the most numerous fish species in the Aleutian Islands. Some of the eastern islands support small herds of caribou.

Land Use

Commercial fishing in the North Pacific and Bering Sea is the primary enterprise (fig. 226-2). Most of the communities support a fleet of boats and related fishing facilities. Reindeer herding and harvesting of fur seals for pelts and meat occur on St. Paul Island. Small herds of reindeer and cattle are on Umnak Island. Tourism and wildland recreation are becoming increasingly important. Subsistence hunting, fishing, and gathering provide food and a variety of other resources to local residents and are a major component of the local economy.

The major soil resource concerns are water erosion and mass wasting of soils that formed in volcanic ash and cinders, particularly on steep slopes. Minimizing the degree and extent of surface disturbance during construction helps to control erosion. Overgrazing by reindeer is a local concern. Control of animal numbers and proper herd management help to prevent overgrazing and allow natural restoration of depleted range.

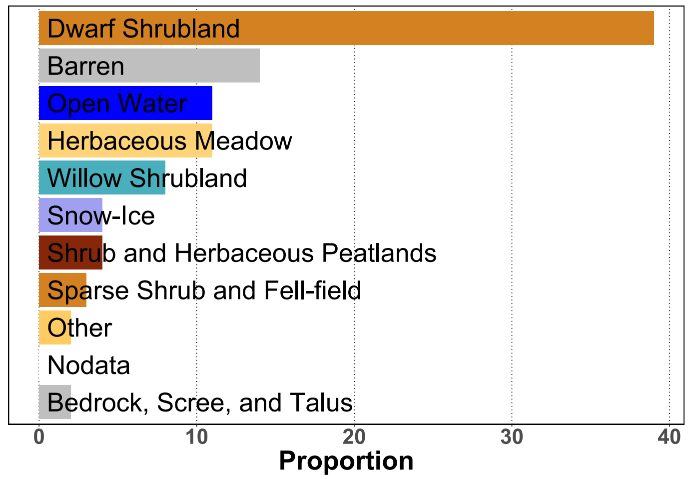

Figure 226-2: Relative proportions (percentages) of land use in MLRA 226.

Figure X1-1: Location and size of Land Resource Region X1, which covers 665,525 square kilometers (256,960 square miles) and includes the vast interior of Alaska, from the south slope of the Brooks Range to the north slope of the Alaska Range and the Copper River Basin with its surrounding mountains.

X1—Interior Alaska

Land Resource Region X1 (fig. X1-1) is the complex terrain of structural basins and scattered mountains bounded by the Brooks Range to the north and the Alaska Range to the south. This semiarid region of forests and tundra is dissected by the Yukon River. The mountains surrounding the region consist of folded and faulted strata that were extensively glaciated during the Pleistocene Epoch. Almost all parts of the region below the highest mountain peaks are unglaciated. The intermountain basins of the Yukon Flats and Interior Alaska Lowlands are broad Pleistocene and Holocene flood plains and terraces. The Copper River Plateau, to the southeast, is a higher basin with broad alluvial and lacustrine terraces and glacial landforms. The Yukon, Tanana, and Kuskokwim Rivers drain most of this region to the west into the Bering Sea. In most of the Copper River Basin, drainage is into the Gulf of Alaska via the Copper River. Landforms consist of flood plains, broad alluvial plains and terraces, hills, mountain slopes, and ridges. Elevations along the Yukon River are low; Fort Yukon, which is more than 800 miles upriver, has an elevation of only 430 feet. Elevational relief, however, is great, with heights reaching 20,320 feet (6,195 meters) on the summit of Denali (formerly Mount McKinley). Owing to its continental climate, this region has the most extreme weather in Alaska. Temperatures can occasionally reach 100 degrees F (38 degrees C) in summer and -75 degrees F (-60 degrees C) in winter. This region contains eight major land resource areas. The extent of these MLRAs and their range in elevations are shown in table X1-1.

The boundaries between Region X1 and the neighboring land resource regions are based on differences in permafrost and bioclimatic conditions. The northern boundary, with Region Y, marks the boundary between discontinuous permafrost (Region X1) and continuous permafrost (Region Y). The southern boundary, with Region W1, marks the change to discontinuous-sporadic permafrost. The western boundary, with Region X2, is not based on permafrost, as both regions have discontinuous permafrost, but on vegetation as Region X1 transitions to a treeless region.

Region X1 has a dry and cold continental subarctic climate that is characterized by short, warm summers and long, cold winters. The annual precipitation extremes range from about 8 inches (150 millimeters) in the northwest lowlands to 100 inches or more (2,540 millimeters) in the Alaska Range. In summer, afternoon thunderstorms are common in valleys and at the lower elevations in the mountains. Lightning-caused wildfires often burn many thousands of acres. The average annual temperatures range from a low of -24 degrees F to a high of 36 degrees F (-12 to 2 degrees C). They vary most in the mountainous areas. Freezing temperatures may occur in any month in most of the region. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables X1-2 and X1-3.

Table X1-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
227	19,710	7,610	140	450	450	1,490	690	2,280	890	2,910	1,880	6,180
228	140,385	54,205	60	220	350	1,160	1,040	3,430	1,910	6,280	6,160	20,210
229	101,180	39,065	10	40	30	110	130	420	380	1,250	1,300	4,270
230	109,540	42,295	10	40	80	280	230	770	450	1,480	1,360	4,470
231	156,730	60,515	40	140	220	720	550	1,810	980	3,230	1,970	6,490
232	58,020	22,400	80	270	120	400	220	730	370	1,230	1,050	3,460
233	21,765	8,405	30	100	110	370	260	850	560	1,840	1,390	4,580
234	58,195	22,470	90	310	510	1,690	910	3,010	1,420	4,670	2,480	8,140

Table X1-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set. Dashes indicate data were not available.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
227	-5	23	-3.4	26	-2.8	27	-1.5	29	-0.1	32	---	---	---	---	---
228	-31.1	-24	-6.4	20	-3.2	26	-1.1	30	2.4	36	---	---	---	---	---
229	-4.9	23	-3.8	25	-2.9	27	-1.5	29	-0.4	31	---	---	---	---	---
230	-5.4	22	-3.6	26	-2.4	28	-1.1	30	0.7	33	---	---	---	---	---
231	-9.2	15	-5.7	22	-4.2	24	-2.2	28	-0.5	31	---	---	---	---	---
232	-6.8	20	-5.5	22	-5.1	23	-4.4	24	-1.9	28	---	---	---	---	---
233	-6.4	20	-5.7	22	-5.1	23	-4.5	24	-3.6	26	---	---	---	---	---
234	-11.6	11	-8.1	17	-6.5	20	-5.2	23	-4.2	24	---	---	---	---	---

Table X1-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
227	250	10	316	12	379/390	15/15	474	19	880	34
228	260	10	405	16	596/745	23/29	1,293	51	4,180	164
229	250	10	318	13	377/390	15/15	468	18	600	24
230	340	14	403	16	456/475	18/19	556	22	920	36
231	200	8	294	12	386/395	15/16	505	20	790	31
232	170	7	223	9	256/270	10/11	325	13	550	21
233	350	14	381	15	430/450	17/18	562	22	830	32
234	240	10	312	12	418/440	16/17	587	23	1,150	45

The soils in Region X1 formed in a variety of gravelly, sandy, silty, clayey, and organic parent materials of Quaternary age as well as in loess deposits blown from alluvial flats. Patterned ground is common. Gelisols and Inceptisols are the dominant soils, with smaller areas of Spodosols, Entisols, Histosols, Mollisols, and Andisols. On mountain slopes, Orthels and Turbels are intermixed with Gelepts and Gelolls. In these areas, the soils that are not affected by permafrost formed in the coarser textured materials on the steeper slopes. The Orthels and Turbels are intermixed with Cryepts on low hills and mountains. An even mixture of Gelisols and Inceptisols dominates the basins. The Inceptisols have a more recent history of fire than the Gelisols. Wildfires disturb the insulating organic material at the surface, lowering the permafrost layer and eliminating perched water tables from these former Gelisols. Depending on the frequency of the fires, landform position, and particle size, these Inceptisols may or may not revert back to Gelisols. The Histosols are in depressions throughout the region. Organic soils include Histels with permafrost and Hemists without permafrost. The Spodosols and Andisols are of limited extent in the region. Cryods are in scattered areas in some of the mountainous parts of the region. Cryands are in parts of the Yukon-Kuskokwim Highlands. Restrictive zones occur in most soils in Region X1 as permafrost, abrupt textural changes, or paralithic or lithic bedrock.

This region is in the zone of discontinuous permafrost. Not all of the soils have permafrost. With a temperature near 30 degrees F (-1 degree C), the permafrost is warmer than that in the Northern Alaska Region (Region Y). Distribution of the permafrost-affected soils is determined by landform position, particle size, and moisture content of the soils. Much of the area on the flanks of the Brooks and Alaska Ranges is covered by rock, snow, and ice. The soils in the region have a cryic soil temperature regime or a subgelic soil temperature class, a udic or aquic soil moisture regime, and dominantly mixed mineralogy.

Land use along the Yukon River and in some other parts of the region is diverse and includes urban development and rural settlement, agriculture, forestry, mining, subsistence hunting and fishing, and wildlife habitat (fig. X1-2). Much of this region, however, is sparsely populated wildland. Native vegetation across the region ranges from boreal forests to alpine tundra. The southern Brooks Range and the flanks of the Alaska Range are dominated by alpine tundra with grasses, sedges, mosses, lichens, ericaceous shrubs, and willows. The low hills and mountains have a mixture of alpine tundra and boreal forests. The basins are dominantly boreal forests with black spruce, white spruce, paper birch, and quaking aspen.

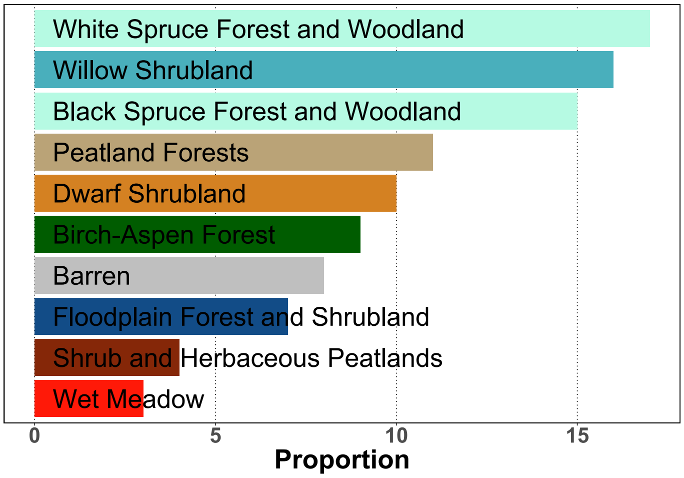

Figure X1-2: Relative proportions (percentages) of land use in LRR X1.

227—Copper River Basin

MLRA 227 (fig. 227-1) includes the Talkeetna, Chugach, and Wrangell Mountains and the Copper River Plateau, a broad intermontane basin bordered by the Alaska Range. It makes up about 7,610 square miles (19,710 square kilometers). It is mainly on nearly level to undulating plains and rolling hills in the zone of discontinuous permafrost. The area is mostly undeveloped wildland and is sparsely populated. The climate is continental subarctic.

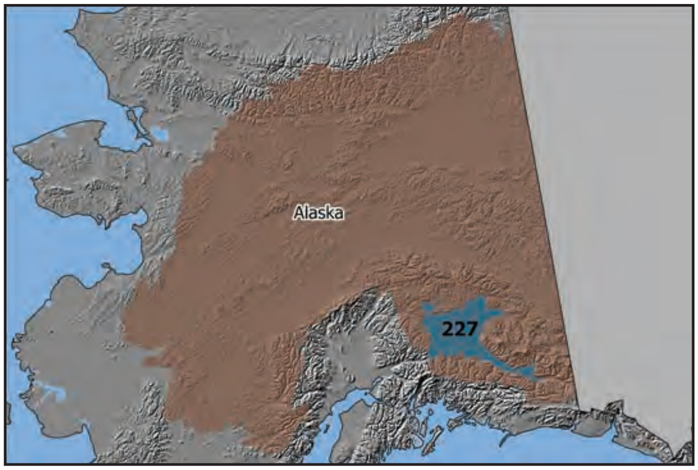

Figure 227-1: Location of MLRA 227, which covers 1,970,900 hectares (4,870,400 acres), within Region X1.

MLRA 227 is bordered by two distinct and physiographically dissimilar areas: MLRA 228 (Interior Alaska Mountains), which has high mountain slopes and glaciated hills and plains, almost exclusively, and MLRA 223 (Cook Inlet Mountains), which has rugged, moderate to high mountains, near Gunsight Mountain at Tahneta Pass.

Physiography

The MLRA lies within the Coastal Trough province of the Pacific Mountain System. Many depressions and shallow basins on the plains have lakes and interconnecting wetlands, particularly in the western and northern parts of the area. Narrow flood plains and stream terraces are along the rivers and streams. In many places the rivers are deeply incised with high escarpments and breaks between the river bottom and adjacent plains. Isolated, low- to moderate-relief mountains are in the northern and western parts of the MLRA. Long footslopes are common at the base of the mountains. In general, elevation ranges from about 600 feet (185 meters) along the Copper River at Chitina to about 2,600 feet (795 meters) along the edge of the basin. The highest point in the area, Windy Point on Slide Mountain, is 3,806 feet (1,160 meters).

The Copper River drains most of the area through the Chugach Mountains to the Gulf of Alaska. The major tributaries of the Copper River are the Gulkana, Gakona, Tazlina, and Chitina Rivers. The largest lakes are Lake Louise, Susitna Lake, Crosswind Lake, and Ewan Lake. Lakes make up about 10 percent of the MLRA.

Permafrost is commonly close to the surface in areas of finer textured sediments on plains, stream terraces, and the more gently sloping footslopes and hills. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. Permafrost generally does not occur on flood plains or in close proximity to lakes and other water bodies.

Geology

During the latter part of the Pleistocene Epoch, glacial ice dammed the Copper River drainage, forming a large proglacial lake in the center of the basin. Glaciers from the surrounding mountains extended into the basin, probably calving into the lake much of the time. At the onset of the Holocene Epoch, the glaciers receded and the lake emptied, exposing a broad, nearly level to rolling plain. The central basin is filled with clayey lacustrine deposits that become progressively siltier toward the outer margins of the former lake. Slightly modified glacial moraines and drift, as well as some drumlins and eskers, are above the level of the former lake. During the Holocene Epoch, the rivers and streams in the area cut into the lacustrine deposits, creating low to high escarpments and depositing coarse textured alluvium on flood plains and stream terraces. A layer of calcareous silty loess of varying thickness mantles much of the modern landscape. Quaternary and Tertiary volcanic rocks are exposed along river escarpments in the southeastern part of the MLRA. Isolated mountains in the basin formed in stratified sedimentary rocks of Permian and Pennsylvanian age.

Climate

Brief, warm summers and long, cold winters characterize the continental subarctic climate of the area. Freezing temperatures are not unusual in summer, particularly at the higher elevations. The average annual precipitation ranges from about 10 inches (255 millimeters) in the central basin to more than 20 inches (510 millimeters) at the higher elevations in the northern and western parts of the MLRA. The average annual snowfall ranges from about 40 to 70 inches (100 to 180 centimeters). The average annual temperature ranges from about 23 to 28 degrees F (-5 to -2 degrees C). The freeze-free period averages 35 to 90 days.

Water

Because of its chemical quality, the surface water in the area generally is suitable for all uses. However, the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks.

Soils

The dominant soil orders are Gelisols, Inceptisols, Spodosols, Entisols, and Mollisols. The soils in the area have a subgelic soil temperature class or a cryic temperature regime, an aquic or udic moisture regime, and dominantly mixed mineralogy. The Inceptisols and Mollisols have a more recent history of fire than the Gelisols. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the taxonomic classification. Depending on the frequency of the fires, landform position, and particle size, these soils may or may not revert back to Gelisols. Miscellaneous (nonsoil) areas make up about 12 percent of this MLRA. The most common are riverwash and water.

The main soils and their series:

- Cryofluvents that formed in loamy alluvium over gravelly alluvium on flood plains and low terraces (Klutina series)
- Cryorthents that formed in loamy alluvium over gravelly alluvium on flood plains and low terraces
- Fibristels that are shallow or moderately deep to permafrost, poorly drained or very poorly drained, and in depressions
- Haplocryepts that are well drained and formed in thick deposits of loess or in a mantle of loess over clayey lacustrine sediments or gravelly till and outwash; on stream terraces, lacustrine terraces, till plains, and hills (Pippin, Gakona, and Gulkana series)
- Haplocryolls that are well drained and formed in thick deposits of loess or in a mantle of loess over clayey lacustrine sediments or gravelly till and outwash; on stream terraces, lacustrine terraces, till plains, and hills (Kenny Lake and Tonsina series)
- Hemistels that are shallow or moderately deep to permafrost, poorly drained or very poorly drained, and in depressions (Wrangell series)
- Historthels that are poorly drained and formed in thick deposits of loess or in a mantle of loess over clayey lacustrine sediments or gravelly till and outwash; on stream terraces, lacustrine terraces, till plains, and hills (Dadina and Klawasi series)
- Histoturbels that are well drained and formed over shallow permafrost in a loess layer over variable material, including glacial till, lacustrine deposits, and bedrock (Strelna series)

Biological Resources

On productive, well drained soils in the uplands, forest vegetation includes white spruce, aspen, and paper birch.

White spruce and white spruce-balsam poplar forests are on high flood plains and low stream terraces. Stunted black spruce and white spruce woodland of low productivity is on north-facing slopes, high stream terraces, and cold, wet sites with shallow permafrost. Following wildfires, willow, shrub birch, and ericaceous shrub scrub invade most sites until they eventually are replaced by forest vegetation. On most forest and woodland sites, post-fire succession leads to a relatively rapid accumulation of organic matter and mosses on the surface. This accumulation results in a decrease in soil temperature, biologic activity, and nutrient availability and a gradual decrease in site productivity. Nonforest vegetation in areas of peat, in drainageways, and above the tree line includes low to tall willow, shrub birch, and ericaceous shrub scrub. Wet sedge meadows, sedge-grass meadows, and sedge-moss bog meadows are along the margins of lakes and on continuously ponded sites. Willow and alder scrub are on low flood plains.

Mammals common to the area include brown bear, black bear, caribou, moose, wolf, and a variety of rodents. Ponds and wetlands provide high-quality habitat for tundra swans and other waterfowl. Bald eagles are common along most rivers. The rivers and lakes support lake trout, rainbow trout, grayling, burbot, northern pike, and whitefish.

Land Use

Several small farms are in the Kenny Lake area. Grasses, small grains, potatoes, and cool-season vegetables are grown on less than 1 percent of the MLRA. Small-scale timber harvesting occurs in a few places. Each year, hunting, fishing, boating, hiking, and other kinds of wildland recreation attract thousands of visitors. Subsistence hunting, fishing, and gathering provide food and a variety of other resources to both native and non-native residents. Less than 1 percent of the area is urban (fig. 227-2).

The major soil resource concerns are wind erosion and water erosion where native vegetation has been removed. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and thermal balance of the soils.

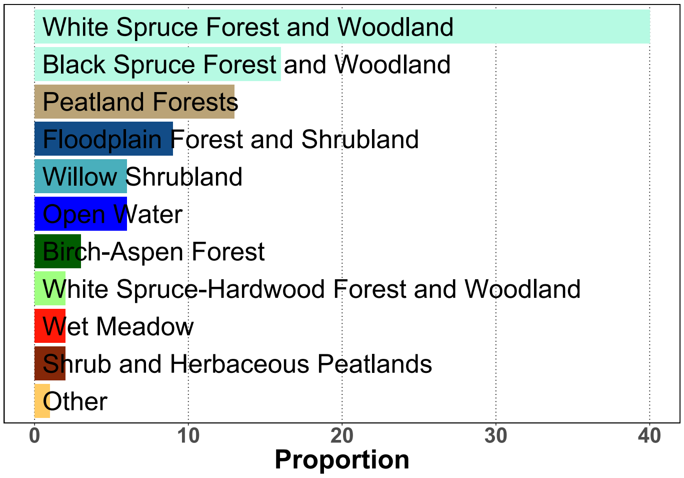

Figure 227-2: Relative proportions (percentages) of land use in MLRA 227.

228—Interior Alaska Mountains

MLRA 228 (fig. 228-1) includes the high mountain slopes and glaciated hills and plains of the Alaska Range, Talkeetna Mountains, Chugach Mountains, Wrangell Mountains, and the northern Aleutian Range. It makes up about 54,205 square miles (140,385 square kilometers). The area consists of rugged, high mountains and low, rounded hills and extended footslopes along the base of the mountains. It is primarily undeveloped wildland and includes the true alpine and subalpine zones. The geology consists of sedimentary, metamorphic, and igneous bedrock. The climate is continental subarctic.

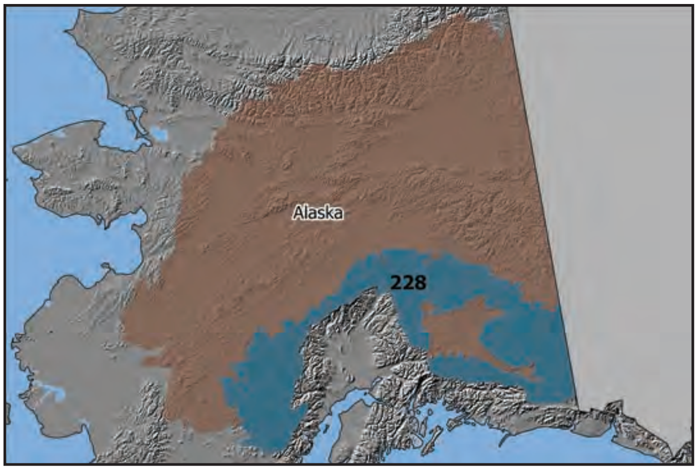

Figure 228-1: Location of MLRA 228, which covers 14,038,400 hectares (34,689,800 acres), within Region X1.

MLRA 228 shares a less apparent border to the southeast with MLRA 222 (Southern Alaska Coastal Mountains), where the maritime climate transitions to continental in the true alpine zone of the Coastal Mountains. To the south is the geologically dissimilar MLRA 223 (Cook Inlet Mountains), which is dominated by sedimentary geology with an admixture of loess and volcanic ash. MLRA 228 has a similar boundary with MLRA 225 (Southern Alaska Peninsula Mountains), where volcanic activity in Mount Katmai and other volcanoes has deposited a layer of volcanic ash across much of the landscape. This boundary occurs from the Chigmit Mountains along the Lake Clark National Preserve boundary to Chekok Lake. To the west, north, and east are distinct boundaries based on physiography with MLRAs 236, 227, and 229. MLRA 236 (Bristol Bay-Northern Alaska Peninsula Lowlands) has nearly level to rolling lowlands, uplands, and isolated hills. MLRA 227 (Copper River Basin) has a broad intermontane basin. MLRA 229 (Interior Alaska Lowlands) has flood plains and terraces. To the west and northwest is a discontinuous boundary with the physiographically dissimilar MLRA 230 (Yukon-Kuskokwim Highlands), which lies in the Western Alaska physiographic province of the Intermontane Uplands and Lowlands system (Wahrhaftig, 1965).

Physiography

This MLRA lies within the Pacific Mountain System. The part of this area in the Aleutian and Alaska Ranges lies within the Alaska-Aleutian province, the part in the Chugach and Wrangell Mountains lies within the Pacific Border Ranges province, and the part in the Talkeetna Mountains lies within the Coastal Trough province. The mountains throughout the MLRA are deeply dissected by narrow to broad, high-gradient valleys, typically with braided flood plains on the valley bottoms. Coalescing fans and steep footslopes are common in the valleys. Large valley glaciers occur throughout the MLRA. Glaciers and permanent ice and snow make up about 15 percent of the area. Elevation ranges from about 1,500 feet (455 meters) near Paxson in the basin of the Copper River to 20,320 feet (6,195 meters) at the summit of Denali.

Surface water on the north slopes of the Aleutian and Alaska Ranges drains into the Bering Sea via the Tanana and Kuskokwim Rivers. The major tributaries of the Kuskokwim River are the Stony River and the North Fork of the Kuskokwim River. The major tributaries of the Tanana River are the Kantishna, Nenana, Delta, and Nabesna Rivers. Surface water in the mountains bordering the basin of the Copper River drains into the Copper River, the Gulf of Alaska, and the North Pacific. The major tributaries of the Copper River are the Gulkana, Tazlina, and Chitina Rivers. The headwaters of the Susitna River, which drains into the Cook Inlet Lowlands (MLRA 224) and Cook Inlet, are in this MLRA. Lakes and ponds make up less than 1 percent of the area. The area, however, has several large lakes and lake systems, including Tazlina, Klutina, and Tonsina Lakes in the Chugach Mountains and Paxson Lake and the Tangle Lakes system in the Alaska Range.

This MLRA is in the zone of discontinuous permafrost. Generally, permafrost is close to the surface only in areas of finer textured sediments on stream terraces and in swales on hills and footslopes. In the mountains, permafrost occurs only in gently sloping areas of rounded ridges, swales, and footslopes. Flood plains generally have no permafrost.

Geology

During the Late Pleistocene Epoch, all of this area was covered with glacial ice, except for the highest peaks and steep upper ridges. For the most part, glacial deposits eroded away or were buried by mountain colluvium and alluvium, which accumulated during the Holocene Epoch across about 60 percent of the landscape. Slightly modified to highly modified glacial moraines, drift, and outwash deposits are extensive on the lower mountain slopes and in valleys at the lower elevations. Silty eolian deposits are limited to the lower mountain slopes and valleys. Valley bottoms are buried by recent fluvial deposits. The bedrock geology consists primarily of Upper Paleozoic and Mesozoic sedimentary, metamorphic, and igneous rocks and Tertiary intrusive and volcanic rocks. The Usibelli Coal Mine and some commercial and recreational gold mines are in this area.

Climate

Brief, cool summers and long, cold winters characterize the continental subarctic climate of the area. The extreme variation in elevation results in a wide range of climatic conditions. The average annual precipitation ranges from about 15 to 20 inches (380 to 510 millimeters) at the lower elevations. It is as much as 100 inches (2,540 millimeters) at the highest elevations in the Alaska Range and Wrangell Mountains. The amount of rainfall generally is highest in July, August, and early September. The average annual snowfall ranges from about 70 to 400 inches (180 to 1,015 centimeters). The average annual temperature at Denali Park headquarters in the Alaska Range is 27 degrees F (-3 degrees C). The freeze-free period averages about 50 to 80 days. At the higher elevations, freezing temperatures can occur during every month.

Water

Because of its chemical quality, the surface water generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, leaking fuel storage tanks, and industrial waste from coal and gold mining.

Soils

The dominant soil orders are Gelisols, Inceptisols, Spodosols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. Miscellaneous (nonsoil) areas make up about 58 percent of this MLRA. The most common are rock outcrop, rubble land, and glaciers.

The main soils:

Cryofluvents and Cryorthents that are somewhat poorly drained to well drained and formed in loamy alluvium over sandy and gravelly alluvium on flood plains

Gelepts and Cryepts that do not have permafrost, are shallow to very deep, are well drained, and formed in gravelly colluvium over fractured bedrock on steep mountain slopes

Haplocryods that are somewhat excessively drained and formed in a thin layer of silty eolian deposits over sandy and gravelly outwash and alluvium on outwash plains, hills, and terraces

Histoturbels and Aquiturbels that are shallow or moderately deep to permafrost, generally are poorly drained, and formed in loamy and gravelly glacial till on mountain slopes, hills, and plains

Biological Resources

The alpine vegetation consists of a variety of dwarf scrub and herbaceous communities. Black crowberry, ericaceous shrubs, dwarf willow, or Dryas typically dominates dwarf scrub. Various sedges, grasses, and low forbs dominate herbaceous communities. Low willow scrub is common in drainages. Lichens, scattered herbs, and dwarf shrubs dominate bedrock exposures and very shallow soils. In general, there is little or no plant growth at elevations above about 7,500 feet (2,285 meters). The vegetation in the subalpine zone generally is low and medium scrub dominated by shrub birch and ericaceous shrubs that grade into white spruce woodlands at the lower elevations. Tall alder scrub is common in many places.

Mammals common to the area include brown bear, black bear, Dall sheep, caribou, moose, wolf, coyote, fox, snowshoe hare, Arctic ground squirrel, and hoary marmot. Ptarmigan, American golden plovers, golden eagles, and a wide variety of other birds are common in many places.

Land Use

Remote wildland recreation is the principal land use (fig. 228-2). The rugged mountains, extensive glaciers, and wilderness qualities of the area attract hikers and wilderness enthusiasts from around the world. Every summer, hundreds of people attempt to climb Denali and other high peaks in the area. More people visit Denali National Park than any other park in Alaska. Hunters pursue moose, caribou, Dall sheep, brown bear, and black bear. Back-country recreationists and hunters are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. A large-scale, open-pit mine in the mountains near Healy provides fuel for electrical generator plants in Fairbanks and elsewhere in Alaska. Small-scale commercial and recreational gold mines operate along several streams. There are no major resource concerns in this MLRA.

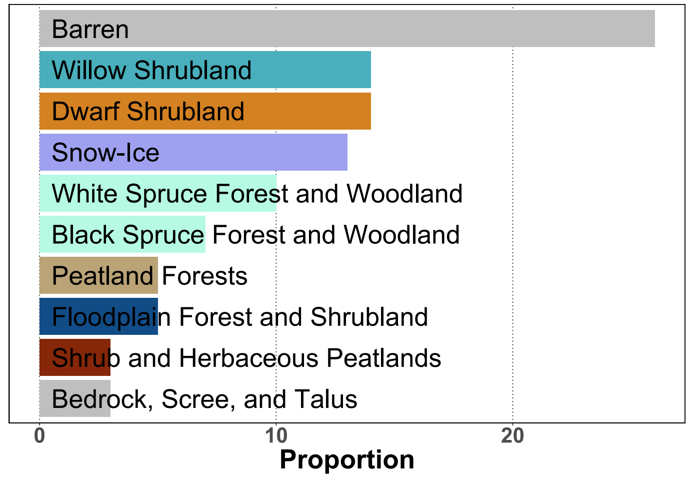

Figure 228-2: Relative proportions (percentages) of land use in MLRA 228.

229—Interior Alaska Lowlands

MLRA 229 (fig. 229-1) includes the flood plains and terraces along the upper reaches of the Tanana and Kuskokwim Rivers and the middle reaches of the Yukon River. It makes up about 39,065 square miles (101,180 square kilometers). It is on broad, nearly level, braided to meandering flood plains, stream terraces, and outwash plains in the zone of discontinuous permafrost. The area is filled with a deep layer of Pleistocene glaciofluvial deposits that has a significant content of mica derived from source parent materials. The climate is continental subarctic. The area was never glaciated.

MLRA 229 has boundaries based on physiographical differences with MLRAs 228 (Interior Alaska Mountains), 230 (Yukon-Kuskokwim Highlands), 231 (Interior Alaska Highlands), 233 (Upper Kobuk and Koyukuk Hills and

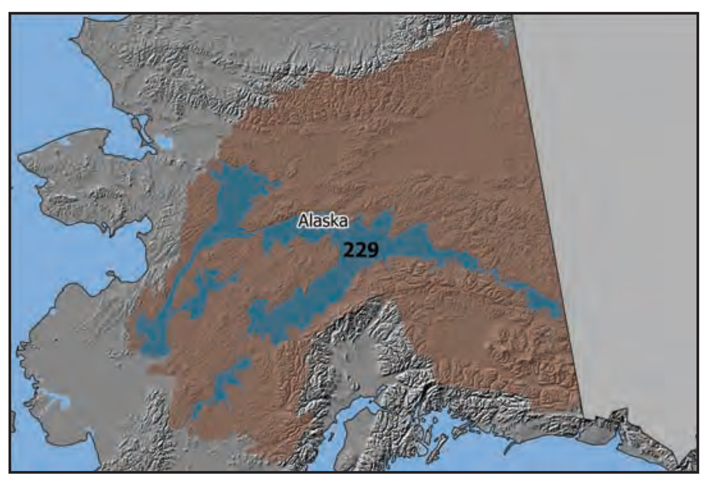

Figure 229-1: Location of MLRA 229, which covers 10,117,900 hectares (25,001,900 acres), within Region X1.

Valleys), and 238 (Yukon-Kuskokwim Coastal Plain). MLRA 228, to the south, has high mountain slopes and glaciated hills and plains. MLRA 230, to the west and in the interior, has moderate- to high-relief mountains, hills, and valleys. MLRA 231, to the northeast, has extensive hills, low to moderately high mountains, and valleys. MLRA 233, to the north, has nearly level lowlands, rolling uplands, and isolated hills and mountains along the Kobuk River. MLRA 238, to the southwest, has a broad, nearly level delta formed by the lower reaches of the Kuskokwim and Yukon Rivers.

MLRA 229 has a less apparent boundary with MLRA 236 (Bristol Bay-Northern Alaska Peninsula Lowlands) near Shotgun Hills. Much of MLRA 236 has been mantled with a layer of silty volcanic ash and loess of varying thickness from regional volcanoes.

Physiography

This area lies within the Western Alaska province and Northern Uplands and Lowlands province of the Intermontane Uplands and Lowlands System. In many places shallow basins and undulating stream terraces are dotted with hundreds of small and medium-size lakes and interconnecting wetlands. Sloughs, oxbow lakes, and low to high escarpments along river channels are features associated with the flood plains, terraces, and basins. Isolated bedrock-controlled hills and low- to moderate-relief mountains are in scattered areas throughout the MLRA. Extended footslopes are common at the base of hills and mountains and along the boundaries with adjoining mountainous MLRAs. Elevation ranges from about 100 feet (30 meters) in the southwestern part of the area, along the lower Yukon River, to about 1,900 feet (580 meters) in the upper Tanana Valley.

Surface water throughout the MLRA drains to the Bering Sea via the Tanana, Yukon, and Kuskokwim Rivers. The major tributaries of the Tanana River are the Kantishna, Nenana, Delta, and Nabesna Rivers. The major tributaries of the Yukon River, in addition to the Tanana River, are the Koyukuk and Innoko Rivers. The major tributaries of the Kuskokwim River are the Stony River and the North Fork of the Kuskokwim River. Lakes make up about 10 percent of the MLRA.

Permafrost commonly is close to the surface in areas of finer textured sediments on plains, stream terraces, and the more gently sloping footslopes and hills. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. Permafrost generally does not occur on flood plains or in areas near lakes and other water bodies.

