United States Department of Agriculture

Assessment of Ecological and Socio-Economic Conditions and Trends

Chugach National Forest, Alaska

Forest Service | Alaska Region | Chugach National Forest | R10-MB-787 November 2014

Assessment of the Ecological and Socio-Economic Conditions and Trends Chugach National Forest, Alaska

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Abstract: The Forest Service has prepared this assessment in compliance with provisions of the 2012 land management planning rule as outlined in Title 36 Code of Federal Regulations Part 219, along with other relevant Federal and state laws and regulations. This assessment summarizes existing information about the ecological, economic, and social conditions and trends within the context of the broader landscape and their relationship to the 2002 Chugach National Forest Land and Resource Management Plan (as amended). This assessment identifies relevant information that will inform the preliminary need to change the 2002 Chugach National Forest Land and Resource Management Plan.

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Map Package Appendix (11x17-inch maps)

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Chapter 1 Assessment Overview

Organization of this Report

The Forest Service has prepared this assessment report in compliance with the provisions of the 2012 National Forest System Land Management Planning Final Rule (2012 Planning Rule). The report includes three chapters:

Chapter 1 Assessment Overview explains the Forest Service land management planning framework, describes the planning area's location and distinctive features, and provides brief overviews of the dominant ecological, social, and economic influences on the planning area. The uses and benefits derived from the Chugach National Forest (national forest) are listed and the public engagement efforts and feedback received during the assessment phase are summarized. Chapter 1 concludes with discussion on how the relevant information from the assessment will be used to inform subsequent planning stages, beginning with the identification of the preliminary needs to change the 2002 Chugach National Forest Land and Resource Management Plan (2002 Forest Plan).

Chapter 2 Ecological Conditions and Trends describes the range of ecosystems encountered within the Chugach National Forest, including aquatic (watersheds and fish), terrestrial (soils, vegetation, and wildlife) and the interface between the two (riparian areas and wetlands). Key characteristics of each ecosystem are identified, including species composition and diversity, structure, function, and connectivity. Existing conditions and trend of the key characteristics are described for each ecosystem. System drivers are also discussed and include identification of the dominant ecological processes, disturbance regimes, and stressors for the different ecosystems. The chapter concludes with an overview of ecosystem vulnerability to adapt to a changing climate.

Chapter 3 Cultural and Socio-Economic Conditions and Trends describes the multiple uses and benefits of the Chugach National Forest, including Native Alaskan cultural subsistence activities; areas of tribal importance; land status; access; social, cultural, and economic conditions; designated areas; ecosystem services; and natural resource benefits. This chapter is different than chapter 2 in that it focuses on resources as used and enjoyed by people.

Chapter 4 Literature Cited includes a list of citations referenced throughout this assessment.

Map Package Appendix contains 11x17-inch maps of relevant information referenced in the report.

Background

The National Forest Management Act (NFMA) of 1976 requires every national forest or national grassland managed by the Forest Service to develop and maintain an effective land management plan (also known as a forest plan) and to amend or revise the plan when conditions significantly change. The process for the development and revision of plans, along with the required content of plans, is outlined in the planning regulations, often referred to as the planning rule. Managers of individual national forests and national grasslands follow the direction of the planning rule to develop a land management plan specific to their unit that sets forth the direction the Forest Service will follow in the future management of lands and resources within the unit's boundary. The current rule guiding Forest Service land management planning activities was approved in April 2012, and is published in its entirety at Title 36 Code of Federal Regulations (CFR) Part 219.

Forest Plan Revision Framework

NFMA regulations require that each forest plan be revised every 10 to 15 years (36 CFR 219.10). The Chugach National Forest Land and Resource Management Plan, was approved in May 2002 and has been amended five times, most recently in 2013. The five amendments include:

- Kenai Winter Access Amendment (July 2007)
- Amendment to Add Three Monitoring Questions to the Monitoring and Evaluation Strategy (September 2010)
- Management Indicator Species Amendment (May 2012)
- Heritage Resources Amendment (September 2012)
- Monitoring and Evaluation Strategy Amendment (January 2013)

In early 2012, the Chugach National Forest was selected as one of eight national forests to revise their existing land management plans using the requirements of the 2012 Planning Rule. As stated in the 2012 Planning Rule, planning for a national forest is an iterative process that includes an assessment; developing, amending, or revising a plan; and monitoring. These three phases of the framework are complementary and may overlap. The intent of the planning framework is to create a responsive planning process that informs integrated resources management and allows the Forest Service to adapt to changing conditions, including climate change, and improve management based on new information and monitoring. The Chugach National Forest planning process consists of the following three steps:

1. **Assessment Phase**. The evaluation of existing information, such as relevant ecological, economic, and social conditions, trends, and sustainability, and its relationship to the land management plan within the context of the broader landscape.
2. **Revision Phase**. The updating of information, including identification of the need to change the forest plan based on the assessment, development of a proposed plan and alternatives, consideration of the environmental effects of the proposed plan and alternatives, provision for public review of and comment on the proposed plans, provision to object before a proposed plan is chosen, and, finally, approval of the selected plan.
3. **Monitoring Phase**. The continuous observation and collection of feedback for the planning cycle that is used to test relevant assumptions, track relevant conditions over time, and measure management effectiveness.

Assessment Phase

This document, the assessment, is the result of completing phase one. The assessment is designed to evaluate and present existing information about relevant ecological, economic, and social conditions; trends and sustainability; and associated relationships to the land management plan. Assessments are not decision-making documents but provide current information on select topics relevant to the plan area. This assessment contributes to the planning process by:

- Providing information to help identify the need for change in the plan revision process
- Identifying and evaluating a solid base of existing information relevant to the plan revision
- Building a common understanding of that information with the public and other interested parties before starting the plan revision
- Developing relationships with interested parties, government entities, Indian tribes, private landowners, and other partners
- Developing an understanding of the complex topics across landscapes that are relevant to planning for the national forest

To complete the assessment, the responsible official shall carefully evaluate readily available information that is relevant. Relevant means the information must pertain to the topics under consideration at spatial and temporal scales appropriate to the plan area and to a land management plan. Relevance in the assessment phase is information that is relevant to the conditions and trends of the following 15 topics identified at 36 CFR 219.6(b):

1. Terrestrial ecosystems, aquatic ecosystems, and watersheds
2. Air, soil, and water resources and quality
3. System drivers, including dominant ecological processes, disturbance regimes, and stressors, such as natural succession, wildland fire, invasive species, and climate change; and the ability of terrestrial and aquatic ecosystems on the plan area to adapt to change
4. Baseline assessment of carbon stocks
5. Threatened, endangered, proposed and candidate species; potential species of conservation concern (SCC); and species of public interest present in the plan area
6. Social, cultural, and economic conditions
7. Benefits people obtain from the Chugach National Forest planning area (ecosystem services)
8. Multiple uses and their contributions to local, regional, and national economies
9. Recreation settings, opportunities and access, and scenic character
10. Renewable and nonrenewable energy and mineral resources
11. Infrastructure, such as recreational facilities and transportation and utility corridors
12. Areas of tribal importance
13. Cultural and historical resources and uses
14. Land status and ownership, use, and access patterns
15. Existing designated areas located in the plan area including wilderness, wild and scenic rivers, and potential need and opportunity for additional designated areas.

In general, for each of the 15 topics, the assessment may:

- Describe or identify important information evaluated in this phase.
- Describe the nature, extent, and role of existing conditions and reasonably foreseeable future trends within the plan area and in the broader landscape. Trends may imply a range of changes that are reasonably foreseeable in the future. Statistical analysis is not implied or necessary to identify and describe trends in the assessment phase. Trends may be described in broad terms, such as increasing, decreasing, or remaining stable.
- Describe the contribution that the planning area makes to ecological, social, or economic sustainability related to the topic.
- Identify information gaps as described in 36 CFR 219.6(a)(3).

Description and Distinctive Features of the Planning Area

The Chugach National Forest is in southcentral Alaska and is where distinctive cultures, customs and ways of life converge–urban and rural residents alike value it for subsistence, recreation, work, and adventure. The Chugach National Forest has been continuously inhabited for more than 10,000 years, and its first nations include the Chugach, Eyak, Ahtna, and Dena'ina. Communities within the planning area include Whittier, Hope, Seward, Cooper Landing, Moose Pass, Tatitlek, Chenega Bay, Eyak, and Cordova. Adjacent to the planning area are the communities of Anchorage, Girdwood, Valdez, Sterling, Kenai, and Soldotna. Its 5.4 million acres (see figure 1) are quite literally the backyard for approximately half of Alaska's people.

Land Areas of the National Forests is an annual report containing national statistics on land areas administered by the Forest Service. According to the most recent report available (containing data as of September 30, 2013), the Chugach National Forest includes 5,417,172 acres of National Forest System lands. Land ownership patterns are dynamic; however, and acreage values identified throughout this assessment may vary, depending on when the source data were collected.

The Chugach National Forest is the farthest north and west of all national forests in the National Forest System and by declaration is the second largest. It is subdivided into three administrative units: the Glacier, Seward, and Cordova Ranger Districts. The planning area spans three broad geographic areas: the Copper River Delta, Kenai Peninsula, and Prince William Sound.

Nearly 96 percent (5,184,000 acres) of the Chugach National Forest is managed to allow natural ecological processes to occur with very limited human influence. It is in the remaining 4 percent (216,000 acres), primarily on the Kenai Peninsula, where active management and the largest amount of human uses occur.

To the northeast and near the Copper River Delta, the Chugach National Forest is bordered by the Wrangell-Saint Elias National Park and Preserve while to the east it is bordered by public lands managed by the Bureau of Land Management. On the Kenai Peninsula and to the west, it is bordered by the Kenai National Wildlife Refuge and the Kenai Fjords National Park. To the north and near Girdwood, it is bordered by the Chugach State Park.

The following paragraphs briefly describe the three distinct geographic areas of the Chugach National Forest that are evaluated as part of the broader landscape.

Copper River Delta

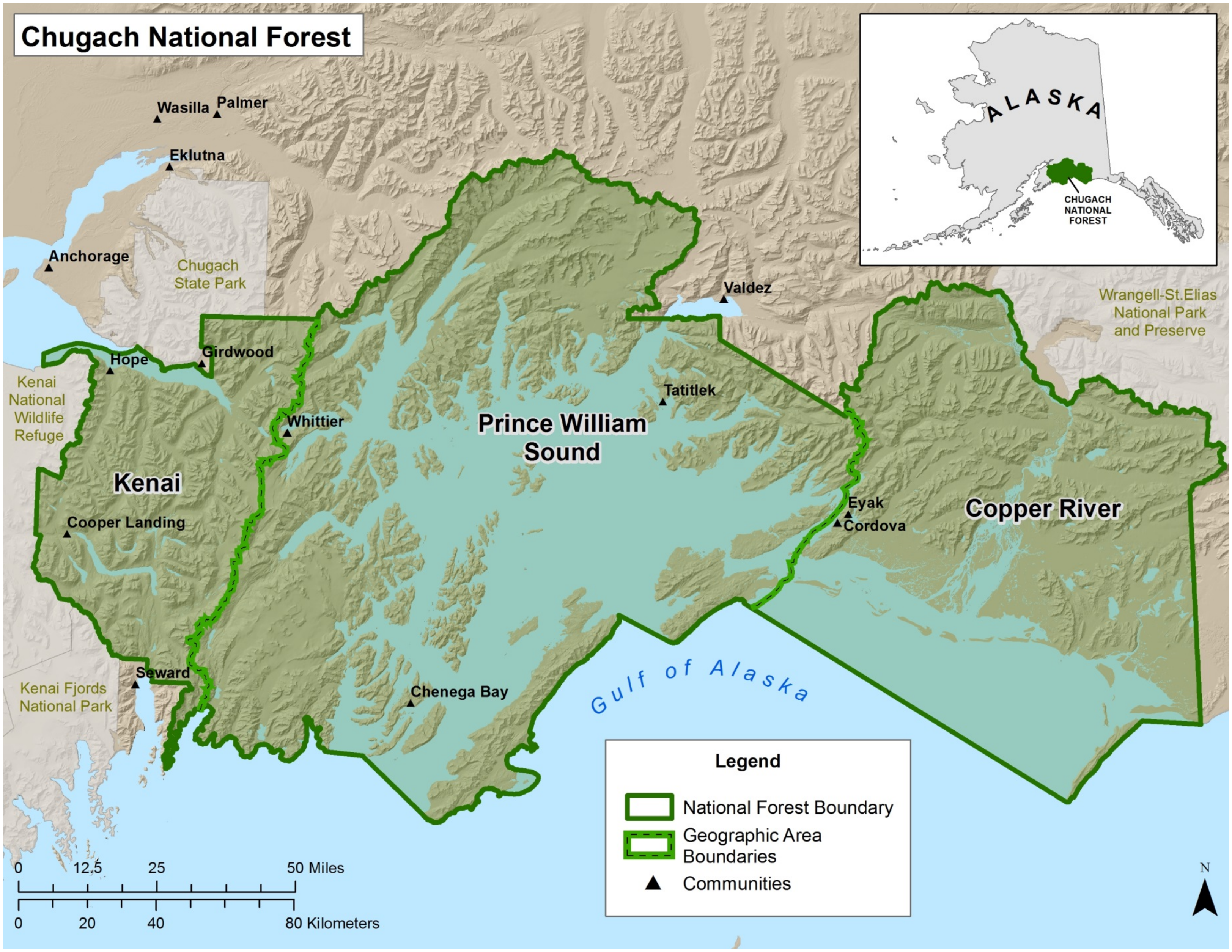
The Copper River Delta geographic area makes up 31 percent (1.66 million acres) of the national forest. The area is known for its vast wetland wildlife habitats, mountains, and glaciers. It enjoys a well-deserved reputation as a birder’s paradise and is the home habitat of the famous Copper River red (sockeye) salmon, one of the most highly prized fish in the world. As prescribed by Section 501(b) of the Alaska National Interest Lands Conservation Act (ANILCA), the Copper River Delta is to be managed for the primary purpose of conserving fish and wildlife and their habitat.

Kenai Peninsula

The Kenai Peninsula geographic area makes up 21 percent (1.16 million acres) of the national forest. Nearly half of Alaska’s population lives within a short drive to the Kenai Peninsula, making it the most accessible area of the Chugach National Forest. Its forested lands, mountains, and rivers receive the most human use of the three geographic areas.

Prince William Sound

The Prince William Sound geographic area is in the heart of the national forest and accounts for 48 percent of the acres (2.6 million). It is an area of forested islands, intricate coastline, and glaciers. A portion of the Prince William Sound was the site of the Exxon Valdez oil spill in 1989. Lands in the western portion were designated as the Nellie Juan-College Fiord Wilderness Study Area (WSA) in Section 704 of ANILCA in 1980.



Map 1. Geographic Areas of the Chugach National Forest

Overview of Ecological Influences

Detailed discussions of the ecological conditions and trends of the planning area are described in chapter 2. The following paragraphs briefly summarize the more predominant ecological influences identified during the assessment.

Glaciation has been one of the dominant forces of influence within the Chugach National Forest. Almost all the land now within the national forest was covered by glaciers until 14,000 years ago. The topography of the national forest was partially formed as the lands were scoured and exposed by up to 18 periods of glacial formation and retreat. Glacial outwash formed river valleys and drainages and distributed sediments. Snow and ice currently cover 27 percent of the Chugach National Forest, and glaciers continue to influence this landscape and its hydrologic processes.

Tectonic movement has also greatly influenced the Chugach National Forest. Southcentral Alaska is one of the most tectonically active areas of the world. The Kenai and Chugach mountains were formed by the Pacific Plate sliding beneath the North American Plate. Movement can be rapid and result in large disturbed and displaced areas; the 1964 earthquake raised much of the eastern part of the Chugach National Forest an average of 10 feet in a matter of minutes.

Climate influences physical and ecological processes in the planning area, such as the development and retreat of glaciers. Climate within the Chugach National Forest is influenced by both maritime and continental weather patterns, and each of the three geographic areas is different. The Copper River Delta is influenced by strong continental winds that blow in from the north and cool the area. The Kenai Peninsula receives the least amount of precipitation. Prince William Sound receives the most precipitation and has the largest percent of perennial snow and ice cover. There is uncertainty about what changes in climate may occur in the planning area. Modeling completed as part of an ongoing Climate Change Vulnerability Assessment suggests that temperatures will warm and precipitation will increase, although less as snow and more as rain.

The vegetation diversity that currently exists within the Chugach National Forest is an outcome of the interaction of glaciation, tectonic movement, topography, and climate. As land became exposed following glacial retreat, vegetation gradually became established. Patterns in vegetation distribution, life stage, and species composition are directly related to elevation, slope aspect, temperature, precipitation, soil development, and time since last disturbance. Areas where temperature and snow and ice cover have previously limited the establishment of vegetation may become available with future climate regimes. Changed conditions may also allow currently non-native or potentially invasive species to become established.

The wildlife diversity of the planning area has a similar representation of species as what was described by the first European explorers in the mid-1700s. The distribution and abundance of wildlife populations have been manipulated over time by people through hunting, trapping, introductions, and reintroductions. Changing climate conditions may allow a few currently non-native species (those found in association with human habitation) to become established within the national forest.

Five salmon species occur within the Chugach National Forest, and these species provide an important input of nutrients into some forest ecosystems when their bodies decompose after spawning. Salmon populations are influenced by many factors outside of the Chugach National Forest boundary.

Overview of Social and Economic Influences

Detailed discussions of cultural and social and economic conditions and trends of the planning area are in chapter 3. The following paragraphs briefly summarize the predominant cultural and socio-economic influences identified during the assessment.

Social and economic information is summarized for three population areas: the Municipality of Anchorage (population 287,000), the Kenai Peninsula Borough (population 55,000), and the Valdez-Cordova census area (population 9,600). The Kenai Peninsula geographic area is closest to the largest population centers (Municipality of Anchorage, Kenai Peninsula Borough) and is accessed by the Seward and Sterling Highways. Both the Copper River Delta and Prince William Sound are included in the Valdez-Cordova census area. Travel to or within these geographic areas is primarily by boat or float plane.

During the last census period (2001-2010), population in the Municipality of Anchorage and Kenai Peninsula Borough increased by 27 and 35 percent, respectively. Population decreased by four percent in the Valdez-Cordova census area.

Four main industries that use forest related resources in the planning area are commercial salmon fishing and processing; tourism and recreation; wood products; and minerals (excluding oil and gas). The proportion of jobs provided by forest resource related industries is 12.1, 6.5, and 3.4 percent in the Kenai Peninsula Borough, Valdez Cordova census area, and Municipality of Anchorage, respectively. Most of the employment and income from forest resource related industries is in commercial fishing and processing, followed by tourism and recreation.

The Chugach National Forest offers businesses and individuals opportunities for jobs and income related to forest health management, outdoor recreation, and tourism. Communities with larger populations have more diverse economies and are less dependent on the Chugach National Forest for these opportunities.

Overview of Resource Uses and Benefits

Resources within the Chugach National Forest provide a wide variety of goods, services, and benefits to individuals and society. Alongside these ecosystem services, the national forest is managed to allow multiple uses. This section summarizes ecosystem services and multiple uses found in the planning area. See chapter 2 for more discussion on ecosystem processes and chapter 3 for descriptions of Chugach National Forest products and uses.

Alaskan Natives continue to live within and use the resources of the Chugach National Forest. People derive broad nonmaterial benefits from the planning area that include educational opportunities, recreational experiences, tourism, aesthetics, and spiritual and cultural heritage. People from all over the world visit the national forest to see glaciers, salmon, and bears and to hike, raft, ski, snowmachine, hunt, and fish.

Harvesting and gathering occurs within the Chugach National Forest as both recreational and cultural subsistence activities. Examples include fish, big game, furbearers, small game, fruits, berries, mushrooms, and medicinal plants. Although no commercial timber harvest occurs, wood products, such as fuelwood and house logs, are also collected. Good quality water is provided for municipal and public water supplies, fish hatcheries, and fish and wildlife habitat. Ample water supply provides water for hydroelectric operations, fish passes, and water related recreation.

Some benefits obtained from ecosystem processes within the Chugach National Forest include water storage and filtration, soil stabilization, and carbon storage. Rapidly growing plants store carbon in plant tissues. Healthy wetlands and riparian areas store water, releasing it slowly over time. Wetlands (approximately 15 percent of the Chugach National Forest) act as water filters to remove impurities.

Supporting services contribute to the production of other ecosystem services. The majority of the national forest has intact and properly functioning watershed conditions. These watersheds support aquatic and terrestrial ecosystems that are functioning within their natural range of variation. Human caused disturbances influence localized areas across the Chugach National Forest; however, ecological integrity is high within most of the national forest.