Geology

Although never glaciated, this area is filled with a deep layer of Pleistocene glaciofluvial deposits. Additional fluvial sediments from the Alaska Range and the northern Aleutian Range accumulated along the Tanana and Kuskokwim Rivers during the Holocene Epoch. The Koyukuk and lower Yukon River drainages have undergone several periods of deposition followed by erosion. In some places old terraces are 33 to 250 feet (10 to 75 meters) above the flood plain. Quaternary glaciofluvial and fluvial sediments are estimated to be as much as 330 to 660 feet (100 to 200 meters) thick throughout the area. Much of the MLRA, particularly along the Tanana and Kuskokwim Rivers, is mantled with a layer of silty micaceous loess originating from the unvegetated flood plains and outwash plains along the Alaska Range. Thick eolian deposits, including loess and sand dunes, make up about 12 percent of the area. Inclusions of glacial moraines and drift are near the mountains. Unconsolidated sediments bury the bedrock geology, except for structural hills in some places.

Climate

Short, warm summers and long, very cold winters characterize the continental subarctic climate of the area. The average annual precipitation ranges from 10 to 15 inches (255 to 380 millimeters) in the eastern and northern parts of the MLRA and from 15 to 20 inches (380 to 510 millimeters) in the southern and western parts. The maximum precipitation occurs in late summer, mainly during thunderstorms. The average annual snowfall ranges from 30 to 80 inches (75 to 205 centimeters). The average annual temperature ranges from about 22 degrees F (-6 degrees C) in the eastern part of the area to 28 degrees F (-4 degrees C) in the western part. The freeze-free period averages about 70 to 120 days. The temperature usually remains above freezing from June through mid-September.

Water

In most years precipitation is adequate for crops, but in some years yields are reduced by short, dry periods in summer. Permanent streams, originating in the surrounding mountainous regions, bring water to nearly all parts of the MLRA. The area has numerous large natural lakes and some constructed reservoirs. The surface water is used for public supply, placer mining, cooling thermoelectric power plants, and some limited irrigation. It is generally suitable for all uses. Rivers fed by glacial meltwater streams below placer mines typically carry high loads of suspended sediment. Flooding from ice dams that form during the spring thaw is a concern.

The ground water used is primarily from unconsolidated sediments in river valleys (alluvium) or from buried glacial outwash deposits in the river valleys. This water is hard or very hard but is otherwise of excellent quality. Wells in these aquifers generally are shallow, and the aquifers are constantly recharged with freshwater (rainfall and runoff). The level of iron greatly exceeds the secondary (esthetic) standard for drinking water. The iron can stain ceramic and porcelain and precipitate in pipes. Since the aquifers are close to the surface and water moves through them quickly, they are highly susceptible to contamination from runoff. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks.

Some ground water can be obtained from the Fairbanks-North Star bedrock aquifer near Fairbanks and from unnamed bedrock aquifers in other parts of the MLRA. Except for lower levels of iron, the water in the unnamed bedrock aquifers is similar in quality to that in the unconsolidated sediments. The water in the Fairbanks-North Star aquifer is harder than that in the unconsolidated sediments. The level of iron is similar to that of the water in the alluvium or outwash. Tests indicate that the level of arsenic in water from the Fairbanks-North Star bedrock aquifer can exceed the national drinking water standard.

Soils

The dominant soil orders are Gelisols, Inceptisols, Entisols, and Spodosols. The soils in the area have a subgelic soil temperature class or a cryic temperature regime, an aquic or udic moisture regime, and dominantly mixed mineralogy. Many of the soils have a significant content of mica derived from parent materials.

All of the Gelisols are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the taxonomic classification. Depending on the frequency of the fires, landform position, and particle size, these soils may or may not revert back to Gelisols. Haplocryepts, Dystrocryepts, Cryaquepts, and Haplocryods occur on the same landforms and formed in the same kind of material as the Gelisols. Unlike the Gelisols, they do not have permafrost within the soil profile. Miscellaneous (nonsoil) areas make up about 19 percent of this MLRA. The most common are riverwash and water.

The main soils and their series:

- Aquiturbels that formed in silty loess of varying thickness over loamy, sandy, and gravelly alluvial deposits, on nearly level stream terraces and outwash plains; that formed in silty loess over loamy slope alluvium and colluvium, on elongated footslopes (Tanana series)
- Cryaquepts that are poorly drained or very poorly drained (Liscum series)
- Cryofibrists that are very poorly drained, are along the margins of lakes and in shallow basins, and formed in floating fibrous peat
- Cryofluvents that are moderately well drained to excessively drained and formed in stratified silty, sandy, and gravelly alluvium; on flood plains and low stream terraces (Jarvis and Salchaket series)
- Cryorthents that are moderately well drained to excessively drained and formed in stratified silty, sandy, and gravelly alluvium; on flood plains and low stream terraces (Chena series)
- Dystrocryepts that are well drained to excessively drained (Zitziana series)
- Fibristels that formed in thick layers of organic material, in depressions on stream terraces, outwash plains, and elongated footslopes (Lemeta series)
- Haplocryepts that are well drained to excessively drained (Volkmar series)
- Hemistels that formed in thick layers of organic material in depressions on stream terraces, outwash plains, and elongated footslopes (Bolio series)
- Histoturbels that formed in silty loess of varying thickness over loamy, sandy, and gravelly alluvial deposits, on nearly level stream terraces and outwash plains; that formed in silty loess over loamy slope alluvium and colluvium, on elongated footslopes (Tanacross series)

Biological Resources

On productive, well drained soils in the uplands, forests include white spruce and mixed white spruce, paper birch, and quaking aspen. White spruce and white spruce-balsam poplar forests are on high flood plains and low stream terraces. Stunted black spruce and white spruce woodland of low productivity occurs on north-facing slopes, high stream terraces, and cold, wet sites with shallow permafrost. On permafrost-affected flats, tamarack and paper birch occur in association with spruce. Lightning-caused wildfires are common. Many thousands of acres are often burned during a single fire. Following wildfires, willow, shrub birch, and ericaceous shrub scrub invade most sites until they eventually are replaced by forest vegetation. On all forest and woodland sites, post-fire succession leads to a relatively rapid accumulation of organic matter and mosses on the surface. This accumulation results in decreases in soil temperature, biologic activity, and nutrient availability and a gradual decrease in site productivity. Nonforest vegetation includes low to tall willow, shrub birch, and ericaceous shrub scrub in peat areas and in drainageways. Wet sedge meadows, sedge-moss bog meadows, and sedge-grass meadows are along the margins of lakes and on continuously ponded sites. Low to tall willow and alder scrub are on low flood plains.

Mammals common to the area include brown bear, black bear, caribou, moose, wolf, lynx, and a variety of rodents. Ponds and wetlands provide high-quality habitat for tundra swans, sandhill cranes, and other waterfowl. Bald eagles are common along most rivers. The rivers and lakes support salmon, lake trout, rainbow trout, Arctic grayling, burbot, northern pike, blackfish, and whitefish.

Land Use

The southwest part of this MLRA and nearby portions of the Interior Alaska Highlands (MLRA 231) are the second most densely populated areas in Alaska. Elsewhere, this MLRA is mostly undeveloped wildland (fig. 229-2) and is sparsely populated. Farming is a major land use in the Tanana Valley near Fairbanks and Delta Junction. Grasses, small grains, potatoes, and other cool-season vegetables are the principal

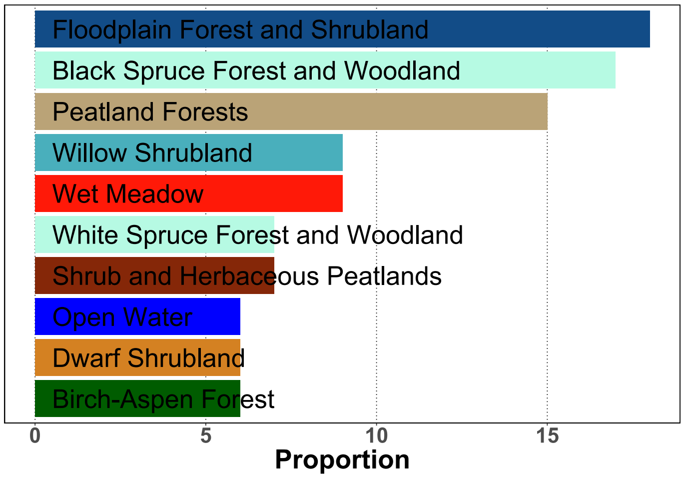

Figure 229-2: Relative proportions (percentages) of land use in MLRA 229.

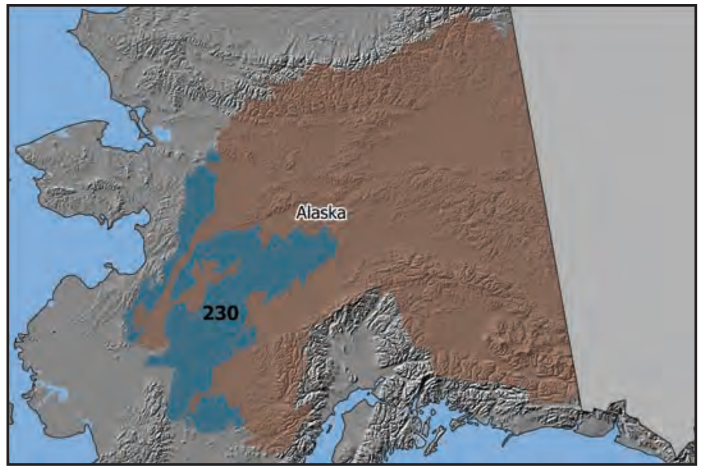

Figure 230-1: Location of MLRA 230, which covers 10,953,700 hectares (27,067,400 acres), within Region X1.

crops. Some dairy cattle, beef cattle, and hogs are raised on the farmland. The flood plains and low stream terraces along the Tanana and Yukon Rivers are among the most productive forestlands in Interior Alaska. Logging provides important wood products for local use and export. Extractable minerals, dominantly gold and silver, occur in certain areas. Wildland recreation, primarily hunting for moose and other game, is a significant land use. Many residents rely on subsistence hunting, fishing, and gathering for a large part of their food. Urban development, particularly along the road system, has impacted less than 1 percent of the area. Urban development and road construction require a significant quantity of construction material, and gravel pits of various sizes are along the major roads and near urban developments.

The major soil resource concerns are wind erosion and water erosion where the native vegetation has been removed. Most urban and rural developments are adjacent to rivers, where flooding is a severe hazard. Flooding is associated with spring snowmelt and runoff from the adjacent mountains and ice jamming at river bends during periods of ice breakup.

Conservation practices on forestland generally include timber stand improvement and proper construction of roads, landings, and stream crossings. Erosion- and sediment-control practices are important in the areas used for urban development.

230—Yukon-Kuskokwim Highlands

MLRA 230 (fig. 230-1) includes the mountains, hills, and valleys of the Lime Hills, the Kuskokwim Mountains, and the eastern side of the Nulato Hills. It makes up 42,295 square miles (109,540 square kilometers). The mountains have moderate to high relief, and the valleys are narrow and flat-bottomed. The area is mostly undeveloped wildland in the zone of discontinuous permafrost and is sparsely populated.

MLRA 230 has a boundary based physiography with MLRA 238 (Yukon-Kuskokwim Coastal Plain) to the southwest. This adjacent MLRA has the broad, nearly level delta formed by the lower reaches of the Yukon and Kuskokwim Rivers. MLRA 230 also has boundaries based on physiography with MLRAs 229 (Interior Alaska Lowlands), 242 (Northern Seward Peninsula-Selawik Lowlands), and 236 (Bristol Bay-Northern Alaska Peninsula Lowlands). These adjacent MLRAs are identifiable by broad, nearly level, braided to meandering flood plains, stream terraces, outwash plains, and extended mountain footslopes.

MLRA 230 also has boundaries based on physiography with MLRAs 233 (Upper Kobuk and Koyukuk Hills and Valleys), 228 (Interior Alaska Mountains), and 237 (Ahklun Mountains). MLRA 233 has isolated hills and low mountains. MLRA 228 has high mountain slopes and glaciated hills and plains. MLRA 237 has steep, rugged low mountains.

MLRA 230 has less apparent boundaries based on climate with MLRAs 240 (Nulato Hills-Southern Peninsula Highlands) and 241 (Seward Peninsula Highlands). The climate of MLRA 240 is maritime for most of the year but changes to strongly continental in winter. The prevalent climate of MLRA 241 is continental arctic.

Physiography

This area lies within the Western Alaska province of the Intermontane Uplands and Lowlands System. Local relief is highest in the Kuskokwim Mountains. In the Nulato, Nushagak, and Lime Hills, it is generally lower. Most of the mountains at the mid and higher elevations have gently sloping to strongly sloping, rounded summits. In a few places, particularly at the highest elevations in the Kuskokwim Mountains, the mountains are more rugged and have sharp ridges. Valley bottoms consist of nearly level flood plains and stream terraces, which transition to moderately steep mountain footslopes and alluvial and colluvial fans at the base of the mountains. Elevation ranges from about 30 feet (9 meters) in the western part of the MLRA, along the edge of the

Yukon-Kuskokwim Coastal Plain (MLRA 238), to 4,508 feet (1,374 meters) at the summit of Von Frank Mountain, in the southeastern Kuskokwim Mountains.

Surface water on the eastern slope of the Nulato Hills, the Kuskokwim Mountains, and the western part of the Lime Hills drains into the Bering Sea via the Yukon, Innoko, and Kuskokwim Rivers. Surface water on the eastern and southern Lime Hills drains into the Mulchatna and Nushagak Rivers and Bristol Bay. Lakes make up about 7 percent of the MLRA.

Permafrost commonly is close to the surface in places with finer textured sediments throughout the MLRA. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. The prevalence of permafrost decreases to the southwest. Permafrost generally does not occur on flood plains or on south-facing slopes on steep mountains.

Geology

During the Pleistocene Epoch, the Lime Hills in the southeastern part of this area were covered extensively by glaciers originating in the Alaska Range and the northern Aleutian Range. Glacial moraines and drift are common in this part of the MLRA. Elsewhere, the area generally was not glaciated and the uplands are covered primarily by bedrock colluvium and slope alluvium originating from the underlying bedrock. Silty loess deposits of limited extent cover footslopes and the lower backslopes of hills near the major rivers. The bedrock geology consists primarily of Cretaceous and Lower Paleozoic stratified sedimentary rocks and many (and in places extensive) inclusions of Cretaceous and Tertiary intrusive and volcanic rocks. The area is cut by numerous northeast-trending faults. Quaternary fluvial and eolian deposits cover valley bottoms and the lower mountain slopes.

Climate

The climate is transitional, from continental subarctic in the eastern part of the MLRA to maritime in the southwestern part, along the boundary with the Western Region of Alaska. The average annual precipitation ranges from about 10 to 15 inches (255 to 380 millimeters) at the lower elevations in the eastern part of the MLRA to 20 to 40 inches (510 to 1,015 millimeters) at the higher elevations in the western and southwestern parts. The average annual snowfall ranges from about 80 to 100 inches (205 to 255 centimeters). The average annual temperature is estimated to be about 20 to 25 degrees F (-7 to -4 degrees C). The freeze-free period at the lower elevations averages about 60 to 80 days. Freezing temperatures may occur in any month at the higher elevations.

Water

This MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, Spodosols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic temperature regime, an aquic or ustic moisture regime, and dominantly mixed mineralogy. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the taxonomic classification. Depending on the frequency of the fires, landform position, and particle size, these soils may or may not revert back to Gelisols. Miscellaneous (nonsoil) areas make up about 10 percent of this MLRA. The most common are rock outcrop and rubble land. In many valleys placer mine tailings are common.

The main soils:

- Aquiturbels that formed in gravelly colluvium or in loess over gravelly colluvium; on long footslopes, ridges above the tree line, and solifluction lobes
- Cryofluvents, Cryaquents, and Cryorthents that formed in stratified loamy, sandy, and very gravelly alluvium and range from very poorly drained to excessively well drained; on flood plains
- Dystrocryepts and Haplocryepts that formed in colluvium over fractured bedrock on the upper slopes and on ridges
- Fibristels and Hemistels that formed in thick layers of organic material; in depressions (thermokarst depressions in places) on terraces and in swales on hillslopes
- Gelisols that are shallow or moderately deep to permafrost and are poorly drained or very poorly drained
- Histoturbels that formed in moderately thick layers of organic material over loamy colluvium or loess; on north-facing slopes, footslopes, rolling uplands, and valley bottoms
- Humicryods and Haplocryods that formed in loess over loamy or gravelly alluvium on south-facing slopes and stream terraces
- Inceptisols and Spodosols that do not have permafrost within their profile and generally are well drained

Biological Resources

The well drained soils on mountain slopes at low and mid elevations are dominated by white spruce forests and woodlands, mixed spruce-hardwood forests, tall alder shrub, tall and low willow scrub, and low ericaceous scrub. Areas of peat and moderately well drained mineral soils have black spruce woodlands and low ericaceous and shrub birch scrub, commonly with tussock-forming sedges or various sedges and grasses in the ground layer. Drainages and lakeshores have wet sedge meadows, sedge-grass meadows, and sedge-moss meadows. Well drained soils on valley bottoms at the lower elevations have white spruce, balsam poplar, and mixed balsam poplar-white spruce forests. The higher elevations and the shallow soils on mountain slopes and ridges commonly have alpine dwarf scrub dominated by ericaceous shrubs, Dryas, and shrub birch. These communities often have a considerable amount of lichen cover and bare ground. Bedrock exposures with only lichens and scattered shrubs and herbs in pockets of fine earth dominate the highest elevations and ridges.

Mammals common to the area include brown bear, black bear, moose, caribou, wolf, and a variety of small mammals. Golden eagles and peregrine falcons nest on cliffs along the major rivers and on rock outcrops on ridges at the higher elevations. The rivers in the area support runs of salmon. Arctic grayling are common in clear-water streams.

Land Use

Most of this area still supports natural vegetation and is used primarily for subsistence hunting, fishing, and gathering by local residents (fig. 230-2). People from outside the MLRA use the area for hunting and wildland recreation.

The major soil resource concerns are erosion of the shallow soils on uplands and disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

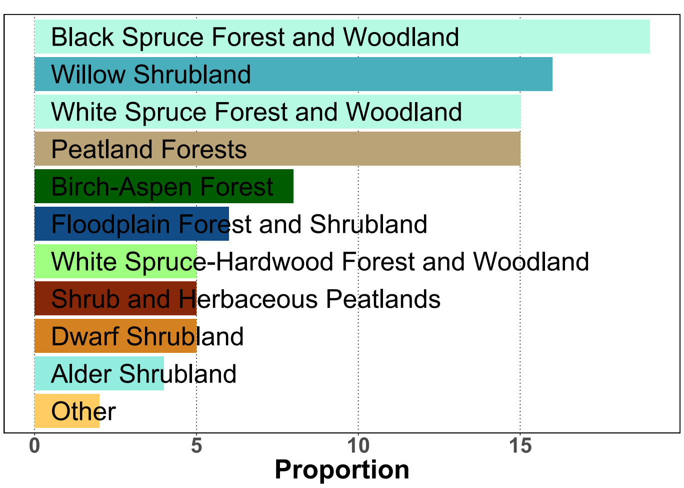

Figure 230-2: Relative proportions (percentages) of land use in MLRA 230.

231—Interior Alaska Highlands

MLRA 231 (fig. 231-1) is identified by its moderately steep or steep, moderate- to high-relief hills and mountains and its narrow to broad, flat-bottomed valleys. It lies between the Tanana River to the south and the Brooks Range to the north but does not include the lowlands between the Alaska and Brooks Ranges. It makes up about 60,515 square miles (156,730 square kilometers). Most of the landscape is mantled with bedrock colluvium. Many of the soils have a significant content of mica derived from micaceous parent materials and are covered with a surface layer of silty loess. The area is mostly undeveloped wildland in the zone of discontinuous permafrost and is sparsely populated.

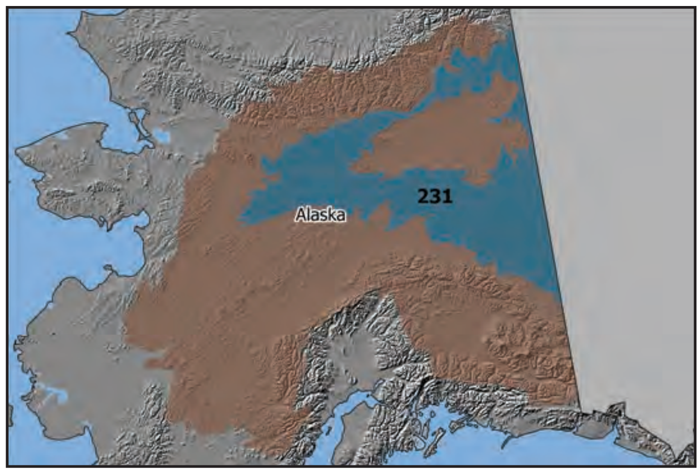

Figure 231-1: Location of MLRA 231, which covers 15,672,900 hectares (38,728,500 acres), within Region X1.

MLRA 231 has boundaries based on physiography with MLRAs 229 (Interior Alaska Lowlands) and 232 (Yukon Flats Lowlands), which have flood plains, stream terraces, and nearly level to undulating outwash plains. Its boundary with MLRA 233 (Upper Kobuk and Koyukuk Hills and Valleys) is difficult to distinguish as both MLRAs have the same vegetative and climatic characteristics. It also has boundaries based physiography with MLRA 234 (Interior Brooks Range Mountains), which has dominantly steep, rugged high mountains, and MLRA 244 (Northern Brooks Range Mountains), which has a continental arctic climate in addition to its steep, rugged high mountains.

Physiography

This area lies within the Northern Uplands and Lowlands province of the Intermontane Uplands and Lowlands System. The mountains are generally rounded at the lower elevations and sharp-ridged at the higher elevations. The Davidson Mountains, in the northwestern part of the area, are rounded to flat-topped at the higher elevations. Elevation ranges from about 400 feet (120 meters) in the western part of the MLRA, along the boundary with the Interior Alaska Lowlands (MLRA 229), to 6,583 feet (2,007 meters) at the summit of Mount Harper, in the southeastern part.

Surface water in this MLRA drains into the Bering Sea via the Yukon, Tanana, and Koyukuk Rivers. The major tributaries of the Yukon River are the Porcupine, Chandalar, Fortymile, and Charley Rivers. The major tributaries of the Tanana River are the Goodpaster, Salcha, Chatanika, and Melozitna Rivers. The upper Kanuti River is the major tributary of the Koyukuk River in this area. Lakes make up less than 2 percent of the area.

Permafrost commonly is close to the surface in places with finer textured sediments throughout the MLRA. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. Permafrost generally does not occur on flood plains or south-facing slopes on steep mountains. Periglacial features, such as pingos, thermokarst pits and mounds, ice-wedge polygons, and earth hummocks, are on the lower slopes and in upland valleys, particularly in the Davidson Mountains, in the northwestern part of the area.

Geology

This MLRA generally was glaciated during the Pleistocene Epoch only in the highest mountains and in the northern part of the area, where glaciers extended into the area from the Brooks Range. For the most part, glacial moraines and drift are limited to the upper elevations of the highest mountains. Valley bottoms are filled with Holocene fluvial deposits and slope alluvium from the adjacent mountain slopes. Silty loess, which originated from unvegetated flood plains in and adjacent to this area, covers much of the surface. On low hills near the major river valleys, the loess is many feet thick. On high ridges, it is less than 1 foot thick. Bedrock is exposed on the highest ridges. The dominant bedrock types are Paleozoic sedimentary and Permian through Jurassic igneous rocks in the northeastern part of the MLRA, Permian and Lower Cretaceous sedimentary and metamorphic rocks in the eastern part, and Precambrian and Paleozoic metamorphic and sedimentary rocks with common Cretaceous intrusives in the southwestern and western parts.

Climate

Short, warm summers and long, cold winters characterize the continental subarctic climate. The average annual precipitation is less than 10 inches (255 millimeters) on valley bottoms and lowlands in the northeastern part of this area and ranges from 20 to 40 inches (510 to 1,015 millimeters) at the higher elevations. The maximum rainfall occurs in late summer, mainly the result of thunderstorms. The average annual snowfall ranges from about 45 to 100 inches (115 to 255 centimeters). The average annual temperature is about 10 to 16 degrees F (-12 to -9 degrees C) in the northern part of the MLRA and 20 to 25 degrees F (-7 to -4 degrees C) in the southern part. The freeze-free period at the lower elevations averages about 60 to 100 days, and the temperature usually remains above freezing from June through mid-September.

Water

In most years precipitation is adequate for crops at the lower elevations, but in some years yields are reduced by short, dry periods in summer. Permanent streams carry water to nearly all parts of the MLRA, and the area has some natural lakes. The surface water is used primarily for public supply and the needs of the forest product industry. It is generally suitable for all uses. Rivers fed by glacial meltwater typically carry high loads of suspended sediment. Flooding from ice dams that form during the spring thaw is a concern.

The ground water used in this area is primarily from unconsolidated sediments in river valleys (alluvium) or from buried glacial outwash deposits in river valleys or on uplands. Most of the measurable water use from these aquifers occurs along the southern edge of this area, near Fairbanks, and along the boundary with the Yukon Flats Lowlands (MLRA 232). This water is hard or very hard but is otherwise of excellent quality. Wells in these aquifers generally are shallow, and the aquifers are constantly recharged with freshwater (rainfall and runoff). The level of iron may exceed the secondary (esthetic) standard for drinking water. The iron can stain ceramic and porcelain and precipitate in pipes. Since the aquifers are close to the surface and water moves through them quickly, they are highly susceptible to contamination from runoff. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks.

Small amounts of ground water can be obtained from the bedrock aquifer in this area. This water is similar in quality to that in the unconsolidated sediments.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, Entisols, and Spodosols. The soils in the area have a subgelic soil temperature class or a cryic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. Many of the soils have a significant content of mica derived from micaceous parent materials.

The Gelisols on stream terraces formed in loamy alluvial deposits. All of the Gelisols are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the taxonomic classification. Depending on the frequency of fires, landform position, and particle size, these soils may or may not revert back to Gelisols.

The Inceptisols and Spodosols do not have permafrost within their profile, are generally moderately deep or deep, and are well drained. Miscellaneous (nonsoil) areas make up about 2 percent of this MLRA. The most common are rock outcrop and rubble land. In many valleys placer mine tailings are common.

The main soils and their series:

Aquiturbels that formed in thick deposits of silty loess or in loess over loamy and gravelly colluvium; on north-facing slopes, on south-facing footslopes, and in valleys (Bradway and Chatanika series)

Cryofluvents that are very poorly drained to excessively well drained and formed in stratified loamy, sandy, and very gravelly alluvium on flood plains (Jarvis series)

Cryorthents that are very poorly drained to excessively well drained and formed in stratified loamy, sandy, and very gravelly alluvium on flood plains (Chena series)

Dystrocryepts that formed in silty loess over loamy and gravelly colluvium or in loamy and gravelly colluvium over fractured bedrock; on mountain slopes and hillslopes, especially south-facing slopes (Brigadier and Gilmore series)

Fibristels in depressions on stream terraces and footslopes and in swales on hills and mountains (Lemeta series)

Haplocryepts that formed in silty loess over loamy and gravelly colluvium or in loamy and gravelly colluvium over fractured bedrock; on mountain slopes and hillslopes, especially south-facing slopes (Fairbanks and Steese series)

Haplocryods that formed in silty loess over loamy and gravelly colluvium or in loamy and gravelly colluvium over fractured bedrock; on mountain slopes and hillslopes, especially south-facing slopes

Haploturbels that formed in thick deposits of silty loess or in loess over loamy and gravelly colluvium; on north-facing slopes, on south-facing footslopes, and in valleys

Hemistels in depressions on stream terraces and footslopes and in swales on hills and mountains (Bolio series)

Histoturbels that formed in thick deposits of silty loess or in loess over loamy and gravelly colluvium; on north- and south-facing footslopes and in valleys (Ester and Goldstream series)

Biological Resources

Most of this area is forested below an elevation of about 1,800 to 2,000 feet (550 to 610 meters). White spruce, paper birch, quaking aspen, and mixed forests cover most slopes. White spruce forests and mixed white spruce-balsam poplar forests are common on high flood plains and low terraces. Black spruce woodlands are on steep north-facing slopes, high stream terraces, and other sites with poor drainage and shallow permafrost. Tussock-forming sedges commonly are dominant in the ground layer. Low to tall willow and alder scrub are extensive on low flood plains. Lightning-caused wildfires are common, often burning many thousands of acres during a single fire. Following wildfires, willow, shrub birch, and ericaceous shrub scrub invade most sites until they are eventually replaced by forest vegetation. With increasing elevation, the forests and woodlands transition to low scrub dominated by shrub birch and ericaceous shrubs. At even higher elevations and on shallow soils on mountain slopes and ridges, alpine dwarf scrub dominated by ericaceous shrubs, Dryas, and shrub birch is common. Many of these communities have a considerable amount of lichen cover and bare ground. Bedrock exposures with only lichens and scattered shrubs and herbs in pockets of fine earth dominate the highest elevations and ridges.

Mammals common to this area include moose, caribou, black bear, brown bear, wolf, wolverine, and a variety of small mammals. Dall sheep are in some of the higher mountains. Golden eagles are common at the higher elevations, and peregrine falcons nest in rocky canyons along many rivers. The area’s wetlands provide high-quality habitat for waterfowl, sandhill cranes, and other birds. Clear-water streams support runs of salmon and are important habitat for Arctic grayling.

Land Use

Less than 1 percent of the MLRA is used for hay, small grains, potatoes, or other cool-season vegetables (fig. 231-2). Logging provides important wood products for local use and export. Extractable minerals, particularly gold and silver, occur in certain areas. Less than 1 percent of the MLRA is urban. Urban development near Fairbanks and wildland recreation, primarily hunting for moose and other game, are significant land uses. The Alaska road system penetrates much of the area and provides good access for recreational activities. Subsistence hunting, fishing, and gathering provide food for local residents.

The major soil resource concerns are erosion of the shallow soils on uplands and disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material

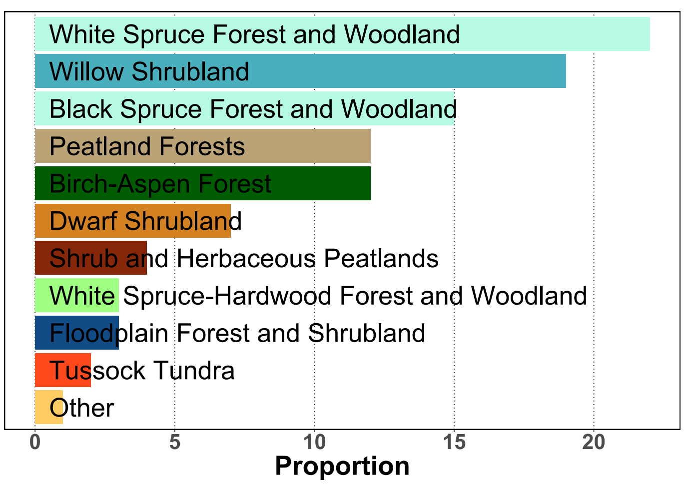

Figure 231-2: Relative proportions (percentages) of land use in MLRA 231.

at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

232—Yukon Flats Lowlands

MLRA 232 (fig. 232-1) includes the broad expanse of lowlands and low hills adjacent to the middle reaches of the Yukon River, known locally as the Yukon Flats. The MLRA consists primarily of a complex of nearly level to undulating, marshy stream terraces and flood plains supporting natural vegetation. It has two distinct regions—lowlands and marginal uplands. The lowlands have minimal local relief. Landforms associated with the lowlands are flood plains and stream terraces. The marginal uplands consist of rolling and dissected plains that are transitional to the lowlands and adjacent mountain systems. The MLRA is not accessible by road, is mostly undeveloped wildland, and is sparsely populated. It is in the zone of discontinuous permafrost. It makes up about 22,400 square miles (58,020 square kilometers). MLRA 232 is surrounded by the physiographically dissimilar MLRA 231 (Interior Alaska Highlands), which has moderately steep or steep, moderate- to high-relief hills and mountains.

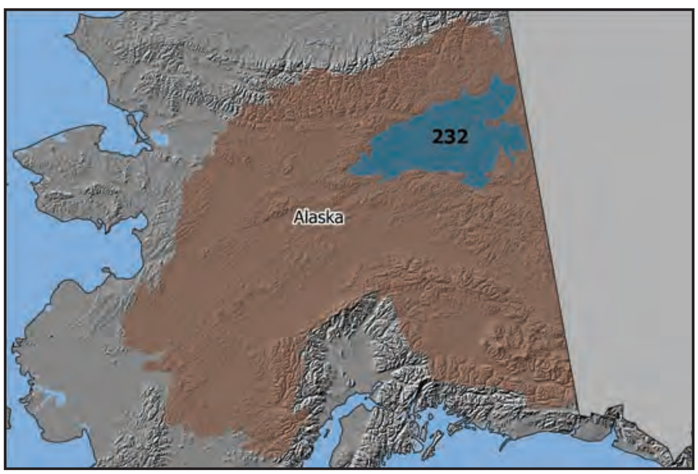

Figure 232-1: Location of MLRA 232, which covers 5,801,800 hectares (14,336,500 acres), within Region X1.

Physiography

This area lies within the Northern Uplands and Lowlands province of the Intermontane Uplands and Lowlands System. Thousands of lakes, ponds, and interconnecting wetlands fill depressions, shallow basins, and abandoned river channels across the stream terraces. Flood-plain features include multiple channels and islands, meander scars, oxbow lakes, sloughs, and low escarpments. The water in the lakes and wetlands is maintained by the yearly flooding associated with spring breakup of ice on the Yukon River and its tributaries. Strongly sloping to rolling uplands surround the lowlands. These uplands, which consist of elongated footslopes and coalescing alluvial fans, are at the base of the hills and mountains of the Interior Alaska Highlands (MLRA 231). Elevation ranges from about 300 feet (90 meters) to about 1,000 feet (305 meters).

Surface water in all of the area drains into the Yukon River and Bering Sea. On the Yukon Flats, the major tributaries of the Yukon River are the Porcupine, Sheenjek, Black, and Chandalar Rivers. Lakes make up approximately 20 percent of the area. Permafrost commonly is close to the surface in places with finer textured sediments on plains, stream terraces, and the more gently sloping footslopes and hills. Isolated masses of ground ice occur in thick deposits of loess on terraces and the lower side slopes of hills. Permafrost generally does not occur on flood plains or near lakes and other water bodies.