Public Engagement and Collaboration Efforts

The Forest Service has a long history of collaboration with the public and the communities in and around the Chugach National Forest. In this assessment, the Forest Service has built upon that platform and made extensive efforts to use new and innovative ways to extend these strong ties and engage new audiences in the planning process.

Throughout the assessment phase, the Forest Service worked to develop and provide:

- Focused, meaningful opportunities for participation that recognize and build from the public's previous contributions in previous collaborations
- Timely information to help the public understand the process and how to get involved
- Clear expectation/understanding of how the public can participate in plan revision at every step of the process
- Broad stakeholder engagement to new and underserved audiences, including youth, minorities, and low income populations

To be more successful, key seasons and community events (e.g., summer tourist, commercial fishing, fishing and hunting seasons, and other local planning efforts) were considered when scheduling the various engagement efforts. The Forest Service developed a timeline to respect people's availability and to integrate the ongoing three-year public participation process with the requirements of forest plan revision.

April and May 2012 Community Workshops

Beginning in March 2012, the Forest Service began to lay the foundation to educate and engage the public about the forest plan revision process. In addition to alerting the public and stakeholders through press releases, letters and Web-based information, the Forest Service partnered with the University of Alaska Anchorage (UAA) to design and host community workshops to:

- Educate the public about the national forest's selection as an early adopter and share a broad timeline for upcoming plan revision
- Gather insights on public interest and concern about forest plan revision
- Obtain initial public feedback on values, use, and trends to help inform forest plan revision and begin a dialogue about the Forest Service's unique role and contribution within southcentral Alaska

Workshops were developed to be interactive and included multiple methods for data generation, including workbook activities, a participatory mapping exercise, and interactive group discussion. Community workshops were held in 10 communities during April and May 2012:

- Kenai/Soldotna (April 16), Kenai Peninsula College, 2 participants
- Cooper Landing (April 17), Cooper Landing Community Center, 8 participants

- Moose Pass (April 18), Moose Pass School, 2 participants
- Seward (April 19), Legends Building, 7 participants
- Cordova (April 24), Masonic Lodge, 14 participants
- Valdez (April 26), Prince William Sound Community College, 8 participants
- Hope (April 30), Hope School Gym, 2 participants
- Whittier (May 3), Whittier School, 8 participants
- Anchorage (May 8), University of Alaska Anchorage, 13 participants
- Girdwood (May 10), Girdwood Community Center, 7 participants

In addition to the workshops, an online participatory mapping interface (Talking Points) was available for the public at large to use from April to November 2012. The Web site was hosted by UAA and also provided background information and links to the Chugach National Forest Web site, the 2002 Forest Plan, and dates and locations of the community workshops. In total, the workshops and online mapping tool engaged 103 participants.

February and April 2013 Community Workshops

On January 31, 2013, the Forest Service issued a news release announcing the beginning of the first phase of the three year planning process to revise the 2002 Forest Plan using the 2012 Planning Rule. Additionally, on February 7, 2013, a legal notice was published in the Anchorage Daily News announcing the beginning of the assessment phase of the plan revision and upcoming opportunities for public engagement.

Methods used to invite participation in these workshops included emails, direct mail, electronic and hard copy flyers posted in key community locations, newspaper advertisements, radio spots, community meet and greets, announcements on community partners' Facebook and Twitter platforms, and Forest Service Web site and Twitter communications.

The workshops were designed to capture public and key stakeholder comments on three key topics:

- **Vision**: How the public and/or specific stakeholder groups use the national forest now and how might use and users change during the next plan period (10 to 15 years after approval)
- **Assessment**: What the public and/or specific stakeholder groups see as emerging issues and trends in the assessment topic areas, such as recreation and forest uses, climate change, vegetation and wildlife, watersheds, energy and mineral resources, and cultural heritage
- **Continued Communications and Participation**: How the public can best be involved in the forest plan revision process

During the workshops, Forest Service staff introduced the forest plan revision process and highlighted 2002 Forest Plan achievements. The participants then split into groups of 5 to 10 people to discuss the three key topics outlined previously: vision, assessment, and communications. Additionally, participants were encouraged to rotate between groups after each topic. Note takers recorded responses and discussions. After each topic, the facilitator reported the highlights of the discussion to the public workshop attendees.

Facilitators and note takers sent meeting notes to the Forest Service's Recreation Solutions Enterprise Unit, who standardized the meeting notes by community and topic. Finally, the notes were posted to the Chugach National Forest Web site. The notes also were sorted by overarching assessment categories and placed in a summary matrix and then shared with the forest plan revision interdisciplinary team for consideration as they prepared this assessment document.

Details and summaries of each major public engagement effort, including target audience and method of engagement follow. Not included in these summaries are findings from the public engagement effort related to specific assessment topics. Where applicable, those findings are addressed within the body of the issue-specific chapters of this assessment. More detailed information from all public engagement activities is available online from the Chugach National Forest plan revision Web page.

Workshop locations, dates, and approximate number of participants follow:

- Anchorage (February 7 and February 23)
- Alaska Forum on the Environment, Dena'ina Center, 18 participants
- Chugach National Forest Supervisor's Office, 13 participants
- Girdwood (February 20), Girdwood Community Center, 31 participants
- Seward (February 21), Seward Public Library, 32 participants
- Soldotna (February 21), Soldotna Sports Center, 37 participants
- Cooper Landing (February 25), Cooper Landing Community Center, 19 participants
- Moose Pass (February 25), Moose Pass Community Hall, 9 participants
- Cordova (February 27), Cordova Masonic Hall, 28 participants
- Valdez (February 28), Prince William Sound Community College, 45 participants
- Whittier (April 2), Begich Towers, 4 participants
- Hope (April 6), Hope Social Hall, 32 participants

September and November 2013 Community Workshops

As part of the assessment phase, the Forest Service completed a second round of public meetings in September and November. The meetings were held in Valdez, Cooper Landing, Soldotna, Seward, and Cordova in September and in Hope, Girdwood, and Anchorage in November.

The purpose of the second round of public workshops was to build from the first round of meetings and have a focused, informed dialogue regarding:

- The planning process: schedule, milestones, and status
- Themes from public input and relevant information gleaned during the assessment
- Potential themes/opportunities to inform plan revision
- Next steps and opportunities for providing feedback

The Chugach National Forest plan revision Web page includes a record of public comments received during the fall meetings and a link to a map that displays the geographic- or site-specific comments collected during the meetings. In addition, the general comments are available for review.

Again, the workshops involved participatory mapping and interactive group discussion. Public workshops were held in the following communities:

- Valdez (September 23), Prince William Sound Community College, 17 participants*
- Cooper Landing/Moose Pass (September 24), Cooper Landing Community Center, 6 participants*
- Soldotna (September 25), Soldotna Sports Center, 27 participants*
- Seward (September 26), Seward Public Library and Museum, 7 participants*
- Cordova (September 30), Masonic Hall, 14 participants*
- Hope (November 2), Hope Social Hall, 7 participants*

- Girdwood/Whittier (November 13), Girdwood Community Center, 25 participants*
- Anchorage (November 20), Chugach National Forest Supervisor's Office, 63 participants*

*Some participants did not sign in. It was noted that a significant number of people did not sign in at the Soldotna and Anchorage meetings.

Targeted Engagement Efforts

In addition to the 18 public workshops from February through November 2013, the Forest Service conducted a series of targeted outreach efforts to federally recognized Alaska Native Tribes and Corporations, youth, new audiences, permittees, and neighboring landowners, including the State of Alaska, to capture stakeholder input for this assessment. The next few sections describe these efforts.

Federally recognized Tribes and Alaska Native Corporations

Alaska Natives have lived on and adjacent to the land now identified as the Chugach National Forest for millennia. This land is significant to them as it provides for them and empowers them as individuals, families and people. This connection has many facets which includes language and stories.

Oral tradition describes how the Native name Chugach came to be. This story was passed down by John Klashinoff, who was born at the village of Nuchek in Prince William Sound in 1906. This oral history was recorded by John F.C. Johnson and published in Chugach Legends: Stories and Photographs of the Chugach Region.

> *"For ages and ages Prince William Sound, as it was named by Captain James Cook, was covered by a solid sheet of glacier ice that extended over nearly all of the bays and mountains. One day Native hunters were kayaking along the outer shores of the Pacific Ocean, when a man cried out: "Chu-ga. Chu-ga (hurry, hurry). Let's go see what that black thing is sticking out of the ice."*
>
> *So the hunters paddled closer and closer to see what it was. Within a short distance, the hunters could see mountaintops emerging out of the retreating ice.*
>
> *Thus these ocean travelers settled along the ice-free shores of the sound.*
>
> *As the seasons changed from year to year, the ice melted rapidly, exposing deep fjords and lagoons that were rich in sea life and provided good beaches to settle on. It was known that life thrived in the areas where the salt and fresh water met.*
>
> *When the ice retreated, so did the animals. The Chugach people followed the ice and animals deep into the heart of Prince William Sound, where they remain to this very day."*

When the Chugach National Forest was announced as a 2012 Planning Rule early adopter, and again when the Forest Service began the first phase of the process in January 2013, the forest supervisor invited federally recognized Tribes and Alaska Native Corporations to attend early engagement workshops, to meet privately, and to provide direct consultation. Methods used to invite participation in the process included direct mail, email, and telephone. Each of the parties contacted are displayed in table 1.

Table 1. Tribes and Alaska Native Corporations within and adjacent to the plan area

Federally Recognized Tribes	Village Corporations	Regional Corporations
Chenega Bay IRA Council	Chenega Corporation	Chugach Alaska Corporation
Native Village of Eyak	Eyak Corporation	
Native Village of Nanwalek	English Bay Corporation	
Native Village of Port Graham	Port Graham Corporation	
Native Village of Tatitlek	Tatitlek Corporation	
Chickaloon Native Village	Chickaloon-Moose Creek Native Association	Cook Inlet Region, Incorporated
Eklutna Native Village	Eklutna, Incorporated	
Kenaitze Indian Tribe	Kenai Native Association, Incorporated	
Knik Tribe	Knikatnu, Incorporated	
Ninilchik Village	Ninilchik, Incorporated	
Village of Salamatoff	Salamatoff Native Association, Incorporated	
Seldovia Village Tribe	Seldovia Native Association	
Native Village of Tyonek	Tyonek Native Corporation	

In response to this consultation invitation, the Forest Service met with leaders and representatives of:

- Chugach Alaska Corporation, September 12, 2012
- Native Village of Eyak and Eyak Corporation, February 27, 2013
- Cook Inlet Region, Incorporated, March 12, 2013
- Eklutna Incorporated, March 20, 2013
- Tyonek Corporation, March 25, 2013
- Chenega Corporation, November 7, 2013

The Forest Service also hosted a booth at the Alaska Federation of Natives annual conventions in 2012 and 2013, providing information on forest plan revision efforts.

The 2012 early engagement workshops initiated discussion of:

- The national forest's distinctive roles and contributions or niche (i.e., what makes the Chugach National Forest distinct, including what defines the national forest and the benefits people obtain from its ecosystems and landscapes)
- Seeking perspectives as a neighboring land owner
- How to best integrate traditional knowledge and land ethics while sensitively addressing cultural concerns

The 2013 consultations, notifications, and meetings were designed to communicate the plan revision process and timeline and to encourage and identify each individual stakeholder's preferred participation method(s) throughout the process. In addition, dialogue emphasized the 2012 Planning Rule content and direction with Tribes and Alaska Native Corporations, including:

- Native knowledge, land ethics, cultural issues, and areas of tribal importance
- Consideration of Tribal land management plans and policies
- Identifying conflicts and concerns with the 2002 Forest Plan

- Social, cultural, and economic conditions
- Consideration of Tribes participating as cooperating parties during formal plan revision phase (based on their interest after the potential scope of plan revision is determined and the formal NEPA process is initiated)

What was heard (issues/concerns/items of interest) during the meetings with Alaska Native parties includes the following topic areas:

- Land management: Native corporation lands adjacent to National Forest System lands and Exxon Valdez oil spill acquired lands and interests (easements/covenants), including protection of subsistence/archaeological resources, trespass onto Native corporation lands, sensitivity and need for coordination on names/locations placed on maps and visitor information
- Status of tribal land use plans (CIRI and Eyak Corporation are currently updating their land use plans)
- Management of archaeological sites and collections associated with Alaska Native culture
- Land use permitting on National Forest System lands
- Subsistence (with particular interest in moose and deer; increased competition for subsistence resources in Prince William Sound; concern about decreased funding for Copper River fisheries research)
- Managing and/or meeting public demand for resource amenities, goods, and services
- Concern about invasive species
- Concern about placement of recreation sites/cabins/trails that would increase public use and/or impact cultural sites and/or features
- Concern about new land use designations (i.e., wilderness areas)
- Need to implement the Memorandum of Understanding for the Squilantnu Archaeological District with CIRI, Kenaitze Indian Tribe, USFWS, and the Forest Service and associated Significant Activities noted in the MOU and Section D of the Selection Agreement which includes preparation of a cultural resource management plan (suggestion to consider a management area for the Squilantnu Archaeological District)
- Pond ecology, fisheries (e.g., loss of spawning habitat and glacial retreat) and water rights (e.g., minimum base flows for restoring fisheries)
- Watershed integrity (management for surface and underground water flows and water quality)
- Unauthorized dump sites within the national forest affecting water quality
- Interest in improving local economic development and private land opportunities adjacent to National Forest System lands (e.g., the village of Chenega is considering offering marine services and has interest in community development; the Native Village of Eyak (Cordova) is proposing the Prince William Sound Ocean Restoration Facility and Shepard Point Oil Spill Response Facility, Hartney Bay Subdivision, and woody biomass utilization to reduce diesel fuel)
- Hydroelectric and utility line connections/services on and/or across National Forest System lands (i.e., Valdez to Cordova)
- Access to forest products (e.g., fuelwood collection and berry picking)
- Moose habitat (concern with population decreases on the Kenai Peninsula, moose calf release program in Cordova, and moose browse winter range enhancement in Cordova)
- Recognition of the difficulty sometimes encountered by tribes to provide meaningful input to government processes, such as forest plan revision, due to tribal staff capacity and/or limited natural resource expertise, timeframes, and the nature of information requested

During these discussions, dialogue confirmed that:

- Alaska Natives have and continue to value and utilize natural and cultural resources across the national forest landscape
- Natural and cultural resources provide essential economic, social, recreational, ecological, spiritual, and subsistence value and identity to Alaska Native people
- Many of the 560 recorded plant species have been used for thousands of years for food, shelter, fuel, medicine, crafts, and spiritual purposes
- There are still selected lands to be conveyed under ANCSA
- Appreciation and continued opportunities for continuing and expanding partnerships and resource management in the future

As the plan revision process continues, the Forest Service is exploring opportunities to provide broader outreach to the Alaska Native community through existing forums (such as the Alaska Federation of Natives annual convention) and at Alaska Native community events.

As another example of seeking broader outreach, in April 2013, the forest supervisor met and informed representatives of the Russian River MOU Group that was established in 2010 in accordance with the requirements of the 2001 Russian River Section 14(h)(1) Selection Agreement and the 2002 Russian River Land Act. This group consists of leadership of the Kenaitze Indian Tribe, Cook Inlet Region, Inc., Kenai National Wildlife Refuge, and the Chugach National Forest. The Russian River Land Act requires the Russian River MOU Group parties to cooperate on efforts to "protect and preserve the outstanding historic, cultural and natural resources" in the vicinity of the confluence of the Russian and Kenai rivers.

Youth engagement

The 2012 Planning Rule encourages efforts to engage young people in the planning process. During the assessment phase, Chugach National Forest staff and project partners facilitated interactive planning activities with youth across the national forest in the following locations:

- Cordova (February 27 and 28, 2013), four classes with approximately 60 students
- Anchorage
  - King Career Center Natural Resource Management Students (April 8, 2013), two classes with approximately 30 students
  - Highland High Tech (April 15, 2013), one class with approximately 25 students
- Youth Employment in the Parks Summer Recruits (June 10, 2013), one group with approximately 25 attendees
- Whittier Middle and High School (May 20, 2013), one class with approximately 20 students

Chugach National Forest staff and key partners, including Alaska Geographic, the lead nonprofit partner for the Chugach Children's Forest, worked with local teachers to develop a two-hour forest plan youth planning activity aimed at sharing and learning the following:

- What is the Forest Service, the Chugach National Forest; what do youth know about the Forest Service and the Chugach National Forest?
- What opportunities are there for young people?
- What kinds of activities are youth doing outdoors and where they are doing them (e.g., Anchorage, southcentral Alaska, other places in Alaska)?
- How do youth envision using the outdoors in the future?
- What changes have youth seen in the places where they recreate outdoors?

- How do youth like to learn and share information?

Youth who participated in these activities not only live in communities within and around the national forest, some are actively involved in additional educational and/or employment opportunities. For example, King Career Center participants were enrolled in a natural resources management vocational education class and had participated in Chugach Children's Forest activities. A different group of Anchorage participants were summer youth workers for the Anchorage Parks and Recreation Department. They were hired as part of the Youth Employment in Parks (YEP) program.

The youth planning sessions closely paralleled the public workshops. The sessions began with an activity to actively engage youth in answering key questions:

- How many of you spend time in parks or on trails in your community?
- Where do you like to go in your community and what do you like to do?
- How many of you have gone fishing? Where have you done that?
- How many of you have done outdoor activities outside of your community?

Participants wrote on posters what they like to do in their free time indoors and outdoors. Youth worked together in small teams to map where they used the national forest and how, challenges to their use, and potential solutions to those challenges. The teams shared the results of their work with the class. As a large group, participants then discussed changes they have seen in the national forest and natural world around them.

For the final activity, the participants created a management plan for their ideal national forest. With knowledge of the broad management area prescriptions as outlined in the 2002 Forest Plan, groups created a pie chart that displayed how much area would be dedicated to various uses. As with the public workshops, detailed notes from the youth planning sessions were posted on the Chugach National Forest Web site.

New audiences

In addition to public workshops, the 2012 Planning Rule encourages engagement of new audiences, such as low income and minority populations.

Working in partnership with the UAA, the Forest Service first pursued conducting introductory meetings for first time/new audiences at sites with regular programming for diverse populations in Anchorage (e.g., the Mountain View Library in Anchorage). This approach was modified to conducting small group discussions with key contacts within underserved communities and by asking them to invite a few other stakeholders to join a series of conversations at venues that were convenient for participants. By enlisting the help of existing contacts to invite individuals to a smaller and more focused format, targeted audiences were better reached. Participants were asked similar questions as those asked at the public workshops with a more conversational approach. A sample list of key stakeholder organizations includes:

- East African Community
- Anchorage Literacy Project Hmong Community
- Anchorage Adventurers Neighbor Works
- Joint Base Elmendorf-Richardson UAA Multicultural Center
- UAA English as a Second Language Program
- Northeast Anchorage Girl Scout Troop

Chugach National Forest special use permit holders

In May 2013, 228 Chugach National Forest special use permit holders were contacted directly via letter as part of the public engagement process. The letter encouraged their participation and assistance in the forest plan revision process. Permittees were asked specifically to contribute insights from their use of and experience within the Chugach National Forest. Permittees were encouraged to submit their comments via email or through the forest plan revision online comment form and to attend the public workshops.

The State of Alaska and other neighboring landowners

State of Alaska

On June 13, 2013, the Forest Service met with State of Alaska department leaders and specialists to review existing working agreements, to provide an overview of the 2012 Planning Rule and the revision process, and to discuss potential data gaps and overlapping issues of concern in the assessment topic areas. There were 15 attendees from five State of Alaska Departments, including Commerce, Community, and Economic Development; Environmental Conservation; Fish and Game; Natural Resources; and Transportation and Public Facilities.

On September 17, 2013, the Forest Service met with State of Alaska department leaders and specialists met for a second time to:

- Discuss forest plan revision progress
- Share public meeting materials to be presented at the upcoming fall public meetings, including themes developed from prior public input
- Share assessment findings and emerging opportunities for plan revision
- Review the next steps in the process
- Identify follow up topics

There were 12 attendees from five State of Alaska departments: Commerce, Community, and Economic Development; Environmental Conservation; Fish and Game; Natural Resources; and Transportation and Public Facilities.

The Forest Service and the State of Alaska continue to share dialogue on topics of interest and mutual concern or responsibility as forest plan revision efforts continue.