Geology

This MLRA is a broad intermontane tectonic basin filled with Quaternary and earlier glaciofluvial and fluvial sediments. In the central part of the basin, the glaciofluvial and fluvial deposits overlie lacustrine sediments. Unconsolidated sediments are estimated to be 300 to 400 feet (90 to 120 meters) or more in thickness near the center of the basin. Along the edge of the basin, much of the landscape is mantled with a thick layer of silty loess of Pleistocene and Holocene age. Sand dunes cover some areas. Fluvial and eolian sediments are continually being deposited. The underlying bedrock geology is completely buried by unconsolidated sediments.

Climate

Short, warm summers and long, very cold winters characterize the continental subarctic climate. The surrounding hills and mountains of this MLRA partially isolate it from weather systems affecting other interior lowlands. As a result, temperatures are generally warmer in summer and colder in winter than in other areas of comparable latitude.

The average annual precipitation ranges from about 6 inches (150 millimeters) in the central basin to 15 inches (380 millimeters) along the boundary with the surrounding highlands. The maximum precipitation occurs in late summer, mainly the result of thunderstorms. The average annual snowfall is about 45 to 55 inches (115 to 140 centimeters). The average annual temperature ranges from about 20 to 25 degrees F (-7 to -4 degrees C). The freeze-free period averages 70 to 120 days. The temperature usually remains above freezing from early June through late August.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Most of the communities are along the major rivers or lakes. Because of its chemical quality, the surface water generally is suitable for all uses. However, the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners can obtain ground water from the unconsolidated sediments in river valleys (alluvium or glacial outwash). These aquifers are open to the surface, so they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. The Gelisols are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Wildfires disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the taxonomic classification. Depending on the frequency of fires, landform position, and particle size, these soils may or may not revert back to Gelisols. Miscellaneous (nonsoil) areas make up about 20 percent of this MLRA. The most common are riverwash and water.

The main soils:

Aquiturbels and Histoturbels that formed in loamy, sandy, and gravelly alluvial deposits on nearly level stream terraces and in silty loess over loamy slope alluvium on elongated footslopes

Cryofibrists and Cryohemists that formed in thick layers of organic material and are very poorly drained; along lake margins and in abandoned channels and depressions on stream terraces

Cryorthents and Cryofluvents that formed in loamy, sandy, and gravelly alluvium and range from very poorly drained to excessively drained; on flood plains and low stream terraces

Fibristels and Hemistels that formed in thick layers of organic material in abandoned channels and depressions on stream terraces and the margins of lakes

Haplocryepts, Dystrocryepts, and Cryaquepts that formed in a moderately thick or thick layer of silty loess over alluvial material or, in some places, formed in calcareous loess; on nearly level stream terraces, rolling uplands, and bluffs along the major river channels

Histoturbels that have a moderately thick organic surface layer over mineral material

Biological Resources

The productive, well drained soils on uplands support white spruce, paper birch, quaking aspen, and mixed white spruce-paper birch-quaking aspen forests. Balsam poplar and mixed white spruce-hardwood forests are on high flood plains and low stream terraces. Stunted black spruce and white spruce woodland of low productivity occurs on high stream terraces and on cold, wet sites with shallow permafrost. Tussock-forming sedges and mosses commonly are dominant in the ground layer. Paper birch and, in places, tamarack occur in association with spruce on permafrost-affected flats. Lightning-caused wildfires are common, often burning many thousands of acres during a single fire. Following wildfires, willow, shrub birch, and ericaceous shrub scrub invade most sites until they are eventually replaced by forest vegetation. On all forest and woodland sites, post-fire succession leads to a relatively rapid accumulation of organic matter and moss on the surface. This accumulation results in a decrease in soil temperature, biologic activity, and nutrient availability and a gradual decrease in site productivity. Tall and low scrub dominated by willow and alder is common on low flood plains. The wettest sites dominantly support tall to low alder and willow scrub, sedge-shrub meadows, sedge meadows, and sedge-moss bog meadows.

Mammals common to the area are moose, black bear, brown bear, wolf, caribou, wolverine, lynx, and a variety of small animals. The wetlands provide high-quality nesting habitat for tundra swans and a wide variety of geese and ducks. Sandhill cranes and a variety of raptors, grouse, and passerine birds inhabit the area. Important fish species include salmon, Arctic grayling, whitefish, northern pike, blackfish, and burbot.

Land Use

Most of this area still supports natural vegetation and is used primarily for subsistence hunting, fishing, and gathering by local residents (fig. 232-2). Forests accessible from the villages provide timber for local use. People from outside the MLRA use the area for hunting and other kinds of wildland recreation.

The major soil resource concern is flooding. Most communities are located on the banks of the major rivers and streams where flooding is a severe hazard. The flooding is associated with spring snowmelt and runoff from the adjacent mountains, with ice jamming on rivers during periods of breakup, and occasionally with high-intensity summer thunderstorms. On permafrost-affected soils, disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

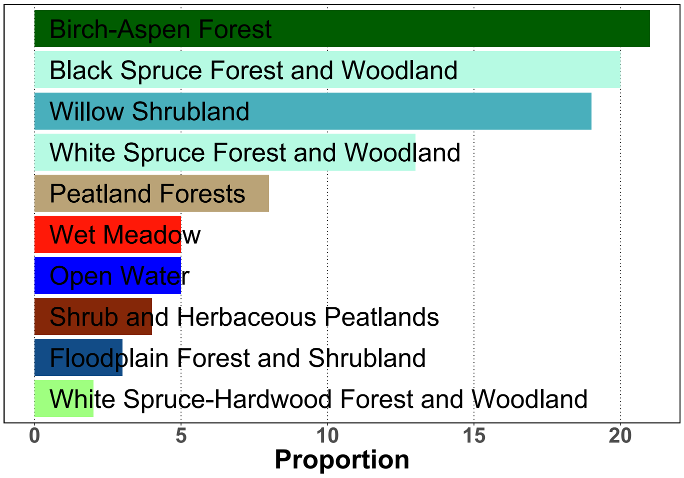

Figure 232-2: Relative proportions (percentages) of land use in MLRA 232.

233—Upper Kobuk and Koyukuk Hills and Valleys

MLRA 233 (fig. 233-1) includes nearly level lowlands, rolling uplands, and isolated hills and low mountains along the upper Kobuk River from approximately its confluence with the Pau River and east to the Kanuti Flats along the middle Koyukuk River. Most of this MLRA is areas of open black spruce forests and black spruce woodland. It is primarily undeveloped wildland and sparsely populated. It makes up about 8,405 square miles (21,765 square kilometers).

MLRA 233 has a boundary based on physiography with MLRA 234 (Interior Brooks Range Mountains), which has steep, rugged high mountains, and MLRA 231 (Interior Alaska Highlands), which has moderately steep or steep, moderate- to high-relief hills and mountains.

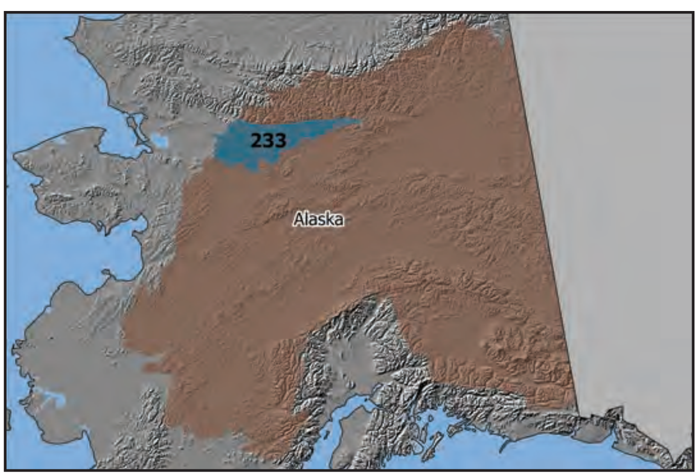

Figure 233-1: Location of MLRA 233, which covers 2,176,600 hectares (5,378,700 acres), within Region X1.

MLRA 233 has less apparent boundaries with MLRAs 242 (Northern Seward Peninsula-Selawik Lowlands), 229 (Interior Alaska Lowlands), 230 (Yukon-Kuskokwim Highlands) at the Purcell Mountains, and 243 (Western Brooks Range Mountains, Foothills, and Valleys). While MLRA 233 has a continental subarctic climate, MLRAs 242 and 243 have a continental arctic climate and MLRA 230 has a transitional continental subarctic to maritime climate. MLRA 229 is distinguishable by its unglaciated, broad, nearly level, meandering and braided flood plains.

Physiography

This area lies within the Western Alaska province of the Intermontane Uplands and Lowlands System. It is in broad, nearly level river valleys, in shallow basins, and on rolling uplands separated by isolated hills and low, rounded mountains. In the river valleys, nearly level flood plains and stream terraces gradually transition to gently sloping to moderately steep slopes leading to the hills and mountains. Extensive, nearly level to undulating basins are on the Pau River Flats between the eastern Zane and Lockwood Hills, on the Kanuti Flats between the Kanuti and Koyukuk Rivers, and along the middle reaches of the Hogatza River. Shallow basins and depressions on stream terraces are dotted with hundreds of lakes and interconnecting wetlands. Elevation ranges from about 150 feet (45 meters) in the western part of the MLRA, at the confluence of the Kobuk and Mauneluk Rivers, to 4,765 feet (1,453 meters) at the summit of Fritts Mountain, in the Angaycuham Mountains.

Surface water in the western third of this MLRA drains into the Kobuk River and eventually into Kotzebue Sound and the Chukchi Sea. The major tributaries of the Kobuk River are the Reed, Beaver, Mauneluk, and Pau Rivers. Surface water in the eastern part of the MLRA drains into the Koyukuk River and eventually into the Yukon River and the Bering Sea. The major tributaries of the Koyukuk River are the Alatna, John, and Kanuti Rivers. The area has a complex of ponds and small lakes in basins and on stream terraces. In addition, there are several large lakes within and on the edge of the MLRA. Lakes make up about 5 percent of the area. The principal lakes are Walker Lake, Nutuvukti Lake, Naruak Lake, and Lake Shelby.

This MLRA is in the zone of discontinuous permafrost. Permafrost is commonly close to the surface in areas of finer textured sediments throughout the MLRA. Isolated masses of ground ice occur on terraces and the lower side slopes of hills. Permafrost generally does not occur on flood plains or on steep south-facing slopes. Periglacial features, such as pingos, thermokarst pits and mounds, ice-wedge polygons, and earth hummocks, are on the lower slopes and in upland valleys.

Geology

The northern part of the MLRA was covered repeatedly by Pleistocene glaciers originating in the Brooks Range to the north. Slightly modified to highly modified moraines and drift cover many of the rolling uplands. Glacial ice flowed over most of the hills and low mountains, removing existing deposits and leaving a thin layer of glacial deposits. Today, the lower mountain slopes, hills, and valley bottoms are covered with a variety of material, including glacial drift, colluvium, slope alluvium, fluvial deposits, and silty loess. In the southern part of the MLRA, basins and valleys are filled with Quaternary glaciofluvial and fluvial deposits. Hills and upland slopes are covered with bedrock colluvium and slope alluvium, which are mantled with loess in places. The bedrock geology underlying much of the area consists dominantly of Permian through Lower Cretaceous stratified sedimentary and volcanic rocks.

Climate

Short, warm summers and long, cold winters characterize the continental subarctic climate of the area. The average annual precipitation ranges from 10 to 20 inches (255 to 510 millimeters) on valley bottoms and in basins and from 20 to 40 inches (510 to 1,015 millimeters) at the higher elevations in the hills and mountains. Most of the precipitation falls as rain between May and September. The average annual snowfall ranges from about 65 to 80 inches (165 to 205 centimeters). The average annual temperature is about 20 to 22 degrees F (-7 to -6 degrees C). The freeze-free period ranges from less than 30 days to about 90 days. Normally, the temperature remains above freezing from mid-June through August in river valleys and basins.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Most of the communities are along the major rivers or lakes. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply is probably obtained from private wells.

Small communities and rural landowners can obtain ground water from bedrock aquifers or from the unconsolidated sediments in river valleys (alluvium or glacial outwash). The unconsolidated sediments aquifer is open to the surface, so it is highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. The Gelisols generally are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the taxonomic classification. Depending on the frequency of fires, landform position, and particle size, the soils may or may not revert back to Gelisols. The Inceptisols and Entisols do not have permafrost within their profile, are deep, and are very poorly drained to excessively drained. Miscellaneous (nonsoil) areas make up about 8 percent of this MLRA. The most common are rock outcrop and water.

The main soils:

- Aquiturbels and Haploturbels that formed in silty loess or alluvium over very gravelly loamy alluvium and glacial drift; on stream terraces, hills, and upland slopes
- Cryofluvents and Cryorthents that formed in stratified loamy, sandy, and very gravelly alluvium on flood plains
- Fibristels in sloughs and depressions on stream terraces and on the margins of lakes
- Haplocryepts, Dystrocryepts, and Cryorthents that formed in silty loess over very gravelly loamy colluvium, glacial till, and alluvium; on upland slopes, shoulders, the crests of hills, and, to a lesser extent, stream terraces
- Hemistels in areas of peat plateaus, palsas, and depressions on hills and upland slopes

Biological Resources

Most of this MLRA consists of open black spruce forests and black spruce woodland. Open white spruce forests and tall alder scrub with common white spruce are on active flood plains and steep mountain slopes with southern aspects. On the drier sites and in areas of recent burns, paper birch and quaking aspen occur along with black spruce. Lightning-caused wildfires are common, often burning many thousands of acres during a single fire. Following wildfires, willow, shrub birch, and ericaceous shrub scrub invade most sites until they are eventually replaced by forest vegetation. On all forest and woodland sites, post-fire succession leads to a relatively rapid accumulation of organic matter and mosses on the surface. This accumulation results in a decrease in soil temperature, biologic activity, and nutrient availability and a gradual decrease in site productivity. Nonforest vegetation includes low to tall willow, shrub birch, and ericaceous shrub scrub in areas of peat, in drainageways, and in areas above an elevation of about 2,000 feet (610 meters). Moist sedge meadows, commonly with tussock-forming sedges, are on nearly level uplands. Wet sedge meadows and sedge-moss bog meadows are along the margins of lakes and on continuously ponded sites. Low to tall willow scrub with common balsam poplar is on low flood plains.

Mammals common to the area include brown bear, black bear, caribou, moose, wolf, beaver, and a variety of small animals. The ponds and wetlands provide high-quality habitat for tundra swans and other waterfowl. Bald eagles are common along most of the rivers. The rivers and lakes have arctic grayling, burbot, northern pike, sheefish, and whitefish.

Land Use

Most of this area still supports natural vegetation and is used primarily for subsistence hunting, fishing, and gathering by local residents (fig. 233-2). The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

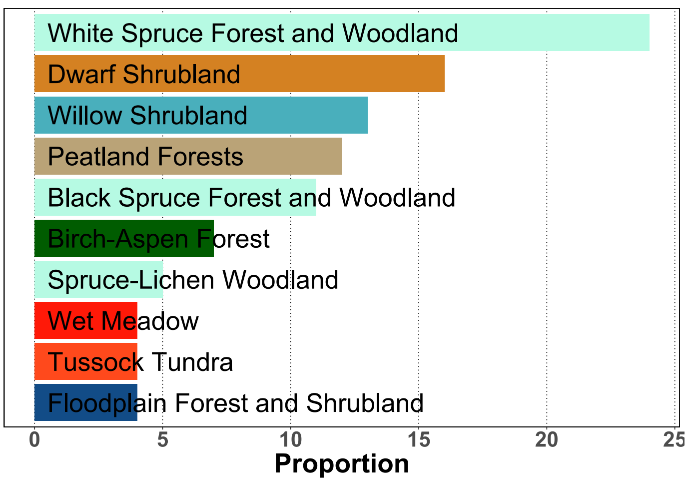

Figure 233-2: Relative proportions (percentages) of land use in MLRA 233.

234—Interior Brooks Range Mountains

MLRA 234 (fig. 234-1) consists of dominantly steep, rugged high mountains and narrow, high-gradient valleys on the southern side of the Brooks Range. The underlying bedrock geology consists almost entirely of stratified sedimentary rocks of Paleozoic and Precambrian age. The MLRA is almost entirely remote wildland and is sparsely populated. It is in the zone of discontinuous permafrost. The area makes up about 22,479 square miles (58,195 square kilometers).

MLRA 234 has boundaries based on physiography with MLRAs 231 and 233. MLRA 231 (Interior Alaska Highlands) has moderate- to high-relief hills and mountains and broad, flat-bottomed valleys of lower gradient. MLRA 233 (Upper Kobuk and Koyukuk Hills and Valleys) has nearly level lowlands, rolling uplands, and isolated hills and low mountains. MLRA 234 has less apparent boundaries with MLRAs 243 (Western

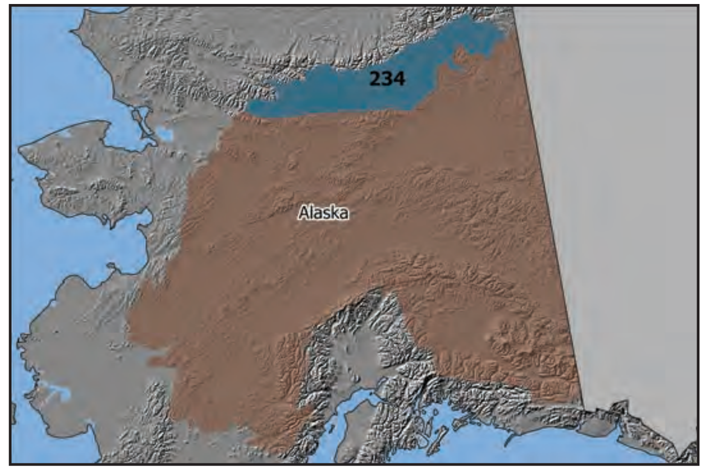

Figure 234-1: Location of MLRA 234, which covers 5,819,600 hectares (14,380,700 acres), within Region X1.

Brooks Range Mountains, Foothills, and Valleys) and 244 (Northern Brooks Range Mountains). MLRAs 243 and 244 have a continental arctic climate whereas MLRA 234 has a continental subarctic climate.

Physiography

This MLRA lies within the Arctic Mountains province of the Rocky Mountain System. The Brooks Range is the most northerly extension of the Rocky Mountains. At the upper elevations, the mountains are generally rocky and have sharp ridges. Small glaciers occur in some areas at the higher elevations. The lower mountain slopes are characterized by coalescing alluvial and colluvial fans and steep footslopes, many of which extend down and into the stream channels. Narrow, discontinuous flood plains are in the wider, more gently sloping parts of the valleys. The bottoms of valleys along the larger rivers and streams have nearly level flood plains and stream terraces. Elevation ranges from about 1,600 feet (490 meters) to nearly 8,000 feet (2,440 meters).

Surface water in this MLRA drains entirely into the Yukon River system and the Bering Sea. The major rivers that have their headwaters in the area are the Sheenjek, Chandalar, Koyukuk, John, and Alatna Rivers. Lakes make up less than 5 percent of the area. Permafrost generally is close to the surface only in areas of finer textured sediments on stream terraces and in swales on hills and footslopes. Periglacial features include gelifluction lobes, polygons, and stripes.

Geology

During the Early and Middle Pleistocene, glacial ice buried most of this area. By the Late Pleistocene, only the highest valleys and mountains were still glaciated. Most glacial deposits have eroded away or been buried by mountain colluvium and slope alluvium, which accumulated during the Holocene across about 95 percent of the landscape. Slightly modified to highly modified glacial moraines, drift, and outwash deposits occur in some areas on the lower mountain slopes and in valleys at the lower elevations. Recent and Pleistocene fluvial deposits are on flood plains, stream terraces, and alluvial fans. The eastern part of the MLRA includes Paleozoic and Early Jurassic volcanic and igneous rocks.

Climate

Short, cool summers and long, cold winters characterize the continental subarctic climate of the area. Strong winds are common at the higher elevations in mountain valleys. The average annual precipitation ranges from about 10 to 15 inches (255 to 380 millimeters) on valley bottoms at the lower elevations and from about 20 to 30 inches (510 to 760 millimeters) at the highest elevations. The average annual snowfall is about 60 to 100 inches (150 to 255 centimeters). The average annual temperature ranges from 8 to 16 degrees F (-13 to -9 degrees C). Freezing temperatures can occur throughout the year, and extended periods of extreme cold are common during most winters.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply is probably obtained from private wells.

Small communities, rural landowners, and miners can obtain ground water from the bedrock aquifer or the unconsolidated sediments in river valleys (alluvium or glacial outwash). The unconsolidated sediments aquifer is open to the surface, so it is highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, leaking fuel storage tanks, and mine waste.

Soils

The dominant soil orders are Gelisols, Entisols, and Inceptisols. The soils in the area have a subgelic soil temperature class or a cryic temperature regime, a udic or aquic moisture regime, and mixed mineralogy. The Gelisols are shallow or moderately deep to permafrost and range from somewhat poorly drained to very poorly drained. Wildfires can disturb the insulating organic material at the surface, lowering the permafrost layer, eliminating perched water tables from Gelisols, and thus changing the taxonomic classification. Depending on the frequency of fires, landform position, and particle size, the soils may or may not revert back to Gelisols. The Inceptisols and Entisols do not have permafrost within their profile and range from excessively drained to poorly drained. Miscellaneous (nonsoil) areas make up about 63 percent of this MLRA. The most common are rock outcrop, rubble land, riverwash, and glaciers.

The main soils:

- Cryofluvents and Cryorthents that formed in loamy, sandy, and gravelly alluvium on flood plains and natural levees along streams
- Cryorthents, Haplocryepts, and Dystrocryepts that formed in loamy to very gravelly colluvium, fractured bedrock residuum, and glacial drift on south-facing slopes and ridges in the foothills and on the bottoms of narrow, steep valleys
- Fibristels and Hemistels that formed in thick layers of organic material in depressions and on the margins of lakes
- Histoturbels and Aquiturbels that formed in loamy to cobbly colluvium, slope alluvium, and fluvial deposits and commonly have a mineral surface layer of silty loess; on the lower mountain slopes, elongated footslopes, and stream terraces
- Histoturbels that have a moderately thick surface layer of organic material
- Turbels, Gelepts, and Gelolls that formed in loamy and gravelly colluvium over fractured bedrock and loamy glacial drift; on mountain slopes, hillslopes, ridges, and fans

Biological Resources

Because of the shallow soils, strong winds, and harsh climate, vegetation is sparse in this area. It generally is limited to valleys and the lower mountain slopes. Dwarf scrub communities on mountain slopes and ridges are dominated by black crowberry, ericaceous shrubs, Dryas, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and exposed bedrock generally are extensive. On the more mesic sites, sedges, forbs, and mosses cover most of the surface. Areas at the lower elevations and the deeper soils in basins and on terraces are dominated by white spruce and mixed spruce-hardwood forests and woodland, low willow and ericaceous shrub scrub, and mesic graminoid herbaceous communities. Black spruce woodlands, commonly with extensive areas of tussock-forming sedges, are common on high stream terraces and mountain footslopes. Depressions, drainageways, and other saturated areas have wet sedge meadows and wet sedge-moss meadows. Low and tall willow scrub is dominant on flood plains.

Mammals common to the area are brown bear, black bear, wolf, caribou, and Dall sheep. The smaller mammals include marmot, red fox, Arctic fox, wolverine, ground squirrel, lemming, and pika. The most common raptors are golden eagles, marsh hawks, and snowy owls.

Land Use

Most of this area still supports natural vegetation and is used primarily for subsistence hunting, fishing, and gathering by local residents (fig. 234-2). The area also is widely used for sport hunting and other kinds of wildland recreation. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. The few communities are along the Haul Road. Sand and gravel pits are along the Dalton Highway. The major resource concerns in this area are maintaining the protective plant cover and the thermal balance of permafrost-affected soils.

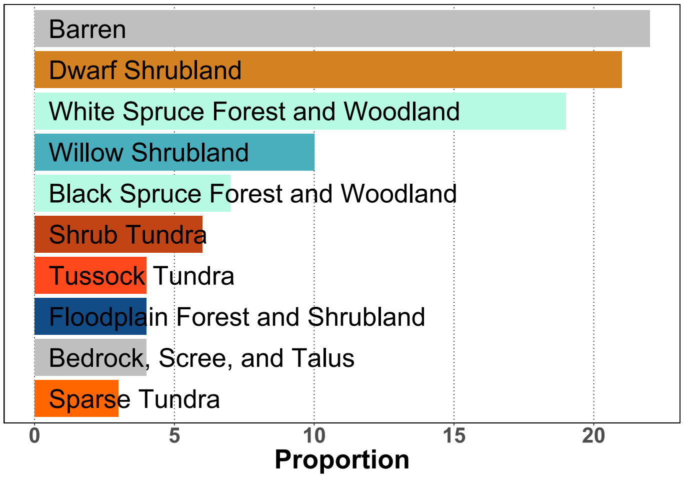

Figure 234-2: Relative proportions (percentages) of land use in MLRA 234.

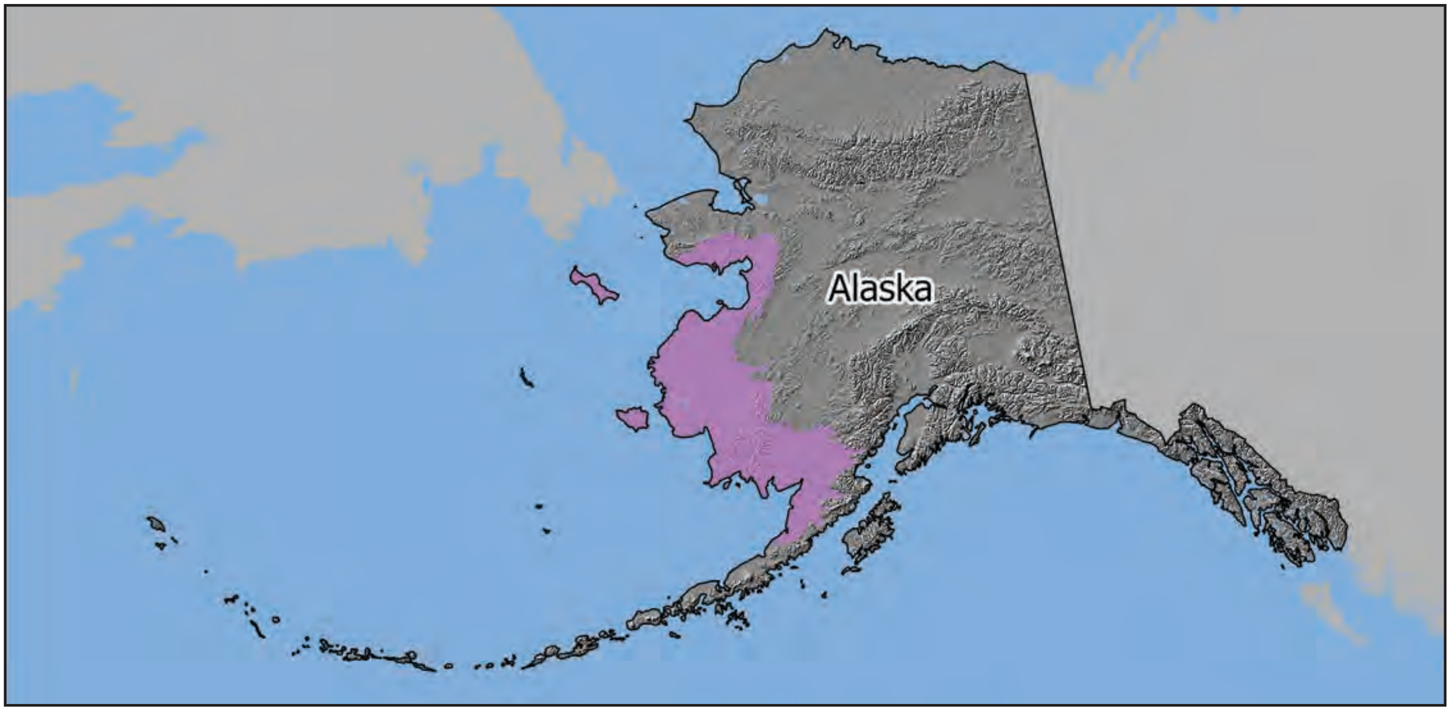

Figure X2-1: Location and size of Land Resource Region X2, which covers 229,995 square kilometers (88,800 square miles) and comprises the western part of Alaska and the northern Bering Sea islands.

X2—Western Alaska

Land Resource Region X2 (fig. X2-1) is the semiarid treeless zone of discontinuous permafrost in Alaska. About one-third of this region consists of the Yukon Delta, which was formed by the Yukon and Kuskokwim Rivers and is roughly twice the size of the Mississippi River Delta. Although Region X2 is more tectonically stable than Regions W1 and W2 to the south, it has experienced uplift, as evidenced by marine terraces on the Seward Peninsula. Landforms in the region include mountains, hills, coastal plains, outwash plains, stream terraces, volcanic cinder cones, and dunes. Elevation ranges from sea level to about 7,000 feet (2,135 meters). The Ahklun, Kilbuck, and Alaska Peninsula Mountains are generally steep and rugged. Rolling hills, low mountains, and broad valleys characterize the Nulato Hills, the Seward Peninsula, and the northern Bering Sea islands. The rest of the region consists of coastal lowlands and rolling uplands. Lakes and interconnecting wetlands cover as much as 80 percent of the coastal lowlands. Permafrost is discontinuous across the region, most prevalent on coastal plains, terraces, and footslopes, but generally does not occur on steep slopes or on flood plains. Patterned ground and gelifluction lobes are common in many of the permafrost-affected areas. This region contains five major land resource areas. The extent of these MLRAs and their range in elevations are shown in table X2-1.

To the north, the boundary between Regions X2 and Y splits the Seward Peninsula where discontinuous permafrost (Region X2) changes to continuous permafrost (Region Y). To the south, the boundary between Regions X2 and W1 is where the discontinuous permafrost changes to sporadic permafrost (Region W1). To the west, the boundary between Regions X2 and X1 is the boundary between the zone of treeless tundra (Region X2) and the interior forest of spruce and birch (Region X1).

The climate in Region X2 ranges from maritime near the coast to continental subarctic away from the coast and at the higher elevations. In the northern part of the region, the winter climate becomes more continental as the ice pack forms in the Bering Sea. Summers are short and warm, and winters are long and cold. In summer, cloudy conditions are common along the coast. The annual precipitation extremes throughout the region range from about 13 to 80 inches (330 to 2,030 millimeters). The amount of precipitation is lowest in lowland areas and the Nulato Hills and increases markedly at the higher elevations of the Ahklun Mountains and Alaska Peninsula mountains. The annual temperature extremes range from 20 to 39 degrees F (-7 to 4 degrees C). They vary most in the mountainous areas. Frost may occur in any month. Strong winds are common, especially in winter. Snow covers the ground for approximately 7 to 9 months each year. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables X2-2 and X2-3.

Table X2-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
236	60,690	23,435	0	0	0	20	60	220	280	930	1,430	4,690
237	29,825	11,515	0	0	50	170	280	920	650	2,140	1,560	5,130
238	81,750	31,565	0	0	0	0	0	20	40	150	720	2,380
239	9,595	3,705	0	0	0	10	50	160	180	590	650	2,160
240	48,140	18,585	0	0	30	100	200	650	480	1,570	1,200	3,950

Table X2-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set. Dashes indicate data were not available.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
236	-3.4	26	0	32	1.2	34	2	36	3.7	39	---	---	---	---	---
237	-4.9	23	-1.9	29	-0.6	31	1.1	34	1.8	35	---	---	---	---	---
238	-3.3	26	-1.8	29	-1	30	-0.4	31	1.1	34	---	---	---	---	---
239	-5.5	22	-3.9	25	-2.3	28	0	32	0.7	33	---	---	---	---	---
240	-6.6	20	-4.4	24	-3.2	26	-1.5	29	-0.8	31	---	---	---	---	---

Table X2-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
236	410	17	547	22	740/750	29/30	978	39	1,840	72
237	450	18	533	21	728/840	29/33	1,336	53	1,890	74
238	300	12	384	15	412/420	16/17	461	18	760	30
239	310	13	355	14	377/385	15/15	416	16	560	22
240	300	12	355	14	426/425	17/17	495	19	640	25

Soils are dominantly Gelisols and Inceptisols in the northern half of Region X2 and Inceptisols and Andisols in the southern half. Smaller areas of Spodosols, Histosols, and Entisols occur throughout the region. Orthels and Turbels are on level to sloping coastal plains and terraces as well as on footslopes and in swales in the hills and mountains. Mollorthels and Molliturbels occur in the limestone uplands of the northern Bering Sea islands. Histels are in most of the depressions throughout the region. Coarse textured Gelepts and Gelolls with a cryic soil temperature regime are on steep slopes in the mountainous areas. Well drained Cryepts and Cryolls are on moraines and outwash plains. Cryands are in areas where volcanic ash and loess mantle older landforms and in areas along the flanks of cinder cones. Well drained Cryods are in scattered areas on uplands throughout the region. Fluvents are on flood plains and levees, and Psamments are in areas of dunes. Restrictive zones occur in most soil profiles in Region X2 as permafrost, abrupt textural changes, or paralithic bedrock. Substantial amounts of soil organic carbon occur in this region.

Land use throughout the region includes reindeer herding, mining, wildlife habitat, and subsistence hunting, fishing, and gathering (fig. X2-2). Native vegetation consists of Arctic tundra and alpine tundra dominated by low and dwarf scrub and herbaceous communities throughout most of this region. Tussock tundra occurs across broad expanses of uplands. Wet sedge and sedge-grass meadows, sedge-moss meadows, and sedge-shrub meadows are on coastal wetlands and in poorly drained areas in drainageways. Open forests and woodland of white and black spruce and, in places, paper birch and balsam poplar are of limited extent on valley bottoms, on well drained soils at the lower elevations. Low and tall scrub, dominated by alder and willow, is common on mid-mountain slopes and flood plains.

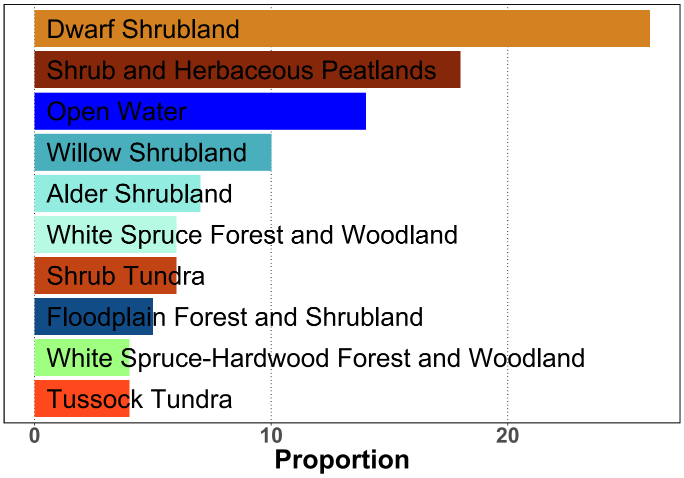

Figure X2-2: Relative proportions (percentages) of land use in LRR X2.