Other neighboring landowners

As part of the outreach to other neighboring landowners in April 2013, the Forest Service directly contacted, via email or letter, other key adjacent Federal and municipality or borough landowners/administrators to invite their participation in the plan revision process. This was done to learn about other plans, studies, or information that may be relevant to the assessment and to discuss areas of common interest. In September 2013, the Forest Service met with planning staff and/or managers of the Kenai Fjords National Park and Cordova, Valdez, and Kenai Peninsula boroughs.

Public Feedback

During 2012 and 2013, Forest Service staff engaged the public to discuss the management of the Chugach National Forest. As discussed previously, specialists have been evaluating existing information along with public feedback. Eight themes emerged both from internal work and from meetings with the public and interested parties:

- Alaska Native traditional knowledge and cultural heritage
- Recreation experiences
- Sustaining biodiversity, intact ecosystems, and connectivity
- Animals and plants as food and resources
- Wood as renewable energy and fuel source
- Water quantity and quality and air quality
- Education and research
- Socio-economic community

More detailed information from all public engagement activities is available online from the Chugach National Forest plan revision Web page (see www.fs.usda.gov/main/chugach/landmanagement/planning). This includes both geographic (site-specific) and general comments. Geographic comments are available in both list form sorted by topics and via a mapping tool. This tool allows users select a specific area within the national forest and see related comments. General comments are sorted by topic.

Communication Tools

Presentations and media appearances

In addition to the previously discussed meetings, the forest supervisor and the plan revision interdisciplinary team leader were invited to make multiple presentations. Of note were presentations at the southcentral Alaska Subsistence Regional Advisory Council meeting, the Citizens Advisory Commission on Federal Areas, and the Iditarod Historic Trail Alliance board of director's partner and collaboration meeting.

Members of the plan revision team and national forest staff and leadership also appeared on local media, including the Anchorage public radio interview show Hometown Alaska and the Anchorage ABC television affiliate, to discuss and share information about the plan revision process. There were interviews with print media in communities throughout the national forest, as well.

Forest plan revision newsletter

In June 2013, a plan revision newsletter was published and distributed to more than 800 individuals, organizations, and businesses. The newsletter provided the public and interested parties with information about the plan revision effort and included a message from the forest supervisor describing public comments and thoughts on the assessment. The newsletter also described what to look forward to as the Forest Service moves through the plan revision process.

Online and social media communications

The Forest Service maintains a Web page dedicated to forest plan revision efforts. The Web page provides plan revision documents, announcements, comment forms, mailing list signup, and agendas and notes from each public workshop. The Forest Service also communicates information related to forest plan revision, such as meeting and press announcements, through its one authorized social media account: Twitter (see @ChugachForestAK). Nonprofit and community partners across the national forest have also been engaged to share forest plan revision information on their social media sites, which often include a broader array of communication platforms.

Best Available Scientific Information

Following the requirements in 36 CFR 219.3, the Forest Service gathered the most accurate, reliable, and relevant information about the planning area to inform the evaluation of conditions and trends for the 15 topics addressed in this assessment. All data, studies, and reports supporting this assessment were evaluated for: (1) data quality, and (2) use of standardized scientific methodology. Opposing views and information along with the acknowledgment of incomplete or unavailable information and scientific uncertainty are also noted.

Information was provided by Forest Service staff using data acquired from many sources. Previous planning documents, landscape assessments, inventory and monitoring reports, publications, and geospatial resource data specific to the Chugach National Forest were used extensively. The Forest Service works cooperatively with many agencies (Federal, state, and local), organizations, and universities, and information generated through these cooperative efforts was also used and incorporated into this assessment. Pertinent information received from the public was also reviewed. Scientific review was provided by the Forest Service Pacific Northwest Research Station to insure the most relevant scientific information was used. References and citations to data sources are included throughout the document and a complete list of references is included. Additional data or relevant information received from external reviews of this assessment will be considered for inclusion in subsequent steps of the forest plan revision process.

Relevant Information

The responsible official will review the relevant information in this assessment to identify the preliminary needs to change the 2002 Forest Plan. Identifying the preliminary need to change is the first step in developing a proposed revised land management plan within the Forest Service planning framework (36 CFR 219.7(c)(2).

Additional information that may inform the preliminary need to change the forest plan includes: provisions of the 2012 Planning Rule, annual Chugach National Forest monitoring reports, and public engagement and collaboration feedback, as well as planning and land use policies of federally recognized Indian Tribes, Alaska Native Corporations, other Federal agencies, and state and local governments where relevant.

As the Chugach National Forest enters the revision phase of the forest planning framework, the Forest Service will continue to provide opportunities for public participation and to consult with federally recognized Indian Tribes, Alaska Native Corporations, other federal agencies, and State and local governments. As next steps, public forums will be scheduled to share the identification of and rationale for the preliminary needs to change the 2002 Forest Plan. Additionally, stakeholders and the public will be invited to participate in or comment on the proposed revised plan as it is being developed.

List of Preparers

The following individuals participated in the assessment of conditions, trends analysis, compilation of findings, and publication of this assessment.

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Chapter 2 Ecological Conditions and Trends

Introduction

Chapter 1 described the Chugach National Forest planning area and the three different geographic areas of the national forest. This chapter describes the overall ecological integrity of the area. Ecological integrity for this assessment is defined as:

> *"The quality or condition of an ecosystem when its dominant ecological characteristics (for example, composition, structure, function, connectivity, and species composition and diversity) occur within the natural range of variation and can withstand and recover from most perturbations imposed by natural environmental dynamics or human influence." (36 CFR 219.19)*

The ecosystems described in this chapter include terrestrial (soils, vegetation, and wildlife), aquatic (freshwater and coastal marine ecology) and the interface between the two (riparian areas and wetlands).These ecosystems are evaluated at the forestwide and geographic area scales where appropriate. Key characteristics of each ecosystem are identified, including species composition and diversity, structure, function, and connectivity. Existing conditions and trends of the key characteristics are described for each ecosystem. System drivers are also discussed and include dominant ecological processes, disturbance regimes, and stressors for the different ecosystems.

This chapter also includes a discussion of federally recognized threatened, endangered, proposed, and candidate species that occur within the Chugach National Forest and a discussion of potential species of conservation concern. It concludes with a discussion and summary findings of the ability of the aquatic, terrestrial, and riparian ecosystems in the plan area to adapt to a rapidly changing climate.

Physical properties of the environment both constrain and enable the development of some ecological systems within the Chugach National Forest. A brief overview of the physical properties of the Chugach National Forest environment follows. Those that most directly influence ecosystems are emphasized.

The Chugach National Forest includes the northernmost coastal temperate rain forests in North America and areas transitional to boreal forests. It is almost entirely within the Kenai-Chugach mountain system. The Kenai-Chugach mountain system is a topographically continuous mountain chain that extends from Kodiak Island through the Kenai Peninsula and around Prince William Sound, eventually connecting to the Saint Elias Range to the east. The principle fault systems in the area follow the same curved trend as the Kenai-Chugach mountain system. The Border Ranges fault lies in the lowlands along the mountain front and nearly parallels the western border of the Chugach National Forest (Karl, Vaughn, & Ryherd, 1997 Guide to geology of the Kenai Peninsula, Alaska, 1997).

Rock type and geologic processes work together to affect the surficial geology of the Chugach National Forest. Ecological and physical dynamics of the national forest are strongly influenced by snow and ice. Glaciers, in conjunction with both tectonic forces and the erosion from rivers, are responsible for carving the topographic relief of the national forest and associated marine environment. Topography in turn affects environmental elements, such as slope, soil types, weather, drainage patterns, and vegetation types. Past episodes of glacial scouring and tectonic activity result in a legacy of disturbance apparent in regionwide patterns of directional change in topography and ecology. In addition to the long-term effects of glaciers and icefields, annual snow accumulation has an impact on vegetation, streamflow and chemistry, stream morphology, fish, wildlife, recreation opportunities, and a myriad of other things.

Aquatic Ecosystems—Watersheds

This section describes the watershed component of the aquatic ecosystems evaluation. Specific items evaluated include key ecosystem characteristics by geographic area, such as water quantity and water quality, drivers and stressors, and watershed condition and trends. This section also provides a summary of the overall watershed conditions across the national forest based on the national Watershed Condition Framework (WCF) and the Forest Service Watershed Condition Classification (WCC) Technical Guide (Potyondy & Geier, 2010) and an evaluation of watershed integrity.

Relevant Information

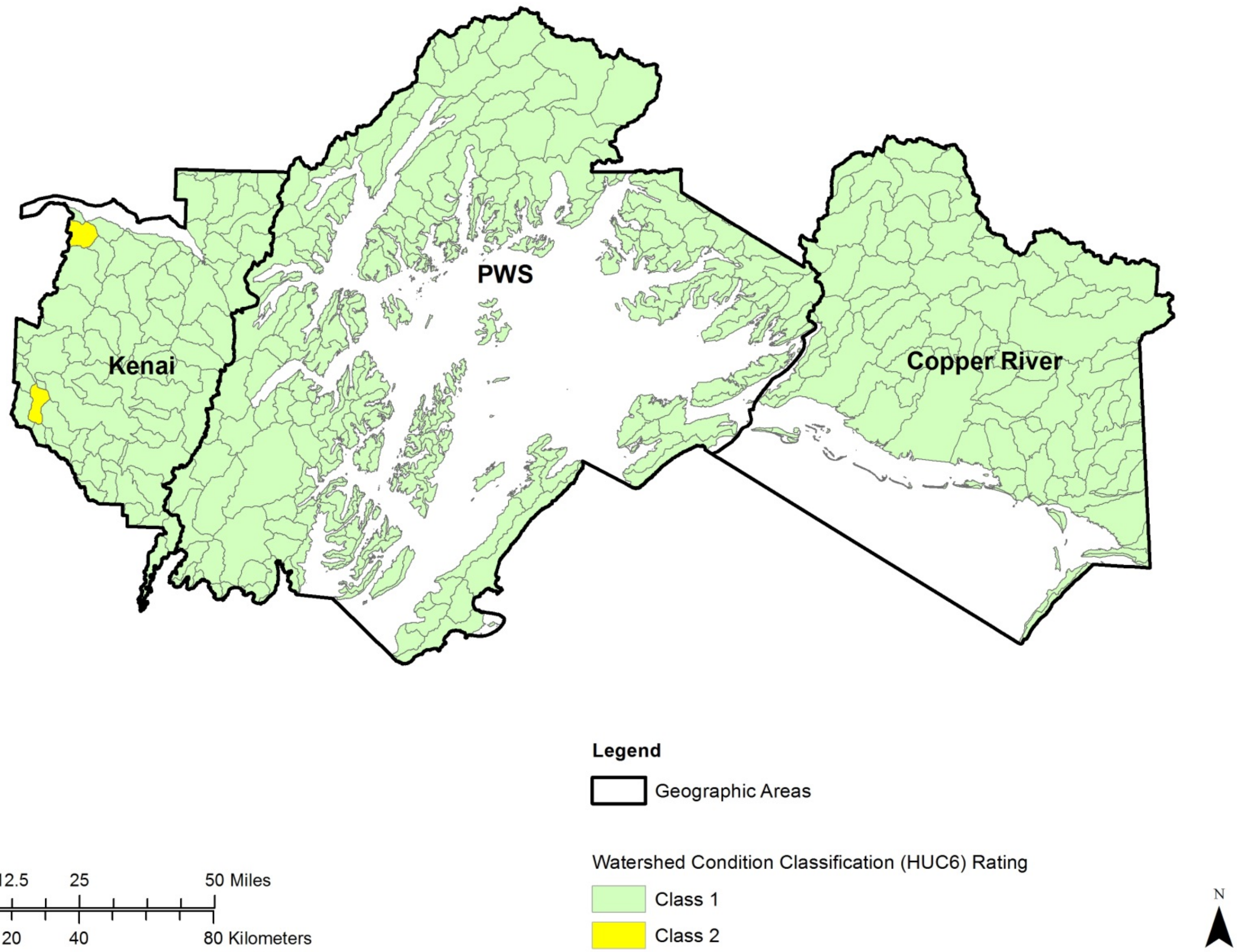
- Watersheds within the Chugach National Forest generally are in good condition, are functioning properly, and have good water quality. Natural processes, such as glaciers, mass wasting, and natural bank erosion, remain the primary sources of sediment loads and turbidity in streams and rivers across the national forest. Human associated water quality concerns exist in limited locations primarily in heavily visited areas close to roads and in developed areas. The following localized water quality concerns exist: erosion, sedimentation, and/or wetland damage from off-highway vehicles (OHVs) on authorized and unauthorized routes; sedimentation and pollutants associated with backcountry motor vehicle use; fecal coliform pollution from recreation related human waste; sedimentation from mining activities; and sedimentation from roads, trails, and recreational activities.
- A number of watershed improvement projects have occurred within the national forest since 2002. These projects have improved the function of streams and riparian areas impacted by past or historic land management activities.
- Changes in watershed characteristics, such as surface and groundwater quantity, quality, and flow regimes as well as erosion and deposition of sediments are occurring across the national forest.
- The primary system driver to Chugach National Forest watersheds is climate change with additional limited and localized stressors of spruce bark beetle infestation, increased invasive aquatic organism and plant infestations, and increased population and/or national forest use.

Ecosystems Evaluated

Watersheds are useful units to delineate aquatic and terrestrial ecosystems. A watershed is the area of a landscape where water from rain or melting snow and ice drains downhill into a body of water, such as a river, lake, reservoir, or ocean. Watersheds include streams and lakes and shallow aquifers, as well as the land surfaces from which water drains. Topography and geology determine where the water flows along with the boundary of each watershed. Small watersheds drain into progressively larger ones, creating a hierarchical structure, or watersheds levels. These watershed delineation levels are based on hydrologic unit codes (HUCs). The Chugach National Forest has 275 6th-level HUC (HUC 6) watersheds that range from 8,000 to more than 300,000 acres spread across the three geographic areas (see table 2 and map 2). Prince William Sound holds nearly half of these. Three watersheds span two geographic areas. Within the Chugach National Forest, most are standard watersheds with a drainage flowing to a single outlet point. Prince William Sound is the exception where the majority of the HUC watersheds are frontal and include several small drainages with more than one outlet along the coastline of the ocean. More than half of Chugach National Forest watersheds have had no modification to natural overland flow and a little more than 40 percent have some glacial component.

Table 2. Number of HUC 6 watersheds for the three different geographic areas

Geographic Area	HUC 6 Watersheds
Both the Copper River Delta and Prince William Sound	3
Copper River Delta	72
Kenai Peninsula	67
Prince William Sound	133
Total	**275**



Map 2. Chugach National Forest Service delineated HUC 6 watersheds by geographic areas and the results of the WCC rating (adapted from (MacFarlane, Zemke, Kelly, Hodges, & DeVelice, 2011)).

Each Chugach National Forest watershed is a network of stream channels that differ in character and are referred to as channel types. Channel types across the national forest vary with landscape and topography and are characterized in the Alaska Region by stream process groups (USDA 2010). These stream process groups are based on primary differences in hydrologic function, landform, and channel morphology and include: estuarine (ES), palustrine (PA), glacial outwash (GO), flood plain (FP), low gradient contained (LC), moderate gradient contained (MC), alluvial fans (AF) and high gradient contained (HC) (see figure 1). Figure 2 displays the lengths and distribution of the different channel type process groups across the geographic areas. Overall, Prince William Sound has the most stream miles, followed by the Copper River Delta and then the Kenai Peninsula. The Copper River Delta has the highest percentage of GO, PA, and ES channel types with the Kenai Peninsula having very minimal ES channels due to its more interior and mountainous topography. Prince William Sound and Kenai Peninsula tend to be dominated more by HC channel types, followed by GO and then some of the more moderate gradient channel types (MM and MC). Individual channel type classification units within each process group are defined by physical attributes, such as channel width and/or incision depth, gradient, and channel pattern.

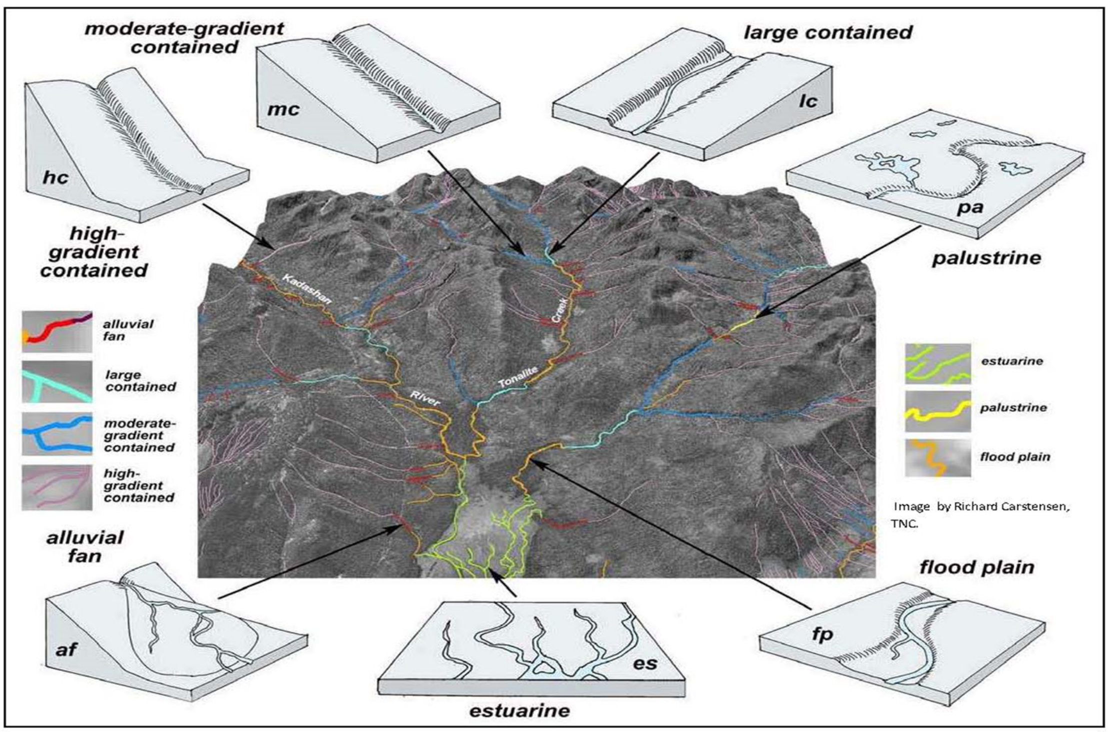


Figure 1. The Alaska Region channel type process groups displayed across the typical landscape (USDA, 2010b).

Figure 2. The lengths and distributions of the Alaska Region channel type process groups across the three geographic areas of the Chugach National Forest. See text for abbreviations.

Key Ecosystem Characteristics

Watershed condition is the state of the physical and biological characteristics and processes within a watershed that affect the hydrologic and soil functions supporting aquatic and terrestrial ecosystems. The basic model used in the WCF provides a systematic, flexible means of classifying and comparing watersheds based on a core set of national watershed condition indicators. These indicators are grouped according to four major process categories:

1. Aquatic physical
2. Aquatic biological
3. Terrestrial physical
4. Terrestrial biological

Each of these four process categories was evaluated using a set of attributes (see table 3). All of these attributes and qualities contribute to the health of the watershed ecosystem.

The Forest Service classified conditions for 275 HUC 6 watersheds using the process outlined in the WCC. The categories displayed in table 4 represent ecosystem processes or mechanisms by which management actions can affect the condition of watersheds and associated resources. Chugach National Forest watersheds were classified by each attribute into one of the three condition classes: Class 1 (good, functioning properly); Class 2 (fair, functioning at risk); or Class 3 (poor, functionally impaired) using data from internal sources: landscape assessments, watershed restoration plans, hydrologic assessments, culvert surveys, and fire regime maps along with data from external sources: Alaska Department of Environmental Conservation (ADEC) and Alaska Department of Fish and Game (ADF&G). In the end, the ratings for each attribute were summed to give an overall general condition of each watershed.

This section provides details of the water quality and water quantity indicator and attributes of the aquatic physical processes. Please refer to the Aquatic Ecosystems—Fish section for more detailed information about the aquatic biota and aquatic habitat indicators and the Aquatic Ecosystems—Riparian and Wetlands section for more detailed information about the riparian vegetation indicator of the Aquatic Biological Process Category. More detailed information about the terrestrial, physical, and biological processes are described in the Terrestrial Ecosystems sections. Overall Chugach National Forest watershed conditions, based on all of the table 3 core indicators and attributes, are also included.