236—Bristol Bay-Northern Alaska Peninsula Lowlands

MLRA 236 (fig. 236-1) consists dominantly of a broad expanse of gently sloping to rolling plains and low- to moderate-relief hills bordered by moderately sloping, elongated mountain footslopes adjacent to Bristol Bay. Much of the area has been mantled with a layer of silty volcanic ash and loess of varying thickness from regional volcanoes and unvegetated flood plains and outwash plains. It is mostly undeveloped wildland and is sparsely populated. The MLRA makes up about 23,435 square miles (60,690 square kilometers).

MLRA 236 has boundaries based on physiography with MLRAs 225 (Southern Alaska Peninsula Mountains), 228 (Interior Alaska Mountains), 230 (Yukon-Kuskokwim Highlands), and 237 (Ahklun Mountains). MLRA 225, to the south, has rugged, low to moderately high mountains deeply dissected with narrow, high-gradient valleys. MLRA 228, to the northeast, has rugged, high mountains and low, rounded hills, including the true alpine and subalpine zones. MLRA 230, to the north, has moderate- to high-relief mountains. MLRA 237, to the west, has steep, rugged, low mountains. MLRA 236 shares a less apparent border with a small part of MLRA 229 (Interior Alaska Lowlands) near Shotgun Hills, which has a continental subarctic climate. Bristol Bay is to the southwest.

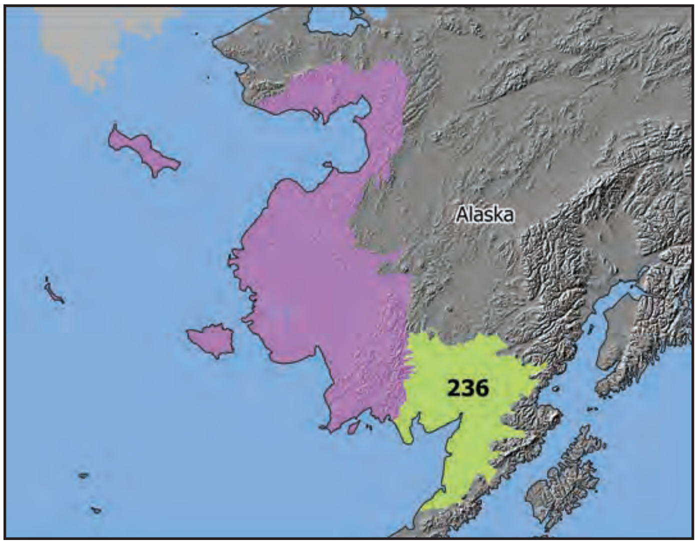

Figure 236-1: Location of MLRA 236, which covers 6,069,100 hectares (14,997,200 acres), within Region X2.

Physiography

This area lies within the Western Alaska province of the Intermontane Uplands and Lowlands System. Depressions and shallow basins on terraces and plains are dotted with small and medium-size lakes and interconnecting stream channels and wetlands. To the west, along the border with the Ahklun Mountains (MLRA 237), and to the east, along the border with the Northern Alaska Peninsula Mountains (MLRA 235), large lakes behind terminal moraines extend from the mountain valleys out onto the plains. Narrow, low-gradient, meandering flood plains and low stream terraces are along the major rivers in the central part of the area. In the southwestern part of the area, short, high-gradient rivers and streams originating in the adjacent mountains have formed broad, braided alluvial fans and flood plains. Isolated hills and rounded, low-relief mountains are in scattered areas throughout the inland part of the MLRA. Elevation ranges from sea level along the coast of Bristol Bay to about 2,500 feet (760 meters) in the mountains.

Surface water in this MLRA drains entirely into Bristol Bay. The major rivers are the Egegik, Kvichak, Mulchatna, Naknek, Nushagak, Ugasik, and Wood Rivers. Most of the rivers and streams are meandering. The large lakes in the Aleutian Range include Lake Grosvenor and Iliamna, Kukaklek, Nonvianuk, Naknek, and Becharof Lakes. The Wood-Tikchik Lakes system is in the western part of the area, along the Ahklun Mountains. Lakes make up about 10 percent of the MLRA.

This area is in the zone of discontinuous permafrost. Permafrost generally is at a considerable depth below the surface and occurs primarily in areas of finer textured sediments on stream terraces, rolling uplands, and gently sloping footslopes. Isolated masses of ground ice occur in some areas of glacial drift and other unconsolidated materials. Permafrost generally does not occur on flood plains, near the coast, or in the southern part of the area.

Geology

During the Early to Middle Pleistocene, the entire area was covered with glacial ice originating in the Aleutian Range to the east and the Ahklun Mountains to the west. Little glaciation remained by the Late Pleistocene, except possibly in the higher hills and foothills near the mountains. Today, Pleistocene moraines, drift, and glaciofluvial deposits cover approximately 60 percent of the area. Elsewhere, mixed Holocene and Pleistocene fluvial and coastal deposits are dominant. Interlayered alluvial and marine sediments occur on the Nushagak Peninsula in the western part of the MLRA and in coastal areas in the eastern and southern parts. The underlying bedrock geology consists primarily of Tertiary and Quaternary stratified sedimentary rocks. Tertiary volcanic rocks are of minor extent in scattered areas near the Aleutian Mountains.

Climate

Summers are short and warm. Cloudy conditions and rain are common in summer. Winters are long and cold. The climate is strongly maritime near the coast of Bristol Bay. Continental weather systems from Interior Alaska probably have a significant influence farther inland, particularly in winter.

The average annual precipitation is 13 to 50 inches (330 to 1,270 millimeters), generally increasing with distance from the coast and with elevation. The average annual snowfall is about 30 to 80 inches (75 to 205 centimeters). The average annual temperature ranges from 30 to 36 degrees F (-1 to 2 degrees C). The freeze-free period averages about 70 to 125 days.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners can obtain ground water primarily from unconsolidated sediments in river valleys (alluvium or glacial outwash). Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soils in this MLRA are Gelisols, Andisols, and the Andic subgroups of Spodosols, Histosols, Inceptisols, and Entisols. The soils in this area have a subgelic soil temperature class or a cryic temperature regime, an aquic or udic moisture regime, and mixed or amorphic mineralogy. The Gelisols in the area are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Miscellaneous (nonsoil) areas make up about 14 percent of the MLRA. The most common are water, riverwash (particularly in the southwestern part of the MLRA), and beaches.

The main soils:

- Andisols and Spodosols that do not have permafrost within their profile and generally are deep and moderately well drained or well drained
- Cryofluvents and Cryaquents that formed in stratified loamy, sandy, and gravelly alluvium, are deep, and range from poorly drained to excessively drained; on flood plains, low stream terraces, and alluvial fans
- Fibristels that formed in thick deposits of organic material and are generally in depressions and shallow basins
- Haplocryands, Haplocryods, Humicryods, and Dystrocryepts that formed in a moderately thick or thick layer of silty volcanic ash over various glacial, fluvial, and colluvial sediments; on rolling uplands and footslopes along the boundary with the adjacent mountains
- Histoturbels and Aquiturbels that formed in loamy, sandy, and gravelly fluvial sediments and commonly have a thin or moderately thick mineral surface layer of silty volcanic ash and loess; on stream terraces and plains

Biological Resources

The moderately well drained soils on plains and rolling uplands in this MLRA generally support low and dwarf scrub dominated by ericaceous shrubs and herbs and in many areas by lichens and mosses. The somewhat poorly drained soils in bogs and other areas of peat generally support low and dwarf scrub dominated by shrub birch, ericaceous shrubs, tussock-forming sedges, and a thick, continuous layer of mosses. Poorly drained soils on lowlands, fens, and the margins of lakes are vegetated with wet herbaceous communities, including sedge marshes, sedge and sedge-moss meadows, and, near the coast, halophytic sedge meadows. Balsam poplar and mixed balsam poplar-white spruce forest communities, typically with an understory of tall and low shrubs, are on flood plains along the major rivers. Alpine dwarf scrub, lichens, and bare ground occur on convex slopes and ridges at the higher elevations of isolated hills and mountains.

Mammals common to the area include brown bear, black bear, wolf, wolverine, caribou, moose, and a variety of other furbearers. The lowlands have good-quality habitat for waterfowl. Many species of migratory waterfowl use the lowlands as staging and nesting areas. Nearly the entire population of Pacific black brant, numbering 250,000, and most of the world's population of the emperor goose use the coastal lagoons and wetlands in this area during their spring and fall migrations. Canada goose, ducks, tundra swans, and sandhill cranes also are common in the area. Many millions of shore birds use the same habitats and flyways as the migrating waterfowl. Most rivers and streams are important spawning areas for salmon, which provide world-class sport fishing during summer and fall for visitors and local residents. Many streams and lakes support rainbow trout. Introduced northern pike, a major predator of small salmon, other desirable fish, and waterfowl, are in many of the lakes.

Land Use

Commercial fishing in Bristol Bay and the Bering Sea is the primary enterprise in this MLRA (fig. 236-2). Most coastal communities support a fleet of boats and related fishing facilities. Many also have fish-processing plants. Less than 1 percent of the MLRA is urban. Most inland areas still support natural vegetation and are used primarily for subsistence hunting, fishing, and gathering by local residents. The Mulchatna caribou herd in the area attracts subsistence and sport hunters from Alaska and elsewhere. Wilderness recreation and sport fishing are increasingly popular. Most visitors are served by air taxi and guiding services out of Dillingham, King Salmon, and other communities and by guest lodges.

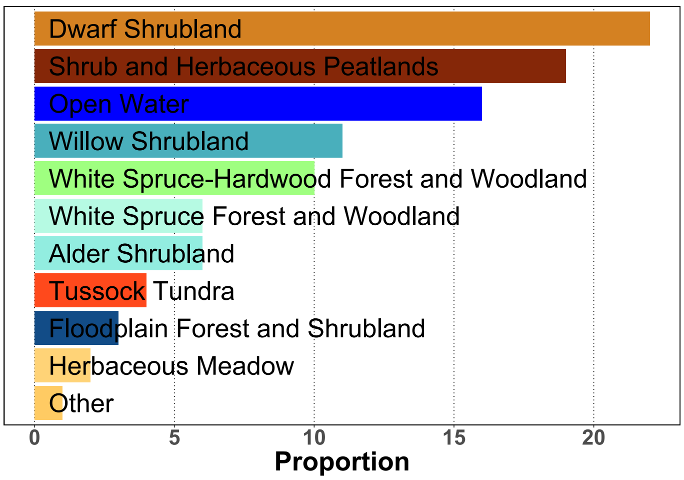

Figure 236-2: Relative proportions (percentages) of land use in MLRA 236.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

237—Ahklun Mountains

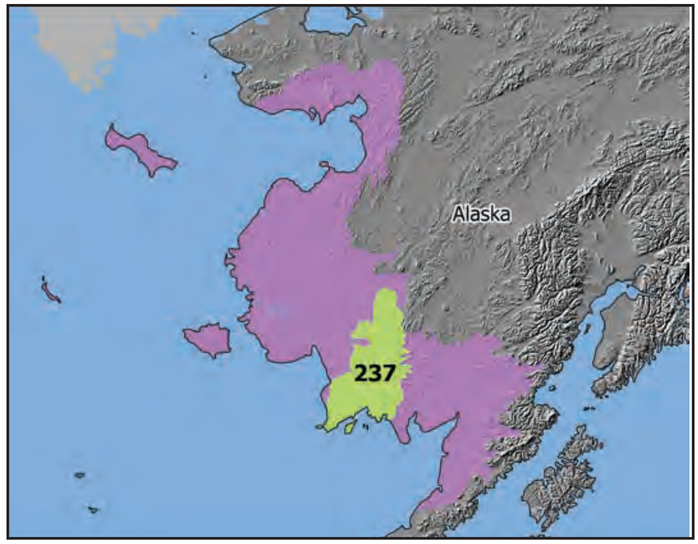

Figure 237-1: Location of MLRA 237, which covers 2,982,200 hectares (7,369,300 acres), within Region X2.

MLRA 237 (fig. 237-1) includes the mountains, hills, and valleys of the Ahklun and Kilbuck Mountains as well as Hagemeister Island and the Walrus Islands in Bristol Bay. The terrain consists of steep, rugged, low mountains cut throughout by numerous northeast-trending faults with narrow to broad valleys. The area makes up about 14,555 square miles (37,715 square kilometers).

MLRA 237 is bordered by the physiographically dissimilar MLRAs 236, 238, and 230. MLRA 236 (Bristol Bay-Northern Alaska Peninsula Lowlands) has broad, nearly level, braided to meandering flood plains, stream terraces, outwash plains, and extended mountain footslopes (where much of the area has been mantled with a layer of silty volcanic ash and loess of varying thickness from regional volcanoes). MLRA 238 (Yukon-Kuskokwim Coastal Plain), north and west of MLRA 237, has the broad, nearly level delta formed by the lower reaches of the Yukon and Kuskokwim Rivers. MLRA 230 (Yukon-Kuskokwim Highlands), to the northeast, has moderate- to high-relief mountains and narrow, flat-bottomed valleys. To the south is Bristol Bay.

Physiography

This area lies within the Ahklun Mountains province of the Intermontane Uplands and Lowlands System. Flood plains and terraces are common at the lower elevations in the valleys along the larger rivers. Alluvial and colluvial fans and steep mountain footslopes are common features of the valleys throughout the MLRA. Along the coast, where the Togiak and Goodnews Rivers empty into the Bering Sea, nearly level to rolling deltas are dotted with numerous small lakes. To the east, along the border with the Bristol Bay-Northern Alaska Peninsula Lowlands (MLRA 236), are deep, east-west-oriented, glacially carved valleys that include the Wood-Tikchik Lakes. Elevation ranges from sea level on the coast of the Bering Sea in the southern part of the area to 4,658 feet (1,420 meters) at the summit of Mount Oratia.

All of the surface water in this area drains into the Bering Sea via numerous rivers. The rivers empty directly into the Bering Sea or into the Wood-Tikchik Lakes to the east or the Kuskokwim River to the north and west. The major rivers are the Goodnews, Togiak, Kanektok, Osviak, Eek, and Arolik Rivers. Lakes make up about 5 percent of the area.

This MLRA is in the zone of discontinuous permafrost. Isolated masses of permafrost are in areas of deep, unconsolidated deposits in the mountains. On lowlands, permafrost occurs as isolated masses primarily in areas of finer textured materials. It generally does not occur on flood plains or near the coast.

Geology

Throughout the Pleistocene Epoch, all of the Ahklun Mountains were extensively glaciated, with the possible exception of the highest peaks and the upper ridges. The Kilbuck Mountains were unglaciated. Coastal lowlands were generally free of ice by the Late Pleistocene. During the Holocene, colluvium and slope alluvium accumulated across about 40 percent of the area. Glacial moraines and drift still cover approximately 45 percent of the area, primarily on the lower mountain slopes, valley bottoms, and coastal plains. Recent alluvial deposits are on flood plains and on interlayered alluvial and marine deposits on coastal lowlands. The bedrock geology underlying most of the area is dominantly Jurassic and Cretaceous stratified sedimentary rocks. Less common are Paleozoic sedimentary rocks. Exposed volcanic intrusive rocks that impart a ring-like structure to some of the isolated mountain groups are scattered throughout the MLRA. Volcanic rocks are more common in the Kilbuck Mountains.

Climate

The climate has both maritime and continental influences, depending on the time of year and the proximity to the coast of Bristol Bay and the Bering Sea. Orographic influences also are likely important. Summers are short and variable. Winters are long and cold.

The average annual precipitation is 20 to 30 inches (510 to 760 millimeters) at the lower elevations and can exceed 50 inches (1,270 millimeters) at the higher elevations. The average annual snowfall ranges from about 80 to 200 inches (205 to 510 centimeters). The average annual temperature along the coast is about 33 degrees F (1 degree C). The length of the freeze-free period along the coast averages 110 to 135 days.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply is probably obtained from private wells.

Small communities and rural landowners can obtain ground water from bedrock aquifers or from the unconsolidated sediments in river valleys (alluvium or glacial outwash). The unconsolidated sediments aquifer is open to the surface, so it is highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can cause some problems along the coast.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, Spodosols, Andisols, and Entisols. The soils in the area have a subgelic temperature class or a cryic temperature regime, an aquic or ustic moisture regime, and mixed or amorphic mineralogy. The Gelisols are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. At the higher elevations, fractured bedrock is at shallow or moderate depth in many of the soils. At the lower elevations, Andisols and Andic subgroups of other orders have a thin or moderately thick surface layer of silty volcanic ash and loess. These soils range from shallow to deep and generally are well drained. Miscellaneous (nonsoil) areas make up about 25 percent of this MLRA. The most common are rock outcrop, rubble land, and beaches.

The main soils:

- Cryaquents and Cryofluvents that formed in stratified silty and sandy alluvium, commonly have a substratum of gravelly and cobbly alluvium, are deep, range from excessively drained to poorly drained, and commonly have an upper mineral layer of silty volcanic ash, loess, or a mixture of both; on flood plains, low stream terraces, and river deltas
- Fibristels that formed in thick deposits of organic material in depressions and shallow basins on stream terraces
- Gelepts, Cryepts, Gelods, and Cryods that formed in gravelly colluvium and slope alluvium on ridges, steep mountain slopes, hills, fans, footslopes, and plains
- Histoturbels and Aquiturbels that formed in various colluvial and alluvial deposits and are somewhat poorly drained or very poorly drained; in swales and depressions on hills, in seepage areas, and on footslopes and stream terraces
- Histoturbels that have a moderately thick surface layer of organic material

Biological Resources

Well drained soils on mountain slopes at low and middle elevations in this area dominantly support tall alder shrub, tall and low willow scrub, and low ericaceous scrub. In areas of peat and moderately well drained mineral soils, low ericaceous shrub and shrub birch scrub occur along with tussock-forming sedges or various sedges and grasses in the ground layer. Wet sedge meadows, sedge-grass meadows, and sedge-moss meadows are in drainages and along lakeshores. Well drained soils at the lower elevations on valley bottoms support balsam poplar, white spruce, and mixed balsam poplar-white spruce forests. Balsam poplar and mixed forest types generally have an understory of tall and low shrubs and herbs. Spruce forest understory commonly is dominated by a nearly continuous layer of feather mosses with only scattered shrubs and herbs. On shallow soils at the higher elevations and on convex mountain slopes and ridges, the most common vegetation is alpine dwarf scrub dominated by ericaceous shrubs, Dryas, and shrub birch. These communities commonly have a considerable amount of lichen cover and bare ground.

Mammals common to the area include brown bear, black bear, moose, caribou, wolf, wolverine, and various other furbearers. Walrus, spotted seals, and fur seals are in coastal areas. The sea cliffs provide important nesting habitat for murres, kittiwakes, fulmars, and cormorants. At the lower elevations, most of the rivers and streams are important spawning areas for salmon.

Land Use

Local residents use this remote area primarily for subsistence hunting, fishing, and gathering (fig. 237-2). Most of the communities are on the coast. Wildland recreation is an increasingly important land use, particularly in the Wood-Tikchik Lakes area. There are no major resource concerns in this area.

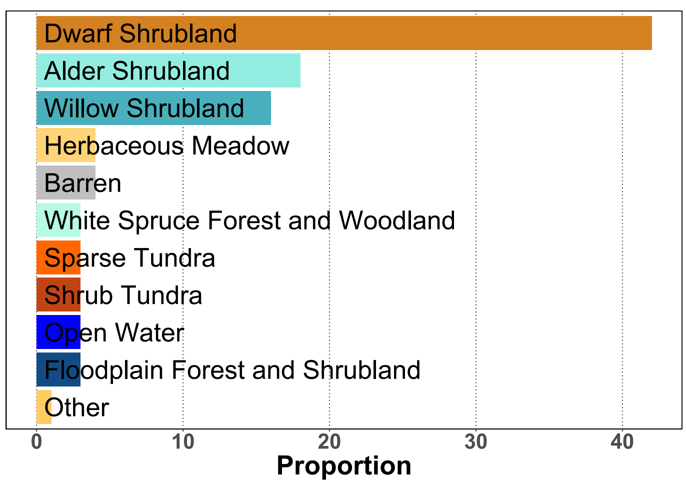

Figure 237-2: Relative proportions (percentages) of land use in MLRA 237.

238—Yukon-Kuskokwim Coastal Plain

MLRA 238 (fig. 238-1) consists of the broad, nearly level delta along the lower reaches of the Yukon and Kuskokwim Rivers, where the rivers empty into the Bering Sea. The Yukon River runs along the northern edge of the area, and the Kuskokwim River runs across the southern edge. The MLRA is mostly undeveloped wildland and is sparsely populated. The MLRA makes up about 31,565 square miles (81,750 square kilometers).

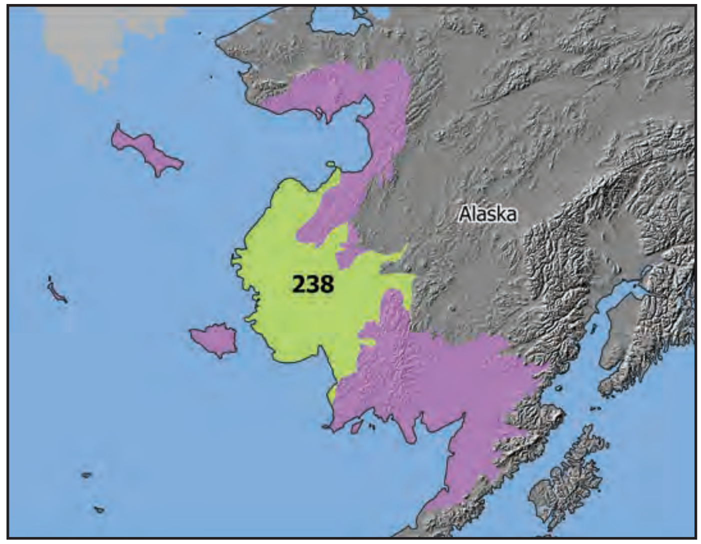

Figure 238-1: Location of MLRA 238, which covers 8,174,800 hectares (20,200,400 acres), within Region X2.

MLRA 238 is bordered by the physiographically dissimilar MLRA 237 (Ahklun Mountains), which has steep, rugged, low mountains; MLRA 230 (Yukon-Kuskokwim Highlands), distinguishable by its moderate- to high-relief mountains and narrow, flat-bottomed valleys; and MLRA 240 (Nulato Hills-Southern Seward Peninsula Highlands), which has rolling hills, low mountains, and valleys. In addition, MLRA 238 borders the Pacific Ocean, Bering Sea, and Norton Sound. It shares a less apparent boundary with MLRA 229 (Interior Alaska Lowlands), which has unglaciated braided to meandering flood plains, stream terraces, and outwash plains in the continental subarctic climate zone.

Physiography

This area lies within the Bering Shelf province of the Intermontane Uplands and Lowlands System. In a few areas, isolated low hills protrude above the surrounding plain. The area is crossed by numerous low-gradient streams, many of which are tributaries or former channels of the Yukon and Kuskokwim Rivers. Depressions and shallow basins on the plain are dotted with interconnecting stream channels, wetlands, and thousands of small and medium-size lakes. The features of the flood plain include low escarpments, meander scars, oxbow lakes, sloughs, and multiple channels and islands. The coastline is broken by several large inlets and bays. Baird Inlet forms a large inland sea behind Nelson Island. Elevation ranges from sea level to about 300 feet (90 meters) in most of the area; it is 2,342 feet (714 meters) at the summit of Towak Mountain, on Cape Romanzof.

Surface water in the vast majority of interior and western Alaska drains into the Bering Sea through this MLRA. The major rivers in the area are the Yukon, Kuskokwim, Tovers, Black, Azun, Kashunuk, and Izaviknek Rivers. Lakes make up about 40 percent of the MLRA.

This area is in the zone of discontinuous permafrost. The layer of permafrost is thin or moderately thick and occurs primarily in fine textured deposits. The maximum depth to the bottom of the permafrost layer is about 600 feet (185 meters). Permafrost generally does not occur on flood plains or in areas near bodies of water.

Geology

This area was unglaciated during the Pleistocene Epoch, except possibly along the extreme southeastern edge, where glaciers from the Ahklun Mountains extended a short distance down onto the lowlands. Sediments across the vast majority of the area consist of fine textured Holocene and Pleistocene deltaic deposits from the Yukon and Kuskokwim Rivers and loamy and sandy Holocene fluvial deposits on flood plains and stream terraces. Several low basalt hills and associated cinder cones and volcanic craters are in scattered areas throughout the western part of the MLRA. These features date to the Cretaceous and Tertiary Periods and are mantled by Holocene colluvium.

Climate

The climate is primarily maritime. In winter, when the Bering Sea ice pack forms, it becomes more continental. Summers are short and variable. Cloudy and rainy conditions are common in summer. Windy conditions are common any time of the year. Winters are long and cold. Fog and poor visibility are common, particularly in coastal areas during winter.

The average annual precipitation is 15 to 30 inches (380 to 760 millimeters). The average annual snowfall ranges from about 40 to 90 inches (100 to 230 centimeters). The average annual temperature is 29 to 33 degrees F (-2 degrees to 1 degree C). The freeze-free period averages about 80 to 135 days. Freezing temperatures can occur in any month, but June, July, and August generally are freeze-free.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. In addition, the rivers are typically fed by glacial meltwater, which carries high loads of suspended sediment. Where surface water is available, treatment for removal of the suspended sediment is normally required. Most of the water used for domestic supply is probably obtained from private wells.

Small communities and rural landowners can obtain ground water primarily from unconsolidated sediments in river valleys or beneath the coastal plain (alluvium or glacial outwash). The unconsolidated sediment aquifers are open to the surface and are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem near the coast.

Soils

The dominant soil orders are Gelisols, Histosols, Inceptisols, and Entisols. The soils in the area have a subgelic temperature class or a cryic temperature regime, an aquic or udic moisture regime, and dominantly mixed mineralogy. Fibristels, Hemistels, Histoturbels, and Aquiturbels (members of the Gelisols order) are the most common soils across the broad expanse of the delta. Fibristels and Hemistels may have mineral soil material within the permafrost layer. Historturbels are common in elevated and convex areas. They formed in a moderately thick layer of organic material over silty and loamy fluvial sediments. Aquiturbels on low terraces and in drainageways formed in stratified silty and sandy alluvial sediments. The Inceptisols, Entisols, and Histosols do not have permafrost within their profile. Miscellaneous (nonsoil) areas make up about 40 percent of this MLRA. The most common are water and beaches.

The main soils:
- Cryofibrists and Cryohemists that are very poorly drained and formed in thick deposits of organic material on lakeshores
- Cryofluvents that formed in silty and sandy alluvium on flood plains
- Cryopsamments that are excessively drained and formed in thick deposits of sand on coastal dunes
- Dystrocryepts that formed in silty and sandy fluvial sediments on hills and elevated ridges
- Fibristels and Hemistels that are very poorly drained and formed in thick deposits of organic material over shallow or moderately deep permafrost; in depressions and shallow basins
- Histoturbels and Aquiturbels that generally are shallow or moderately deep to permafrost and are very poorly drained to moderately well drained

Biological Resources

Lakes, ponds, and other kinds of surface water occur throughout most of this area. Vegetation near these bodies of water includes wet sedge meadows, sedge-shrub meadows, and sedge-moss meadows. Peat mounds and other low uplands support low and dwarf scrub dominated by ericaceous shrubs, tussock-forming sedges, other hydrophytic plants, and mosses. Sites with better drainage and higher local relief support low ericaceous scrub with mosses, lichens, low willows, and forbs. Dense stands of grasses grow on beds of drained thaw lakes. In the southern and eastern parts of the MLRA, spruce forests and woodland occur on well drained soils on flood plains and on the better drained soils on uplands. Both white spruce and black spruce are common. Low ericaceous shrubs, willow, alder, and mosses are dominant in the understory.

Mammals common to the area include brown bear, black bear, caribou, wolf, and various other furbearers. Walrus and seals are in some coastal areas. Most of this MLRA has good-quality habitat for waterfowl, and every year as many as 750,000 swans and geese use the lowlands as staging and nesting areas. More than 220 bird species use this MLRA at various times throughout the year. Significant species that nest in the area include tundra swans, emperor geese, black brants, spectacled eiders, bristle thighed curlews, white wagtails, dovekies, and McKays buntings. About 75 percent of the sandhill cranes in Alaska breed in this MLRA.

Land Use

Local residents use this remote area primarily for subsistence hunting, fishing, and gathering (fig. 238-2). Most of the communities are on the coast or along the major rivers and lakes. Less than 1 percent of the MLRA is urban. The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can lead to ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

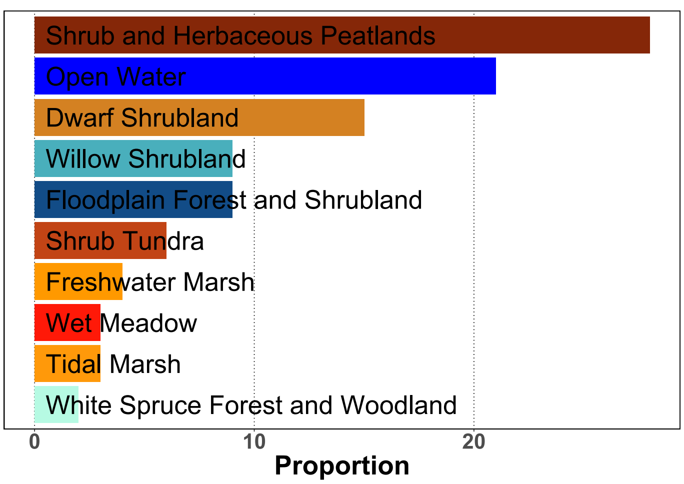

Figure 238-2: Relative proportions (percentages) of land use in MLRA 238.

239—Northern Bering Sea Islands

MLRA 239 (fig. 239-1) includes St. Lawrence, St. Matthew, and Nunivak Islands and several smaller islands in the northern Bering Sea. It makes up about 3,705 square miles (9,595 square kilometers). The terrain consists of nearly level to rolling plains and highlands with mostly gentle slopes. The dominant soil order is Gelisols. The MLRA is surrounded by the Bering Sea but does not include the Pribilof Islands.

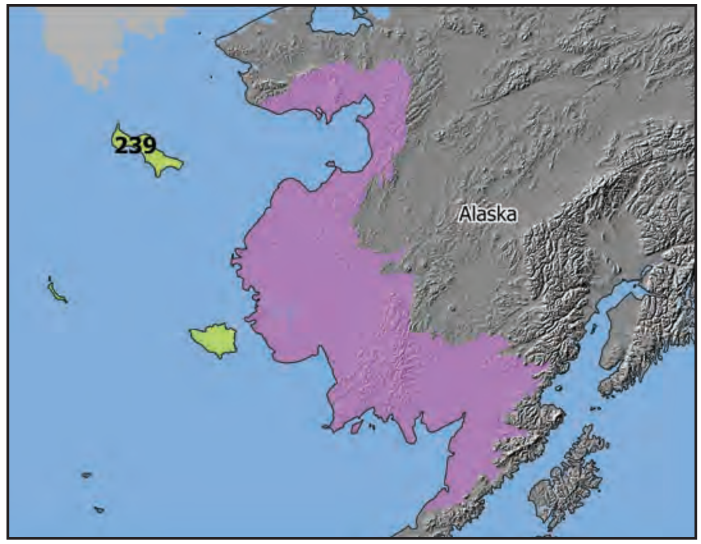

Figure 239-1: Location of MLRA 239, which covers 959,300 hectares (2,370,500 acres), within Region X2.

Physiography

This area lies within the Bering Shelf province of the Intermontane Uplands and Lowlands System. Steep, low-relief volcanic cones, vents, and lava flows are common throughout Nunivak Island and less common on St. Lawrence Island. Coastal lowlands dotted with numerous small and medium-size lakes make up a significant part of St. Lawrence Island. Narrow, discontinuous sand dunes and sand sheets are along many stretches of the coast. Elevation ranges from sea level along the coast to 2,207 feet (673 meters) at the summit of Atuk Mountain, on St. Lawrence Island.

Numerous short, high-gradient streams drain the islands directly into the Bering Sea. On St. Lawrence Island, lakes make up about 10 percent of the area. Lakes are less extensive on Nunivak and St. Matthew Islands.

This MLRA is in the zone of discontinuous permafrost. The layer of permafrost generally is thin or moderately thick and occurs primarily in fine textured deposits. Permafrost generally does not occur on flood plains, in coarse textured sediments on the steep slopes of volcanic cones, along the coast, or near lakes and other bodies of water. The common periglacial features in the area include solifluction lobes, frost boils, and patterned ground on plains and footslopes and in swales on hills.

Geology

The Northern Bering Sea islands rise from the submarine Bering platform. St. Lawrence Island is the most geologically complex of the islands. It is made up primarily of Cretaceous, Tertiary, and Quaternary volcanic rocks and some Paleozoic stratified sedimentary rocks. The coastal lowlands are made up mostly of Quaternary alluvial and marine sediments. Nunivak and St. Matthew Islands are made up almost exclusively of Tertiary and Quaternary volcanic rocks. With the possible exception of a small area on the western end of St. Lawrence Island, the MLRA was unglaciated during the Pleistocene Epoch. Most of the modern landscape is mantled with Quaternary alluvial, marine, and eolian deposits.

Climate

The climate is maritime much of the year and strongly continental in winter, when the Bering Sea ice pack forms. Summers are short and cool. Cloudy, foggy, and rainy conditions are common in summer. Strong winds are common throughout the year. Winters are long and cold.

The average annual precipitation is 10 to 25 inches (255 to 635 millimeters). The average annual snowfall is about 50 to 80 inches (125 to 205 centimeters). The average annual temperature at Gambell on St. Lawrence Island is 25 degrees F (-4 degrees C). The freeze-free period at Gambell averages about 60 to 90 days.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Little surface water is available for use by island residents. Most of the water used for domestic supply is probably obtained from private wells. Small communities and rural landowners on Nunivak and St. Matthew Islands obtain ground water from volcanic bedrock aquifers. The water is in joints, fractures, and rubble zones in the volcanic rocks. Unconsolidated sediments in river valleys and on the coastal plain (alluvium and some glacial outwash) provide ground water for residents of St. Lawrence Island. This ground water generally occurs as a lens of freshwater floating on saltwater near the coast. Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem since most residents live along the coast.