Table 3. Core national watershed condition indicators and attributes (Potyondy & Geier, 2010)

<table>
<tr><th>Process Category</th><th>Indicator</th><th>Attribute</th></tr>
<tr><td rowspan="6">Aquatic physical</td><td rowspan="2">Water quality</td><td>Impaired waters</td></tr>
<tr><td>Water quality problems</td></tr>
<tr><td>Water quantity</td><td>Flow characteristics</td></tr>
<tr><td rowspan="3">Aquatic habitat</td><td>Habitat fragmentation</td></tr>
<tr><td>Large woody debris</td></tr>
<tr><td>Channel shape and function</td></tr>
<tr><td rowspan="4">Aquatic biological</td><td rowspan="3">Aquatic biota</td><td>Life form presence</td></tr>
<tr><td>Native species</td></tr>
<tr><td>Exotic and/or aquatic invasive species</td></tr>
<tr><td>Riparian vegetation</td><td>Vegetation condition</td></tr>
<tr><td rowspan="7">Terrestrial physical</td><td rowspan="4">Roads and trails</td><td>Open road density</td></tr>
<tr><td>Road and trail maintenance</td></tr>
<tr><td>Proximity to water</td></tr>
<tr><td>Mass wasting</td></tr>
<tr><td rowspan="3">Soils</td><td>Soil productivity</td></tr>
<tr><td>Soil erosion</td></tr>
<tr><td>Soil contamination</td></tr>
<tr><td rowspan="6">Terrestrial biological</td><td>Fire regime</td><td>Fire regime condition</td></tr>
<tr><td>Forest cover</td><td>Forest cover condition</td></tr>
<tr><td>Rangeland vegetation</td><td>Rangeland vegetation condition</td></tr>
<tr><td>Terrestrial invasive species</td><td>Terrestrial invasive species condition</td></tr>
<tr><td rowspan="2">Forest health</td><td>Insects and disease</td></tr>
<tr><td>Ozone</td></tr>
</table>

Water Quantity

Watershed condition plays a large role in the magnitude, frequency, and timing of runoff from a watershed. The quantity and timing of streamflow are critical components of water supply, water quality, and the ecological integrity of watersheds. Modifying natural flow regimes and hydrologic processes disrupts the equilibrium between the movement of water and the movement of sediment thereby altering physical habitat characteristics, including water temperature, oxygen content, water chemistry, and substrate composition, and adversely changing the structure or function of aquatic, riparian, and wetland ecosystems.

The Chugach National Forest has an abundant water supply resulting from the heavy precipitation it receives. Water quantity can be subdivided into surface water and groundwater. Surface water is a function of the water flowing into a drainage in the form of precipitation minus the water leaving the system through evaporation, transpiration, and groundwater transport. Groundwater is by definition water that occurs in the zone of saturation below the earth’s surface.

Surface water

Approximately 9,500 miles of perennial stream channels, which includes a line that extends from the head to the mouth of each lake, flow through the national forest. Hundreds of streams flow directly into the

Pacific Ocean, and most of these streams are home to fish species. Chugach National Forest watersheds vary in size from the 24,000 square mile Copper River Basin and the 2,200 square mile Kenai River Basin down to small first order drainages. For some of these drainages, only portions are within the national forest boundary. Surface waters within the Chugach National Forest originate as runoff from snowmelt, rainfall, and glacial melt, yielding approximately 40 million acre-feet of water per year from National Forest System lands. Snowfall is generally the greatest contributor to total runoff, while intense rainfall events and rare glacial outburst floods usually cause the largest floods. The majority of the watersheds within the national forest have some component of glacial drainage. Glaciers within the Chugach National Forest, though still very much present, have been diminishing, releasing stored water as they melt. As glacial retreat continues, the amount of glacial melt diminishes. These glacial contributions provide varying benefits, such as freshwater sources to salt water ecosystems and enhanced flows during warm, low precipitation periods.

Surface water is affected by both the character of its watershed and by precipitation patterns. Chugach National Forest watersheds show a large variety of drainage and flow characteristics. In general, Prince William Sound receives the greatest amount of precipitation and has the most stream flow per square mile while the Kenai Peninsula has the least. May through October is the major runoff season within the Chugach National Forest, with generally more than 80 percent of annual runoff occurring during these six months.

Flows peak rapidly in the shorter, steep gradient, coastal streams in Prince William Sound during heavy rain storms and decrease sharply during dry spells. Highest flows in these watersheds are generally during the period of heaviest rainfall, or August through November.

Inland streams often have highest flows during snowmelt runoff in May, June, and July. They are less likely to have sharp rainfall related flow peaks than coastal streams since they receive lower rainfall intensities. Many Chugach National Forest streams have characteristics of both coastal and inland streams, with both June snowmelt peaks and autumn rainfall peaks.

Glacial dominated watersheds have a somewhat different hydrograph. The major runoff from glaciers occurs during mid-summer melt (late-June through August) when air temperatures and solar radiation intensities are highest. Overall, the largest flood peaks generally occur on major rainfall events in the late summer and early fall. The lowest flows generally occur during the February through early April timeframe (Blanchet, 1983).

Hyporheic zones are the loosely defined functional, ecological, and geophysical zones between aquatic and terrestrial systems and between surface water and groundwater. These areas are indicators of proper ecological function and are acknowledged as being very important to water quality, biological diversity, and nutrient recycling (Hancock, Boulton, & Humphreys, 2005). Recent research indicates the organisms in hyporheic zones function in the breakdown of pollutants.

Of particular interest to the Chugach National Forest, the hyporheic zone includes the underground transition between saline and freshwater systems and the biologic communities they support. Healthy hyporheic zones can respond to tidal surges that commonly occur along coastal areas (Williams, 2003).

Gravel extraction, soil compaction, dams, alteration of flooding regimes, and silt load runoff are a few of the impacts that can damage the function of hyporheic zones (Hancock, 2002).

Groundwater

Rainfall and snowmelt also recharge groundwater sources within the national forest. Groundwater flow occurs primarily as localized flow controlled by the permeability of aquifer materials and surface topography. Alluvium of river valleys, glaciofluvial deposits, and the coastal lowlands make up the most productive aquifers within the Chugach National Forest. Recharge and discharge rates from these groundwater aquifers are dependent on porosity and permeability, local precipitation, and time of year. Snow will not recharge the groundwater system until it begins to melt in the spring or during winter warm spells. Groundwater aquifers release water during periods of low precipitation to maintain base flows of streams. In some cases, groundwater seeps and springs are vitally important to providing habitat for over-wintering salmon eggs and fry and some invertebrates. Groundwater dominated systems may provide more moderated flows, bed movement, water temperatures, and sediment loads preferable for salmon spawning and rearing habitat.

Water quantity drivers and stressors

Water quantity condition was evaluated as part of the WCC effort. Water quantity condition addresses changes to the natural flow regime with respect to the magnitude, duration, or timing of natural streamflow hydrographs. The water quantity attribute indicator was evaluated based on the condition rating rule set displayed in table 4.

Disturbance regimes to water quantity include human influences, such as reservoirs, diversions, and withdrawals. Other influences on water quantity include fires, spruce bark beetle infestations, and climate change. Based on parameters outlined in the WCC, these influences were not included in this analysis; however, it is important to note them as drivers and stressors. The water quantity attribute in the WCC was analyzed qualitatively based on general knowledge of existing stream diversions and their effects on water resources using the guidelines in the technical guide (Potyondy & Geier, 2010). This analysis did not include hydropower projects that are in the planning stage (e.g., Grant Lake) or impacts that occur outside the national forest boundary (e.g., Humpback Creek near Cordova) or in areas upstream from National Forest System lands (e.g., water rights and uses in the Copper River Basin).

Table 4. Water quantity condition rating rule set (Potyondy & Geier, 2010)

Attribute	**Water Quantity Condition Indicator**		
	Class 1 (good, functioning properly)	**Class 2 (fair, functioning at risk)**	**Class 3 (poor, functionally impaired)**
Flow characteristics	The watershed lacks significant man-made reservoirs, dams, or diversion facilities. The watershed has primarily free-flowing rivers and streams, unmodified lakes, and no or limited groundwater withdrawals. Stream hydrographs have no or minor alterations from natural (unaltered by anthropogenic actions) conditions.	The watershed contains dams and diversion facilities that are operated to partially mimic natural hydrographs. A departure from a natural hydrograph occurs during periods other than extreme flows (lows or highs). Peaks and base flows are maintained but changes to the timing, rate of changes to the timing, rate of change, and/or duration of mid-range discharges occur.	Dams and diversion facilities are operated so that they fail to mimic natural hydrographs. The magnitude, duration, and/or timing of annual extreme flows (low or high) significantly depart from the natural hydrograph. The timing and rate of change in flows often do not correlate with expected seasonal changes.

Water quantity condition and trends

Most Chugach National Forest watersheds have no human impacts to water quantity in terms of diversions or reservoirs, and stream hydrographs are generally unaltered by human actions. Exceptions to this occur in a few localized areas near communities and along the road system. The results of the WCC rating for water quantity within the Chugach National Forest are displayed in tables 5 and 6 and map 3.

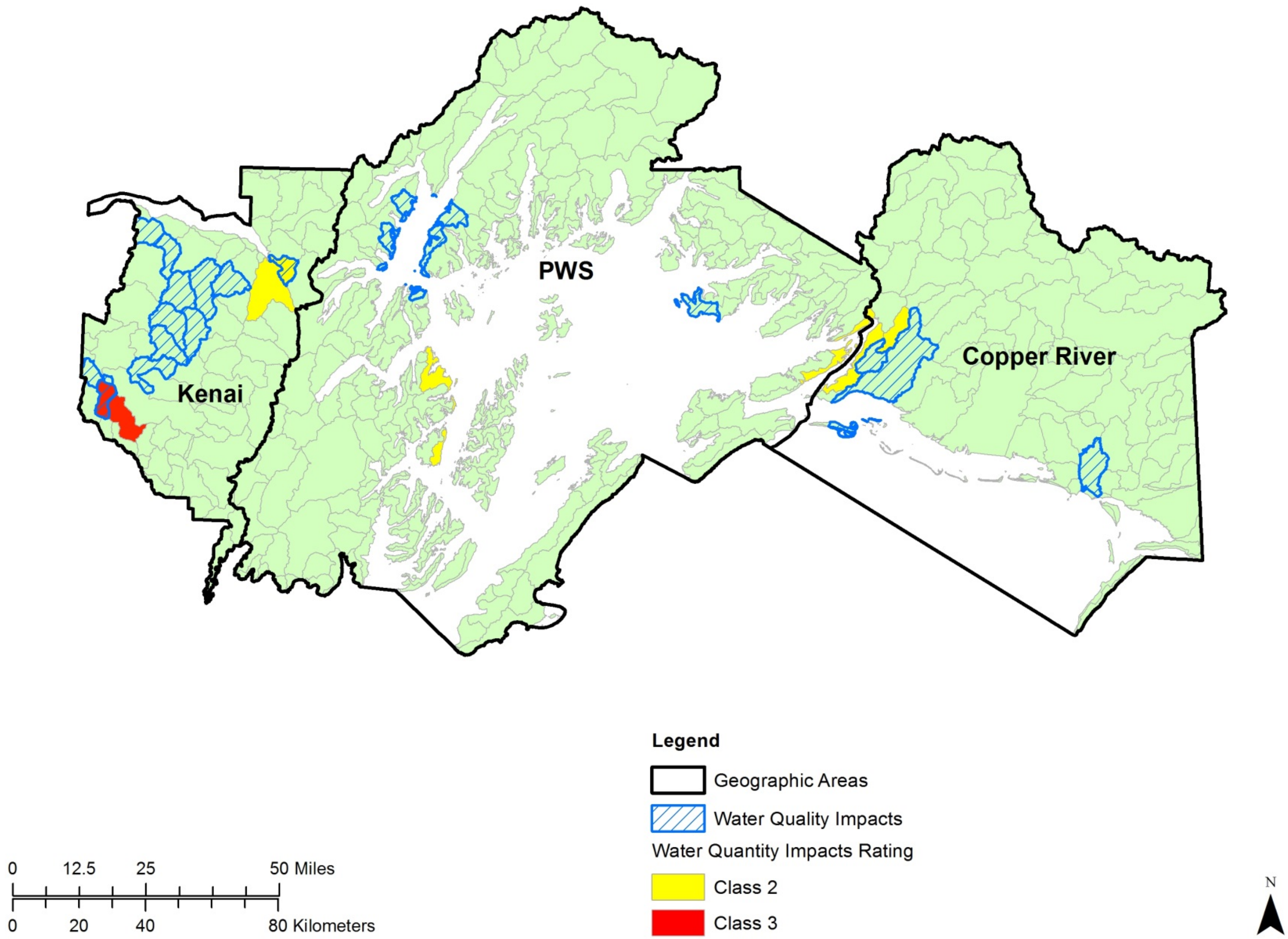
Though it was not included in this list, it is worth mentioning that water is diverted from Resurrection Creek for washplants for placer mining activities during the summer months.

Table 5. Results of the WCC water quantity condition ratings for the Chugach National Forest (MacFarlane, Zemke, Kelly, Hodges, & DeVelice, 2011)

Rating	Watersheds
Class 1 (good, functioning properly)	268
Class 2 (fair, functioning at risk)	5
Class 3 (poor, functionally impaired)	2

Table 6. Watersheds within the Chugach National Forest that exhibit deviations from their natural hydrograph (MacFarlane, Zemke, Kelly, Hodges, & DeVelice, 2011)

Geographic Area	HUC	Watershed Name	Rating	Comments
Copper River Delta	190201041603	Power Creek	2	Run of the river dam de-waters a portion of Power Creek for hydroelectric power generation.
	190202010200	Orca Inlet-Frontal Prince William Sound	2	Heney Creek is municipal watershed for Cordova, with water diverted into Meals Reservoir.
Kenai Peninsula	190203020304	Portage Creek	2	Explorer Creek diverted into Placer River Watershed by Portage Glacier Highway. Flow alteration caused by gravel extraction ponds.
	190203020305	Skookum Creek-Placer River	2	Explorer Creek diverted into Placer River Watershed by Portage Glacier Highway, Railroad diverts some drainages and causes artificial concentration of flows along the tracks.
	190203021402	Cooper Lake	3	Cooper Lake is artificial reservoir, artificial controls on lake water surface elevation with large fluctuations.
	190203021403	Stetson Creek-Cooper Creek	3	Cooper Lake Dam completely de-waters a 1.5-mile section of Cooper Creek.
Prince William Sound	190202012510	Falls Lake-Frontal Prince William Sound	2	Main Bay Fish Hatchery diverts water from lake and de-waters stream at head of bay.



Map 3. Chugach National Forest watersheds with water quantity and water quality impacts.

Water quantity within the national forest is primarily affected by water storage, water withdrawals, and climate change. Upstream water right reservations are held on the Copper River. Full utilization of these reservations coupled with effects from climate change may reduce future stream flows and sediment transport capabilities to the Copper River Delta. There are also several proposed (not yet constructed) hydroelectric projects within the national forest. These projects have the potential to or will affect water quantity by diverting and/or impounding water. During the last 10 years, numerous hydroelectric projects within or near the Chugach National Forest have been proposed. The water resources of the national forest are receiving regional, national, and international attention as a potential source for renewable energy. This trend is expected to continue for the foreseeable future. Please refer to the Hydroelectric section in chapter 3 for more detail. Given this trend, it can be anticipated that demands for water from the national forest will increase, which would ultimately affect future water quantity and alter natural flow conditions.

Although not part of the WCC, the impacts of severe wildland fire and beetle kill have had documented effects on the hydrologic regime and hydrograph of watersheds. In general, some of these effects have included increased snow accumulation and melt, reduced interception loss and evaporation, and increased runoff and streamflow (Pugh & Small, 2011; Schnorbus, 2011; Winkler, 2011).

Water Quality

Water quality refers to the chemical, physical, and biological characteristics of water. The quality of water, both surface and groundwater, affects the health of the entire watershed, including all of the components of the aquatic and terrestrial ecosystems. In this section, class refers to a Forest Service designation based on WCC and category refers to a state designation based on the Clean Water Act.

Water quality drivers and stressors

Water quality drivers and stressors within the Chugach National Forest include natural and human caused disturbances. Natural disturbances primarily include climate change, landslides, and floods. Human caused physical, biological, and chemical impacts to water quality were assessed for 275 watersheds within the Chugach National Forest as part of the WCC. Data sources for this analysis included knowledge from local specialists, the Alaska Department of Environmental Conservation 2010 Water Quality Inventory and Assessment Report (ADEC, 2010), the Alaska's DRAFT 2012 Integrated Water Quality Monitoring Assessment Report (ADEC, 2012) and Alaska's FINAL 2012 Integrated Water Quality Monitoring and Assessment Report (ADEC, 2013). The methodology is outlined in the WCC (Potyondy & Geier, 2010).

Water quality function and condition were evaluated based on the following attributes as listed in State of Alaska Department of Environmental Conservation Section 303(d) (of the Clean Water Act): impaired waters and water quality problems not listed as impaired waters. Alaska state water quality standards (WQS) specify a variety of pollutants for fresh and marine uses. Attainment of standards is required for the following: color; fecal coliform bacteria; dissolved oxygen; dissolved inorganic substances; petroleum hydrocarbons, oils, and grease; pH; radioactivity; residues (floating, solids, foam, debris, and deposits); sediment; temperature; toxic substances; and turbidity (ADEC, 2012). Water quality condition was then rated into three classifications: Class 1 (good, functioning properly); Class 2 (fair, functioning at risk); or Class 3 (poor, functionally impaired) (see table 7).

Table 7. Water quality condition rating rule set (Potyondy & Geier, 2010)

Attribute	Water Quality Condition Indicator		
	Class 1 (good, functioning properly)	**Class 2 (fair, functioning at risk)**	**Class 3 (poor, functionally impaired)**
Impaired waters (303(d) listed)	No state-listed impaired or threatened water bodies.	Less than 10 percent of the stream miles or lake area of a watershed is listed on the 303(d) or 305(b) lists and are not supporting beneficial uses.	More than 10 percent of the stream miles or lake area of a watershed are water quality limited and are not fully supporting beneficial uses as identified by the Alaska Department of Environmental Conservation integrated report (303(d) and 305(b)).
Water quality problems (not listed)	The watershed has minor or no water quality problems. For example, no documented evidence of excessive sediment, nutrients, chemical pollution or other water quality issues above natural or background levels; no consumption advisories or contamination from abandoned or active mines; little or no evidence of acidification, toxicity, or eutrophication because of atmospheric deposition.	The watershed has moderate water quality problems. For example, consumption advisories in localized areas; minor contamination from active or abandoned mines; localized incidence of accelerated sediment, nutrients, chemicals, or infrequent, documented incidents of contamination of public drinking water sources. Moderate evidence of acidification, eutrophication, or toxicity because of atmospheric deposition.	The watershed has extensive water quality problems. For example, consumption advisories over extended areas; excessive sediment, nutrients, chemicals; extensive contamination from active or abandoned mines; or frequent incidents of contamination of public drinking water sources. Strong evidence of acidification, eutrophication, or toxicity because of atmospheric deposition.

Watersheds were ranked by impaired waters based on categorical listings from ADEC (ADEC, 2010; ADEC, 2012) as described in the technical guide and displayed in table 7 (Potyondy & Geier, 2010). The state of Alaska assigns categories to water bodies by the degree to which water quality goals are attained. The five categories and three subcategories follow:

- Category 1: All WQS for all designated uses are attained
- Category 2: Some WQS for the designated uses are attained, but data and information to determine whether WQS for the remaining uses are attained is insufficient or absent
- Category 3: Data or information is insufficient to determine whether the WQS for any designated uses are attained
- Category 4: The waterbody is determined to be impaired but does not need a total maximum daily load (TMDL)
    - Category 4a. An established and EPA-approved TMDL exists for the impaired water
    - Category 4b. Requirements from other pollution controls have been identified to meet WQS for the impaired water
    - Category 4c. Failure to meet water quality standards for the impaired water is not caused by a pollutant; instead, the impairment is caused by a source of pollution, such as nuisance aquatic plants, degraded habitat, or a dam that affects flow
- Category 5: WQS for one or more designated uses are not attained and the water body requires a TMDL or recovery plan; Category 5 waters are those waters identified by the Section 303(d) list of impaired waters

Watersheds were ranked and analyzed qualitatively on non-listed water quality problems based on input by resource professionals, knowledge, reports, and professional judgment of conditions in the watersheds using the guidelines in the technical guide (Potyondy & Geier, 2010).

Water quality condition and trends

Overall, water quality, both surface and subsurface, is good within the Chugach National Forest. Natural processes, such as glaciers, mass wasting, and natural bank erosion, remain the primary sources of sediment loads and turbidity in streams and rivers across the national forest. Human associated water quality concerns exist in limited locations primarily in heavily visited areas close to roads and in developed areas.

The results of the condition rating for water quality in the WCC for the Section 303(d) listed impaired waters attribute are displayed in table 8.

Table 8. Water quality condition rating for State Section 303(d) listed impaired waters (MacFarlane, Zemke, Kelly, Hodges, & DeVelice, 2011)

Rating	Watersheds
Class 1 (good, functioning properly)	274
Class 2 (fair, functioning at risk)	1
Class 3 (poor, functionally impaired)	0

All watersheds within the Chugach National Forest were rated Class 1 (good, functioning properly) for this attribute with one exception: Eyak Lake, which rated as Class 2 (fair, functioning at risk). Eyak Lake was placed on the 303(d) list in 2002-03 for non-attainment of the petroleum hydrocarbons oils and grease standard for petroleum products as a result of above ground storage tank spills. Remedial actions at the Cordova Electric power plant on Eyak Lake have been effective at eliminating sheen on the surface of the lake, which was observed in 2005. Groundwater treatment and monitoring is anticipated to continue at this site. Water quality studies were completed in 2005, 2006, and 2009. ADEC removed Eyak Lake from the Category 5/Section 303(d) list and placed the waterbody in Category 2 in the final 2012 report (ADEC, 2013).

A number of beaches in Prince William Sound were previously Section 303(d) listed in 1990 as a result of the petroleum products remaining from the Exxon Valdez oil spill but have been placed in Category 4b because of restoration efforts specified in the Exxon Valdez Restoration Plan.

A number of watersheds that have water quality issues from impacts, such as mining, hydropower facilities and water impoundments, recreational use, roads, sediment, and industrial uses, are not listed in Category 5/Section 303(d) by the state (see map 3 and tables 9 and 10). These water quality impacts are primarily localized effects. Additional water quality issues occur in and around the communities of Seward, Girdwood, Whittier, Valdez, and Cordova, but the water quality impacts from these communities are primarily outside the Chugach National Forest boundary. The results of the condition rating for water quality in the Watershed Condition Classification Framework for the Chugach National Forest (MacFarlane, Zemke, Kelly, Hodges, & DeVelice, 2011) included the following table for the water quality problems not Section 303(d) listed by the state.

Table 9. Water quality condition rating for impaired waters that are not state 303(d) listed

Rating	Watersheds
Class 1 (good, functioning properly)	257
Class 2 (fair, functioning at risk)	18
Class 3 (poor, functionally impaired)	0

No watersheds within this non-state listed category are known to have extensive water quality problems. A number of waterbodies within or near the Chugach National Forest are classified as ADEC Category 3 for water quality impairment (ADEC, 2010), including Bear Creek near Hope, Cooper Creek, Eyak River, Mills Creek, Quartz Creek, Resurrection Creek, and Two Moon Bay. While specific water quality issues have not necessarily been identified on these streams, they have been identified as being of concern for various reasons, which the State of Alaska and Forest Service have documented. Many of these have also been ranked as Alaska Clean Water Action Priorities (ACWA). All of these watersheds received a Class 2 rating. Some watersheds with major highways immediately adjacent to streams or lakes on National Forest System lands also received a Class 2 rating to account for road-derived pollutants.

Table 10. Watersheds within the Chugach National Forest by geographic area that received Class 2 ratings for state non-listed water quality impairments (ADEC, 2013; MacFarlane, Zemke, Kelly, Hodges, & DeVelice, 2011)

Geographic Area	HUC	Watershed Name	Rating	Comments
Copper River Delta	190104021701	Katalla River	2	Oil remains from Katalla oil field exploration.
	190201041604	Eyak Lake	2	Eyak Lake was ADEC 303(d) listed for hydrocarbons and industrial pollutants in 2010. It was classified as Category 2 in 2012.
	190201041605	Eyak River-Frontal Gulf of Alaska	2	Eyak River is ADEC Category 3 listed.

Geographic Area	HUC	Watershed Name	Rating	Comments
Kenai Peninsula	190203020304	Portage Creek	2	Portage Creek susceptible to highway and railroad pollutants; bank erosion; gravel extraction activities; sewage lagoon.
	190203020401	Headwaters Canyon Creek	2	Streams and lakes receive pollutants from heavy traffic on the Seward highway because of close proximity. Potential water quality impacts from numerous abandoned hard rock mines.
	190203020402	Mills Creek	2	Sediment from Juneau Creek slide, sediment and hydrocarbons from existing placer mining, ADEC Category 3 listing
	190203020403	Outlet Canyon Creek	2	Sediment from Juneau Creek slide; streams receive pollutants from Seward highway because of heavy traffic, historic placer mining and dam construction.
	190203020406	Granite Creek	2	Streams receive pollutants from heavy traffic on the Seward highway because of close proximity.
	190203020407	East Fork Sixmile Creek	2	Streams receive pollutants from heavy traffic on the Seward highway because of close proximity.
	190203020502	Palmer Creek	2	Heavy metals from Swetman Mine and other hard rock mines.
	190203020504	Lower Resurrection Creek	2	Sediment from bank erosion and settling ponds in large scale placer mines, hydrocarbons from existing large scale mining operations, sediment from bank erosion in recreational mining areas, potential mercury from historic placer mining operations.
	190203020706	Bear Creek-Frontal Turnagain Creek	2	Bear Creek is ADEC Category 3 listed, sediment from mining impacts.
	190203021102	Headwaters Quartz Creek	2	Streams susceptible to pollutants from Seward highway, Quartz Creek is ADEC Category 3 listed.
	190203021104	Outlet Quartz Creek	2	Streams and lakes susceptible to pollutants from Sterling Highway (tanker spills known to have occurred in Daves Creek), Quartz Creek is ADEC Category 3 listed.
	190203021403	Stetson Creek-Cooper Creek	2	Sediment from Cooper Creek slide (initiated by hydraulic mining and road), low temperatures in Cooper Creek from dam and dewatering, ADEC Category 3 listed.
	190203021406	Jean Creek-Kenai River	2	Rivers and streams susceptible to pollutants from Sterling Highway.
Prince William Sound	190202011201	Goose Island-Frontal Prince William Sound	2	Sediment into streams from logging roads and landslides.
	190202012105	Port Wells-Frontal Prince William Sound	2	Heavy metals present from Granite Mine (abandoned hard rock mine) and potentially other abandoned mines.

Studies of groundwater in the Cook Inlet Basin and on the Kenai Peninsula indicate that some domestic and public water supply wells yield water containing concentrations of arsenic that exceed the Alaska standard. These studies and samples occurred outside, but in close proximity to the Chugach National Forest boundary and were not included in the WCC analysis (Glass, 1996). It is possible that these concentrations exist in national forest aquifers. Analyses of streambed substrate samples indicate that concentrations of arsenic in the Cook Inlet Basin appear to be naturally high (Frenzel, 2000). Arsenic in surface water is derived primarily from the natural weathering of soils and rocks and from discharge of groundwater. Despite high concentrations in streambed substrate and groundwater samples, detectable arsenic concentrations were documented to be uncommon in surface waters of Cook Inlet basin streams (Glass, 1996).

Despite the majority of the Chugach National Forest watersheds being rated Class 1, water quality concerns exist in a number of watersheds in limited locations. Most impacts and activities that affect stream banks, wetlands, and riparian areas also have the potential to affect water quality. Many of the known water quality impacts are in heavily visited areas close to roads and developed areas. Several campgrounds, recreational areas, and outhouses are now within riparian management zones since rivers have shifted and eroded banks following floods. Additionally, several outhouses are located in poor proximity to the campground public water systems. Changes in management and restoration of these areas could improve the existing conditions. Mechanisms are in place to mitigate the impact of Forest Service activities, such as best management practices (BMPs), reclamation, and access control. However, increased use and activities within the national forest coupled with climate change may increase the potential for impact to water quality in developed areas.

Overall Current Watershed Condition and Trends

Using all of the core national watershed condition indicators and attributes produces the overall results of the Chugach National Forest watershed condition rating, as displayed in table 11 and map 2 (MacFarlane, Zemke, Kelly, Hodges, & DeVelice, 2011; Potyondy & Geier, 2010).

Table 11. Overall current watershed condition ratings for the Chugach National Forest (adapted from MacFarlane et al. 2011)

Rating	Watersheds
Class 1 (good, functioning properly)	273
Class 2 (fair, functioning at risk)	2
Class 3 (poor, functionally impaired)	0

These watershed condition classifications were based only on watersheds within the Chugach National Forest. In a draft report by MacFarlane et al. (2011), it was noted that 270 watersheds were rated Class 1, and 5 watersheds were rated Class 2. Three of these Class 2 watersheds were not acknowledged as Class 2 in the draft final assessment (Zemke, Develice, and McFarlane, personnel communication, 2013) due to a question of reliable data spanning across lands of other ownership. Management of watersheds entirely or partially outside the Chugach National Forest may have cumulative effects on the condition class rating of these watersheds; however, the reliability of data makes quantifying it at this time difficult. The two Chugach National Forest watersheds that remain rated as Class 2 (fair, functioning at risk) in the draft final are Resurrection Creek near Hope and Cooper Creek near Cooper Landing.

Overall, the majority of Chugach National Forest watersheds are in a good, functioning properly condition (Class 1). Much of this may be attributed to a combination of the glacial coverage and roadless character of the national forest. Minimal human impacts exist on 64 percent of the watersheds with 21 percent of the watersheds containing greater than 50 percent glacier coverage and 43 percent of the watersheds dominantly roadless and/or only accessible by boat and/or floatplane. Variable degrees of human impacts exist in 36 percent of the watersheds with half of these located along road systems (MacFarlane, Zemke, Kelly, Hodges, & DeVelice, 2011).

The major sources of human impacts to watersheds within the Chugach National Forest, particularly to stream channel morphology, include bank degradation from recreational uses, such as fishing the Russian River, OHV trail use on some areas within the Copper River Delta, historic placer mining on Resurrection and Cooper Creeks, existing placer mining operations, gravel extraction (such as in Portage Valley), and roads. In high use areas within the national forest, bank erosion from angler trampling has been a persistent problem and has been difficult to address. The construction of angler trails, boardwalks, and river access stairs on the Russian River in conjunction with bank reconstruction has improved some of these conditions. Rerouting OHV trails and user education have also benefited areas within the Copper River Delta. Other restoration projects, such as Resurrection Creek (Phase I), have successfully dealt with historic mining impacts as will future anticipated projects (Resurrection Creek Phase II and Cooper Creek).

Ecosystem Integrity

Watershed condition reflects a range of variability from natural (functioning properly) to degraded (severely altered state or impaired). Watersheds that are functioning properly have terrestrial, riparian, and aquatic ecosystems that capture, store, and release water, sediment, coarse woody debris, and nutrients within the natural range of variation for these processes. When watersheds are functioning properly, they create and sustain functional terrestrial, riparian, aquatic, and wetland habitats that are capable of supporting diverse populations of native aquatic and riparian dependent species. In general, the greater departure from the natural state, the more impaired the watershed condition is likely to be. Watersheds that are functioning properly are commonly referred to as healthy watersheds. Healthy watersheds provide high water quality, recharge streams and aquifers, and are more capable of moderating climate vulnerability and providing long term soil productivity. These watersheds generally exhibit strong integrity and create and sustain resilient and adaptive terrestrial, riparian, aquatic, and wetland habitats that support diverse populations of plants and animals capable of rapid recovery from natural and human disturbances.

Because 99 percent of Chugach National Forest watersheds are in Class 1 (good, functioning properly), they are considered to have good integrity and are more likely to recover to the desired condition when disturbed by large natural disturbances or land management activities. Despite this, concerns associated with human impacts exist in a number of watersheds in limited locations. A list of anticipated increased impacts to watershed condition that could affect integrity if not addressed through management follows:

- Erosion, sedimentation, and wetland damage from user trails (foot and OHV), particularly on the Copper River Delta
- Stress on streambanks along the Russian River, despite management efforts to restore and protect banks
- Stress on streambanks associated with increased back country trail use or use by pack animals (consider rerouting trails where they are close to streams/riparian areas)
- Continued risks of introduced species through waders, intentional pet release, off-site bait use, and organisms that attach to boats, fishing gear, or floatplanes
- Sedimentation and pollutants associated with backcountry motor vehicle use
- Fecal coliform pollution from recreation related human waste
- Loss of stream channel, stream bank and riparian vegetation integrity, and sedimentation from mining activities, including recreational dredging
- Acid drainage from hard rock mines
- Release of mercury during stream restoration activities and placer mining from historical placer mined areas

A number of watershed restoration projects have occurred within the national forest within the last decade. These improvements have included large scale stream and riparian restoration projects (i.e., Resurrection and Daves creeks), small scale stream bank restoration projects (i.e., Kenai and Russian rivers), trail improvements, and abandoned mine cleanup efforts. The Forest Service has also been implementing watershed restoration work and monitoring on lands affected by the Exxon Valdez oil spill, including acquired lands on Knowles Head. All of these projects have improved the functions of streams and riparian areas and water quality associated with impacts from past or historic land management and current activities. Continuing to restore these watersheds will maintain and improve watershed integrity.

Information Needs

Currently the Chugach National Forest has limited baseline data for assessing climate change, particularly in regards to water quality and water quantity. Since 2007, the number of USGS stream gage network sites funded and supported by the Forest Service has declined from three to one. Sixmile Creek on the Kenai Peninsula is the sole funded gage. There is limited stream temperature, dissolved oxygen, hydrocarbons, and turbidity data, and there are very few stream gages or ground water wells in the national forest. Partners, such as the Kenai River Watershed Forum, USGS, and the Pacific Northwest Research Station, have collected valuable data in limited locations. Strengthening and continuing these partnerships into the future will aid in achieving agency goals. The Arctic, North Pacific, Northwest Boreal, and Western Alaska Landscape Conservation Cooperative (LCCs) along with the Alaska Climate Science Center (ACSC), the Alaska Climate Change Executive Roundtable (ACCER), many state and Federal agencies, and others have all identified the need to better understand the changes in hydrology due to climate change as a high priority for Alaska. Water temperature monitoring and forecasting were identified as a high priority information need. Data on national forest water quantity and water quality will be necessary to project future ecosystem trends from the aforementioned stressors and make meaningful recommendations for future resource management. Heavily used winter snowmachine areas may be contributing elevated levels of hydrocarbons in key locations, such as Granite Creek, Placer Valley, and the Lost Lake area. It may be valuable to acquire baseline data for these systems for comparison to data in the future.

There is limited data on the quantity, quality, timing, and distribution of groundwater resources and groundwater-dependent ecosystems within the national forest. Information on national forest groundwater resources will likely be valuable if there is more demand for surface water or consumptive groundwater use associated with increased water use or development. It will also be valuable for understanding the contributions to the aquatic ecosystems and their role in acting as refugia for buffering climate change impacts.

Adequate data on aquatic invasive species that may be transported to Chugach National Forest waterways, lakes, and rivers via floatplane and boat use is essential to prevent the spread and degradation of watershed health.

Aquatic Ecosystems—Fish

The section describes the integrity of aquatic ecosystems associated with the Chugach National Forest. The perspective is fish and the aquatic habitats they depend upon for production and survival. The metrics devised to examine aquatic ecosystem integrity are intended to estimate the trend, range of variation, function, and relative importance of key aquatic ecosystem characteristics. The approach was shaped by the reality that some of the existing data relevant to the aquatic ecosystems of the Chugach National Forest are limited across the assessment area.

Relevant information is presented in a topical order that includes: a description of the aquatic ecosystems being evaluated, a discussion of key aquatic ecosystem characteristics, an estimate of aquatic ecosystem condition, an assessment of aquatic ecosystem integrity, and a documentation of important information needs.

Relevant Information

- The Chugach National Forest is a patchwork of five different kinds of aquatic ecosystems distributed across 607 stream systems. The pink/chum salmon aquatic ecosystem is most common, with 254 systems assigned to this classification. With only 24 stream systems identified, the Chinook salmon aquatic ecosystem is least common.
- The sockeye/coho salmon aquatic ecosystem is the most common in the Copper River Delta geographic area representing 43 percent of the stream systems. Prince William Sound is dominated by the pink/chum aquatic ecosystem with 51 percent of the stream systems. The Chinook salmon and Dolly Varden char aquatic ecosystems are the most common for the Kenai Peninsula geographic area, together representing 64 percent of the stream systems.
- The presence of salmon is one of the defining features of ecosystems within the Chugach National Forest. Decaying salmon carcasses infuse critically important marine derived nutrients into aquatic, riparian, and terrestrial ecosystems.
- Beginning about 100 years ago, up to 60 percent of each year's salmon return has been caught in commercial fisheries. As a result, fewer salmon are reaching spawning grounds than in historical times, which means that the source of marine derived nutrients into these ecosystems has been reduced.
- Of the five salmon species examined, the Chinook salmon aquatic ecosystem had the lowest index for ecosystem integrity, while the coho salmon aquatic ecosystem had the highest index. The uncertainty associated with these scores was much greater than the differences between any two aquatic ecosystems.
- Based on modeling results, the salmon habitat and species distributions will be vulnerable to climate change. During the next 50 years, as the warm water and cold water boundaries change along the Alaska coastline, the specific habitat suitability for salmon species may dramatically affect the distributions that are currently observed (Abdul-Aziz, Mantua, & Myers, 2011).

Aquatic Ecosystems—Fish Evaluated

Within each of the three geographic areas of the national forest there is considerable variation in both stream system character and the species that are present. The occurrences of key and ecologically distinct fish species were used as the means to identify five different aquatic ecosystems. These are distributed across the Chugach National Forest landscape in a fine-scaled patchwork of stream systems.

This evaluation is based on using fish as an indicator of aquatic ecosystem character and function. The underlying assumption is that the condition of primary fish species can be informative of the overall condition of the aquatic ecosystem where they occur (Irvine & Riddell, 2007). The primary advantage of using this approach is that data of sufficient detail and scope were readily available making it possible to make these classifications with some confidence for most of the Chugach National Forest. There are other means to classify aquatic habitats, such as using channel types (see Aquatic Ecosystems—Watersheds); however, they require some additional understanding of the functional relationship between stream habitat character and how this influences species distribution and relative productivity. Such information is currently limited for stream systems within the Chugach National Forest.

Salmon or other members of the salmon family (e.g., char and trout) were used as a means to identify aquatic ecosystems because they are the most dominant species in the aquatic ecosystems of the Chugach National Forest. Five salmon species are present in varying amounts and distribution: Chinook, coho, sockeye, chum, and pink salmon. Salmon have several unique features. First, they are anadromous, meaning their life history includes a freshwater phase dedicated to reproduction and early life and a marine phase where they take advantage of the rich ocean environment for rapid growth and transition to adulthood. For Chinook and coho salmon, the freshwater phase is longer; however, all species depend on the freshwater environment to complete their life cycle. While access to freshwater is an absolute requirement of these species, the necessity of the marine environment is not as fixed. For example, kokanee, the resident form of sockeye, naturally occur in many land-locked lake systems. When introduced into novel freshwater environments, such as the Great Lakes, all five species have completed their life cycle without a migration to the marine environment. Therefore, it appears that while salmon can adapt to the loss of the marine environment, they cannot survive if they are deprived of the freshwater environment. In southcentral Alaska, much of this freshwater environment is represented by watersheds that occur within the Chugach National Forest. Nearly all salmon populations in this area make extensive migrations into the North Pacific Ocean, often thousands of miles from their place of birth. However, once these fish have achieved sufficient growth to mature, they navigate their way back to their natal stream where they spawn and shortly thereafter die.

The fidelity of salmon to their home stream has important biological implications. Among these is that salmon tend to form independent populations that typically exist at a relatively fine geographic level of detail. Because of their relative isolation, each population tends to follow its own path to maximize genetic adaptation to the local conditions of the home stream and associated migration pathways. The end result is that, during a sufficient amount of time, a considerable amount of geographically fine-scaled population diversity can evolve across the salmon landscape. Not only does this diversity benefit the viability of individual populations, it also provides a raw source of genetic variation that helps the species as a whole adapt when large scale conditions change, such as during periods of glacial retreat or advance.

Fidelity of salmon to their home stream varies and is not 100 percent. A portion of each year's return stray to other stream locations. Under natural conditions, it is thought that stray fish from other populations generally comprise 10 percent or less of the spawning population (Quinn, 1997). Because genetic differences are often found between adjacent salmon populations, the genetic impact of this background straying rate does not appear to prevent the divergence and adaption of most local populations. This straying behavior is also ecologically advantageous as a means for salmon and related species to colonize newly accessible habitats (Griswold, 2002).