Soils

The dominant soil order is Gelisols. The Gelisols are shallow or moderately deep to permafrost and are poorly drained to somewhat poorly drained. The MLRA also has small areas of Mollisols and Inceptisols. The soils in the area have a subgelic temperature class or a cryic temperature regime; an aquic, ustic, or udic moisture regime; and mixed mineralogy. Miscellaneous (nonsoil) areas make up about 10 percent of this MLRA. The most common are water, lava flows, rubble land consisting of volcanic rocks, and sandy and gravelly beaches.

The main soils:

- Dystrocryepts that formed in gravelly and sandy materials, do not have permafrost within their profile, and generally are well drained; on plains, hills, and the lower mountain slopes
- Fibristels and Hemistels that formed in thick deposits of organic material, are shallow or moderately deep to permafrost, and are poorly drained; in depressions and swales on plains and hills
- Haplocryolls that formed in residuum, do not have permafrost within their profile, and generally are well drained; on limestone uplands
- Historthels that have a moderately thick surface layer of organic material on plains, hills, and the lower mountain slopes
- Histoturbels and Aquiturbels that formed in gravelly and sandy materials on plains, hills, and the lower mountain slopes
- Mollorthels and Molliturbels that formed in residuum, are shallow or moderately deep to permafrost, and are somewhat poorly drained or poorly drained; on limestone uplands

Biological Resources

The areas of peat, gentle mountain slopes, plains, and deeper soils in this MLRA generally support low and dwarf scrub and sedge-shrub meadows dominated by black crowberry, ericaceous shrubs, sedges, tussock-forming sedges, and a variety of forbs and mosses. Shallow soils on convex mountain slopes and ridges commonly support alpine dwarf scrub dominated by ericaceous shrubs, Dryas, and dwarf willows. These communities commonly have a considerable amount of lichen and bare ground. Bedrock exposures with lichens and scattered shrubs and herbs in pockets of fine earth dominate the highest elevations and ridges and other windblown sites. Drainages and the shores of lakes support wet sedge meadows, sedge-grass meadows, and sedge-moss meadows. Well drained soils on flood plains commonly support low to tall willow scrub with dense grasses and forbs in the understory.

Various marine mammals and seabirds inhabit the coastal waters, rocky shorelines, and sea cliffs in the area. Waterfowl nest on coastal lowlands. The common marine mammals include northern fur seals, ribbon seals, sea lions, and walrus. Seabirds include eiders, cormorants, kittiwakes, puffins, auklets, oldsquaw, and murres. In winter, flocks of rare spectacled eiders congregate in openings in the sea ice south of St. Lawrence Island. Caribou, reindeer, musk ox, Arctic fox, and other small mammals are on many of the islands.

Land Use

Local residents use this remote area primarily for subsistence hunting, fishing, and gathering (fig. 239-2). Reindeer herding on Nunivak and St. Lawrence Islands provides meat and other products to the residents. Most of the communities in the MLRA are on the coast. Tourism and wildland recreation are minor but increasingly important land uses.

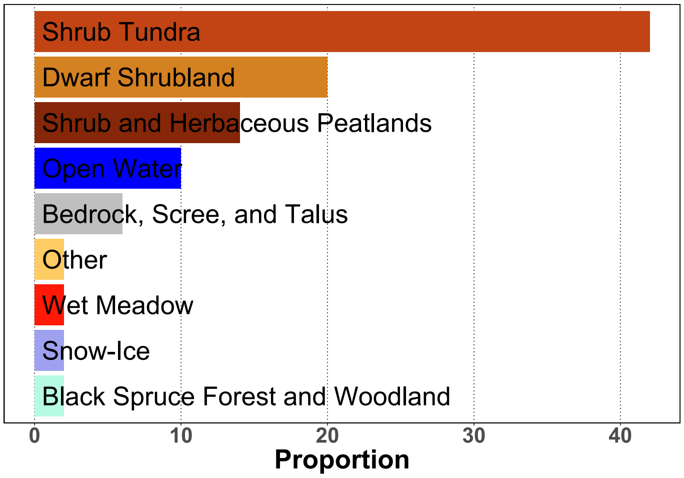

Figure 239-2: Relative proportions (percentages) of land use in MLRA 239.

The major soil resource concerns are disturbance of the fragile permafrost-affected soils and erosion of Andic soils and the steeper soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can lead to ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

240—Nulato Hills-Southern Seward Peninsula Highlands

MLRA 240 (fig. 240-1) consists primarily of the rolling hills, low mountains, and valleys on the southern Seward Peninsula and western slopes of the Nulato Hills. Much of the MLRA is mantled with fine textured to coarse textured mountain colluvium and alluvium. It is primarily undeveloped wildland and is sparsely populated. The area makes up about 18,585 square miles (48,140 square kilometers).

MLRA 240 is bordered by the physiographically dissimilar MLRA 238 (Yukon-Kuskokwim Coastal Plain), which has the broad, nearly level delta formed by the lower reaches of the Yukon and Kuskokwim Rivers, and Norton Sound. It shares a less apparent boundary with MLRA 230 (Yukon-Kuskokwim Highlands), where the climate is transitional from continental subarctic to maritime, and MLRA 241 (Seward Peninsula Highlands), where a continental arctic climate prevails.

Physiography

This area lies within the Seward Peninsula and Western Alaska provinces of the Intermontane Uplands and Lowlands

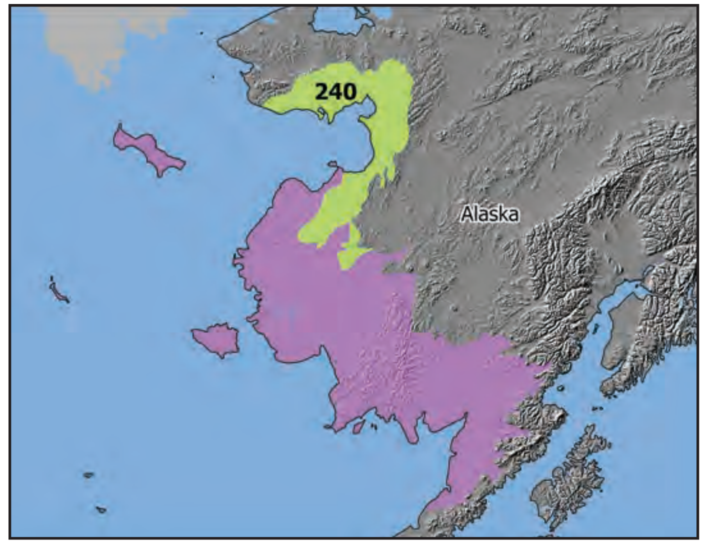

Figure 240-1: Location of MLRA 240, which covers 4,813,800 hectares (11,895,300 acres), within Region X2.

System. The terrain near the coast of Norton Sound consists of rolling hills and broad valleys. Rounded, low mountains occur farther inland. Narrow flood plains border the many clear-water streams in the area. Narrow, nearly level coastal plains are in several areas along the coast of Norton Sound. Elevation ranges from sea level to about 3,900 feet (1,190 meters).

Surface water throughout the area drains into Norton Sound and the Bering Sea by way of numerous short streams and rivers originating in the mountains. The principal rivers are the Unalakleet, Koyuk, and Fish Rivers. Lakes make up less than 1 percent of the MLRA.

This area is in the zone of discontinuous permafrost. Permafrost is common on coastal plains, on gently sloping footslopes, and in swales on hills and mountains. It generally does not occur on flood plains or near lakes and other bodies of water. Isolated masses of permafrost are in deep, unconsolidated deposits in the mountains. In the vicinity of Nome, the base of the permafrost layer is at a depth of as much as 121 feet (37 meters).

Geology

Large areas of the Seward Peninsula were glaciated during the Early and Middle Pleistocene. By the Late Pleistocene, glacial ice was limited to the upper elevations. Moderately modified or highly modified glacial moraines and drift and scattered glaciofluvial deposits are still in glaciated areas. Holocene deposits fill most of the coastal lowlands. Recent fluvial deposits are on flood plains and stream terraces. The bedrock geology in the MLRA consists dominantly of Cretaceous, Precambrian, and Paleozoic stratified sedimentary rocks and Cretaceous through Tertiary volcanic rocks. Many coastal areas and areas at the lower elevations of hills and mountains are mantled with a thin layer of silty eolian deposits of Holocene age.

Climate

The climate is maritime much of the year and strongly continental in winter, when the Bering Sea ice pack forms. Orographic influences are significant at the higher elevations. Summers are brief and cool. Cloudy and windy conditions are common throughout the year. Winters are long and cold.

The average annual precipitation is about 15 to 20 inches (380 to 510 millimeters) at the lower elevations and 20 to 40 inches (510 to 1,015 millimeters) at the higher elevations. Most of the precipitation falls as rain in late summer. The average annual snowfall is 40 to about 100 inches (100 to 255 centimeters). The average annual temperature along the coast is about 26 degrees F (-3 degrees C). The freeze-free period along the coast averages about 55 to 90 days.

Water

Permanent streams, originating in the mountainous regions surrounding the MLRA, bring some surface water to villages and the town of Homer. Water from rivers and natural lakes is used for some public supply, mining, and domestic purposes. It generally is suitable for all uses. Flooding from ice dams that form during the spring thaw is a concern.

The ground water used for public supply, domestic purposes, and mining is primarily from bedrock aquifers. Some unconsolidated sediments in river valleys or coastal plains (alluvium or glacial outwash) also provide some water. The ground water is hard or very hard but is otherwise of excellent quality. The level of iron may exceed the secondary (esthetic) standard for drinking water. The iron can stain ceramic and porcelain and precipitate in pipes. Wells in this area generally are shallow, so these aquifers are highly susceptible to contamination from runoff. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders are Gelisols, Inceptisols, and Entisols. The soils in the area have a subgelic soil temperature class or a cryic temperature regime, an aquic or udic moisture regime, and dominantly mixed mineralogy. Many of the soils on mountains and hills are moderately deep or deep over fractured bedrock. The Gelisols are common on mountains, hills, and coastal plains. They are shallow or moderately deep to permafrost and are poorly drained or somewhat poorly drained. Miscellaneous (nonsoil) areas make up about 5 percent of this MLRA. The most common are rock outcrop, rubble land, and beaches.

The main soils:

- Cryofluvents and Cryorthents that are deep, range from somewhat poorly drained to well drained, and formed in stratified loamy alluvium over sandy and gravelly alluvium; on flood plains
- Dystrocryepts and Haplocryepts that are shallow to deep over bedrock and well drained and formed in gravelly colluvium over fractured bedrock; on steep mountain slopes, particularly at the higher elevations
- Histoturbels and Aquiturbels that have a moderately thick, in places, discontinuous surface layer of organic material and that formed in loamy and gravelly colluvium on mountains and hills and in mixed loamy and gravelly colluvium and slope alluvium on coastal plains
- Mollorthels that formed in loamy and gravelly colluvium on mountains and hills and in mixed loamy and gravelly colluvium and slope alluvium on coastal plains

Biological Resources

Well drained soils on slopes at low and middle elevations in this area dominantly support tall alder shrub, tall and low willow scrub, and low ericaceous shrub scrub. Areas of peat and moderately well drained mineral soils support low ericaceous shrub and shrub birch scrub along with tussock-forming sedges or various sedges and grasses in the ground layer. Drainages support wet sedge meadows, sedge-grass meadows, and sedge-moss meadows. Well drained soils at the lower elevations on valley bottoms have open forests and woodland of mixed spruce and paper birch. Areas at the higher elevations and the shallow soils on convex mountain slopes and ridges commonly support alpine dwarf scrub dominated by ericaceous shrubs, Dryas, and dwarf willows. These communities commonly have a considerable amount of lichen and bare ground. Bedrock exposures with lichens and scattered shrubs and herbs in pockets of fine earth dominate ridges and area at the highest elevations.

Mammals common to the area include brown bear, caribou, moose, wolf, and a variety of other furbearers. Golden eagles inhabit areas at the higher elevations and nest in cliffs and other protected sites. Tundra swans and a variety of other waterfowl nest in the wetlands and ponds. Coastal areas are inhabited by ribbon seals and walrus. The Unalakleet River and other rivers support summer runs of pink salmon.

Land Use

This remote area is used primarily for subsistence hunting, fishing, and gathering (fig. 240-2). The Seward Peninsula also is used for reindeer herding. Less than 1 percent of the MLRA is urban. Mining, primarily placer mining and dredge mining, was once a major land use and played an important role in the growth and development of Nome. Several mines throughout the area continue to operate.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Another concern is the suspended sediment load in rivers downstream from placer mines. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can lead to ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

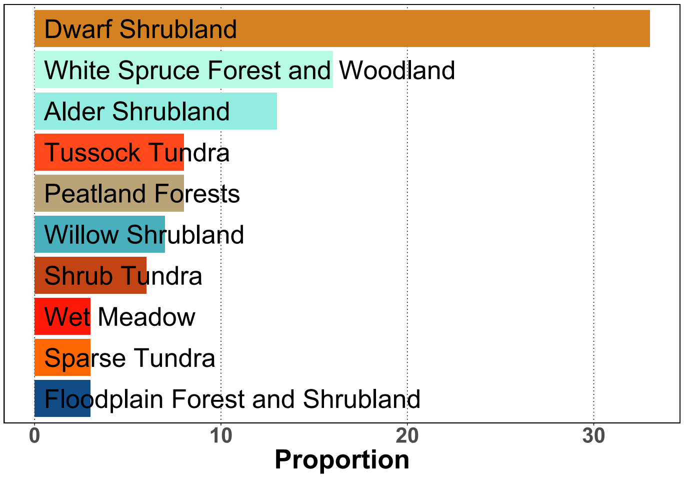

Figure 240-2: Relative proportions (percentages) of land use in MLRA 240.

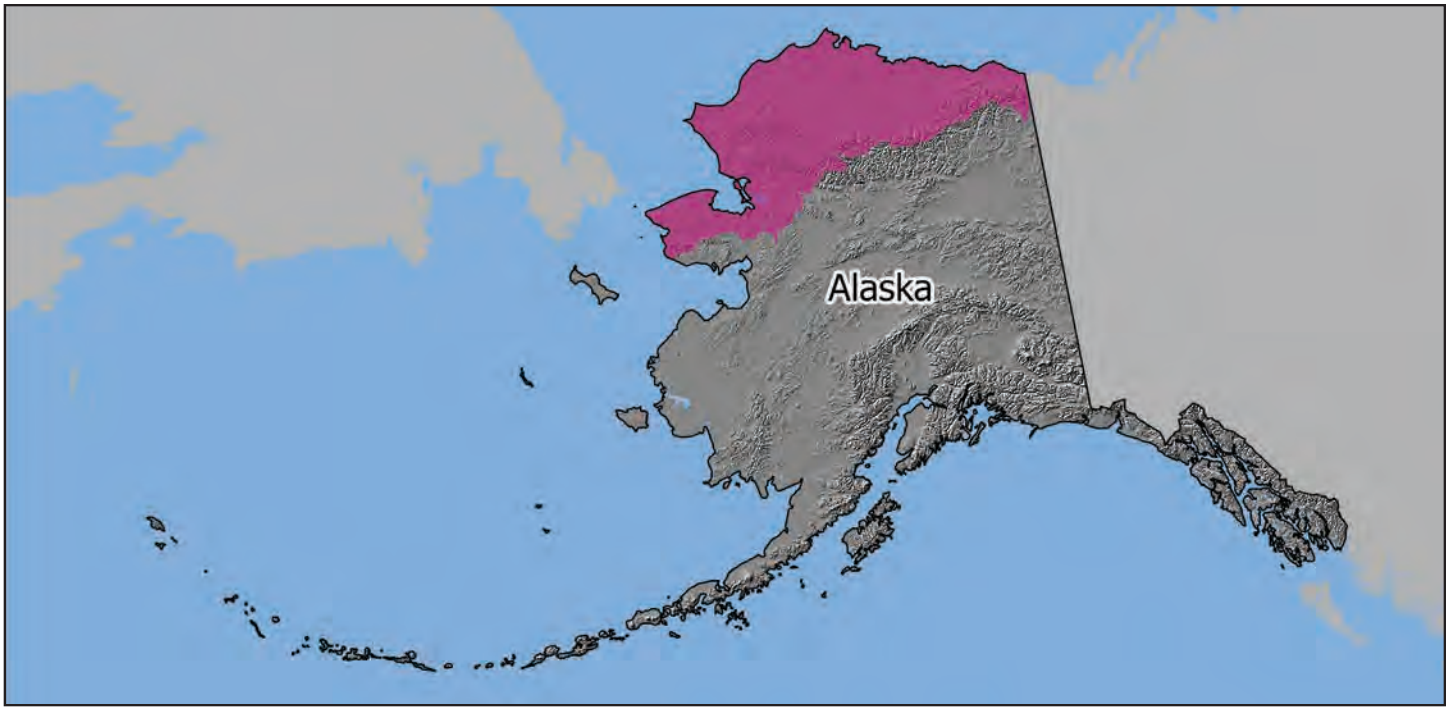

Figure Y-1: Location and size of Land Resource Region Y, which covers 329,445 square kilometers (127,200 square miles) and includes the northern slope of the Brooks Range, the western Brooks Range, and the northern and western Seward Peninsula.

Y—Northern Alaska

Land Resource Region Y (fig. Y-1) is the continuous permafrost area of Alaska. It extends from the crest of the east-west-oriented Brooks Range northward and downslope across the foothills and the gently sloping coastal plain to the Arctic Ocean. This patterned-ground region of cold, long winters and semiarid to arid tundra contains numerous lakes, swamps, and north-flowing meandering streams and their deltas. The north flanks of the Brooks Range consist of folded and faulted strata that were uplifted during the Cretaceous Period. The mountains were extensively glaciated during the Pleistocene Epoch. To the north, the rolling hills, ridges, and plateaus extend to the gently rolling to level, unglaciated Arctic Coastal Plain. Periglacial features, such as patterned ground, pingos, beaded drainages, and gelifluction lobes, are common throughout the region. The southwest part of the region, extending into the Seward Peninsula, includes flood plains, rolling lowlands, and mountains. In most of the region, surface water drains to the north and west into the Arctic Ocean and the Chukchi Sea. On the western Seward Peninsula, however, it drains into the northern Bering Sea. Elevation ranges from sea level on the coast to 8,570 feet (2,613 meters) at the summit of Mount Igikpak, in the Brooks Range. This region contains six major land resource areas. The extent of these MLRAs and their range in elevations are shown in table Y-1.

The boundary between Region Y and Regions X1 and X2 (fig. 3, page 7) is the boundary between continuous permafrost (Region Y) and discontinuous permafrost (Regions X1 and X2). The boundary with Region X1 is also the boundary between tundra (Region Y) and the white spruce- and birch-dominated forest (Region X1).

The region has an arctic climate, which is dry and cold and characterized by very short summers and long winters. Most of the region is above the Arctic Circle and consequently receives continuous sunlight for several weeks in summer and continuous twilight for several weeks in winter. The mean annual precipitation ranges from about 4 to 10 inches (100 to 255 millimeters) at the lower elevations in the northern and western parts of the region and from 30 to 40 inches (760 to 1,015 millimeters) at the higher elevations in the Brooks Range and on the Seward Peninsula. The average annual temperature ranges from 10 to 27 degrees F (-12 to -3 degrees C). Freezing temperatures can occur in any month. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables Y-2 and Y-3.

The soils in Region Y are in the zone of continuous permafrost. The permafrost is shallow or moderately deep, except on steep, coarse textured soils in the high mountains. Most of the soils in the region are Gelisols, having permafrost within their profile. Mollisols and Inceptisols also occur in

Table Y-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
241	35,560	13,730	0	0	30	120	160	540	380	1,270	1,420	4,670
242	21,870	8,445	0	0	0	0	10	60	70	230	600	1,990
243	58,805	22,705	0	0	40	150	370	1,220	820	2,700	2,320	7,630
244	37,615	14,525	0	10	630	2,070	1,080	3,560	1,650	5,430	2,720	8,920
245	118,015	45,565	0	0	60	220	260	880	620	2,050	1,710	5,610
246	57,585	22,235	0	0	0	0	20	70	70	230	250	830

Table Y-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set. Dashes indicate data were not available.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
241	-7	19	-5.5	22	-5	23	-4.1	25	-2.7	27	---	---	---	---	---
242	-6.3	21	-5.5	22	-5.3	22	-4.8	23	-4.3	24	---	---	---	---	---
243	-10.6	13	-8	18	-6.2	21	-4.7	23	-3.9	25	---	---	---	---	---
244	-12.3	10	-9.4	15	-8.1	17	-7.3	19	-6.3	21	---	---	---	---	---
245	-12.2	10	-11.1	12	-9.8	14	-7.4	19	-4.4	24	---	---	---	---	---
246	-11.7	11	-11.5	11	-11.2	12	-10.5	13	-8.2	17	---	---	---	---	---

Table Y-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
241	260	10	294	12	337/360	13/14	448	18	750	30
242	190	8	254	10	326/320	13/13	390	15	570	22
243	290	12	383	15	477/520	19/20	714	28	1,170	46
244	180	7	311	12	439/450	17/18	593	23	960	38
245	120	5	168	7	279/295	11/12	472	19	850	33
246	100	4	126	5	140/150	6/6	192	8	320	12

the mountains (fig. 3). Orthels and Turbels, the dominant suborders, occur on all landforms in the region. Aquorthels and Histoturbels are on the gentler slopes and on poorly drained hillsides. Glacic subgroups occur near the coasts. Mollorthels are on some well drained, south-facing slopes, and Psammorthels are on dunes. Fibristels formed in thick deposits of organic material in depressions throughout the region. Coarse textured Gelepts and Gelorthents are on some steep hillslopes and ridges. They have a mean annual soil temperature below 32 degrees F (0 degrees C) but do not have permafrost. Restrictive zones occur in most soil profiles in the region not only as permafrost but also as abrupt textural changes and paralithic bedrock (fig. 10, page 14). This region has substantial amounts of soil organic carbon (fig. 15, page 19).

Land uses in the region are primarily reindeer grazing, wildlife habitat, mineral and petroleum extraction, and subsistence hunting, fishing, and gathering (fig. Y-2). Some areas are used for wilderness recreation. The native vegetation on foothills and lowlands is arctic tundra with grasses, sedges, mosses, lichens, ericaceous shrubs, and willows. The native vegetation in mountainous areas is dominantly alpine tundra with dwarf scrub communities. In these areas, sedges and lichens dominate the ground cover. Forested communities occur along the lower Noatak and Kobuk Rivers in the western part of the region.

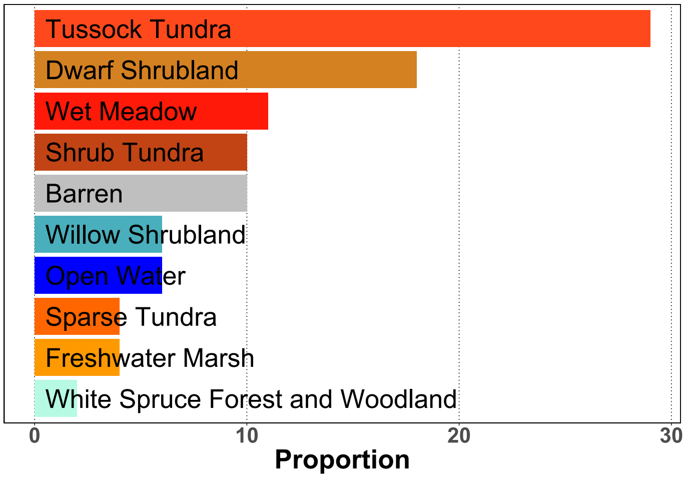

Figure Y-2: Relative proportions (percentages) of land use in LRR Y.

241—Seward Peninsula Highlands

MLRA 241 (fig. 241-1) includes the broad, rolling uplands and isolated rugged mountains of the central Seward Peninsula, stretching from Cape Prince of Wales east to the Selawik Hills. It makes up about 13,730 square miles (35,560 square kilometers). Several highly mineralized areas can be mined, and several mines still operate. This area is mainly undeveloped wildland and is sparsely populated. It is in the zone of continuous permafrost.

MLRA 241 is bordered by the physiographically dissimilar MLRA 242 (Northern Seward Peninsula-Selawik Lowlands), which is distinguishable by its nearly level to rolling plains, river deltas, and extended mountain footslopes, and by Kotzebue Sound, the Bering Sea, and Norton Sound. It has less apparent boundaries with MLRA 240 (Nulato Hills-Southern Seward Peninsula Highlands), where the climate is maritime for much of the year and strongly continental in winter, and MLRA 230 (Yukon-Kuskokwim Highlands), where the climate is transitional from continental subarctic to maritime.

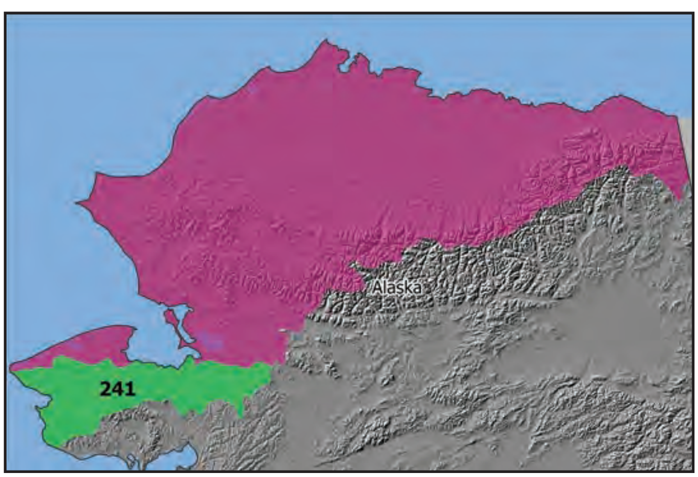

Figure 241-1: Location of MLRA 241, which covers 3,555,700 hectares (8,786,500 acres), within Region Y.

Physiography

This MLRA lies within the Intermontane Uplands and Lowlands System. It is primarily within the Seward Peninsula province, but the eastern part is within the Western Alaska province. The terrain consists of extensive rolling hills, intervening lowlands, and isolated groups of rugged, moderately high mountains. Narrow flood plains and stream terraces are along the rivers. Elevation ranges from sea level along the coast to 4,714 feet (1,437 meters) at the summit of Mount Osborn, in the Kigluaik Mountains.

Surface water in the northern part of the area drains into Kotzebue Sound and the Chukchi Sea via numerous relatively short rivers. The major rivers in this part of the area are the Buckland, Kiwalik, and Serpentine Rivers. Surface water in the western part of the area drains to the west into the northern Bering Sea. The principal rivers in this part of the area are the Agiapuk-American, Kougarok, and Kuzitrin Rivers. Lakes make up less than 2 percent of the MLRA.

Moderately thick layers of permafrost are common in most unconsolidated materials, except along flood plains and near lakes. Periglacial features are common. Bedrock structures have altiplanation terraces. Unconsolidated materials in the uplands have gelifluction sheets, benches, lobes, and high-center polygons. Wet lowlands have low-center polygons, thermokarst pits, thaw lakes, and pingos. Massive ice wedges and lenses occur throughout the MLRA.

Geology

During the Late Pleistocene Epoch, this area was mostly unglaciated. The York Mountains in the western part of the area, the Kigluaik and Bendeleben Mountains along the southern edge, and the upper Kiwalik River drainage were glaciated in the Early and Middle Pleistocene. The modern landscape is mantled with coarse textured to fine textured colluvium, slope alluvium, and silty loess. Bedrock is at or near the surface in many upland areas. Recent alluvial and coastal sediments are along rivers and near the coast. Slightly modified to highly modified glacial moraines and drift are in glaciated areas. The bedrock geology consists of a complex mixture of rock ages and types. Stratified sedimentary rocks, ranging in age from Quaternary to Precambrian, are the dominant rock types. Tertiary or Quaternary volcanic rocks and inclusions of Cretaceous and Tertiary igneous rocks are in scattered areas throughout the MLRA.

Climate

Brief, cool summers and long, very cold winters characterize the continental arctic climate across much of the MLRA. In summer, maritime conditions prevail along the coast of the Bering Sea. Strong winds are common throughout the area.

The average annual precipitation ranges from about 10 to 15 inches (255 to 380 millimeters) in the northern and western parts of this area and from about 20 to 40 inches (510 to 1,015 millimeters) in the mountains in the southern and eastern parts. The average annual snowfall is about 40 to 100 inches (100 to 255 centimeters). Exposed, windblown ridges generally are free of snow. The average annual temperature at Wales is 21 degrees F (-6 degrees C). The freeze-free period at Wales averages about 45 to 75 days. Freezing temperatures can occur in any month of the year, particularly in inland areas and at the higher elevations.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water in the area generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Most of the water used for domestic supply in this area is probably obtained from private wells.

Small communities and rural landowners can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash) or beneath the coastal plains. Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Gelisols, Entisols, and Inceptisols. The soils in the area have a subgelic or pergelic soil temperature class or a cryic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. The Gelisols are shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Miscellaneous (nonsoil) areas make up about 5 percent of this MLRA. The most common are rock outcrop, riverwash, and water.

The main soils:

- Cryofluvents that formed in sandy to gravelly alluvium, generally do not have permafrost within their profile, and range from poorly drained to excessively drained; on flood plains and stream terraces
- Fibristels that formed in thick deposits of organic material, are shallow to permafrost, are very poorly drained, and may have mineral soil material within the permafrost layer; on plains and in depressions, basins, and drainageways
- Gelepts and Gelorthents that are moderately well drained, formed in residuum, and do not have permafrost within their profile; on steep hillslopes and ridges
- Histoturbels, Aquiturbels, Haplorthels, and Mollorthels that formed in colluvium and slope alluvium on elongated toeslopes adjacent to coastal areas, on broad interior uplands and hills, and on mountain slopes

Biological Resources

Uplands in this MLRA generally support dwarf scrub dominated by Dryas, black crowberry, ericaceous shrubs, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and bedrock generally are extensive. On the more mesic sites, sedges, forbs, and mosses cover most of the surface. Areas at the lower elevations and the deeper soils in the nearly level uplands and basins generally support low willow and ericaceous shrub scrub and mesic graminoid herbaceous communities, commonly with extensive areas of tussock-forming sedges. Depressions, drainageways, and other saturated areas support wet sedge meadows and wet sedge-moss meadows. The vegetation on flood plains consists of a mixture of tall and low scrub dominated by various willows, shrub birch, and alder.

Mammals common to the area include brown bear, caribou, moose, musk ox, black bear, wolf, red fox, a variety of other furbearers, and rodents. Reindeer were introduced to the area in the early 1900s to provide an industry for local native residents. Many species of migratory waterfowl and shore birds nest on the wet tundra. Raptors in the area include gyrfalcon, peregrine falcon, golden eagle, hawks, and owls.

Land Use

This remote MLRA is used primarily for reindeer herding or for subsistence hunting, fishing, and gathering (fig. 241-2). Reindeer provide meat and other products for local use and export. Several highly mineralized areas can be mined. Most of the mining has been placer mining for gold. Several mines are still operating.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can result in ponding, soil subsidence,

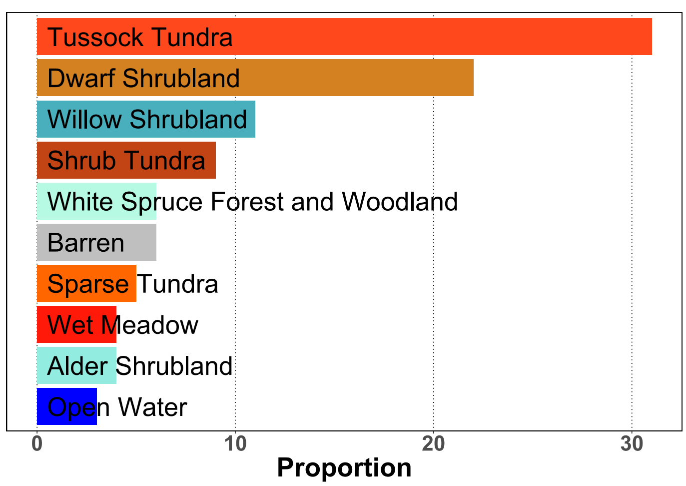

Figure 241-2: Relative proportions (percentages) of land use in MLRA 241.

erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

242—Northern Seward Peninsula-Selawik Lowlands

MLRA 242 (fig. 242-1) includes the mosaic of coastal lowlands, river deltas, gently sloping uplands, and isolated hills and low mountains along the northern Seward Peninsula and in the lower Selawik Basin at the head of Kotzebue Sound. To the east, the area extends to the lower slopes of the Purcell Mountains, Zane Hills, and Sheklukshuk Range. The MLRA makes up about 8,445 square miles (21,870 square kilometers). The terrain consists of nearly level to rolling plains, river deltas, and extended mountain footslopes. Lakes, ponds, and saturated soils occur throughout most of this area. The MLRA is mostly undeveloped wildland and is sparsely populated. It is in the zone of continuous permafrost.

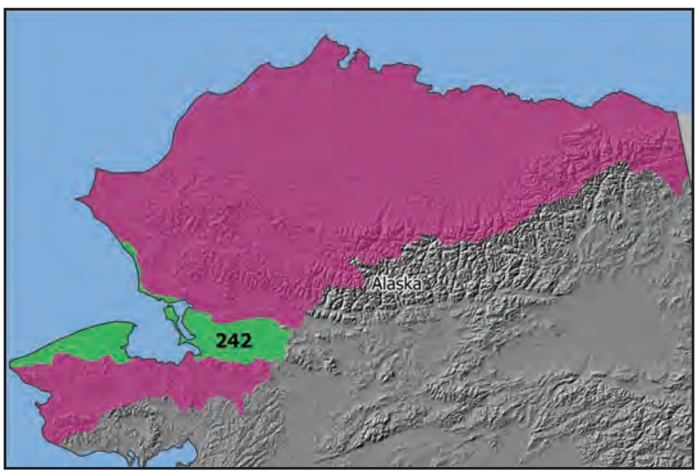

Figure 242-1: Location of MLRA 242, which covers 2,186,700 hectares (5,403,600 acres), within Region Y.