Perhaps the most significant feature of the salmon life history is that after spawning in their home stream, they die and their carcasses decompose to provide a substantial, annual source of marine derived nutrients to the aquatic ecosystem. The importance of this enrichment to the aquatic ecosystem has been demonstrated in a number of studies (Cederholm, Kunze, Murota, & Sibatani, 1999; Helfield & Naiman, 2001; Rinella, Wipfli, Stricker, Heintz, & Rinella, 2012; Holtgrieve & Schindler, 2011). The contribution of salmon does not stop at the water's edge. Not only are salmon a primary food source for top terrestrial predators, such as bears, eagles, and mink; the marine nutrients find their way into the terrestrial ecosystem, including lichens, trees, and other riparian vegetation. Coastal brown bear, the world's largest land-based predator occurs in Alaska because of salmon. Wilson and Halupka (1995) use salmon in their role as contributors to a broad scale ecological impact to define what they refer to as a keystone species.

Aquatic ecosystem descriptions

Chinook salmon aquatic ecosystem

Chinook salmon (*Oncorhynchus tshawytscha)* aquatic ecosystems occur in moderate to large stream systems that have a diversity of rearing habitats for juveniles. The habitat requirements are somewhat similar to that of the coho salmon. For every location within the Chugach National Forest where Chinook salmon are known to exist, coho salmon are also present. However, there are many more locations within the Chugach National Forest where coho salmon occur and Chinook salmon are absent. The patchy occurrence of Chinook salmon among the many streams occupied by coho salmon is evidence that there are habitat differences that have thus far not been clearly identified.

Coho salmon aquatic ecosystem

These aquatic ecosystems are generally associated with watersheds that have no lakes yet contain coho salmon (*Oncorhynchus kisutch*). Sockeye salmon are usually missing from these systems because there is no lake habitat for sockeye juveniles. However, these systems do contain freshwater habitat for older, one- to three-year-old juvenile coho salmon. Such stream habitat is essential to the life cycle of this species. These habitat characteristics are often associated with larger streams having a steeper gradient than those used by pink and chum salmon. The density of spawners in such watersheds is low, because the population is naturally limited by the amount of juvenile rearing habitat.

Sockeye/coho salmon aquatic ecosystem

These aquatic ecosystems are represented by watersheds that contain lakes or lake-like habitat, which is generally a requirement for sockeye salmon (*Oncorhynchus nerka*) for spawning and juvenile rearing. Coho salmon are also typically found in these systems, often in large numbers, utilizing the lake habitat for juvenile rearing and overwintering. Pink and chum salmon are less common and frequently absent, especially in these aquatic ecosystems in the Copper River Delta. It is likely there are cryptic, yet to be discovered characteristics of these habitats that make them less favorable to pink and chum salmon.

Pink/chum salmon aquatic ecosystem

This aquatic ecosystem is dominated by pink salmon (*Oncorhynchus gorbuscha*) and chum salmon (*Oncorhynchus keta*). The streams that characterize this aquatic ecosystem are usually small, with a short spawning reach that often includes a sizable portion within the intertidal zone. These streams typically contain adequate spawning gravel and a sufficient water supply to facilitate the incubation of eggs during the winter months. Another characteristic feature of this aquatic ecosystem is that the streams have very little habitat for older-aged juvenile salmon. Consequently, coho and Chinook salmon, which need this type of juvenile habitat, are uncommon in these streams. The density of adult pink and chum salmon during the spawning season is typically very high. The pink/chum salmon aquatic ecosystem is prevalent across much of Prince William Sound.

Resident Dolly Varden char aquatic ecosystem

The primary feature of this type of aquatic ecosystem is that it cannot be reached by anadromous fish because of naturally occurring barriers to upstream migration; usually in the form of waterfalls. The dominant species in such non-anadromous areas is Dolly Varden char (*Salvelinus malma*). Although in some locations cutthroat trout (*Oncorhynchus clarki*) or rainbow trout (*Oncorhynchus mykiss*) fulfill this role. Fish that exist in this aquatic ecosystem must complete their entire lifecycle in freshwater. Any members that emigrate to the sea as juveniles are not able to return to their natal home as adults because of isolating migration barriers. These systems do not have a regular infusion of marine derived nutrients as do the other four aquatic ecosystems where anadromous fish dominate. The density and biomass of fish is also much lower. Streams tend to be smaller and higher gradient than those in the other aquatic ecosystems.

Aquatic ecosystem classifications

The Anadromous Waters catalog maintained by ADF&G is the source of information used to identify those stream systems within the Chugach National Forest that contain anadromous fish (Johnson & Blanche, 2012). This catalog also provides the location of fish species. Not every watershed listed in the catalog was used in this evaluation. Using the interactive online mapping feature provided by ADF&G, stream systems that were very small were excluded from this analysis. Using this selection process, 405 salmon stream systems were considered. Of this total, the 330 are in Prince William Sound (see table 12). For the Kenai Peninsula and Copper River Delta, 41 and 34 stream systems were identified, respectively.

No information is readily available to determine how many streams should be classified as belonging to the Dolly Varden char aquatic ecosystem. The number of stream systems reported here for the Dolly Varden char aquatic ecosystem are very rough estimates with values set to equal half the total count of anadromous stream systems. The genesis of this *ad hoc* approximation is the informal yet frequent observations by Forest Service biologists of Dolly Varden in stream sections upstream of natural salmon barriers, such as waterfalls. These non-anadromous zones were treated as a separate stream system for the purposes of this assessment. Conceptually, the salmon migration barrier was used to split a stream system into two ecosystem types. For example, the anadromous zone downstream of a barrier waterfalls might be classified as belonging to the coho salmon ecosystem based on the presence of that species with the portion upstream classified as belonging to the Dolly Varden ecosystem. It is likely that if a comprehensive inventory of non-anadromous waters was actually conducted the number of stream systems classified into the Dolly Varden char aquatic ecosystem would be greater than the estimate (202 stream systems).

Under this classification approach, any of the five aquatic ecosystems may contain other fish species in addition to those that define it. For example, a sockeye/coho salmon aquatic ecosystem may frequently contain pink and chum salmon. However, the presence of sockeye salmon generally means that fish have access to a lake or lake-like habitat, including sloughs and oxbow ponds. Stream systems with lakes function differently ecologically and have different physical attributes than those without lakes. Therefore, even though pink and chum salmon may be present, the defining feature is the presence of sockeye salmon.

Across the Chugach National Forest, 42 percent of the stream systems were assigned to the pink/chum salmon aquatic ecosystem (see table 13). Least common were stream systems classified as belonging to the Chinook aquatic ecosystem (4 percent). These aquatic ecosystems were not evenly distributed across the three geographic areas. Within the Copper River Delta, the dominant aquatic ecosystem was sockeye/coho, accounting for 43 percent of the stream systems. For Prince William Sound, the pink/chum salmon aquatic ecosystem was the most common, with 51 percent of the stream systems in this category. In the Kenai Peninsula, the Dolly Varden char aquatic ecosystem (33 percent) and the Chinook salmon aquatic ecosystem (31 percent) were the primary aquatic ecosystems. In summary, each of the three geographic areas was dominated by a different aquatic ecosystem.

Table 12. Number of Chugach National Forest watersheds in each of the five aquatic ecosystems identified in this assessment by geographic area

Geographic Area	Aquatic Ecosystem					Totals
	Chinook salmon	**Coho salmon**	**Sockeye/coho salmon**	**Pink/chum salmon**	**Dolly Varden char***	
Copper River Delta	4	8	26	3	20	**61**
Kenai Peninsula	16	4	13	1	17	**51**
Prince William Sound	4	45	31	250	165	**495**
Totals	**24**	**57**	**70**	**254**	**202**	**607**

*The number of stream systems that should be classified as the Dolly Varden char type aquatic ecosystems is not known, the numbers provided here are a rough approximation based on the 50 percent of the total number of salmon stream systems (see text).

Table 13. The proportion of fish bearing stream systems in the geographic areas assigned to Chinook, coho, sockeye/coho, and pink/chum salmon and Dolly Varden char aquatic ecosystems

Geographic Area	Aquatic Ecosystem				
	Chinook salmon	**Coho salmon**	**Sockeye/coho salmon**	**Pink/chum salmon**	**Dolly Varden char***
Copper River Delta	0.07	0.13	0.43	0.05	0.33
Kenai Peninsula	0.31	0.08	0.25	0.02	0.33
Prince William Sound	0.01	0.09	0.06	0.51	0.33
Totals	**0.04**	**0.09**	**0.12**	**0.42**	**0.33**

*The percentage of stream systems that should be classified as the Dolly Varden char type aquatic ecosystems is not known, the numbers provided here are a rough approximation based on the 50 percent of the total number of salmon stream systems (see text).

Key Ecosystem Characteristics

The five aquatic ecosystems identified here have a diversity of physical, biological, and anthropomorphic attributes. Some of these are relatively fixed, such as the location of barriers to upstream salmon migration or stream gradient. Others, like marine survival, are more cyclical and change over longer periods of time. Some, such as precipitation, vary annually. All contribute to the character and dynamic function of these aquatic ecosystems.

Physical attributes

Stream length

The amount of salmon-producing habitat for a given stream is directly related to the stream's length. Streams with many miles of habitat accessible to salmon, in general, produce more fish than short streams. Most streams within the Chugach National Forest are relatively short because of the steep mountain topography and the close proximity to the ocean (less than 10 miles long). In Prince William Sound, it is common for salmon to have access only to the intertidal portion of the stream. However, even with these limitations, the production of salmon in this region is substantial. Conversely, the Copper and Kenai rivers are large systems with many miles of salmon-bearing waters, a portion of which is outside of the Chugach National Forest boundary.

Stream gradient

Stream gradient, while relatively fixed, has a strong influence on fish production potential and species distribution. Very steep gradient streams constrain fish passage and do not contain the pools necessary for juvenile rearing of salmon. Dolly Varden char, cutthroat trout, and rainbow trout can be found in quite steep and small streams. Streams that are moderate in gradient (2 to 4 percent) are generally not good habitat for chum and pink salmon and are more often preferred by Chinook and coho salmon. All species can be found in lower gradient stream sections; however, pink and chum salmon tend to utilize these areas most.

Migration barriers

Barriers to upstream migration of salmon, usually waterfalls, impact the distribution of aquatic species. The height of the falls and the timing of run with regard to flow conditions can have an impact on the ability of anadromous species to use the area above moderate sized barriers. For example, coho and Chinook can negotiate falls in the range of 8 to 10 feet high, while pink and chum salmon are likely blocked by any falls greater than 4 feet. Waterfalls that are barriers to all anadromous fish provide the isolation mechanism that is needed for the Dolly Varden char aquatic ecosystem to flourish, as this aquatic ecosystem exists only where it is isolated from anadromous fish.

Precipitation and stream flow

The amount of precipitation, when it falls and whether or not it is mostly in the form of snow or rain, has a strong influence on stream flow characteristics and stream temperature. Variations in precipitation and temperature are substantial across the Chugach National Forest as noted in climate change portion of the assessment, and this has a bearing on the type of stream. Chugach National Forest stream types may include glacier driven, snow driven, rain driven, and groundwater driven. Variations in precipitation have the greatest potential to impact streams that are either snow or rain driven. Highest flows for snow driven streams occur during the period of spring snowmelt. Highest flows for rain dominated streams occur during the late summer months when rainfall amounts are typically greatest. These differences, along with a corresponding water temperature signature, have a major impact on which timing window is best for spawning, incubation, and post-emergence survival of newly hatched juvenile salmon (fry). These hydrologic characteristics may also play a role in the suitability of a watershed for one species over another.

Water turbidity

Streams with high turbidity generally represent suboptimal conditions for spawning and rearing conditions for salmon, char, and trout, although there may be some advantage of turbid waters in terms of reducing the vulnerability of juvenile salmon to predation. Many streams within the Chugach National Forest carry a heavy sediment load from glaciers melting during the warmer portion of the year. This greatly reduces light penetration into the water column and retards phytoplankton growth. This impact is transferred up the food chain and ultimately means juvenile fish have less to eat during the primary growing season. As a result, waters carrying a heavy glacial sediment load are less productive. Water turbidity from glaciers also affects the lakes that juvenile sockeye rear in. Annual variations in the rate of glacial melt and associated lake turbidity can have dramatic year to year impacts on sockeye salmon production.

Spawning gravel quality

Heavily compacted or sediment laden gravel is unfavorable for the incubation of salmon eggs. Freshly spawned eggs must survive for six to nine months in the same location before the young hatch and emerge in the spring. This is a critical stage in the life history, as the survival rate during this period is typically in the range of 10 percent (Bradford, 1994). Lower survival rates are associated with streams having heavy silt loads, flooding, winter dewatering, and ice scouring. Heavy silt, whether from human-caused sources, such as road building, or natural ones, such as glaciers, reduces inter-gravel water circulation and oxygen supply to the incubating eggs causing them to suffocate. This will lower a population’s overall egg to fry survival rate and result in fewer salmon in the next generation.

Juvenile rearing habitat

Juvenile coho and Chinook salmon as well as all char and trout need stream habitats that will sustain them for at least 1 to 4 years. Streams with the largest portion of this required habitat will produce more fish than those streams that are mostly lacking such habitat. This specialized habitat is usually associated with pools and some type of structure or hiding cover, usually in the form of woody debris.

Biological attributes

Marine survival cycles

Marine survival of juvenile salmon fluctuates widely. Perhaps more than any other factor, it is the survival rate during the marine phase of a salmon's life history that best predicts the subsequent run-size, catch, and level of marine derived nutrients that are infused back into the freshwater aquatic ecosystem. Survival rates, usually expressed as juvenile to returning adult survival, are difficult to obtain for wild populations. However, where such data exist, they have been found to correlate well with cyclic patterns of salmon abundance. In other words, periods of high marine survival result in large salmon returns, periods of low marine survival result in fewer numbers of returning salmon.

Marine-derived nutrients

Salmon have a major influence on the productivity and function of aquatic ecosystems in Alaska as well as terrestrial ecosystems. Their presence provides a nutrient subsidy that is critical to maintain the productivity of the aquatic ecosystem (Hicks, Wipfli, Lang, & Lang, 2005). This influence comes from a boost of nutrients from decomposing salmon carcasses in fresh water systems. The carcasses are supplied each year after the spawning season is over as the salmon die and decompose. This seasonal boost of nutrients increases stream productivity significantly and benefits the capacity of the system to produce all forms of aquatic life, including fish. Without this annual nutrient supply, the productivity of these systems would be much reduced, a factor of high significance especially for Chinook, coho, and sockeye salmon as a substantial part of their life history occurs in freshwater. Salmon are also important to the terrestrial ecosystem, benefitting both wildlife and riparian vegetation.

Species diversity

Interactions among different naturally occurring species have an influence on the function of aquatic ecosystems and the productivity of individual species. Although at this time these interactions are poorly understood, changes in the relative number and distribution of these species provides an important indicator of aquatic ecosystem disturbance.

There are at least 19 fish species that occupy the Chugach National Forest (see table 14). In terms of abundance, economic value, cultural significance, and ecological importance, the five species of Pacific salmon play the primary role. In addition, there are six additional anadromous species that occupy national forest waters and are also part of the indigenous aquatic ecosystem, including steelhead trout, sea-run cutthroat trout, sea-run Dolly Varden char, eulachon, Pacific lamprey, and threespine stickleback. As displayed in table 14, some of these species are widespread and others have a very limited distribution. For example, eulachon return in large numbers annually to specific basins (e.g., Twentymile and Copper rivers).

The Chugach National Forest also contains a number of fish species that spend their entire life in freshwater (see table 14). Included are: Dolly Varden char (resident form), rainbow trout (resident form), cutthroat trout (resident form), arctic char, two species of whitefish, ninespine stickleback, and three sculpin species.

Table 14. Common name, scientific name, and general distribution of fish produced in the Chugach National Forest

Common Name	Scientific Name	Distribution
Chinook salmon	*Oncorhynchus tshawytscha*	Across the national forest
Coho salmon	*Oncorhynchus kisutch*	Across the national forest
Sockeye salmon	*Oncorhynchus nerka*	Across the national forest
Chum salmon	*Oncorhynchus keta*	Across the national forest
Pink salmon	*Oncorhynchus gorbuscha*	Across the national forest
Steelhead trout	*Oncorhynchus mykiss (anadromous form)*	Eastern national forest (Copper and Martin rivers) and Turnagain Arm tributaries
Cutthroat trout	*Oncorhynchus clarki*	Scattered across Prince William Sound and the Copper River Delta
Rainbow trout	*Oncorhynchus mykiss*	Kenai Peninsula, Copper and Martin rivers
Dolly Varden char	*Salvelinus malma*	Across the national forest
Arctic char	*Salvelinus alpinus*	Cooper Lake (single location)
Lake trout	*Salvelinus namaycush*	Kenai Lake
Arctic grayling	*Thymallus arcticus*	Crescent and Grayling Lakes (introduced species)
Round whitefish	*Prosopium cylindraceum*	Kenai Peninsula, Copper River
Humpback whitefish	*Coregonus oidschian*	Copper River
Eulachon	*Thaleichthys pacificus*	Turnagain Arm, Copper River Delta
Burbot	*Lota lota*	Juneau Lake (single location)
Coast Range sculpin	*Cottus aleuticus*	Likely across the national forest
Prickly sculpin	*Cottus asper*	Likely across the national forest
Slimy sculpin	*Cottus cognatus*	Likely across the national forest
Threespine stickleback	*Gasterosteus aculeatus*	Across the national forest, often anadromous
Ninespine stickleback	*Pungitius pungitius*	Kenai Peninsula, infrequent
Pacific lamprey	*Entosphenus tridentata*	Copper and Kenai rivers

Anthropogenic attributes

Fishery impacts

Salmon, char, and trout are all caught in fisheries. As a result, a portion of each year's production is removed from the population prior to spawning. Although Chugach National Forest salmon populations have sustained this often significant annual source of mortality for many years, it is not clear what the long term ecological effect may be of fewer salmon carcasses on the spawning grounds as a result of these fisheries.

The ecological character of most anadromous streams is likely different today than in historical times before the start of large-scale salmon fisheries. Evidence for this change is provided by Rodgers et al. (2012) in the reconstruction of salmon population numbers for the past 500 years based on the evaluation of stable nitrogen isotopes in sediments from 20 lakes in western Alaska. In the 400 years before 1900, salmon populations fluctuated independently from each other in a non-synchronous pattern. However, virtually all spawning populations declined after 1900, which coincides with the start of large-scale fisheries. The authors infer that these fisheries have reduced the infusion of salmon derived nutrients into the freshwater aquatic ecosystem by 60 percent relative to the historical baseline from 1500 to 1900.

Hatchery influence on wild salmon

Hatchery fish are common in Prince William Sound and in the lower Kenai Peninsula. A number of studies on coho, Chinook, and steelhead have demonstrated that hatchery and wild fish spawning under natural conditions differ considerably in their relative ability to produce surviving offspring (Araki, Berejikian, Ford, & Blouin, 2008; Buhle, Holsman, Scheuerell, & Albaugh, 2009; Chilcote, 2003; Leider, Hulett, Loch, & Chilcote, 1990). The magnitude of the difference is large. Chilcote et al. (2011) estimated that a naturally spawning population composed entirely of hatchery fish would have approximately one-tenth the reproduction rate as a population composed entirely of wild fish. Such differences between hatchery and wild fish have not been demonstrated for salmon populations that occur within the Chugach National Forest, although Hilborn and Eggers (2000) concluded that hatchery pink salmon have replaced rather than reproductively supported wild pink salmon populations in Prince William Sound.

Invasive species

Invasive species via predation and competition for food and space can disrupt the functional stability aquatic ecosystems. In terms of fish, the primary threats to southcentral Alaska are northern pike (*Esox lucius*) and Atlantic salmon (*Salmo salar*). Northern pike are not native to the Chugach National Forest, but indigenous populations do exist in Alaska. This species has been found in lakes on the western portion of the Kenai Peninsula (likely due to unauthorized introductions), but none have yet been reported within the national forest. Atlantic salmon, likely escapees from commercial pen-rearing hatchery operations in British Columbia, have been recovered in the marine environment near Cordova. In general, Atlantic salmon do not seem to be able to establish self-sustaining natural populations in the streams draining into the Pacific Ocean. The exception is several streams on the east coast of Vancouver Island in British Columbia where natural populations of this species have become established. Invasive invertebrates and fish pathogens also pose a threat to Chugach National Forest aquatic ecosystems, although at this time there is no evidence that any contact has occurred.

Climate change

Salmon and their associated ecosystems are sensitive to climatic variations and the possible effects are many and complex (Bryant, 2009). Anticipated changes in stream hydrologic condition due to climate change will have varying effects on salmon life history. For example, it is expected that warming water temperatures will accelerate the rate at which salmon eggs develop in gravel and this will result in a timing change for hatching and emergence of young salmon that may be too early relative to the optimum ecological window for survival and growth. It is also expected that, up to a certain point, warmer ocean temperatures may improve the growth and survival of salmon in this region. In the recent past, periods of colder ocean temperature have been less favorable to survival of Alaska salmon than when ocean temperatures were warmer (Mantua, 2009).

Oil spills

In 1989, the T/V Exxon Valdez ran aground and 11 million gallons of crude oil were spilled into Prince William Sound. This had an adverse impact on the marine ecology and food webs that salmon depend on. It also impacted the intertidal zone of many streams in Prince William Sound where a large portion of the pink and chum salmon spawn. Most salmon populations are thought to have recovered from this event, although residue from the oil spill is still detectable in the environment.

Since 1989, shipping procedures and oil spill response measures have been implemented to reduce the likelihood of a spill and in the event of another spill help contain the scale of impact. However, oil tankers continue to travel Prince William Sound and the chance of another oil spill has not been eliminated.

Condition and trends

As a means to evaluate the current condition of the aquatic ecosystems, three indicators or elements were selected, including trends in fish abundance, hatchery impact on natural production, and climate change. The primary criteria for selection of these indicators are that they are known to be related to the sustainability of fish populations and their associated ecosystems.

Trends in fish abundance: Chinook salmon aquatic ecosystems

The Chinook aquatic ecosystem in the Kenai Peninsula is represented by the early and late runs of Chinook salmon returning to the Kenai River. Annual numbers of Chinook for both of these runs are based on estimates presented by Begich and Pawluk (2011) and ADF&G (ADF&G, 2014c). Since 1986, there has been a downward trend in both groups of fish, especially in the last 10 years (see figure 3). In addition, the run sizes in 2012 and 2013 were the lowest on record and appear to be outside of the natural range of variation for these two populations. Although the reason for this decline is unknown, it is plausible that the primary factor involved occurs during the ocean phase of the life cycle as Chinook salmon populations from other western portions of Alaska are also in low abundance. The shared ocean environment of these and the Kenai population is the common denominator for all of these Chinook salmon.

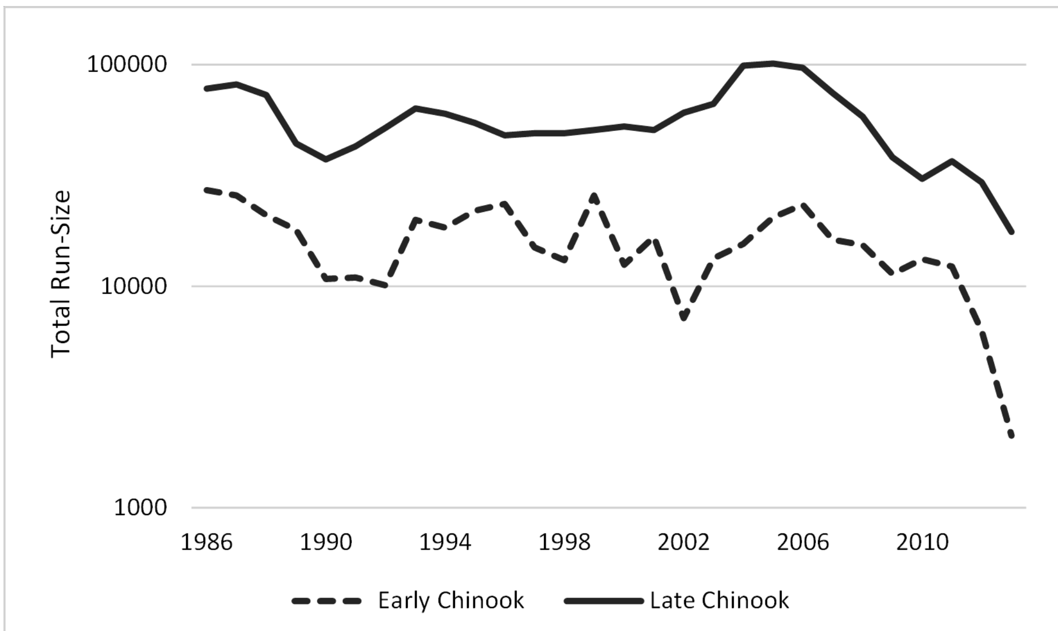


Figure 3. Run sizes for early-run and late-run Chinook salmon returning to the Kenai River from 1986 to 2013 (ADF&G, 2013a; ADF&G, 2014c; Begich & Pawluk, 2011).

Comparable information is not available for Prince William Sound or the Copper River Delta. However, as an index of run size, recreational fishery catch data as reported by Hochhalter et al. (2011) was examined for trends for the Prince William Sound and Kenai Peninsula and compared to recreational fishery data for the Kenai River (see figure 4). The catch for Kenai Peninsula Chinook salmon has declined, most noticeably since 2010. Copper River Delta catch numbers have also declined while the Prince William Sound catch has increased during the same period. The trends for Prince William Sound and the Copper River Delta are further complicated because after the early 2000s, the catch may include an unknown number of hatchery origin Chinook salmon.

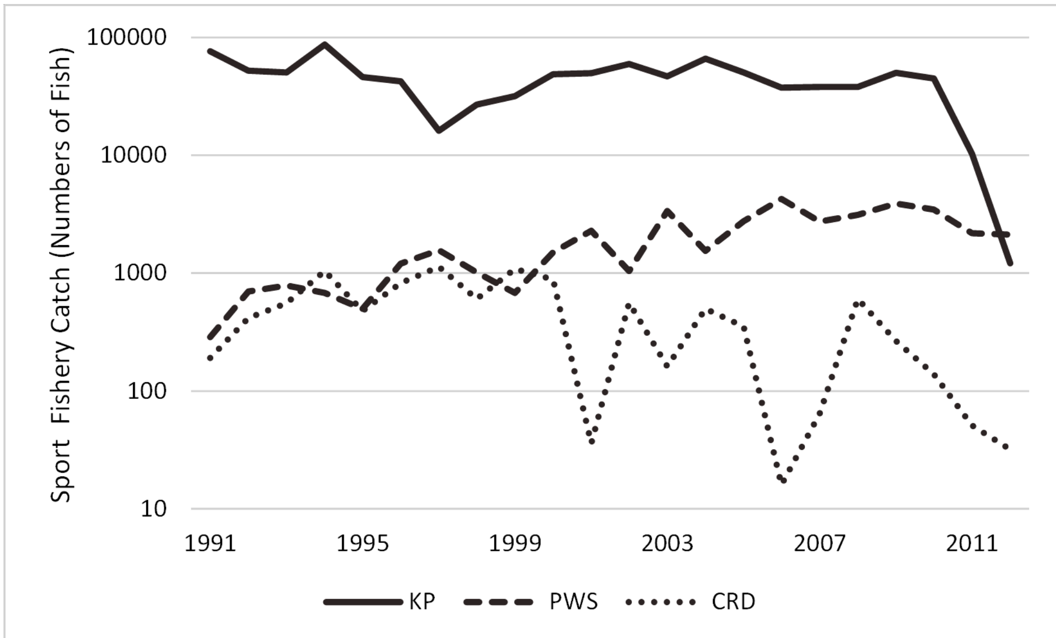


Figure 4. Estimated numbers of Chinook salmon caught in recreational fisheries for the geographic areas from 1991 to 2012 (Begich & Pawluk, 2011; Hochhalter, Blain, & Failor, 2011; ADF&G, 2014c).

Trends in fish abundance: coho salmon aquatic ecosystems

ADF&G's estimates of coho salmon harvested from 1996 to 2012 (caught and kept) for the Copper River Delta, Kenai Peninsula, and Prince William Sound were used to examine trends for those stream systems classified as belonging to the coho salmon aquatic ecosystem (Begich & Pawluk, 2011; Hochhalter, Blain, & Failor, 2011). These data show that there was an upward trend in the harvest of Copper River Delta coho salmon, while for both Kenai Peninsula and Prince William Sound coho salmon, no trends were apparent (see figure 5). This provides only a rough representation of the coho salmon aquatic ecosystem since these harvest estimates include an undetermined number of coho salmon produced from the Chinook salmon and sockeye/coho salmon aquatic ecosystems as well.

While spawner escapement data that is watershed specific would provide much better means to assess trends for coho salmon, such information is nearly unavailable. The problem is that salmon spawning surveys are rarely done from mid-September through mid-November when many coho spawn. There are two reasons for this, the weather conditions at this time of year are not conducive for conducting stream surveys and the fishery management need for coho salmon escapement numbers is less than for other, more intensively managed species, such as pink salmon.

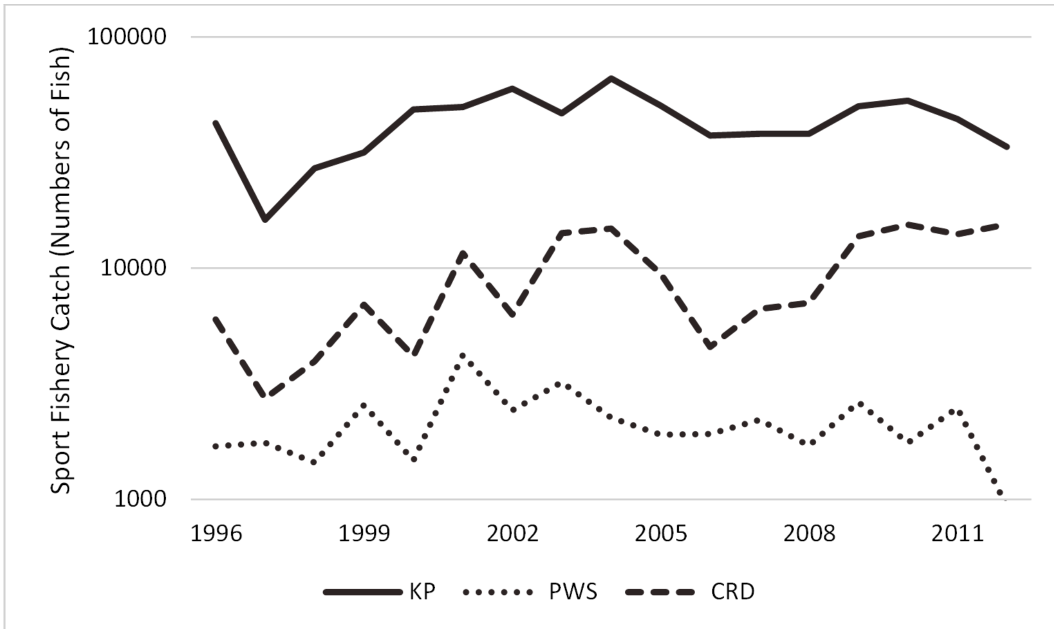


Figure 5. Estimated numbers of coho salmon caught in sport fisheries as reported by ADF&G for the geographic areas from 1996 to 2012 (Begich & Pawluk, 2011; Hochhalter, Blain, & Failor, 2011).

Trends in fish abundance; Sockeye/coho salmon aquatic ecosystems

Information available for trends in the number of coho salmon for each area has been reported previously (see figure 5). For sockeye salmon, the data used here were estimates of the number of sockeye salmon spawning each year in several key producing stream systems in each geographic area of the Chugach National Forest (Botz, Sheridan, Weise, Scannell, Brenner, & Moffitt, 2013; Shields & Dupuis, 2012). Based on these data, there is an upward trend in the number of sockeye salmon for the Kenai Peninsula (in this case represented by the Kenai River). In contrast, the trend in number of sockeye spawners for the Prince William Sound index stream systems (Coghill and Eshamy stream systems) decreased (see figure 6). The trend for Copper River Delta streams also appears to be decreasing, although the dataset does not start until 2001 and this is probably too short of an interval to establish long term patterns.

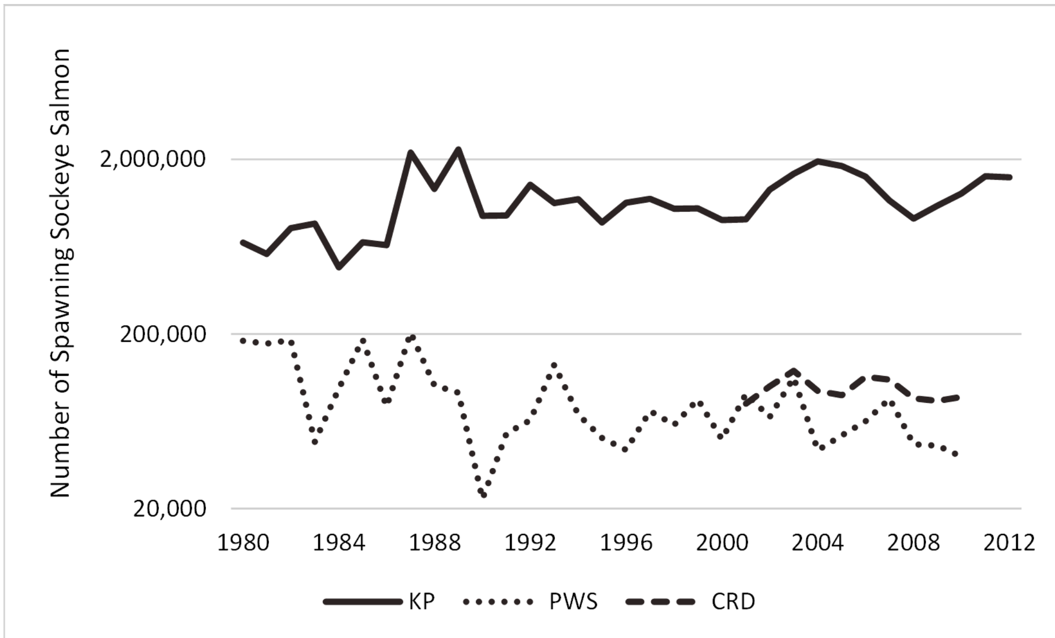


Figure 6. Estimated number of sockeye salmon spawning in key sockeye/coho salmon aquatic ecosystem watersheds from 1980 to 2012 for the geographic areas (Botz, Sheridan, Weise, Scannell, Brenner, & Moffitt, 2013; Shields & Dupuis, 2012).

Trends in fish abundance; pink/chum salmon aquatic ecosystems

As described previously, of the 254 Chugach National Forest stream systems that were assigned to the pink/chum salmon aquatic ecosystem classification, all but four occur within Prince William Sound (see table 14). While fish abundance data is lacking for this aquatic ecosystem in the Kenai Peninsula and Copper River Delta, within the Prince William Sound area, run-size information is robust with comprehensive accounting of both spawner escapement and fishery harvest across most of the production area (Botz, Sheridan, Weise, Scannell, Brenner, & Moffitt, 2013). For the past 50 years, the number of wild pink salmon produced in Prince William Sound fluctuated around an average of about 10 million fish. During this period, there has been no long term pattern of decline or increase (see figure 7). Since the late 1990s, there has been a large number of hatchery produced pink salmon returning to Prince William Sound. An intensive effort by ADF&G to estimate hatchery and wild fish in the fisheries and on the spawning grounds has made it possible to estimate how many pink and chum salmon were produced in the wild after the hatchery operations started in the late 1980s. This effort made it possible to assess the run-size pattern for naturally produced wild fish for a long continuous period.

The information for wild chum salmon in Prince William Sound was used to document that the average run size since 1970 has been in the range of 1 million fish (an order of magnitude less than for the pink salmon). There does not appear to be a long-term trend in the chum run-size during the last 40 years, although considerable variation occurred within this time period (see figure 7).

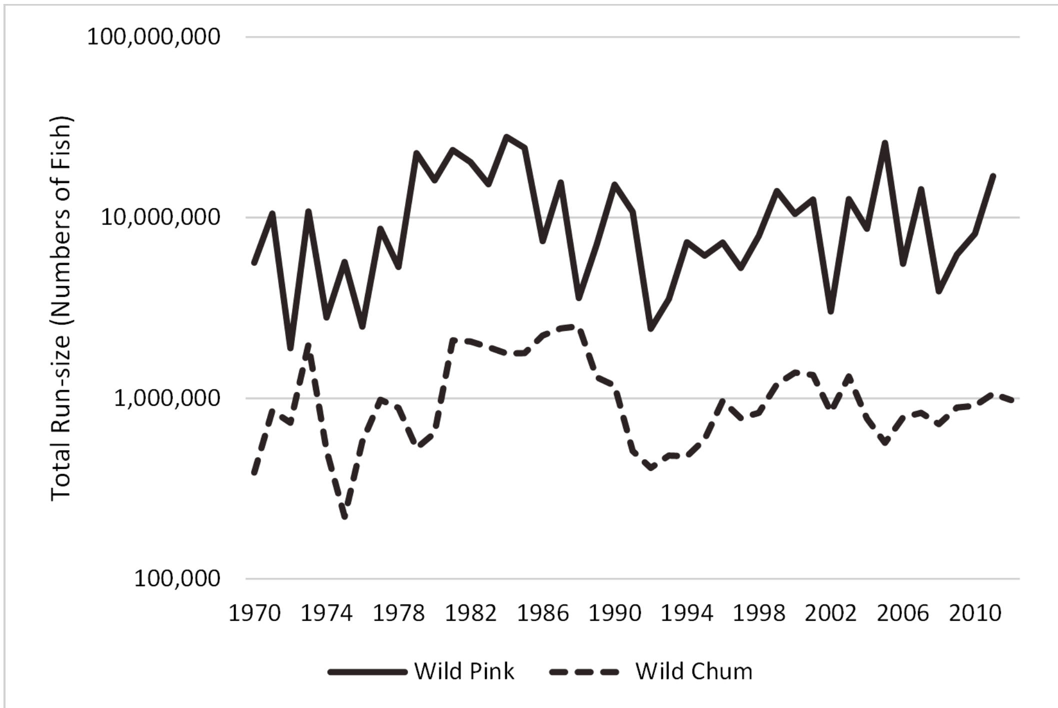


Figure 7. Total run-size (fishery harvest plus spawner escapement) of wild pink salmon and wild chum salmon based on ADF&G data collected from 1960 to 2011 (Botz, Sheridan, Weise, Scannell, Brenner, & Moffitt, 2013).

The run-size pattern for pink and chum salmon both seem to reflect a cyclical behavior. To better visualize this, annual data were combined into a series of five-year moving averages. This smoothed out some of the annual variation and established the presence to two similar cycles of fish production (see figure 8).

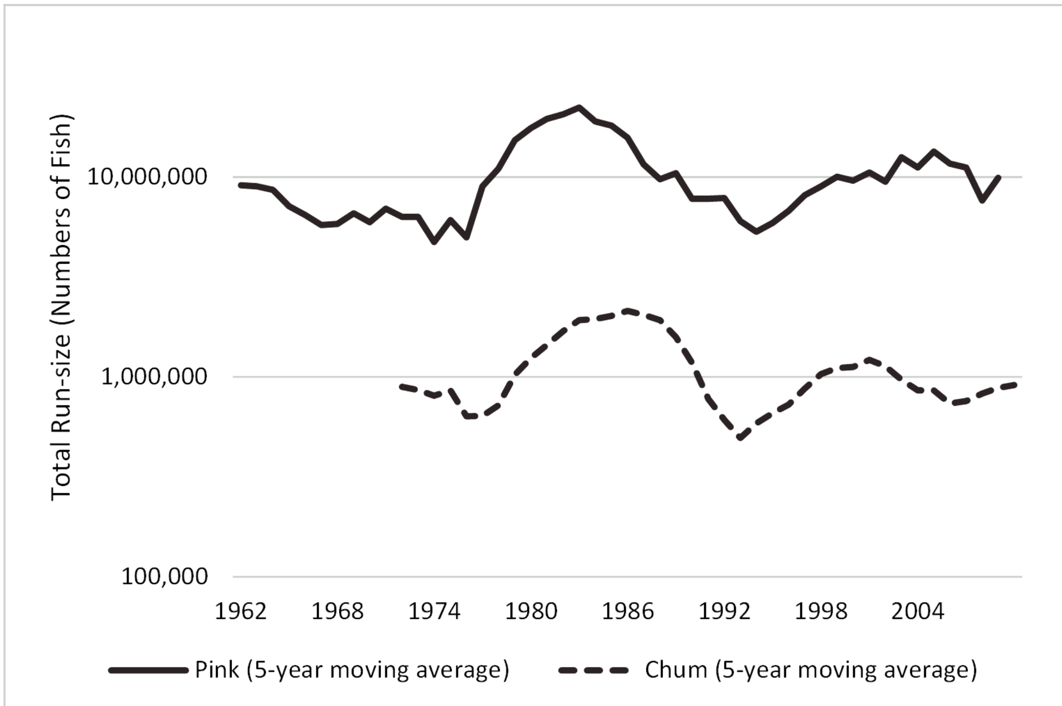


Figure 8. Total run-size of wild pink salmon and wild chum salmon expressed as a five-year moving average of annual run size estimates from 1960 to 2011 (Botz, Sheridan, Weise, Scannell, Brenner, & Moffitt, 2013).