MLRA 242 has boundaries based on physiography with MLRAs 241, 230, 243, and 245. MLRA 241 (Seward Peninsula Highlands) has broad, rolling uplands and isolated high, rugged mountains. MLRA 230 (Yukon-Kuskokwim Highlands) has moderate- to high-relief mountains and narrow, flat-bottomed valleys (in the transitional continental subarctic to maritime climate zone). MLRA 243 (Western Brooks Range Mountains, Foothills, and Valleys) encompasses the southern slopes of the De Long Mountains, the Baird Mountains, the Noatak River drainage, and the lower Kobuk River drainage. MLRA 245 (Arctic Foothills) has broad, rounded hills and nearly level uplands (near Kivalina Lagoon). In addition, MLRA 242 borders the Chukchi Sea and Kotzebue Sound. It shares a less apparent boundary with MLRA 233 (Upper Kobuk and Koyukuk Hills and Valleys), which is distinguishable by its continental subarctic climate.

Physiography

This MLRA lies within the Intermontane Uplands and Lowlands System. It is primarily within the Seward Peninsula province, but the eastern part lies within the Western Alaska province. Depressions and shallow basins are dotted with hundreds of small lakes and interconnecting wetlands. Nearly level, meandering flood plains are along rivers. In a few areas the landscape is broken by rounded, low-relief hills protruding above the surrounding lowlands. In general, elevation ranges from sea level in the coastal lowlands to about 300 feet (90 meters) near the adjacent mountainous areas.

Surface water in the entire area drains into Kotzebue Sound and the Chukchi Sea. The major river systems that traverse the area are the Selawik and Buckland Rivers and the Kobuk and Noatak river deltas. Lakes make up about 25 percent of the MLRA.

Thin or moderately thick layers of permafrost occur primarily in fine textured deposits. Near Kotzebue, the maximum depth to the bottom of the permafrost layer is as much as about 240 feet (75 meters). Permafrost generally does not occur on flood plains or near lakes and other bodies of water. Periglacial features, such as beaded drainages, patterned ground, thaw gullies, pingos, and frost boils, occur throughout the area.

Geology

The western part of this area was unglaciated during the Pleistocene Epoch. Most of the eastern part was covered by glacial ice originating in the Waring Mountains and Brooks Range to the north. Sediments across the vast majority of the area consist of fine textured, Holocene and Pleistocene deltaic and fluvial deposits on coastal lowlands, Holocene fluvial deposits on flood plains and stream terraces, and mixed colluvium and slope alluvium on mountain footslopes. The underlying bedrock geology consists primarily of stratified sedimentary rocks and volcanic rocks of Cretaceous, Tertiary, and Quaternary age.

Climate

Brief, cool summers and long, very cold winters characterize the climate. In summer, maritime conditions prevail near the coast, becoming more continental farther inland. In winter, when the ice pack forms on Kotzebue Sound, continental arctic conditions prevail throughout the area.

The average annual precipitation ranges from less than 10 inches (255 millimeters) in the coastal lowlands to 20 to 30 inches (510 to 760 millimeters) in the hills and mountains in the southern and eastern parts of this MLRA. The average annual snowfall is about 40 to 60 inches (100 to 150 centimeters). The average annual temperature at Kotzebue is 22 degrees F (-6 degrees C). The freeze-free period at Kotzebue averages about 75 to 95 days. Freezing temperatures can occur in any month of the year, particularly at the higher elevations in inland areas.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Most of the water used for domestic supply is probably obtained from private wells.

Small communities and rural landowners can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash) or beneath coastal plains. Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders in this MLRA are Gelisols, Inceptisols, and Entisols. The soils in the area have a subgelic or pergelic soil temperature class or a cryic temperature regime and generally have an aquic moisture regime and mixed mineralogy. The Entisols have no permafrost within their profile and range from very poorly drained to excessively drained. Fibristels, Histoturbels, and Aquiturbels are the most common soils on coastal lowlands and deltas. The Histoturbels have a moderately thick surface layer of organic material. Miscellaneous (nonsoil) areas make up about 25 percent of this MLRA. The most common are water and beaches.

The main soils:

Cryopsamments that formed in thick deposits of sand on coastal dunes

Cryorthents, Cryaquents, and Cryofluvents that formed in silty and sandy alluvium on flood plains and stream terraces

Fibristels that formed in thick deposits of organic material, are shallow or moderately deep to permafrost, are very poorly drained, and may have mineral soil material within the permafrost layer; in depressions and shallow basins

Gelepts that formed in silty and sandy fluvial sediments, do not have permafrost within their profile, and generally are well drained or moderately well drained; on hills and elevated ridges

Histoturbels and Aquiturbels that formed in silty and sandy material over a gravelly substratum, are shallow or moderately deep to permafrost, commonly have surface microtopography of polygons and stripe hummocks, and generally are poorly drained or very poorly drained; in elevated and convex areas on low terraces and long footslopes

Biological Resources

Areas adjacent to the lakes and ponds and where surface water generally occurs include wet sedge meadows, sedge-shrub meadows, and sedge-moss meadows. Peat mounds and other low uplands support low and dwarf scrub dominated by ericaceous shrubs, sedges, other hydrophytic plants, and mosses. Areas with better drainage and areas of higher local relief support low ericaceous shrub scrub with common mosses, lichens, low willows, and forbs. Dense stands of grasses grow on the beds of drained thaw lakes. Flood plains support low and tall willow scrub and alder scrub. In the eastern part of the MLRA, spruce forests and woodland occur on well drained flood plains and the better drained uplands. Both white spruce and black spruce are common. Low ericaceous shrubs, willow, alder, and mosses are dominant in the understory.

Mammals common to the area include brown bear, caribou, wolf, and various other furbearers. Walrus and seals are in some coastal areas. Most of the MLRA has good-quality habitat for waterfowl. Every year, thousands of swans, geese, and ducks use the lowlands as staging and nesting areas. Sandhill cranes and a variety of shore birds and passerine birds nest throughout the area.

Land Use

Local residents use this remote area primarily for subsistence hunting, fishing, and gathering (fig. 242-2). Most of the communities are along the major rivers or lakes or on the coast. The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can lead to ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

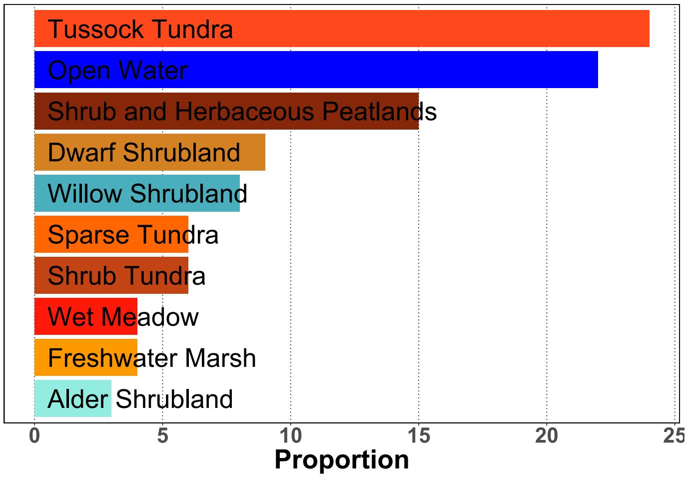

Figure 242-2: Relative proportions (percentages) of land use in MLRA 242.

243—Western Brooks Range Mountains, Foothills, and Valleys

MLRA 243 (fig. 243-1) encompasses the southern slopes of the De Long Mountains, the Baird Mountains, the Noatak River drainage, and the lower Kobuk River drainage. The southern limit of the area includes the western Lockwood Hills, Sheklukshuk and Waring Mountains, and Kiana and Igichuk Hills. The MLRA makes up about 22,705 square miles (58,805 square kilometers). It is mostly undeveloped wildland and is sparsely populated. It is in the zone of continuous permafrost.

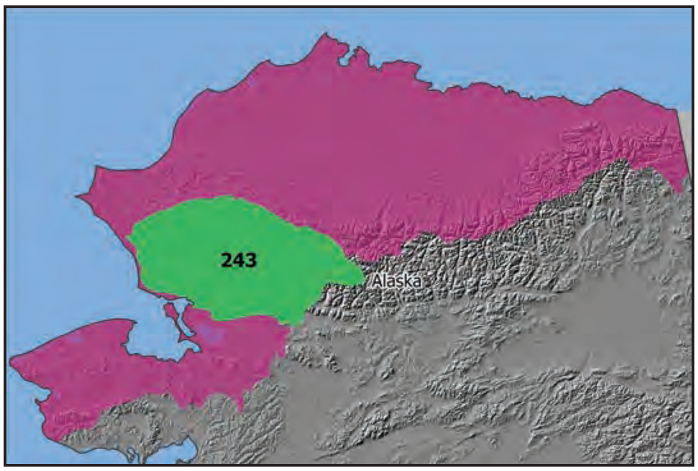

Figure 243-1: Location of MLRA 243, which covers 5,880,400 hectares (14,530,800 acres), within Region Y.

MLRA 243 has boundaries based on physiography with MLRAs 242, 244, and 245. MLRA 242 (Northern Seward Peninsula-Selawik Lowlands) has nearly level to rolling plains, river deltas, and extended mountain footslopes. MLRA 244 (Northern Brooks Range Mountains) has steep, rugged, high mountains and narrow valleys. MLRA 245 (Arctic Foothills) has broad, rounded hills and nearly level uplands at the base of the Brooks Range. MLRA 243 shares a less apparent boundary with MLRAs 233 (Upper Kobuk and Koyukuk Hills and Valleys) and 234 (Interior Brooks Range Mountains), where a continental subarctic climate prevails.

Physiography

This area lies within the Arctic Mountains province of the Rocky Mountain System. The terrain consists of a complex of flood plains, stream terraces, and rolling hills and upland slopes along the Noatak River and the lower Kobuk River. These features quickly transition to moderately steep foothills and lower mountain slopes, which in turn lead to steep, rugged, high-relief mountains. The upper mountain slopes generally are rocky, having extensive surface bedrock and rock rubble. Small glaciers and permanent snowfields are at the heads of some high-elevation valleys. Broad flood plains and extended mountain footslopes along the Kobuk, Squirrel, Ambler, and lower Noatak Rivers are dotted with numerous small and medium-size lakes and interconnecting wetlands. Elevation ranges from about 20 feet (6 meters) along the lower Noatak River in the western part of the MLRA to 8,570 feet (2,613 meters) at the summit of Mount Igikpak, in the eastern part.

Surface water in most of the area drains into the Noatak River via numerous other rivers. Surface water on the south slopes of the Baird Mountains drains into the Squirrel River, the Ambler River, and other tributaries of the Kobuk River. Both the Noatak and Kobuk Rivers empty into Kotzebue Sound and the Chukchi Sea. Lakes make up about 3 percent of the area.

In the mountains, permafrost is most evident in unconsolidated materials. In the valleys, thick layers of permafrost occur in both fine textured and coarse textured materials. Depth to the base of the permafrost layer may be 1,000 feet (305 meters) or more. In close proximity to water bodies, it may be 600 feet (185 meters) or more. Periglacial features, such as pingos, thermokarst pits, thaw lakes, gelifluction lobes, and high- and low-center polygons, are common on stream terraces, on the lower mountain slopes, and in swales on foothills.

Geology

The entire area was glaciated during the Early and Middle Pleistocene, except for possibly small portions of the Baird Mountains. By the Late Pleistocene, glaciers had retreated from most of the area, except for the central, upper-elevation portions of the De Long Mountains in the northern part of the MLRA. The valley of the upper Noatak River likely was covered by extensive proglacial lakes during parts of the Pleistocene Epoch. In the mountains, glacial deposits have eroded away or been buried by mountain colluvium and alluvium, which accumulated during the Holocene Epoch across about 60 percent of the present landscape. Slightly modified to highly modified glacial moraines, drift, and outwash deposits are extensive on the lower mountain slopes and in valleys at the mid and lower elevations. These deposits cover about 18 percent of the MLRA. Flood plains, stream terraces, and alluvial fans have Recent and Pleistocene fluvial deposits. The underlying bedrock geology consists almost entirely of stratified sedimentary rocks of Paleozoic and Precambrian age and, in some cases, Cretaceous age.

Climate

Short, generally cool summers and long, very cold winters characterize the continental arctic climate of the area. The average annual precipitation ranges from about 10 to 15 inches (255 to 380 millimeters) at the lower elevations in the western part of this area and along the central Noatak River and from about 20 to 40 inches (510 to 1,015 millimeters) in the mountains. The average annual snowfall is about 35 to 100 inches (90 to 255 centimeters). The average annual temperature ranges from about 8 to 16 degrees F (-13 to -9 degrees C). Snow and freezing temperatures can occur in any month of the year, particularly at the higher elevations.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Most of the water used for domestic supply is probably obtained from private wells.

Small communities and rural landowners can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash) or beneath coastal plains. Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil orders are Gelisols, Entisols, Inceptisols, and Mollisols. The soils in the area have a subgelic or pergelic soil temperature class or a cryic temperature regime, an aquic or udic moisture regime, and mixed mineralogy. The soils generally are shallow to deep over fractured bedrock on the upper mountain slopes and ridges. Miscellaneous (nonsoil) areas make up about 27 percent of this MLRA. The most common are rock outcrop, rubble land, and water.

The main soils:

- Cryofluvents that are well drained and formed in stratified loamy, sandy, and gravelly alluvium on flood plains
- Fibristels that are shallow or moderately deep to permafrost, are very poorly drained to somewhat poorly drained, and formed in thick deposits of organic material; in depressions, in shallow basins, and along lake margins
- Gelorthents, Gelepts, and Gelolls that are shallow to deep, are generally well drained, and formed in loamy to stony colluvium and residuum; on the upper mountain slopes and ridges
- Histoturbels, Aquiturbels, and Haploturbels that are shallow or moderately deep to permafrost, are poorly drained or very poorly drained, and formed in loamy to gravelly and stony colluvium, slope alluvium, and glacial drift; on slopes, ridges, and fans in the mountains; on foothills, long upland slopes, and high terraces; and on flats in valleys (Histoturbels have a moderately thick surface layer of organic material)

Biological Resources

The mountain slopes and ridges in this area generally support dwarf scrub dominated by Dryas, black crowberry, ericaceous shrubs, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and bedrock generally are extensive. On the more mesic sites, sedges, forbs, and mosses cover most of the surface. Areas at the lower elevations and areas of the deeper soils on nearly level uplands, terraces, and basins generally support low willow and ericaceous shrub scrub and mesic graminoid herbaceous communities, commonly with extensive areas of tussock-forming sedges. Depressions, drainageways, and other saturated sites support wet sedge meadows and wet sedge-moss meadows. Flood plains support a mixture of tall and low scrub dominated by various willows, shrub birch, and alder. Along the lower Noatak and Kobuk Rivers, white spruce and mixed spruce-balsam poplar forests and woodland are associated with the scrub.

Mammals common to the area include brown bear, caribou, moose, musk ox, black bear, wolf, red fox, a variety of other furbearers, and rodents. Many species of migratory waterfowl and shore birds nest in the ponds and wetlands. Raptors include gyrfalcon, peregrine falcon, golden eagle, hawks, and owls. Arctic char and Arctic grayling are in most of the rivers. Lake trout and northern pike are common in many lakes.

Land Use

Local residents use this remote area primarily for subsistence hunting, fishing, and gathering (fig. 243-2). Hunting and other kinds of wildland recreation are increasingly important. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Most of the communities are along the major rivers or lakes or on the coast.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating

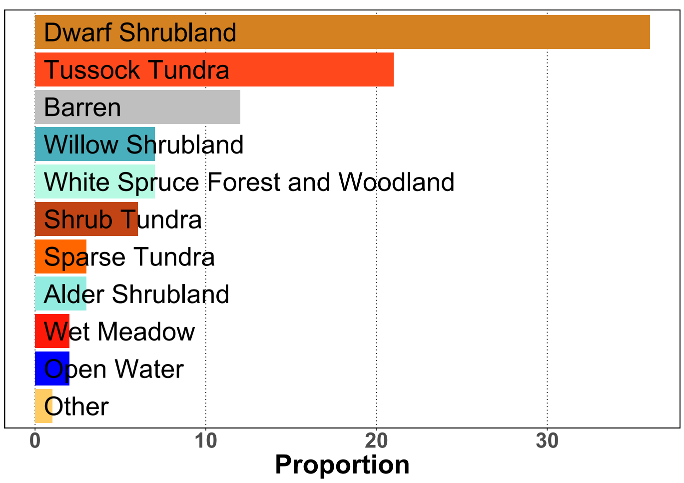

Figure 243-2: Relative proportions (percentages) of land use in MLRA 243.

organic material at the surface results in thawing of the upper soil layers. This thawing can lead to ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

244—Northern Brooks Range Mountains

MLRA 244 (fig. 244-1) includes the high mountains and valleys on the northern side of the Brooks Range, where surface water drains into the Colville River and other Arctic Ocean drainage basins. It makes up about 14,525 square miles (37,615 square kilometers). The terrain consists of steep, rugged, high mountains and narrow valleys. The underlying bedrock geology consists almost entirely of stratified sedimentary rocks of Paleozoic and Precambrian age. The area is entirely remote wildland and is sparsely populated. It is in the zone of continuous permafrost.

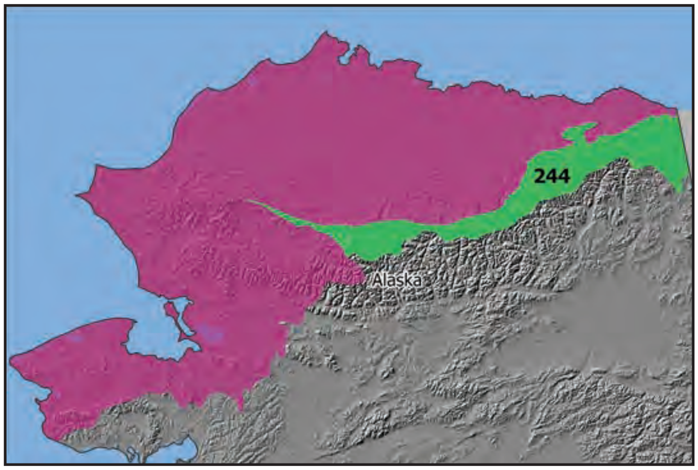

Figure 244-1: Location of MLRA 244, which covers 3,761,500 hectares (9,294,900 acres), within Region Y.

MLRA 244 has boundaries based on physiography with MLRAs 246, 245, and 243. MLRA 246 (Arctic Coastal Plain) has a level to gently rolling plain along the coast of the Arctic Ocean. MLRA 245 (Arctic Foothills) has broad, rounded hills and nearly level uplands at the base of the Brooks Range. MLRA 243 (Western Brooks Range Mountains, Foothills, and Valleys) encompasses the southern slopes of the De Long Mountains, the Baird Mountains, the Noatak River drainage, and the lower Kobuk River drainage. MLRA 244 shares a less apparent boundary with MLRAs 234 (Interior Brooks Range Mountains) and 231 (Interior Alaska Highlands), which are distinguishable by a continental subarctic climate.

Physiography

This area lies within the Arctic Mountains province of the Rocky Mountain System. The Brooks Range is the most northerly extension of the Rocky Mountains. In places small glaciers occur at the higher elevations, particularly in the Romanzof Mountains, in the eastern part of the area. The upper mountain slopes generally are rocky, having extensive surface bedrock and rock rubble. The lower slopes are characterized by coalescing fans and steep footslopes that extend to stream channels in narrow valleys. The bottoms of the valleys along the larger rivers and streams have nearly level flood plains and stream terraces and some rolling uplands. Elevation ranges from about 1,969 feet (600 meters) along the edge of the Arctic Foothills (MLRA 245) to 8,570 feet (2,613 meters) at the summit of Mount Igikpak, in the western part of the MLRA along the border with the adjacent Brooks Range.

Numerous rivers drain this MLRA through the Arctic Foothills and Coastal Plain to the Arctic Ocean. The major rivers are the Kongakut, Aichilik, Jago, Canning, Ivishak, Ribdon, Atigun, Anaktuvuk, and Killik Rivers. Lakes make up less than 2 percent of the area.

In the mountains, permafrost is most evident in areas of deep unconsolidated deposits. In valleys, thick layers of permafrost occur in both fine textured and coarse textured deposits. Periglacial features, including gelifluction lobes, polygons, and stripes, are common on stream terraces, on hills, and in gently sloping areas in the mountains.

Geology

Except for the highest peaks, the steep upper ridges, and some unglaciated valleys, most of this area was covered with glacial ice during the Early and Middle Pleistocene. In many places, the ice extended northward down onto the adjacent Arctic Foothills (MLRA 245). By the Late Pleistocene, only the highest valleys and mountains remained glaciated. Most glacial deposits have eroded away or have been buried by mountain colluvium and alluvium, which accumulated during the Holocene Epoch across about 75 percent of the present landscape. Slightly modified to highly modified glacial moraines, drift, and outwash deposits are extensive on the lower mountain slopes and in valleys at the lower elevations. These deposits cover about 20 percent of the MLRA. Flood plains, stream terraces, and alluvial fans have Recent and Pleistocene fluvial deposits. Inclusions of Paleozoic and Early Jurassic volcanic and igneous rocks occur in the eastern part of the MLRA.

Climate

Brief, cool summers and long, very cold winters characterize the continental arctic climate of the area. The average annual precipitation throughout most of this area ranges from 15 to 40 inches (380 to 1,015 millimeters). The average annual snowfall is about 50 to 100 inches (125 to 255 centimeters). The average annual temperature ranges from about 8 to 16 degrees F (-13 to -9 degrees C). Freezing temperatures can occur in any month of the year.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Because of its chemical quality, the surface water generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Most of the water used for domestic supply is probably obtained from private wells.

Small communities and rural landowners can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, and leaking fuel storage tanks.

Soils

The dominant soil order in this MLRA is Gelisols. The soils in the area generally have a pergelic soil temperature class, an aquic or udic moisture regime, and mixed mineralogy. Miscellaneous (nonsoil) areas make up about 75 percent of this MLRA. The most common are rubble land, chutes, rock outcrop, and small glaciers.

The main soils:

- Aquiturbels, Histoturbels, Molliturbels, and Haploturbels that are shallow or moderately deep to permafrost, are poorly drained or very poorly drained, and formed in loamy to stony colluvium, slope alluvium, and residuum
- Fibristels that are shallow or moderately deep to permafrost, are very poorly drained, and formed in thick deposits of organic material; in depressions, drainageways, and basins

Biological Resources

Because of the shallow soils, high winds, and harsh climate, the vegetation is sparse and generally limited to valleys and the lower mountain slopes. Dwarf scrub communities on mountain slopes and ridges are dominated by black crowberry, ericaceous shrubs, Dryas, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and bedrock generally are extensive. On the more mesic sites, sedges, forbs, and mosses cover most of the surface. Areas at the lower elevations and deeper soils in basins and on terraces generally support low willow and ericaceous shrub scrub and mesic graminoid herbaceous communities, commonly with extensive areas of tussock-forming sedges. Depressions, drainageways, and other saturated sites support wet sedge meadows, sedge-shrub meadows, and wet sedge-moss meadows. Low and tall willow scrub is dominant on flood plains.

Mammals common to the area include brown bear, black bear, wolf, caribou, and Dall sheep. The smaller mammals include marmot, red fox, Arctic fox, wolverine, ground squirrel, lemming, and pika. Common raptors include golden eagles, marsh hawks, and snowy owls.

Land Use

Residents of nearby villages use this remote area primarily for subsistence hunting, fishing, and gathering (fig. 244-2). The area also is used for sport hunting and other kinds of wildland recreation. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Most of the communities in the area are along the major rivers at the lower elevations. Mineral resources have been prospected and mined in several places. Construction and maintenance of the Dalton Highway have led to the development of numerous sand and gravel pits along the road corridor.

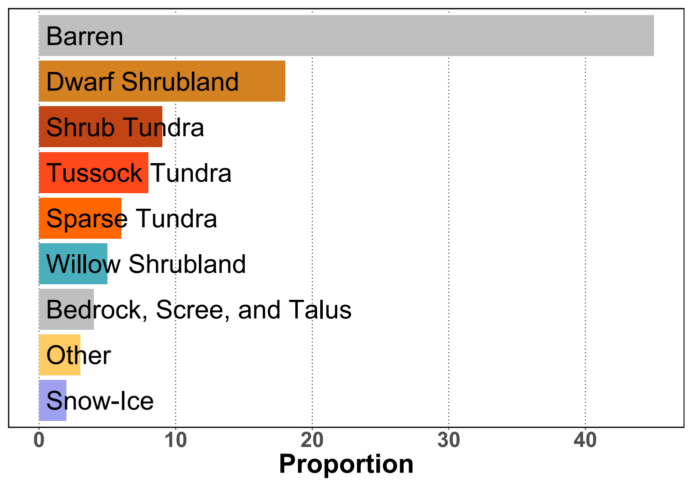

Figure 244-2: Relative proportions (percentages) of land use in MLRA 244.

Generally, no major resource concerns affect land use in this sparsely populated area. Because of the highways and pipeline that cross the area, however, disturbance of the fragile permafrost-affected soils is a concern. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can lead to ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

245—Arctic Foothills

MLRA 245 (fig. 245-1) includes the broad, rounded hills and nearly level uplands at the base of the Brooks Range from Point Hope, in the west, to Demarcation Point, in the east. It makes up about 45,565 square miles (118,015 square kilometers). Periglacial features occur throughout the area. The area is

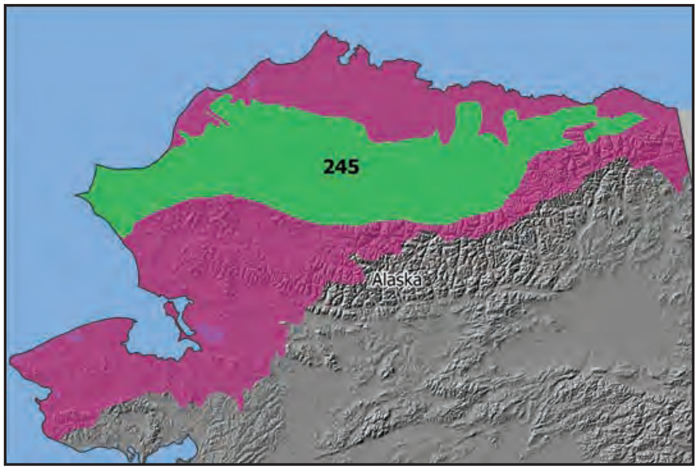

Figure 245-1: Location of MLRA 245, which covers 11,801,300 hectares (29,161,600 acres), within Region Y.

entirely undeveloped wildland and is sparsely populated. It is in the zone of continuous permafrost.

MLRA 245 has boundaries based on physiography with MLRAs 242, 243, 244, and 246. MLRA 242 (Northern Seward Peninsula-Selawik Lowlands), near Kivalina Lagoon, is distinguishable by nearly level to rolling plains, river deltas, and extended mountain footslopes. MLRA 243 (Western Brooks Range Mountains, Foothills, and Valleys) encompasses the southern slopes of the De Long Mountains, the Baird Mountains, the Noatak River drainage, and the lower Kobuk River drainage. MLRA 244 (Northern Brooks Range Mountains) has steep, rugged, high mountains and narrow valleys. MLRA 246 (Arctic Coastal Plain) has a level to gently rolling plain along the coast of the Arctic Ocean. MLRA 245 also is bordered by the Chukchi Sea.

Physiography

This area lies within the Arctic Foothills province of the Rocky Mountain System. The northern part of the area consists of broad, rounded ridges and mesa-like uplands. The southern part, which is higher than the northern part, consists of irregular buttes, mesas, and linear ridges with intervening undulating plains and plateaus. Many streams and rivers are in swales and valleys between hills. Most rivers are confined to a single, moderate-gradient, slightly meandering channel. Braided sections occur across level areas. Elevation generally ranges from about 655 feet (200 meters) in the northern part of the MLRA, along the border with the Arctic Coastal Plain (MLRA 246), to about 2,000 feet (610 meters) in the southern part, along the border with the Northern Brooks Range Mountains (MLRA 244). Some hills bordering the Brooks Range reach an elevation of 3,600 feet (1,100 meters).

Numerous rivers originating in the Brooks Range drain through the Arctic Coastal Plain to the Arctic Ocean. The major drainage is that of the Colville River. Other major rivers are the Canning and Sagavanirktok Rivers. Lakes make up less than 2 percent of the MLRA.

Thick layers of permafrost occur in both fine textured and coarse textured deposits. Depth to the base of the permafrost layer is as much as 2,100 feet (640 meters). Periglacial features, such as pingos, gelifluction lobes, and patterned ground, occur throughout the area.

Geology

This MLRA remained unglaciated during the Pleistocene Epoch, except possibly for the upper areas along the edge of the Northern Brooks Range Mountains (MLRA 244). Bedrock and coarse to fine rubble mantle the surface of convex uplands. Elsewhere, Quaternary surface deposits include various alluvial, eolian, or glaciofluvial materials. Slightly modified to highly modified moraines and drift occur in areas adjacent to the Brooks Range. The bedrock geology consists primarily of Cretaceous and Late Paleozoic to Lower Mesozoic stratified sedimentary rocks. These rocks occur in about 67 percent of the MLRA. The rest of the area consists of uplifted Cretaceous and Tertiary continental deposits.

Climate

Brief, cool summers and long, very cold winters characterize the arctic climate of the area. The average annual precipitation is less than 10 inches (255 millimeters) at the lower elevations along the MLRA's northern boundary with the Arctic Coastal Plain (MLRA 246) and ranges from 15 to 20 inches (380 to 510 millimeters) at the higher elevations in the southern part. The average annual snowfall ranges from about 40 to 60 inches (100 to 150 centimeters). The average annual temperature ranges from 10 to 18 degrees F (-12 to -8 degrees C). The average freeze-free period is fewer than 10 days to 55 days.

Water

This sparsely populated MLRA has very limited amounts of freshwater available. Some mining and oil and gas extraction operations use some surface water in the area. Because of its chemical quality, the surface water generally is suitable for all uses, but the rivers are frozen for much of the year or flow little during winter. Most of the water used for domestic supply is probably obtained from private wells.

Most small communities, rural landowners, and mineral industries can obtain ground water either from bedrock aquifers or from unconsolidated sediments in river valleys (alluvium or glacial outwash). Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, leaking fuel storage tanks, and waste from mineral, oil, and gas extraction. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil order in this MLRA is Gelisols. Entisols and Inceptisols are of minor extent. Most of the soils in the area have a pergelic soil temperature class, an aquic moisture regime, and mixed mineralogy. The soils generally are shallow or moderately deep to permafrost, poorly drained or very poorly drained, and loamy and gravelly. Miscellaneous (nonsoil) areas make up about 4 percent of this area. The most common are rock outcrop, talus, and ice.

The main soils:

Aquiturbels, Histoturbels, and Molliturbels that formed in loamy and gravelly colluvium and slope alluvium on ridges, gently sloping to steep hills, and valley bottoms and in gravelly alluvium on stream terraces

Fibristels that formed in thick deposits of organic material in depressions, on valley bottoms, and in drainageways

Gelepts and Gelorthents that are moderately well drained, have a cryic temperature regime, and do not have permafrost within their profile; on some steep hillsides

Biological Resources

The uplands in this area generally support dwarf scrub dominated by Dryas, black crowberry, ericaceous shrubs, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and bedrock generally are extensive. On the more mesic sites, sedges, forbs, and mosses cover most of the surface. The mesic sites and deeper soils in valleys and basins and on terraces generally support low and dwarf willow and ericaceous shrub scrub and mesic graminoid herbaceous communities, commonly with extensive areas of tussock-forming sedges. Depressions, drainageways, and other saturated sites support wet sedge meadows and wet sedge-moss meadows. Flood plains support a mixture of tall and low scrub dominated by various willows, shrub birch, and some alder.

Mammals common to the area include brown bear, wolf, wolverine, caribou, Arctic fox, snowshoe hare, tundra hare, hoary marmot, brown lemming, and northern bog lemming. Musk oxen, which were decimated by hunting in the late 1800s, are becoming more common in many places. Common birds include willow ptarmigan, rough-legged hawk, American golden plover, short-eared owl, and snowy owl. Arctic char and Arctic grayling are in most of the rivers.

Land Use

Local residents use this area primarily for subsistence hunting, fishing, and gathering (fig. 245-2). Sport hunting and other kinds of wildland recreation are becoming increasingly important. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Most of the communities in the area are along the major rivers at the lower elevations or are on the coast. Some limited extraction of minerals, including oil and gas, occurs locally.

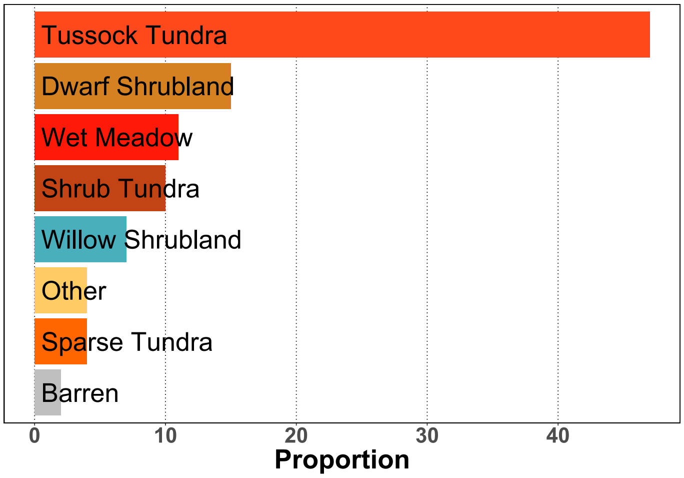

Figure 245-2: Relative proportions (percentages) of land use in MLRA 245.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can lead to ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils.

246—Arctic Coastal Plain

MLRA 246 (fig. 246-1) consists of a level to gently rolling plain along the coast of the Arctic Ocean. It makes up about 22,235 square miles (57,585 square kilometers). It is mostly remote wildland and is sparsely populated. This area is in the zone of continuous permafrost.

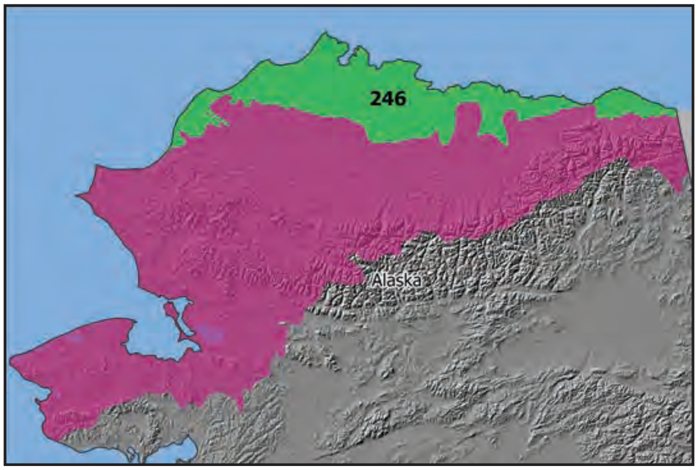

Figure 246-1: Location of MLRA 246, which covers 5,758,600 hectares (14,229,800 acres), within Region Y.

MLRA 246 has boundaries based on physiography with MLRAs 245 and 244. MLRA 245 (Arctic Foothills) has broad, rounded hills and nearly level uplands at the base of the Brooks Range. MLRA 244 (Northern Brooks Range Mountains) has steep, rugged, high mountains and narrow valleys. MLRA 246 also is bordered by the Beaufort and Chukchi Seas.

Physiography

This area lies within the Arctic Coastal Plain province of the Interior Plains System. The plain rises from the Arctic Ocean to the Arctic Foothills (MLRA 245). The area is dotted by thousands of small and medium-size lakes and interconnecting wetlands. Many of the lakes are elongated thaw lakes, which are consistently oriented from north to northwest. Narrow, nearly level flood plains and stream terraces are along the many rivers that cross the area. In the central part of the area, near the coast, small sand dunes also occur along the rivers. Elevation ranges from sea level to about 655 feet (200 meters).

Numerous rivers, mostly originating in the Brooks Range to the south, drain from this MLRA to the Arctic Ocean. The major rivers are the Canning, Colville, Jago, Kongakut, Kuk, Utukok, and Sagavanirktok Rivers. Lakes and other kinds of surface water make up about 20 percent of the area.

Thick layers of permafrost occur in both fine textured and coarse textured deposits. Depth to the base of the permafrost layer is as much as 2,100 feet (640 meters). Periglacial features, such as beaded drainages, patterned ground, thaw gullies, pingos, and frost boils, occur throughout the area.

Geology

This area was never glaciated. The bedrock geology consists of Cretaceous and Tertiary stratified sedimentary rocks and uplifted continental deposits. The modern landscape is mantled with Quaternary deposits of alluvial, eolian, or glaciofluvial origin.

Climate

Brief, cool summers and long, very cold winters characterize the continental arctic climate of the area. The average annual precipitation is 4 to 6 inches (100 to 150 millimeters). The average annual snowfall is about 20 to 40 inches (50 to 100 centimeters). The average annual temperature ranges from 8 to 14 degrees F (-15 to -10 degrees C). The average freeze-free period is fewer than 5 days to 20 days. Freezing temperatures can occur in any month.

Water

Operations for extracting minerals, including oil and gas, use most of the surface water in this area. Some communities along the major rivers or on the coast use some surface water for their public supply. Because of its chemical quality, the surface water generally is suitable for all uses, but the rivers are frozen or flow little during winter. Most of the water used for domestic supply is probably obtained from private wells.

Most small communities, rural landowners, and mineral industries obtain ground water from unconsolidated sediments in river valleys (alluvium or glacial outwash) or beneath the coastal plain. Where these aquifers are close to the surface, they are highly susceptible to contamination from surface activities. Possible sources of contamination include septic systems, landfills, leaking fuel storage tanks, and waste from mineral extraction. The intrusion of seawater can be a problem along the coast.

Soils

The dominant soil order in this MLRA is Gelisols. The soils have a pergelic soil temperature class. Most have an aquic moisture regime and mixed mineralogy. All of the soils have permafrost. They are generally shallow or moderately deep to permafrost and are poorly drained or very poorly drained. Miscellaneous (nonsoil) areas make up about 20 percent of this MLRA. The most common are water, riverwash, and beaches.

The main soils:

- Aquiturbels, Histoturbels, and Haploturbels that formed in loamy to gravelly sediments on nearly level to rolling plains, low hills, and pingos
- Aquiturbels and Haplorthels that formed in sandy and gravelly alluvium on flood plains and stream terraces
- Aquiturbels in areas between dunes
- Fibristels that formed in thick deposits of organic material in depressions, basins, and drainageways and along lake margins
- Psammoturbels that formed in thick deposits of sandy material on dunes

Biological Resources

Wet soil conditions are prevalent across much of this area. The vegetation occurs primarily in a variety of mesic and wet sedge, sedge-grass, and sedge-moss meadows. The drier sites and low uplands support dwarf scrub dominated by Dryas, black crowberry, ericaceous shrubs, and dwarf willow. On shallow, rocky soils and exposed sites, lichens and scattered herbs dominate the ground layer. Bare soil and bedrock generally are extensive. Flood plains support a mixture of low willow scrub and scattered herbs.

Mammals common to the area include brown bear, wolf, wolverine, caribou, arctic hare, mink, weasel, and lemming. Small herds of musk oxen are in scattered areas throughout the MLRA. This species was decimated by hunting in the late 1800s and reintroduced to the area in 1969. Pack ice and coastal areas are inhabited by polar bear, walrus, and Arctic fox. Many species of migratory waterfowl, including lesser snow goose, tundra swans, brant, and common eider, nest in the lakes and ponds. Sea birds, including the pomarine jaeger, glaucous gull, and black guillemot, are abundant along the coast. A wide variety of passerine birds and shore birds use the upland and wetland habitats throughout the MLRA.

Land Use

Local residents use this area primarily for subsistence hunting, fishing, and gathering (fig. 246-2). Sport hunting and other kinds of wildland recreation are becoming increasingly important. Most visitors are served by air taxi, guiding, and outfitting companies operating out of the major Alaska communities. Less than 1 percent of the MLRA is urban. Oil and gas extraction and the related industrial development occur in some areas.

The major soil resource concern is disturbance of the fragile permafrost-affected soils. Disturbance of the insulating organic material at the surface results in thawing of the upper soil layers. This thawing can lead to ponding, soil subsidence, erosion, and disruption of surface drainage. All management activities need to include protection of the organic surface material and the thermal balance of the soils. Oil spills and other kinds industrial pollution are serious concerns in areas of oil extraction and industrial development.

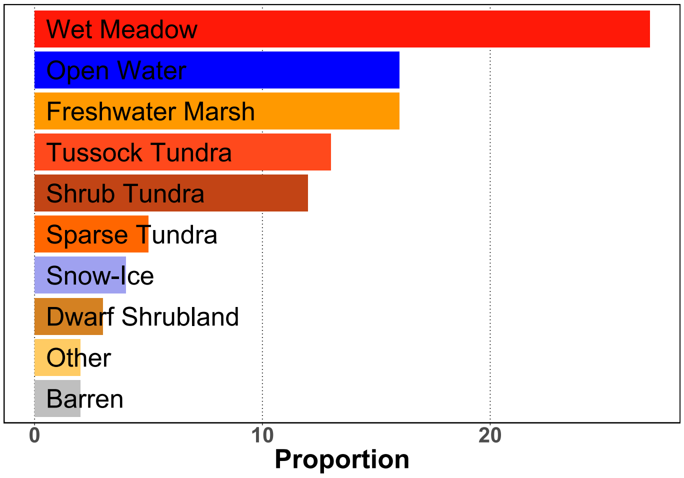

Figure 246-2: Relative proportions (percentages) of land use in MLRA 246.

Figure Z-1: Location and size of Land Resource Region Z, which covers 9,300 square kilometers (3,590 square miles) and includes Puerto Rico (94 percent), the U.S. Virgin Islands of St. Croix, St. Thomas, and St. John (4 percent), and the outlying islands of Vieques, Culebra, Desecheo, and Mona (2 percent).

Z—Caribbean Region

Land Resource Region Z (fig. Z-1) is the chain of islands in the tropical oceanic location just south of the Tropic of Cancer. The islands are the easternmost peaks of a partly submerged mountain range formed at the tectonic boundary between the Caribbean and North American Plates. This is a region of humid and semiarid mountains, valleys, and coastal plains. The highest peak, Cerro de Punta in Puerto Rico, is at an elevation of 4,389 feet (1,338 meters). Other prominent physical features are limestone karst in the northwestern part of the region and coastal plains of varying width along the northern and southern coasts. Slopes are 15 percent or less in about 15 percent of this region, 16 to 45 percent in 25 percent of the region, and more than 45 percent in the rest of the region. Trade winds from the east-northeast bring high rainfall to the northern sides of the islands while rain shadows generate semiarid conditions on the south sides. The rainfall patterns, combined with the effect of changes in elevation, a variety of landforms, hydrology, and the various igneous and limestone parent materials, produce a range of soil types and vegetation, from tropical rainforest to dry forest. This region contains four major land resource areas. The extent of these MLRAs and their range in elevations are shown in table Z-1.

Region Z has a long, warm growing season. The average annual precipitation ranges from 60 to 90 inches (1,525 to 2,285 millimeters) in the humid uplands, from 45 to 60 inches (1,145 to 1,525 millimeters) on the humid coastal plains, from 30 to 45 inches (760 to 1,145 millimeters) in the semiarid mountains and valleys, and from 10 to 45 inches (255 to 1,145 millimeters) on the semiarid coastal plains. The area of rainforest in northwest Puerto Rico has the highest average annual precipitation, 120 to 200 inches (3,050 to 5,080 millimeters). The average annual temperature is 70 to 74 degrees F (21 to 23 degrees C) in the humid uplands, 77 degrees F (25 degrees C) on the humid coastal plains, and 79 degrees F (26 degrees C) in the semiarid mountains and valleys and on the semiarid coastal plains. This region is freeze-free. Statistical distribution of temperature, freeze-free period, and precipitation data for the MLRAs in this region is shown in tables Z-2 and Z-3.

The soils in Region Z include a wide range of Inceptisols, Ultisols, Oxisols, Mollisols, Entisols, Alfisols, Vertisols, Aridisols, and Histosols (fig. 3, page 7). The dominant suborders are Ustepts, Udepts, and Humults in the mountainous areas and Udults and Udox on the coastal plains. Poorly drained Aquepts, Aquolls, and Aquents are common on flood plains, and Ustolls and Udolls are in the better drained areas. Rendolls and Udalfs occur in areas of limestone karst. Saprists occur in depressions. In Region Z, restrictive zones occur mainly as lithic and paralithic bedrock in many soil profiles and as plinthite, salic, and petrocalcic horizons (fig. 10, page 14) in some profiles. Generally, the soils have a thermic or isohyperthermic soil temperature regime, an ustic or udic soil moisture regime, and mixed or smectitic mineralogy.

Table Z-1: Extent and Elevation Statistics for MLRAs
[Values are based on 30-meter USGS national elevation data.]

MLRA	Extent		Elevation									
			Low		10th percentile		50th percentile		90th percentile		High	
	km²	mi²	m	ft	m	ft	m	ft	m	ft	m	ft
270	5,535	2,135	0	0	60	210	280	910	670	2,190	1,330	4,350
271	1,315	510	0	0	10	30	90	290	280	920	860	2,800
272	1,695	655	0	0	0	0	25	80	160	500	330	1,080
273	755	290	0	0	0	0	15	50	70	230	350	1,140

Table Z-2: Temperature and Freeze-Free Period Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set. Dashes indicate data were not available.]

MLRA	Temperature										Freeze-free period (number of days)				
	Low		10th percentile		50th percentile		90th percentile		High		Shortest	10th percentile	50th percentile/ mean	90th percentile	Longest
	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F					
270	18.2	65	21.6	71	24	75	25.2	77	26.4	80	---	---	---	---	---
271	20.9	70	24.1	75	25.5	78	26.5	80	27.5	81	---	---	---	---	---
272	23.9	75	24.8	77	25.5	78	26.2	79	26.8	80	---	---	---	---	---
273	24.5	76	25.5	78	26	79	26.5	80	27.3	81	---	---	---	---	---

Table Z-3: Precipitation Statistics
[Values are 30-year averages (1981-2010) based on the PRISM data set.]

MLRA	Low		10th percentile		50th percentile/mean		90th percentile		High	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
270	1,000	40	1,541	61	1,913/1,945	75/77	2,267	89	4,590	181
271	700	28	857	34	1,139/1,165	45/46	1,493	59	1,960	77
272	1,090	43	1,339	53	1,630/1,615	64/64	1,849	73	2,740	108
273	700	28	768	30	971/960	38/38	1,142	45	1,480	58

Land use in Region Z is mainly pasture of native and improved grasses grown for dairy and beef operations (fig. Z-2). Forestland, mostly unimproved, is widespread, especially in the humid uplands. The climax vegetation consists of forest species.

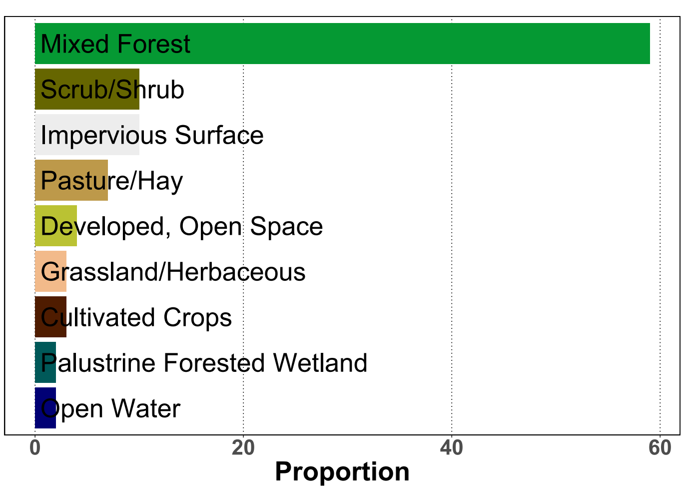

Figure Z-2: Relative proportions (percentages) of land use in LRR Z.

Food crops grown in the region include plantains, bananas, yams, mangos, taniers, vegetables, and some citrus fruit and coconuts. Some unique farmland is used for pineapples or rice. The importance of sugarcane, once the main cash crop in the region, and operations for growing coffee under shade, once a prosperous enterprise, have declined. The encroachment of urban developments, highways, and recreational areas on the better farmland, especially near metropolitan areas, is a concern. The main limitations of soils in the region are shallowness to bedrock and steepness of slope.

270—Humid Mountains and Valleys

This area (fig. 270-1) is in central Puerto Rico. It makes up about 53 percent of the island and consists of about 2,135 square miles (5,535 square kilometers). It has a distinct boundary to the north and east with the physiographically distinct Humid Coastal Plains (MLRA 272). To the south, it has a boundary with the Semiarid Mountains and Valleys (MLRA 271) that is marked by an ecotone transitioning from the udic to the ustic soil moisture regime. This MLRA includes the

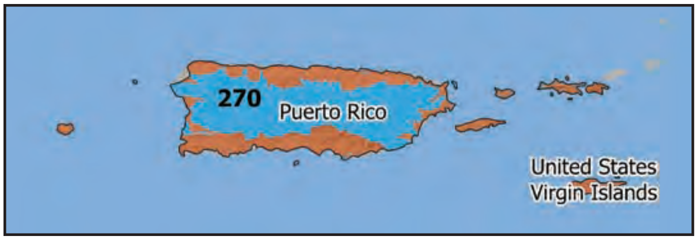

Figure 270-1: Location of MLRA 270, which covers 553,300 hectares (1,367,300 acres), within Region Z.

headwaters of almost all of the rivers and streams on the island. Water resources are very important for the sustainability of the island.

Physiography

This mountainous area has very steep slopes and very narrow to indistinct valleys. Landslides are common. Elevation ranges from 160 to 4,390 feet (50 to 1,340 meters).

Three different mountain ranges occur in the area. The Central Ridge, known locally as Cordillera Central, is the highest and largest of the three. It is in the center of the island and oriented in a general east-west direction. Cerro de Punta, its highest peak, is 4,389 feet (1,338 meters) above sea level. Los Tres Picachos and Monte Guilarte are about 3,952 feet (1,205 meters) high.

Second in extent and elevation is the Sierra de Luquillo in the northeastern part of Puerto Rico. The three highest peaks in this range are El Toro, 3,523 feet (1,074 meters) above sea level; El Yunque, 3,493 feet (1,065 meters); and Pico del Este, 3,447 feet (1,051 meters). Because of elevation and location on the island relative to the easterly trade winds, the higher parts of this range are covered by a rainforest (El Yunque).

The third mountain range is the Sierra de Cayey, in the east-central part of Puerto Rico. The highest peaks in this range are Cerro La Santa, 2,962 feet (903 meters) above sea level, and Cerro de la Tabla, 2,919 feet (890 meters). Contrasting with the strongly dissected uplands are the small undulating areas at elevations of 1,640 to 1,970 feet (500 to 600 meters) near Barranquitas in east-central Puerto Rico. These landscapes are remnants of a Miocene geomorphic surface known as the St. John Peneplain.

Geology

Most of this MLRA consists of volcanic rocks that formed below sea level during the Cretaceous Period (135 to 70 million years ago). The various formations are made up mainly of volcaniclastic rocks (andesite, volcanic sandstone and siltstone, breccia, lava breccia, and pillow lava) of andesitic composition. Large intrusions of plutonic rocks into the volcanic strata occur in the Utuado-Jayuya area in west-central Puerto Rico and in the San Lorenzo area in southeastern Puerto Rico. These batholiths consist of granodiorite and quartz diorite. Plutonic rocks crop out in many small areas throughout the island. Ultrabasic rocks (serpentinite) occur in the Cerro Las Mesas, Monte del Estado, and Bosque de Susúa areas in southwestern Puerto Rico. They formed from peridotite in the Late Jurassic Period, probably 150 million years ago. The extent of the present MLRA emerged from the sea during the Early Tertiary Period as a result of uplift caused by plate tectonics. The uplift of the island produced numerous fractures and fault zones and tilted the originally horizontal strata.

Climate

The average annual precipitation is 80 to 85 inches (2,030 to 2,160 millimeters) in most of this area. It can be as low as 60 inches (1,525 millimeters) along the northern and southern edges of the area and can be 120 to 200 inches (3,050 to 5,080 millimeters) at the highest elevations. Most of the rainfall occurs in the afternoons as frequent, trade-wind showers from May to October, but tropical storms and hurricanes can produce high amounts of rain and result in local flooding and landslides. The area is typically drier from December to March, rainy during April and May, semidry in June and July, and wet from August to November. The average annual temperature is less than 70 degrees F (21 degrees C) at the higher elevations and 74 degrees F (23 degrees C) at the lower elevations. There is little difference in air temperature between the summer and winter seasons. This MLRA is freeze-free.

Water

Rainfall, perennial streams, and lakes provide ample amounts of surface water. Manmade lakes are used to trap and store runoff for public supply and irrigation at the lower elevations outside this MLRA. The surface water generally meets the recommended standards for all uses. Fecal coliform contamination can occur in streams.

The ground water in this area is of good quality but is little used. The principal aquifer is the dense and massive volcanic rock underlying most of the area. Fractures and joints in the rock trap and hold the water. Another source of ground water is the alluvial deposits of very limited extent in narrow valleys.

Soils

The dominant soils in this MLRA are Inceptisols, Ultisols, or Oxisols. The dominant suborders are Udepts, Humults, Udox, and Perox. Most of the soils have an isohyperthermic or isothermic temperature regime, a udic moisture regime, and mixed mineralogy and are clayey or loamy. The soils in the Luquillo area have a perudic soil moisture regime.

Shallow and moderately deep Eutrudepts (Caguabo, Mucara, Quebrada, and Morado series) are on steep side slopes, mainly in the east-central part of the MLRA. Deep, very fine textured Haplohumults (Humatas series) and Haploperox and Kandiperox (Los Guineos and Agueybana series) are on steep side slopes in the west-central part. Deep, extremely weathered Acrudox (Nipe series) are of minor extent in the western part.

Biological Resources

The dominant plant species are carpetgrass, whorled dropseed, pendejuelo, knotroot bristlegrass, creeping wheatgrass, St. Augustine grass, woodland grass, foxtail grass, beardgrass, matojito, flor de conchitas, bitterbrush, sensitive plant, tick trefoil, burbrush, albizia tree, false moneywort, black manzanilla, shepherdsneedle, black sage, rattleweed, wireweed, boton blanco, wild sage, guava, coconut tree, flame tree, white oak, turkey berry, camasey, higuillo, yagrumo hembra, yagrumo macho, tabonuco tree, mango tree, treefern, palma de sierra, Christmas tree, Puerto Rico royal palm, palo de doncella, and basora prieta.

Major wildlife species include Anolis species, bananaquit, bridled quail-dove, cattle egret, Eleutherodactylus species, green-throated carib, Antillean nighthawk, elfin woods warbler, gray kingbird, greater Antillean grackle, killdeer, mongoose (invasive), merlin, plain pigeon, Puerto Rican boa, Puerto Rican bullfinch, Puerto Rican emerald hummingbird, Puerto Rican lizard cuckoo, Puerto Rican nightjar, Puerto Rican screech owl, Puerto Rican tanager, Puerto Rican tody, Puerto Rican woodpecker, Puerto Rican vireo, red-tailed hawk, rodents, ruddy quail-dove, scaly-naped pigeon, sharp-shined hawk, smooth-billed ani, and West Indian whistling duck.

Land Use

The grassland consists of improved forage and native grasses used as pasture. Approximately 7 percent of the MLRA is used for the production of coffee beans (fig. 270-2). Most of the coffee beans are grown in the shade, but some are grown in sunlight. The food crops grown in the area include plantains, bananas, taniers, yams, and pigeon peas. Orchard crops also are grown. The area’s climax vegetation consists of forest species.

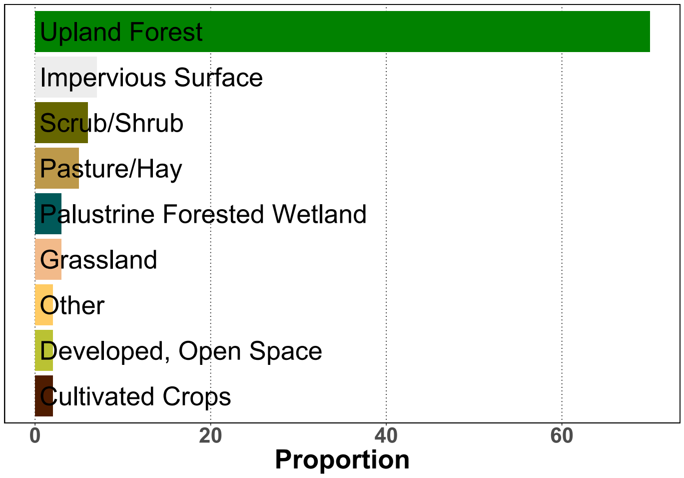

Figure 270-2: Relative proportions (percentages) of land use in MLRA 270.

The major soil resource concerns are water erosion (sheet and rill and ephemeral gully or concentrated flow) and mass movement of soil; maintenance of the content of organic matter, tilth, and fertility of the soils; and water infiltration. Water-quality concerns include surface water contaminants derived from organic and inorganic fertilizers.

Conservation practices on cropland generally include conservation crop rotations, contour farming, hillside ditches, grassed waterways, crop residue management systems (especially no-till), and nutrient and pest management. Conservation practices on pasture generally include fencing, pasture and hayland planting, watering facilities, and prescribed grazing. Urban expansion is becoming a serious land use concern.

271—Semiarid Mountains and Valleys

This area (fig. 271-1) is in Puerto Rico (71 percent), the Virgin Islands (20 percent), and the outlying islands of Vieques and Culebra (9 percent). It makes up about 510 square miles (1,315 square kilometers). All of St. John and St. Thomas are in this MLRA.

Figure 271-1: Location of MLRA 271, which covers 131,500 hectares (325,100 acres), within Region Z.

Physiography

The part of this area in Puerto Rico consists of semiarid mountains that form the southern slopes of the central mountain chain (Cordillera Central), which extends from east to west across the length of the island. Slopes generally range from moderately steep to very steep. They are nearly vertical in the northernmost part of the area. Elevation ranges from 160 to 1,300 feet (50 to 395 meters).

The part of this area in the Virgin Islands and in the two outlying islands is mountainous. A ridge of mountains characterizes the northeast and northwest corners of St. Croix. Mount Eagle, the highest peak in St. Croix, is 1,165 feet (355 meters) above sea level. St. Thomas and St. John are characterized by irregular coastlines, several bays, steep slopes, and small drainage areas. Crown Mountain, the highest peak in St. Thomas, is 1,556 feet (474 meters) above sea level. Bordeaux Mountain, the highest peak in St. John, is 1,297 feet (395 meters) above sea level. All of the streams in the part of this area in Puerto Rico flow to the south; none are perennial.

Geology

The geology of this MLRA is very diverse. The part of the area in Puerto Rico consists of steep mountainsides composed mainly of Cretaceous rocks. The lower mountains consist of Tertiary limestone. Ultrabasic rocks (serpentinite) occur in Sierra Bermeja, in southwestern Puerto Rico. Together with the chert fragments in the same area, they constitute the oldest rocks on the island. They formed in the Late Jurassic Period, about 150 million years ago. Most of the part of the MLRA in Puerto Rico has a mixture of limestone and volcanic rocks in the higher, steeper areas. Some igneous intrusive rocks also occur in the parts of the MLRA in Puerto Rico and the outlying islands. Volcanic rocks are dominant, however, in the higher parts of the Virgin Islands and the other outlying islands around Puerto Rico.

Climate

In the part of this MLRA in Puerto Rico, the average annual precipitation is 35 to 45 inches (890 to 1,145 millimeters) near the coast and as much as 60 inches (1,525 millimeters) in the higher inland areas. Much of the rainfall is lost through evapotranspiration, and the year-round air temperatures are high. As a result, the climate is semiarid. Most of the rainfall occurs in the afternoons as frequent trade-wind showers from May to October, but tropical storms and hurricanes can produce high amounts of rain and result in widespread flooding. This part of the MLRA is typically drier from December through March, rainy during April and May, semidry in June and July, and wet from August through November.

The average annual precipitation in the part of this MLRA on St. Croix is 40 to 50 inches (1,015 to 1,270 millimeters), decreasing nearer the coast. St. Thomas is the driest of the Virgin Islands. Its annual precipitation is 35 to 42 inches (890 to 1,065 millimeters). St. John is the wettest island. Its annual precipitation is 40 to 55 inches (1,015 to 1,395 millimeters).

The average annual temperature in this MLRA is about 79 degrees F (26 degrees C). The difference between summer and winter temperatures is less than 8 degrees F (5 degrees C). This MLRA is freeze-free.

Water

Rainfall provides an ample supply of surface water in the part of this area in Puerto Rico, but most of the precipitation is lost through evapotranspiration before it can reach streams or the ground water table. Manmade lakes are used to trap and store runoff water for public supply and some irrigation. The area has no perennial streams. Fecal coliform levels generally are high when the streams are flowing. During dry periods, the effluent from sewage treatment plants typically makes up almost all of the flow in streams near population centers.

The South Coastal Plains aquifer, one of the two most important aquifers in Puerto Rico, underlies most of the southern half of this MLRA. This alluvial deposit generally holds calcium-bicarbonate water. Along the coast, however, the intrusion of saltwater changes the ground water to a sodium-chloride type. The surface water and ground water generally meet the recommended standards for all uses. The ground water is very hard, and the highest concentrations of nitrate on the island occur in the South Coastal Plains aquifer. However, nitrate levels are still below the limit allowed in drinking water.

Alluvial deposits in valleys and volcanic rocks are the primary sources of ground water in the northern half of the part of this MLRA in Puerto Rico. Narrow valley floors and steep volcanic rock slopes adjacent to the valleys limit the quantities of available ground water in these two aquifers. Most of the ground water used in this area is from the South Coastal Plains aquifer.

In the part of this MLRA on the Virgin Islands and on the outlying islands, streams do not flow throughout the year and the amount of available ground water in the volcanic rocks is low. As a result, freshwater needs on these islands typically exceed the annual supplies. Rooftop catchments and seawater conversion plants are used to provide almost all of the potable water on the islands. Contamination from sewage effluent and septic systems is a water-quality concern.

The limited quantities of ground water in the volcanic rock aquifers on the Virgin Islands are primarily used for domestic purposes. This water is of better quality than the ground water in the calcareous sediments of the King’s Hill aquifer underlying the center of St. Croix. The levels of total dissolved solids (especially chloride), nitrates, and bacteria from fecal sources are much lower in the volcanic rock aquifer.

Soils

The dominant soils in the part of this MLRA in Puerto Rico are Mollisols, Inceptisols, and Alfisols. The dominant suborders are Ustolls and Ustepts. The soils have an isohyperthermic temperature regime, an ustic moisture regime, and mixed mineralogy. They are underlain by volcanic rocks. They generally are shallow or moderately deep and are clayey. Well drained, shallow Haplustolls (Descalabrado series) are dominant throughout this part of the MLRA. Well drained, moderately deep Dystrustepts (Callabo series) and Haplustolls (Jacana series) are on side slopes and footslopes. Of minor extent are shallow, well drained Haplustalfs (Guayama series) on steep side slopes.

The dominant soils in the part of this MLRA in the Virgin Islands are Mollisols or Inceptisols. The dominant suborders are Ustolls and Ustepts. The soils have an isohyperthermic temperature regime, an ustic moisture regime, and mixed mineralogy. They are underlain by volcanic rocks. They generally are shallow or moderately deep, well drained clay loams. Haplustolls (Annaberg-Cramer complex and Fredriksdal-Susannaberg complex) and Haplustepts (Victory-Southgate complex) are dominant throughout this part of the MLRA.

Biological Resources

The dominant plant species in this MLRA are hurricanegrass, guineagrass, Mexican bluegrass, buffelgrass, southern sandbur, Egyptian grass, Kleberg's bluestem, flame tree, white oak, goosegrass, sprawling panicgrass, wiregrass, threeawn, coconut tree, slender grama, lovegrass, coconut paspalum, tamarind tree, sweet acacia, maga tree, whorled dropseed, para grass, pata de conejo, knotroot bristlegrass, purslane, cockspur, sensitive plant, tautaba, mallow, butterfly pea, century plant, Leucaena, giant milkweed, croton, black olive, turpentine, basora, rattlebox, mesquite, Christmas tree, damiana, guayacan tree, and tantan.

Major wildlife species include Adelaide's warbler, barn swallow, Caribbean elaenia, cattle egret, iguana, lesser Antillean pewee, lizards, Puerto Rican lizard cuckoo, mourning dove, northern mockingbird, ovenbird, prairie warbler, Puerto Rican nightjar, sparrow hawk, yellow-faced grassquit, Key West quail-dove, Puerto Rican bullfinch, green-throated carib, brown pelican, common moorhen, masked duck, Puerto Rican woodpecker, Puerto Rican emerald hummingbird, Puerto Rican tody, Puerto Rican vireo (bien-te-veo), Puerto Rican flycatcher (Juí), yellow-shouldered blackbird (Mariquita de Puerto Rico), and donkeys.

Land Use

About 43 percent of the MLRA is pasture, consisting mainly of adapted native grasses (fig. 271-2). About 30 percent is natural forest, and 8 percent supports improved species of hardwoods such as mahogany, teak, and eucalyptus.

The mountainous region in northwestern St. Croix, the largest of the Virgin Islands, supports a fairly dense tropical forest. Other parts of the MLRA support a dense growth of thorny bushes and cacti, which generally grow in semiarid regions with low rainfall and high evaporation rates. Although the soils in the Virgin Islands have severe limitations that preclude their use as sites for dwellings, urban development is significant in this MLRA. Urban expansion is a land use concern.

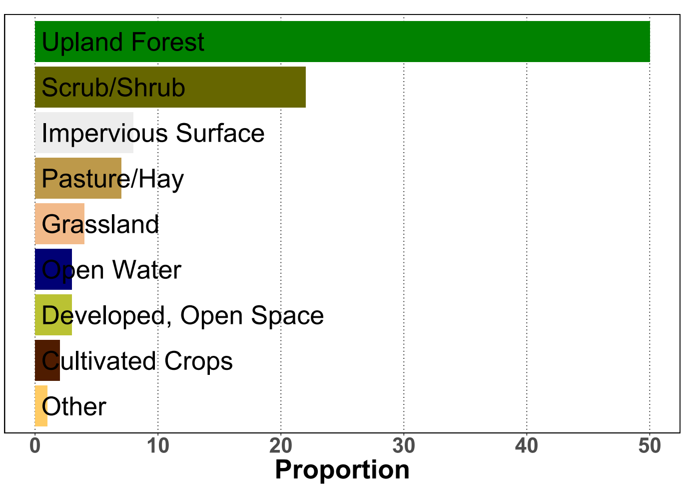

Figure 271-2: Relative proportions (percentages) of land use in MLRA 271.

The major soil resource concerns are water erosion (sheet and rill and ephemeral gully or concentrated flow), maintenance of the content of soil organic matter and tilth, and water infiltration. Water-quality concerns include surface water contaminants derived from organic and inorganic fertilizers. Water-quantity concerns include water management on irrigated land.

Conservation practices on cropland generally include conservation crop rotations, contour farming, grassed waterways, crop residue management systems (especially no-till), and nutrient and pest management. Conservation practices on pasture generally include fencing, planting of pasture and hay, watering facilities, and prescribed grazing.

272—Humid Coastal Plains

This MLRA (fig. 272-1) is primarily on the northern coast of Puerto Rico but includes small areas on the east and west coasts. It makes up about 655 square miles (2,695 square kilometers). More than half of Puerto Rico's population lives in this MLRA.

Figure 272-1: Location of MLRA 272, which covers 169,500 hectares (419,000 acres), within Region Z.

Physiography

This area is divided into two distinct zones. One zone consists of the flat alluvial plains and terraces along the coast, and the second consists of the irregular features of karst limestone in inland areas. In the northwest corner of the MLRA, limestone forms a sharp cliff rising almost 200 feet (60 meters) above sea level a short distance inland from the beach. In the rest of the area, the karst is eroded and is expressed as either low, rolling hills or steep-sided, isolated hills. Longitudinal depressions parallel the coast from Arecibo to Sabana Seca. Swamps and lagoons have developed in these depressions.

Elevation ranges from sea level to 2,300 feet (0 to 700 meters). Streams in the MLRA generally flow to the north. Most of the drainage in the karst zone is underground.

Geology

The mountainous part of this MLRA consists of a series of limestone formations that originated in a marine basin north of the island during the Oligocene to Miocene Epoch of the Tertiary Period (30 to 15 million years ago). After these sediments were uplifted to their present elevation, dissolution of the calcareous rocks produced a distinct karst topography. The limestones of the north coast account for nearly one-fifth of Puerto Rico's land area.

The flat part of this MLRA consists of various alluvial sediments of Quaternary age. The most extensive are the blanket deposits that developed during the Late Tertiary and Early Quaternary Periods as a result of erosion of the interior of the island following the uplift. These deposits consist of sand, silt, and clay in various proportions.

Small areas on the east and west coasts are made up of alluvial flood plains and wave-cut coastal terraces that consist of river alluvium. Lower lying swamps and marshes are near the coast and adjacent to many of the larger rivers. An extensive swampy area is east of Arecibo on the north coast.

Climate

The average annual precipitation in most of this area is 60 to 65 inches (1,525 to 1,650 millimeters), increasing with elevation. Most of the rainfall occurs in the afternoons as frequent, trade-wind showers from May to October, but tropical storms and hurricanes can produce high amounts of rain and result in local flooding and landslides. The area is typically drier from December through March, rainy during April and May, semidry in June and July, and wet from August through November. The average annual temperature is about 77 degrees F (25 degrees C). There is little difference in air temperature between the summer and winter seasons. This MLRA is freeze-free.

Water

Rainfall and perennial streams provide ample supplies of surface water in this area. Manmade lakes are used to trap and store runoff water for cooling hydroelectric power plants and for public supply at the lower elevations. The surface water generally is of good quality, meeting the recommended standards for drinking water. Most of the streams near population centers are contaminated with fecal coliform. In addition, most sewage treatment plants discharge partially treated effluent into streams during most of the year. These discharges generally occur near the coast.

The North Coast Limestone is one of the most heavily used aquifers on the island. Ample supplies of ground water from this aquifer are generally of good quality. Water from both the water table and artesian aquifers meets the recommended drinking water standards. In the water table aquifer, the water can change from a calcium-bicarbonate type to a sodium-chloride type near the coast because of the intrusion of saltwater. The higher levels of chloride typically exceed the recommended limits for drinking water. In the deeper artesian aquifer, the hydrodynamic pressure provides a positive flow of freshwater into the ocean at some distance offshore and so prevents chloride contamination.

The alluvial valley deposits on the east and west coasts are another source of ground water. The level of total dissolved solids in the West Coast alluvial valley aquifer is much higher than the recommended level for drinking water. The intrusion of seawater is a major concern for this aquifer. The level of total dissolved solids in the East Coast alluvial valley aquifer is not much higher than the level in the North Coast Limestone aquifer. The water in the East Coast alluvial valley aquifer, however, is suitable only for irrigation and livestock because of the high levels of iron and manganese (from volcanic rocks and ancient swamp deposits).

Soils

The soils in this MLRA include Ultisols, Inceptisols, Entisols, Histosols, Oxisols, Mollisols, and Alfisols. All of the soils in the area have an isohyperthermic temperature regime, most have an ustic moisture regime, and most are clayey and have mixed or kaolinitic mineralogy.

The MLRA has four distinct geomorphic areas—coastal plains, flood plains along rivers, small lagoon-like depressions, and areas of limestone karst. On the coastal plains, the dominant orders are Ultisols and Oxisols and the dominant suborders are deep, well drained Udults and Udox. On the flood plains, the dominant orders are Mollisols and Inceptisols and the dominant suborders are poorly drained Aquolls, somewhat poorly drained Aquepts, and well drained Udolls. In the small depressions, the dominant orders are Histosols and Entisols and the dominant suborders are poorly drained Saprists and Aquents. Miscellaneous areas of swamps and marshes are in these depressions. In the extensive areas of limestone karst, the dominant orders are Mollisols and Alfisols and the dominant suborders are Rendolls, Udolls, and Udalfs.

Biological Resources

The dominant plant species in this area are Caribgrass, streambank millet, para grass, beach sedge, Durban crowfoot grass, Jamaica fingergrass, lovegrass, flame tree, white oak, beachgrass, St. Augustine grass, carpetgrass, southern sandbur, knotroot bristlegrass, albizia tree, bayhops, seapurslane, Puerto Rico royal palm, wireweed, coconut tree, stargrass, pangolagrass, Venezuela grass, Kleberg's bluestem, Tanner grass, napiergrass, signalgrass, and guineagrass. The dominant vegetation on wetlands includes red mangrove, white mangrove, black mangrove, button mangrove, southern cattail, leatherfern, and para grass.

Major wildlife species include bananaquit, zenaida dove, smooth-billed ani, Puerto Rican lizard cuckoo, lesser Antillean pewee, yellow warbler, cave swallow, white-crowned pigeon, barn swallow, cattle egret, great egret (Garza real), green heron (Martinete), little blue heron, northern waterthrush, West India whistling duck, white-rumped sandpiper, semipalmated sandpiper, least sandpiper, greater yellowlegs, Wilson's plover, yellow-crowned night-heron, blue-winged teal, and white-cheeked pintail.

Land Use

Most of this MLRA is in farms that average 35 acres (14 hectares) in size (fig. 272-2). The pastures in the area support native and improved grasses. The area also has many large dairy farms. The cropland includes about 3,000 acres (1,215 hectares) of farmland of statewide importance, which is in areas of Oxisols planted to pineapples. Many areas that formerly were used for sugarcane are now used for hayland or sod grasses. Orchards, consisting mainly of orange and grapefruit trees, are important in some areas. Urban development is significant, especially in areas adjacent to large metropolitan centers. It is a serious land use concern because it reduces the acreage of prime farmland.

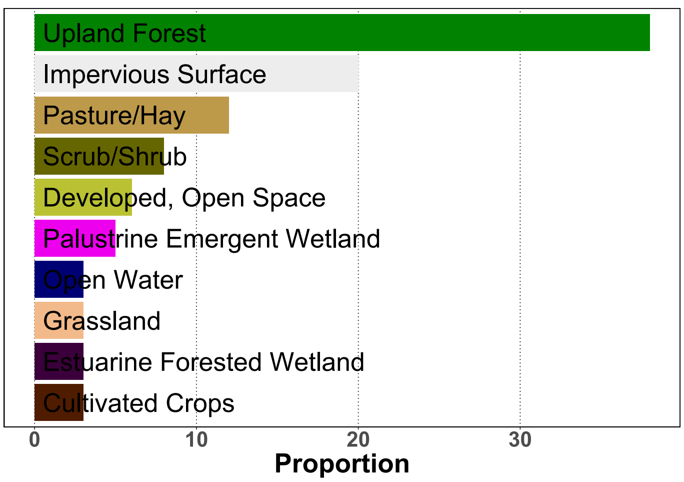

Figure 272-2: Relative proportions (percentages) of land use in MLRA 272.

The major soil resource concerns are water erosion (sheet and rill); maintenance of the content of organic matter, tilth, and fertility of the soils; crusting; and water infiltration. Water-quality concerns include surface water contaminants derived from organic and inorganic fertilizers. Water-quantity concerns include runoff, flooding, and water management on nonirrigated land.

Conservation practices on cropland generally include conservation crop rotations, bedding, deep tillage, grassed waterways, crop residue management systems (especially no-till), and nutrient and pest management. Conservation practices on pasture generally include fencing, pasture and hay planting, watering facilities, and prescribed grazing.

273—Semiarid Coastal Plains

This area (fig. 273-1) is on the south coast of Puerto Rico (81 percent) and on the southern side (mostly) of St. Croix in the Virgin Islands (10 percent) and the outlying islands of Vieques, Desecheo, and Mona (9 percent). It makes up about 290 square miles (755 square kilometers). The part of the area on St. Croix is 28 square miles (72 square kilometers).

Figure 273-1: Location of MLRA 273, which covers 75,400 hectares (186,500 acres), within Region Z.

Physiography

The coastal half of the part of this MLRA in Puerto Rico gently slopes up from the Caribbean Sea. Most of the towns are at an elevation of 5 to 50 feet (2 to 15 meters). The inland half of the area rises sharply to an elevation of 250 feet (75 meters). Steep foothills are at the base of the southern slopes of the central mountain chain (Cordillera Central), which extends from east to west across the length of the island. The part of the area in the Valle de Lajas is a flat coastal plain surrounded by steep foothills on three sides.

A rolling plain marks the part of this area on St. Croix. It generally is at an elevation of 10 to 140 feet (3 to 45 meters). It is flatter along the coast and more rolling in inland areas. The area extends to the coast on both the south and north sides of the eastern end of St. Croix. Elevation rises to almost 200 feet (60 meters) where the northern and southern parts of this MLRA connect. The MLRA separates two mountainous areas on the north side of the island.

In the Valle de Lajas, the main river flows west, but all of the other streams in the part of this MLRA in Puerto Rico flow south. None of the streams in the MLRA are perennial.

Geology

The geology of this MLRA is very similar to that of the lower part of MLRA 271. An important feature is the Lajas Valley, which formed in a geosyncline. This low area was produced by a deeper lying graben, or down-dropped block, between two gravity faults. This valley is in the western part of the MLRA, south of the footslopes of Cordillera Central and north of Sierra Bermeja. It is filled with clayey sediments as thick as 240 feet (75 meters) or more.

Gravel, sands, silts, and clays deposited in the Quaternary Period by rivers typically occur on the flatter parts of this MLRA near the coast. Limestone and volcanic rocks occur in the higher, steeper parts. The flatter alluvial deposits are not very extensive. Of all the Virgin Islands, St. Croix is the only one that has limestone as a soil parent material. Volcanic rocks form the interior and higher parts of the Virgin Islands and the other outlying islands around Puerto Rico.

Climate

The average annual precipitation in most of this MLRA is 30 to 45 inches (760 to 1,145 millimeters). It is lower near the coast and higher on the inland hills. It is 10 to 30 inches (255 to 760 millimeters) in a few small, isolated areas. Almost all of the rainfall is lost through evapotranspiration, and year-round air temperatures are high. As a result, the climate is semiarid. Most of the rainfall occurs in the afternoons as frequent, trade-wind showers from May to October, but tropical storms and hurricanes can produce high amounts of rain and result in widespread flooding. The area typically is drier from December through March, rainy during April and May, semidry in June and July, and wet from August through November. The average annual temperature is about 79 degrees F (26 degrees C). The variation in mean monthly temperatures is only 5 to 8 degrees F (3 to 4 degrees C). This MLRA is freeze-free.

Water

Rainfall provides an ample supply of surface water in the part of this area in Puerto Rico, but 90 percent of the precipitation is lost through evapotranspiration before it can reach streams or the ground water table. Manmade lakes are used to trap and store runoff water for public supply and some irrigation. The area has no perennial streams. The surface water and ground water generally meet the recommended standards for all uses. Fecal coliform levels generally are high when streams are flowing. During dry periods, the effluent from sewage treatment plants typically makes up almost all of the flow in streams near population centers.

The South Coastal Plains aquifer, one of the two most important aquifers in Puerto Rico, underlies this MLRA. The water in this alluvial deposit generally is a calcium-bicarbonate type. Along the coast, however, it is a sodium-chloride type due to the intrusion of saltwater. The ground water is very hard, and the highest concentrations of nitrate occur in the South Coastal Plains aquifer. Nitrate levels, however, are still below the limit allowed for drinking water.

The West Coast alluvial valley aquifer underlies the Valle de Lajas. The water from this aquifer is generally of good quality except for very high levels of total dissolved solids. It typically is a calcium-bicarbonate type, but near the coast, where seawater intrusion is common, it is a sodium-chloride type.

In the Virgin Islands, almost all of the freshwater is used for public supply. Streams do not flow throughout the year, and the amount of available ground water is low. As a result, the needs for freshwater in the Virgin Islands typically exceed the annual supplies. Rooftop catchments and seawater conversion plants are used to provide almost all of the potable water on St. Croix and Vieques. Contamination from sewage effluent and septic systems are water-quality concerns.

Little ground water is used in the Virgin Islands. Most of the ground water that is used comes from the calcareous sediments of the King’s Hill aquifer underlying the center of St. Croix. The water in this alluvial deposit generally is a calcium-bicarbonate type. Near the coast, however, it is a sodium-chloride type because of the intrusion of saltwater. The water in this aquifer exceeds the drinking water standards for total dissolved solids and chloride and is very hard. It is typically desalinized before it is used as potable water. The levels of nitrates, fecal coliform, and fecal streptococci bacteria commonly exceed drinking water standards. Limited quantities of ground water occur in the fractures and joints in the volcanic rocks on Vieques.

Soils

The soils in this MLRA are dominantly Mollisols and Vertisols. The soils in the part of the area in Puerto Rico have an isohyperthermic temperature regime and generally have an ustic moisture regime. They generally are clayey or loamy and have mixed or smectitic mineralogy. In a small area around Ensenada, the soils have an aridic moisture regime. The dominant suborders on the flood plains are very deep, somewhat poorly drained Aquolls and excessively drained and well drained Ustolls. The dominant suborders on high terraces are deep, expansive, clayey Usterts and Aquerts.

The soils in the part of the area on St. Croix have an isohyperthermic temperature regime and an ustic moisture regime. They generally are clayey or gravelly loam and have mixed or carbonatic mineralogy. The dominant suborders on alluvial fans and terraces are well drained Ustolls and Usterts. The dominant suborders on marine terraces and in valleys in the limestone hills and mountains are clayey and loamy Ustolls.

Biological Resources

The dominant plant species in this area are beachgrass, southern sandbur, saltwort, Bermudagrass, Mexican bluegrass, Egyptian grass, matojo de piramide, whorled dropseed, lovegrass, knotroot bristlegrass, sea purslane, heliotrope, chickweed, lechecillo, tautaba, tuna cactus, bayhops, sweet acacia, flame tree, white oak, Leucaena, black olive, turpentine, catclaw blackbead, twisted grass, coconut tree, buffer grass, guineagrass, Kleberg’s bluestem, and mesquite. The dominant vegetation on wetlands includes red mangrove, white mangrove, black mangrove, button mangrove, southern cattail, leatherfern, water panicum, and para grass.

Major wildlife species include yellow warbler, cattle egret, lesser woodpecker, Antillean nighthawk, bananaquit, black-bellied plover, warbler, black-whiskered vireo, blue-winged teal, brown pelican, cave swallow, clapper rail, common ground-dove, common moorhen, common yellowthroat, great blue heron, great egret, greater Antillean grackle, greater yellowlegs, green heron, killdeer, least sandpiper, lesser yellowlegs, little blue heron, mangrove cuckoo, northern mockingbird, ovenbird, prairie warbler, semipalmated plover, semipalmated sandpiper, snowy egret, snowy plover, stilt sandpiper, tricolored heron, white-cheeked pintail, white-crowned pigeon, Wilson's plover, and yellow-shouldered blackbird.

Land Use

The pastures in this area support native and improved grasses and are used mainly for beef production (fig. 273-2). The production of hay for racehorses is an important enterprise in some areas. About 38,000 acres (15,380 hectares) is irrigated by different systems and is used mainly for pasture, hay, plantains, or bananas. Several hundred acres are irrigated by drip systems and are used for the production of avocados, mangos, or oranges. The production of irrigated vegetables is of local economic importance. Rapid urban expansion is a land use concern near the larger cities of Puerto Rico. It has increased the need for new roads, schools, recreational developments, and agricultural land.

Sugarcane grown on St. Croix was once an important part of the economy, but now the sugar mills are closed. Identifying a suitable cash crop has been difficult because of the scarcity of water for irrigation. Approximately 13,665 acres (5,525 hectares) in the Virgin Islands, or 16 percent of the total MLRA, is used for agricultural purposes. Most of this acreage is on St. Croix. More than 78 percent of the acreage is pasture that is grazed by livestock. The main crops are herbs and spices, sugarcane, coconuts, sweet potatoes, yams, and cassava. The commonly grown vegetable crops include cucumbers, eggplant, okra, peppers, and tomatoes. Avocados, bananas, papayas, soursop, sugar apple, guavaberry, citrus fruits, and mangos are the main fruit crops grown on the islands.

The major soil resource concerns in this MLRA are water erosion (sheet and rill) induced by irrigation, surface compaction, maintenance of the content of soil organic matter and tilth, and water infiltration. Water-quality concerns include surface water contaminants derived from organic and inorganic fertilizers. Water-quantity concerns include runoff, flooding, and water management on irrigated land. In the Virgin Islands, limited supplies of soil moisture and ground water, drought, and poor water quality are serious concerns.

Conservation practices on cropland generally include conservation crop rotations, bedding, deep tillage, grassed waterways, crop residue management systems (especially no-till), nutrient and pest management, and irrigation water management. Conservation practices on pasture generally include fencing, planting of pasture and hay, watering facilities, and prescribed grazing.

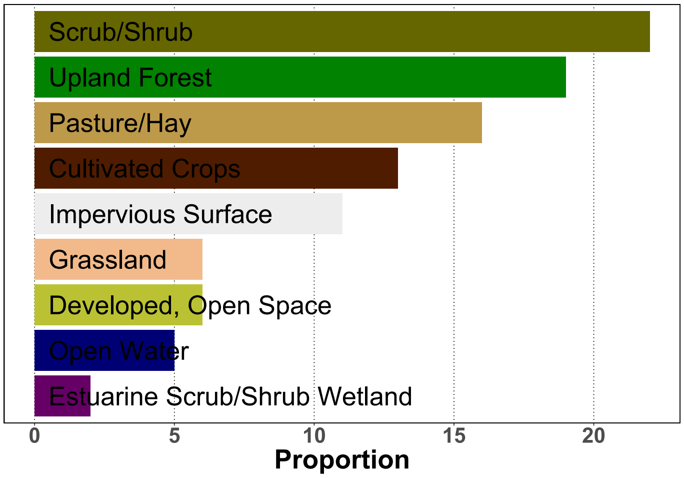

Figure 273-2: Relative proportions (percentages) of land use in MLRA 273.

References

Austin, M.E. 1965. Land resource regions and major land resource areas of the United States. U.S. Department of Agriculture Handbook 296.

Bachman, G.O. 1976. Cenozoic deposits of southeastern New Mexico and an outline of the history of evaporite dissolution. Journal of Research of the U.S. Geological Survey 4(2):135–149.

Bailey, R.G. 1995. Description of the ecoregions of the United States.

Brown, L.D., R. Reilinger, and J. Hagstrum. 1978. Contemporary uplift of the Diablo Plateau, West Texas, from leveling measurements. Journal of Geophysical Research 83:5465–5471.

Cleland, D.T., J.A. Freeouf, J.E. Keys, G.J. Nowacki, C.A. Carpenter, and W.H. McNab. 2005. Ecological subregions: Sections and subsections of the conterminous United States. Map. U.S. Department of Agriculture, Forest Service.

Cornelius, J., P. Kemp, J. Ludwig, and G. Cunningham. 1991. The distribution of vascular plant species and guilds in space and time along a desert gradient. Journal of Vegetation Science 2:59–72.

Duncan, J. 1993a. Geologic map of Broward County, Florida. Florida Geological Survey Open-File Map Series 64, scale 1:126,720.

Duncan, J. 1993b. Geologic map of Collier County, Florida. Florida Geological Survey Open-File Map Series 63, scale 1:126,720.

Duncan, J. 1993c. Geologic map of Dade County, Florida. Florida Geological Survey Open-File Map Series 67, scale 1:126,720.

Duncan, J. 1993d. Geologic map of Monroe County, Florida [northern part]. Florida Geological Survey Open-File Map Series 66/01, scale 1:126,720.

Duncan, J. 1993e. Geologic map of Monroe County, Florida [southern part]. Florida Geological Survey Open-File Map Series 66/02, scale 1:126,720.

Duncan, J., and T. Scott. 1993a. Geologic map of Martin County, Florida. Florida Geological Survey Open-File Map Series 56, scale 1:126,720.

Duncan, J., and T. Scott. 1993b. Geologic map of St. Lucie County, Florida. Florida Geological Survey Open-File Map Series 53, scale 1:126,720.

Evans, III, W.L., R.C. Green, J.R. Bryan, and D.T. Paul. 2004. Geologic map of the western portion of the U.S.G.S. 1:100,000 Scale Gainesville Quadrangle, Northern Florida. Florida Geologic Survey Open-File Map Series No. 93-01, scale 1:100,000.

Fenneman, N.M. 1916. Physiographic subdivisions of the United States. Annals of the Association of American Geographers, Volume 6, Issue 1.

Fenneman, N.M, and D.W. Johnson. 1946 (reprinted 1957). Physical divisions of the United States. U.S. Geological Survey, 1 sheet, scale 1:7,000,000.

Flint, R. 1955. Pleistocene geology of eastern South Dakota. Geological Survey Professional Paper 262. United States Department of the Interior.

Green, R., K. Campbell, and T. Scott. 1995. Surficial and bedrock geology of the eastern portion of the U.S.G.S. 1:100,000 scale Homestead Quadrangle. Florida Geological Survey Open-File Map Series 83/01-07, scale 1:100,000.

Green, R., K. Campbell, and T. Scott. 1996. Surficial and bedrock geology of the western portion of the U.S.G.S. 1:100,000 scale Homestead Quadrangle. Florida Geological Survey Open-File Map Series 83/08-12, scale 1:100,000.

Green, R.C., T.M. Scott, K.M. Campbell, J. Arthur, and G.H. Means. 1997. Surficial and bedrock geology of the western portion of the U.S.G.S. 1:100,000 scale Sarasota Quadrangle, South-Central Florida. Florida Geologic Survey Open-File Map Series No. 86, scale 1:100,000.

Green, R.C., G.H. Means, T.M. Scott, J. Arthur, and K.M. Campbell. 1999. Surficial and bedrock geology of the eastern portion of the U.S.G.S. 1:100,000 scale Arcadia Quadrangle, South-Central Florida. Florida Geologic Survey Open-File Map Series No. 88, scale 1:100,000.

Green, R.C., W.L. Evans, III, D.T. Paul, and T.M. Scott. 2005. Geologic map of the eastern portion of the U.S.G.S. 1:100,000 scale Gainesville Quadrangle, Northern Florida. Florida Geologic Survey Open-File Map Series No. 94-01, scale 1:100,000.

Green, R.C., D.T. Paul, W.L. Evans, III, T.M. Scott, and S.B. Petrushak. 2006. Geologic map of the western portion of the U.S.G.S. 1:100,000 scale Lake City Quadrangle, Northern Florida. Florida Geologic Survey Open-File Map Series No. 97-01, scale 1:100,000.

Green, R.C., C.P. Williams, D.T. Paul, C. Kromhout, and T.M. Scott. 2009. Geologic map of the eastern portion of the U.S.G.S. Ocala 30 x 60 Minute Quadrangle, North-Central Florida. Florida Geologic Survey Open-File Map Series 100, scale 1:100,000.

Green, R.C., C.P. Williams, A.D. Flor, D.T. Paul, C. Kromhout, and T.M. Scott. 2010. Geologic map of the western portion of the U.S.G.S. Ocala 30 x 60 Minute Quadrangle, North-Central Florida. Florida Geologic Survey Open-File Map Series 101, scale 1:100,000.

Green, R.C., C.P. Williams, K.E. Burdette, S.W. Bassett, A.D. Flor, and D.T. Paul. 2011. Geologic map of the eastern portion of the U.S.G.S. Inverness 30 x 60 Minute Quadrangle, Central Florida. Florida Geologic Survey Open-File Map Series 102, scale 1:100,000.

Green, R.C., W.L. Evans, III, C.P. Williams, C. Kromhout, S.W. Bassett, and L.M. Hannon. 2012. Geologic map of the U.S.G.S. Tarpon Springs 30 x 60 Minute Quadrangle, Central Florida. Florida Geologic Survey Open-File Map Series 104, scale 1:100,000.

Green, R.C., W.L. Evans, III, S.W. Bassett, and L.M. Hannon. 2013. Geologic map of the U.S.G.S. Daytona Beach 30 x 60 Minute Quadrangle, Central Florida. Florida Geologic Survey Open-File Map Series 105, scale 1:100,000.

Green, R.C., C.P. Williams, K.M. Campbell, P.W. Bambach, L.M. Hannon, S.W. Bassett, W.L. Evans, III, D.T. Paul, and B. Apoliner. 2014. Geologic map of the U.S.G.S. Saint Augustine 30 x 60 Minute Quadrangle, Northeast Florida. Florida Geologic Survey Open-File Map Series 106, scale 1:100,000.

Green, R.C., C.P. Williams, P.W. Bambach, L.M. Hannon, B. Apoliner, K.M. Campbell, and S.B. Dyer. 2015. Geologic map of the U.S.G.S. Orlando 30 x 60 Minute Quadrangle, Central Florida. Florida Geologic Survey Open-File Map Series 107, scale 1:100,000.

Green, R.C., C.P. Williams, A.G. Lamarche, C.K. Albritton, K.M. White, and S.W. Bassett. 2018. Geologic map of the U.S.G.S. Kissimmee 30 x 60 Minute Quadrangle, Central Florida. Florida Geologic Survey Open-File Map Series 110, scale 1:100,000.

Gutentag, E.D., F.J. Heimes, N.C. Krothe, R.R. Luckey, and J.W. Weeks. 1984. Geohydrology of the High Plains aquifer in parts of Colorado, Kansas, Nebraska, New Mexico, Oklahoma, South Dakota, Texas, and Wyoming. U.S. Geological Survey Professional Paper 1400-B.

Hall, S.A., and R.J. Goble. 2006. Geomorphology, stratigraphy, and luminescence age of the Mescalero Sands, southeastern New Mexico. In: L. Land, V.W. Lueth, W. Raatz, P. Boston, and D.L. Love (eds.) Caves and Karst of Southeastern New Mexico. New Mexico Geological Society 57th Annual Fall Field Conference Guidebook. pp. 297–310.

Haukos, D.A. 2011. Use of tebuthiuron to restore sand shinnery oak grasslands of the Southern High Plains. In: M.N. Hasanee (ed.) Herbicides: Mechanisms and Mode of Action. pp. 103–124.

Hereford, R., R.H. Webb, and C.I. Longpre. 2006. Precipitation history and ecosystem response to multidecadal precipitation variability in the Mojave Desert region, 1893-2001. Journal of Arid Environments 67:13–34.

Hunt, C.B. 1967. Physiography of the United States. W.H. Freeman and Company, San Francisco, California.

Iowa Department of Natural Resources (IA DNR). 1996. Hogs, bogs and logs. Iowa Geological Survey.

Intergovernmental Panel on Climate Change (IPCC). 2018. Global warming of 1.5°C: An IPCC special report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change. https://www.ipcc.ch/sr15/chapter/spm/

Kilmer, L. 1987. Water-bearing characteristics of geologic formations in northeastern New Mexico-southeastern Colorado. In: S.G. Lucas and A.P. Hunt (eds.) Northeastern New Mexico. New Mexico Geological Society 38th Annual Fall Field Conference Guidebook. pp. 275–279.

Kudo, A. 1976. A review of the volcanic history and stratigraphy of northeastern New Mexico. In: R.C. Ewing and B.S. Kues (eds.) Vermejo Park. New Mexico Geological Society 27th Annual Fall Field Conference Guidebook.

Marschner, F.J. 1950 (reprinted 1958). Sheet of the National Atlas of the United States. U.S. Department of Agriculture, Agricultural Research Service. U.S. GPO 0-47154.

Marschner, F.J. 1959. Land use and its patterns in the United States. U.S. Department of Agriculture Handbook 158.

Mason, C., B. Pyle, and C. Oppenheimer. 2004. The size and frequency of the largest explosive eruptions on Earth. Bulletin of Volcanology 66:735–748.

McBride, E. 1988. Geology of the Marathon Uplift, west Texas. Geological Society of America Centennial Field Guide (South-Central Section) 4:411–416.

McNab, W.H., D.T. Cleland, J.A. Freeouf, J.E. Keys, G.J. Nowacki, and C.A. Carpenter. 2005. Description of ecological subregions: Sections of the conterminous United States. U.S. Department of Agriculture, Forest Service.

Minnesota Department of Natural Resources (MDNR). 2003. Field guide to the native plant communities of Minnesota: The Laurentian Mixed Forest Province. Ecological Land Classification Program, Minnesota County Biological Survey, and Natural Heritage and Nongame Research Program.

Muehlberger, W., R. Belcher, and L. Goetz. 1978. Quaternary faulting in Trans-Pecos Texas. Geology 6:337–340.

Ojakangas, R.W., and C.L. Matsch. 1982. Minnesota’s geology. University of Minnesota Press, Minneapolis, Minnesota.

Omernik, J.M. 1987. Ecoregions of the conterminous United States. Map. Annals of the Association of American Geographers 77(1):118–125.

Pearson, B. 1988. A three-hundred mile fault zone: the Trans-Pecos Rift? In: S. Reid, R. Bass, and P. Welch (eds.) Guadalupe Mountains Revisited: Texas and New Mexico. West Texas Geological Society Publication 88.84. pp. 171–176.

Peterson, F.F. 1981. Landforms of the Basin and Range Province defined for soil survey. Nevada Agricultural Experiment Station, Max C. Fleischmann College of Agriculture, University of Nevada–Reno. Technical Bulletin 28.

Potter, L. 1996. Chemical variation along strike in feldspathoidal rocks of the Eastern Alkalic Belt, Trans-Pecos Magmatic Province, Texas and New Mexico. The Canadian Mineralogist 34:241–264.

Randall, J.M., S.S. Parker, J. Moore, B. Cohen, L. Crane, B. Christian, D. Cameron, J. MacKenzie, K. Klausmeyer, and S. Morrison. 2010. Mojave Desert ecoregional assessment. The Nature Conservancy, San Francisco, California. http://conserveonline.org/workspaces/mojave/documents/mojave-desertecoregional-2010/@@view.html

Reeves, C.C., Jr. 1972. Tertiary-Quaternary stratigraphy and geomorphology of West Texas and southeastern New Mexico. In: V.C. Kelley and F.D. Trauger (eds.) East-Central New Mexico. New Mexico Geological Society 23rd Annual Fall Field Conference Guidebook. pp. 108–117.

Robson, S.G., and E.R. Banta. 1995. Ground water atlas of the United States. Segment 2, Arizona, Colorado, New Mexico, Utah. U.S. Geological Survey, Hydrologic Investigations Atlas 730-C.

Roger, S., and C.S. Peterson. 1988. Ecology and management of sand shinnery communities: A literature review. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-16.

Salley, S.W., H.C. Monger, and J.R. Brown. 2016a. Completing the land resource hierarchy. Rangelands 38(6):313–317.

Salley, S.W., C.J. Talbot, and J.R. Brown. 2016b. The Natural Resources Conservation Service land resource hierarchy and ecological sites. Soil Science Society of America Journal 80:1–9.

Scott, T. 1992. Geologic map of Volusia County, Florida. Florida Geological Survey Open-File Map Series 8, scale 1:126,720.

Scott, T. 1993a. Geologic map of Brevard County, Florida. Florida Geological Survey Open-File Map Series 49, scale 1:126,720.

Scott, T. 1993b. Geologic map of Hendry County, Florida. Florida Geological Survey Open-File Map Series 62, scale 1:126,720.

Scott, T. 1993c. Geologic map of Indian River County, Florida. Florida Geological Survey Open-File Map Series 55, scale 1:126,720.

Scott, T. 1993d. Geologic map of Orange County, Florida. Florida Geological Survey Open-File Map Series 47, scale 1:126,720.

Scott, T. 1993e. Geologic map of Palm Beach County, Florida. Florida Geological Survey Open-File Map Series 65, scale 1:126,720.

Sharp, J. 2001. Regional groundwater flow systems in Trans-Pecos Texas. In: R. Mace, W. Millican, and E. Angle (eds.) Aquifers of West Texas. Texas Water Development Board Report 356. pp. 41–55.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://soils.usda.gov/technical/

Soil Survey Staff. 1999. Soil Taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436. http://soils.usda.gov/technical/

Soil Survey Staff. 2014. Keys to Soil Taxonomy. 12th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

Stanley, S.M. 1999. Earth system history. W.H. Freeman and Company, New York. ISBN 0-7167-2882-6.

Thornbury, W.D. 1965. Regional geomorphology of the United States. John Wiley and Sons, Inc., New York.

Trauger, F.D., F.X. Bushman, and N.M. Tucumcari. 1964. Geology and ground water in the vicinity of Tucumcari, Quay County, New Mexico. New Mexico State Engineer, Santa Fe.

Udden, J. 1907. A sketch of the geology of the Chisos Country, Brewster County, Texas. University of Texas Bulletin 93.

United States Army Corps of Engineers (US ACE). 2004. Louisiana coastal area comprehensive coastwide ecosystem restoration study.

United States Department of Agriculture, Forest Service. 2005. Terrestrial ecological unit inventory technical guide. General Technical Report WO-68.

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://soils.usda.gov/technical/

United States Department of Agriculture, Natural Resources Conservation Service. 2006a. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296.

United States Department of Agriculture, Natural Resources Conservation Service. 2006b. Landforms of the Upper Peninsula, Michigan. https://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs141p2_024355.pdf

United States Department of Agriculture, Soil Conservation Service. 1981. Land resource regions and major land resource areas of the United States. U.S. Department of Agriculture Handbook 296. http://soils.usda.gov/survey/geography/mlra/

United States Department of the Interior. 1973. Major ecosystems of Alaska. Joint Federal- State Land Use Planning Commission, U.S. Geological Survey map.

United States Department of the Interior, United States Geological Survey. 1999. Geology of the Loess Hills, Iowa. USGS Information Handout, July 1999. https://pubs.usgs.gov/info/loess/

United States Department of the Interior, United States Geological Survey. 2013. South Central Climate Adaptation Science Center. https://southcentralclimate.org/

United States Environmental Protection Agency. 2003. Level III ecoregions of the conterminous United States. Revised from Omernik, 1987. US EPA National Health and Environmental Effects Research Laboratory (NHEERL). http://www.epa.gov/wed/pages/ ecoregions/level_iii.htm

United States Environmental Protection Agency. 2013. Level III and Level IV ecoregions of the continental United States. National Health and Environmental Effects Research Laboratory, map scale 1:3,000,000. http://www.epa.gov/eco-research/level-iii-and-iv-ecoregions- continental-united-states

Virginia Department of Conservation and Recreation (VA DCR). 2016. Overview of the physiography and vegetation of Virginia.

Wahrhaftig, C. 1965. Physiographic divisions of Alaska. U.S. Geological Survey Professional Paper 482.

Wester, D.B. 2007. The Southern High Plains: A history of vegetation 1540 to present. In: R.E. Sosebee, D.B. Wester, C.M. Britton, E.D. McArthur, and S.G. Kitchen (eds.) Proceedings: Shrubland Dynamics—Fire and Water, August 10-12, 2004, Lubbock, Texas. USDA Forest Service RMRS-P-47.

Williams, C.P., R.C. Green, S.W. Bassett, L.M. Hannon, and A.D. Flor. 2012. Geologic map of the western portion of the U.S.G.S. Inverness 30 x 60 Minute Quadrangle, Central Florida. Florida Geologic Survey Open-File Map Series 103, scale 1:100,000.

Zimmerman, E., T. Davis, G. Podniesinski, M. Furedi, J. McPherson, S. Seymour, B. Eichelberger, N. Dewar, J. Wagner, and J. Fike. 2012. Terrestrial and palustrine plant communities of Pennsylvania, 2nd edition.