Trends in fish abundance; Dolly Varden char aquatic ecosystems

Dolly Varden char fishery data (catch and harvest) were used to assess the population trends for the primary species of this aquatic ecosystem (Begich & Pawluk, 2011; Hochhalter, Blain, & Failor, 2011). Fishery catch for the upper Kenai River from Skilak Lake to Kenai Lake (Kenai Peninsula) has trended strongly upward during the past 20 years with catches ranging from 20,000 fish per year to upwards of 100,000 fish per year currently (see figure 9).

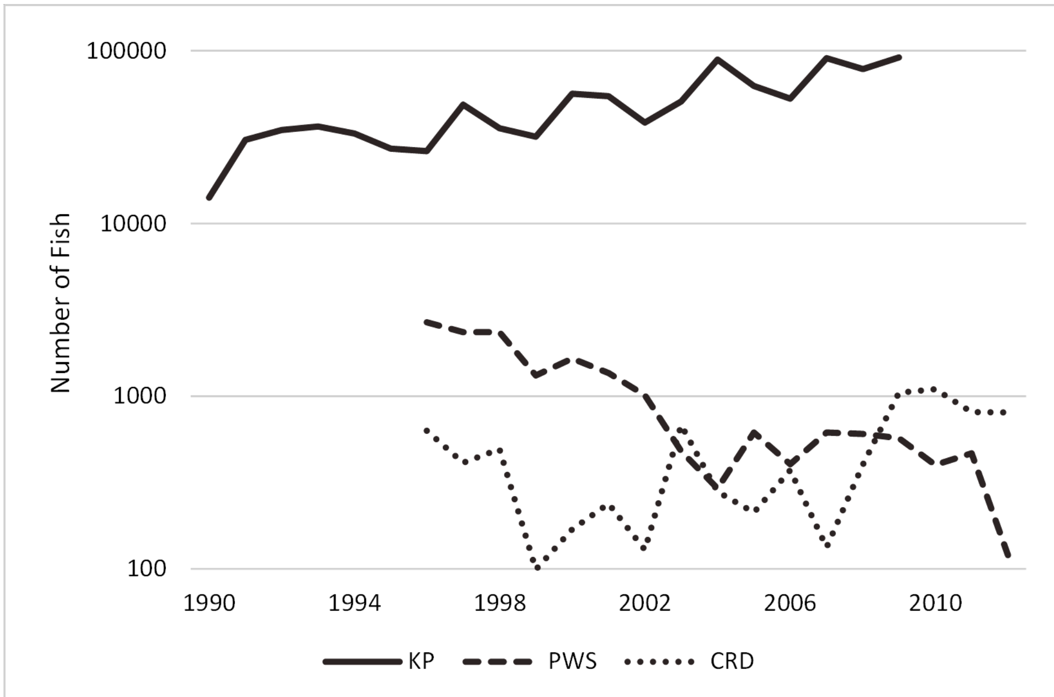


Figure 9. Summary of ADF&G catch information for Dolly Varden char in upper Kenai River (between Skilak and Kenai lakes) from 1984 to 2009, number of Dolly Varden char harvested in representative streams for the Prince William Sound and Copper River Delta from 1996 to 2012 (Begich & Pawluk, 2011; Hochhalter, Blain, & Failor, 2011).

An interesting feature of the upper Kenai River fishery is that less than one percent of the Dolly Varden char caught are retained by anglers as harvest (Begich & Pawluk, 2011), effectively making it a catch and release fishery.

There are no comparable Dolly Varden char fishery data for Prince William Sound and the Copper River Delta. What is available are estimates of fishery harvest only, unlike the case for the Kenai Peninsula where estimates for both the number of fish caught and kept (harvest) and the number of fish that are caught and released exists. For Prince William Sound, fishery harvest of Dolly Varden char appears to have declined from 1996 to 2012. Similar harvest data for the Copper River Delta streams do not show any clear trend up or down.

Another problem with data from the geographic areas is that they are obtained in locations where the Dolly Varden char caught may be anadromous (sea-run), rather than the resident form. Therefore, the trends shown here (see figure 9) may or may not be representative of the conditions for non-anadromous zones associated with the Dolly Varden char aquatic ecosystem described in this assessment.

Although, the Dolly Varden char in the upper Kenai River from the outlet at Kenai Lake downstream to where it enters Skilak Lake may be both resident and anadromous forms, the rainbow trout in this same reach of the Kenai River are believed to be entirely resident (Begich & Pawluk, 2011). The catch of rainbow trout in this river section (as reported by Begich and Pawluk 2011) shows a strong upward trend. The nature of the fishery is similar too, with less than one percent of the fish caught actually being kept and harvested (see figure 10). Together, the catch of Dolly Varden char and rainbow trout in this portion of the Kenai River is approaching 200,000 fish per year.

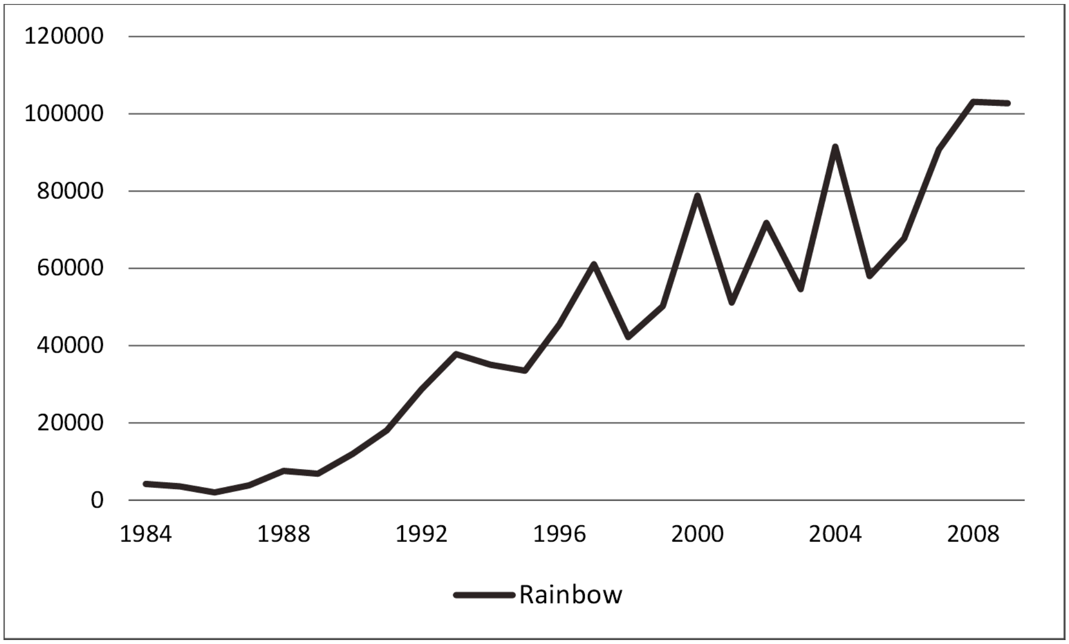


Figure 10. Catch of rainbow trout in upper Kenai River (between Skilak and Kenai Lakes) from 1984 to 2009 (Begich & Pawluk, 2011).

Hatchery impact on natural production

The potential for interactions between hatchery fish and wild fish within the Chugach National Forest is very low for the Copper River Delta and most of the Kenai Peninsula. The exceptions are the Salmon Creek watershed in the southeast portion in the Kenai Peninsula and much of the Prince William Sound. For the Salmon Creek watershed (Kenai Peninsula), specific measurements of the level of hatchery fish mixing with natural populations of coho, Chinook, and sockeye are unavailable; however, based on the size of the hatchery program, it is possible the mixture rate is high (USDA, 2011c).

For Prince William Sound, hatchery fish have been present since the late 1980s, when large-scale production of hatchery pink and chum salmon was initiated. The fish that return from this hatchery production releases are caught in associated fisheries and are important to the local economies. Hatchery fish that are not caught either return to their release point at a hatchery or stray into nearby natural spawning areas and mix with wild fish.

ADF&G biologists are monitoring and assessing the rate of mixing between hatchery and wild fish in Prince William Sound. Based on a model, Brenner et al. (2012) found that across all pink salmon populations the potential impact of stray hatchery fish is greatest in the southwestern portion of Prince William Sound and in the vicinity of the primary pink salmon hatcheries. Only in one-quarter of the streams were hatchery strays predicted to comprise 5 percent or less of the naturally spawning population. Hatchery strays would exceed 10 percent of the spawning population in nearly 39 percent of the streams with pink salmon.

To conserve the long-term genetic character and productivity of natural populations, several authors have suggested that stray hatchery fish should comprise no more than 5 to 10 percent of the spawning population (Ford, 2002; Mobrand, et al., 2005).

Hatchery-origin chum salmon are also known to stray into natural spawning areas within Prince William Sound. However, the fraction of these strays in natural chum populations is known for only a relatively small number of stream systems. Of the 25 locations examined in Prince William Sound during a four-year period, Brenner et al. (2012) found that the incidence of stray hatchery fish was 5 percent or greater for about half of the locations. Although the number of streams sampled may be too few to be representative of Prince William Sound in general, it appears that the level of hatchery fish in naturally spawning chum salmon populations may be higher in the southwestern portion of Prince William Sound.

Climate change

As reported in the Climate Change section of this chapter, the Climate Change Vulnerability Assessment effort estimated that 10 percent of the watersheds in the Chugach National Forest would be vulnerable to climate change. In all cases, this consisted of a watershed transitioning from a snow dominated form of precipitation to a transitional snow type category, characterized by more rain and less snow. It was assumed these vulnerable watersheds would be in locations where the aquatic ecosystem may be stressed in the future.

The Climate Change Vulnerability Assessment effort estimates that during the next 50 years that the pink salmon population may benefit from the rate of warming expected, with a possible production increase of 26 percent. For chum salmon, a model-based decrease of up to 41 percent production was estimated. However, this estimate was not a statistically significant possibility because the number of populations (16) involved in the estimate is too few given the range of variation in response among the different populations.

Abdul-Aziz et al. (2011) examined 18 global climate models' sea surface temperature simulation outputs to develop seasonal high-seas thermal habitats for six species of Pacific salmon. Their results for pink salmon and chum salmon indicate that the populations of these species may very well decline in the Gulf of Alaska, a result of substantial reductions of historical habitat. Any observed increases in production of both species may be due to a compensation for the southern habitat losses from the shift of the warm water boundaries by the 2040s and 2080s and by habitat gains in adjacent seas due to the northward movement of cold water boundaries.

Aquatic Ecosystem Integrity

In this evaluation, information about living organisms (salmon and char) is used as tools to evaluate the condition of the five aquatic ecosystems distributed across the Chugach National Forest. The measureable elements considered were trends in fish abundance (present), potential impact of hatchery fish (present and future), and climate change (present and future). In presenting these findings, a numerical rating system for each assessment element with possible values from negative 2.0 (very adverse condition) to 2.0 (very robust condition) for each geographic area was used. Using the number of stream systems classified into each geographic area as weights, an overall score for each element was computed (i.e., trend, hatchery fish, and climate change). A score was assigned to each element for information uncertainty ranging from 0.5 for relatively certain to 2.0 for highly uncertain. Element scores (for trend, hatchery fish, and climate change) were averaged to obtain an overall condition rating for the aquatic ecosystem. The uncertainty scores were also averaged as an index of overall uncertainty in the aquatic ecosystem rating.

In viewing the results based on this scoring system, it is emphasized that the values obtained should be considered relative indices of aquatic ecosystem condition and not absolute measures. They are best used to describe the condition of the five aquatic ecosystems relative to each other. They are not well suited for making an absolute statement about the degree of aquatic ecosystem integrity. It is also emphasized that, although the uncertainty scores associated with each aquatic ecosystem index value are qualitatively based, they are a critically important element of the aquatic ecosystem assessment and should receive at least equal focus.

Chinook salmon aquatic ecosystem (net score -0.44)

This aquatic ecosystem is most common in the Kenai Peninsula and the index for the condition of this area is the early and late runs of Chinook returning to the Kenai River. In recent years, the declines in both of these populations have been substantial and have reached previously unrecorded low levels. A negative 2.0 score was assigned for Kenai Peninsula Chinook salmon. For Prince William Sound and Copper River Delta, scores of 1.0 and negative 1.0, respectively, were assigned. The impact of hatchery fish is likely negligible across all areas as is the impact of climate change; however, there is a high degree of uncertainty in the assessment concerning the climate change impacts (see table 15).

Table 15. Indices of relative aquatic ecosystem integrity and associated uncertainty for Chugach National Forest stream systems classified as belonging to the Chinook salmon aquatic ecosystem

Evaluation Elements	Geographic Area (Number of Stream Systems)			Index Score	Uncertainty Score
	Copper River Delta (4)	Kenai Peninsula (16)	Prince William Sound (4)		
Population trends	-1.0	-2.0	+1.0	-1.33	1.0
Hatchery impacts	0	0	0	0.00	0.5
Climate change	0	0	0	0.00	2.0
Combined				-0.44	1.17

Coho salmon aquatic ecosystem (net score 0.09)

Sport fishery catch of coho salmon was used as the primary indicator of trend for this aquatic ecosystem. Based on the strongly upward trend for Copper River Delta data, a trend score of 2.0 was assigned (see table 16). The score of zero for Kenai Peninsula and Prince William Sound reflected the lack of any trend in the data. However, watershed specific information on spawner numbers is lacking in nearly all areas. The uncertainty score of 2.0 for the trend scores reflects this data shortcoming. The impacts of hatchery fish and climate change are likely minor throughout most of the coho aquatic ecosystem watersheds. However, there is a high degree of uncertainty as the data necessary to assess such impacts is limited to only a few locations, which may or may not be representative of the whole. Hatchery coho salmon are more common in watersheds with lakes and therefore associated with the sockeye/coho salmon aquatic ecosystem classification, which is presented next.

Table 16. Indices of relative aquatic ecosystem integrity and associated uncertainty for Chugach National Forest stream systems classified as belonging to the coho salmon aquatic ecosystem

Evaluation Elements	Geographic Area (Number of Stream Systems)			Index Score	Uncertainty Score
	Copper River Delta (8)	Kenai Peninsula (4)	Prince William Sound (45)		
Population trends	+2.0	0	0	0.28	2.0
Hatchery impacts	0	0	0	0.00	1.0
Climate change	0	0	0	0.00	2.0
Combined				0.09	1.67

Sockeye/coho salmon aquatic ecosystem (net score -0.15)

Lakes or lake-like habitat is a typical feature of watersheds that contain both sockeye and coho salmon assigned to this aquatic ecosystem. A score of 1.0 was assigned to Kenai Peninsula stream systems because of an upward trend in sockeye salmon abundance and neutral trend for coho salmon (see table

17). Impacts of hatchery fish are possible in Prince William Sound and the Kenai Peninsula for both species as is reflected in the scoring (see table 17). For the Kenai Peninsula, these impacts do not occur in the Kenai River system, which is the primary fish producer of the area, but may be a factor in the Salmon Creek system (near Seward), and the possibility of hatchery coho salmon straying into the streams of Turnagain Arm (near Portage) exists. Lakes that are typical for the stream systems of this aquatic ecosystem are expected to cushion some of the impacts from climate change on water temperatures and stream flow. There is also some indication that sockeye populations in Prince William Sound may benefit from temperature changes expected with climate change. The scoring for climate change (0.44) reflects this possibility, although the uncertainty remains high because the data needed to perform this analysis is limited to a few stream systems.

Table 17. Indices of relative aquatic ecosystem integrity and associated uncertainty for Chugach National Forest stream systems classified as belonging to the sockeye/coho salmon aquatic ecosystem

Evaluation Elements	Geographic Area (Number of Stream Systems)			Index Score	Uncertainty Score
	Copper River Delta (26)	Kenai Peninsula (13)	Prince William Sound (31)		
Population trends	0	1.0	-1.0	-0.26	1.0
Hatchery impacts	0	-1.0	-1.0	-0.63	1.0
Climate change	0	0	1.0	0.44	2.0
Combined				-0.15	1.33

Pink/chum salmon aquatic ecosystem (net score -0.33)

For the pink/chum salmon aquatic ecosystem, the detail of information on fish abundance (in fisheries and on the spawning grounds) is excellent for Prince William Sound, especially for pink salmon. Although comparable information for the Kenai Peninsula and Copper River Delta is limited, this is not a major assessment problem since all but 4 of the 254 stream systems classified into the pink/chum salmon aquatic ecosystem occur in Prince William Sound (see table 18).

The score for hatchery impacts of negative 1.0 reflects the fact that hatchery fish stray into many natural production areas and may impact the genetic diversity and resilience of wild pink and chum salmon populations within Prince William Sound (see table 18). It appears that pink salmon populations may benefit from the warmer temperatures expected as a result of climate change; however, the opposite may be true for chum salmon. In addition, pink/chum salmon aquatic ecosystem watersheds appear to be more vulnerable to climate change. In light of this information, a net score of zero was assigned to this assessment element (see table 18).

Table 18. Indices of relative aquatic ecosystem integrity and associated uncertainty for Chugach National Forest stream systems classified as belonging to the pink/chum salmon aquatic ecosystem

Evaluation Elements	Geographic Area (Number of Stream Systems)			Index Score	Uncertainty Score
	Copper River Delta (3)	Kenai Peninsula (1)	Prince William Sound (250)		
Population trends	0	0	0	0.00	0.5
Hatchery impacts	0	0	-1.0	-0.98	0.5
Climate change	0	0	0	0.00	1.0
Combined				-0.33	0.83

Dolly Varden char aquatic ecosystem (net score -0.22)

Little information is available about the distribution and abundance of Dolly Varden char, which is the primary species that represents this aquatic ecosystem. Freshwater catches of Dolly Varden char appear to be declining in Prince William Sound and increasing in the Kenai Peninsula, at least for the upper Kenai River, where catches of resident rainbow trout are increasing as well. A score for this element of negative 0.65 reflects the fact that the majority of stream systems classified into this aquatic ecosystem are within Prince William Sound where trends may be decreasing (see table 19). However, the uncertainty score of 2.0 for the trend element reflects the fact that much of the catch data probably comes from anadromous stream portions and therefore are not representative of this aquatic ecosystem, which occurs only in non-anadromous waters. The impacts of climate change on this aquatic ecosystem are not clearly negative or positive.

Table 19. Indices of relative aquatic ecosystem integrity and associated uncertainty for Chugach National Forest stream systems classified as belonging to the Dolly Varden char aquatic ecosystem

Evaluation Elements	Geographic Area (Number of Stream Systems)			Index Score	Uncertainty Score
	Copper River Delta (20)	Kenai Peninsula (17)	Prince William Sound (165)		
Population trends	0	+2.0	-1.0	-0.65	2.0
Hatchery impacts	0	0	0	0.00	1.0
Climate change	0	0	0	0.00	2.0
Combined				-0.22	1.67

Summary

Among the five aquatic ecosystems, the condition of the Chinook salmon aquatic ecosystem had the lowest rating, while the coho salmon aquatic ecosystem had the highest rating (see figure 11). As noted earlier, these index scores are best used as a means to make relative comparison among the five aquatic ecosystems evaluated. They are not well suited as a measurement of absolute aquatic ecosystem integrity.

Finally, there is a great deal of uncertainty in accuracy of the aquatic ecosystem condition scores presented here. Using professional judgment, the uncertainty is characterized as low, medium, or high with assigned numerical values of 0.5, 1.0, and 2.0, respectively. These values were combined to obtain a single uncertainty rating for each aquatic ecosystem. By adding and subtracting each uncertainty rating with its respective aquatic ecosystem condition score, an upper and lower bounds of possible scores was generated as illustrated in figure 11. It may or may not be appropriate to calculate possible ranges for aquatic ecosystem condition in this manner. However, as a relative comparison of ranges among the five aquatic ecosystems, it provides useful insight. The amount and quality of information for Pink/chum salmon aquatic ecosystem is superior among the five and this is reflected in a relatively narrow range of possible condition scores. In contrast, the information for the coho salmon and Dolly Varden char aquatic ecosystems is marginal and this is reflected in a much wider spread of possible condition scores. It is also important to note that while the point values for the aquatic ecosystem integrity index differ among the five aquatic ecosystems this difference is minimal compared to the range of possible values generated by the uncertainty assumed to be associated with these estimates.

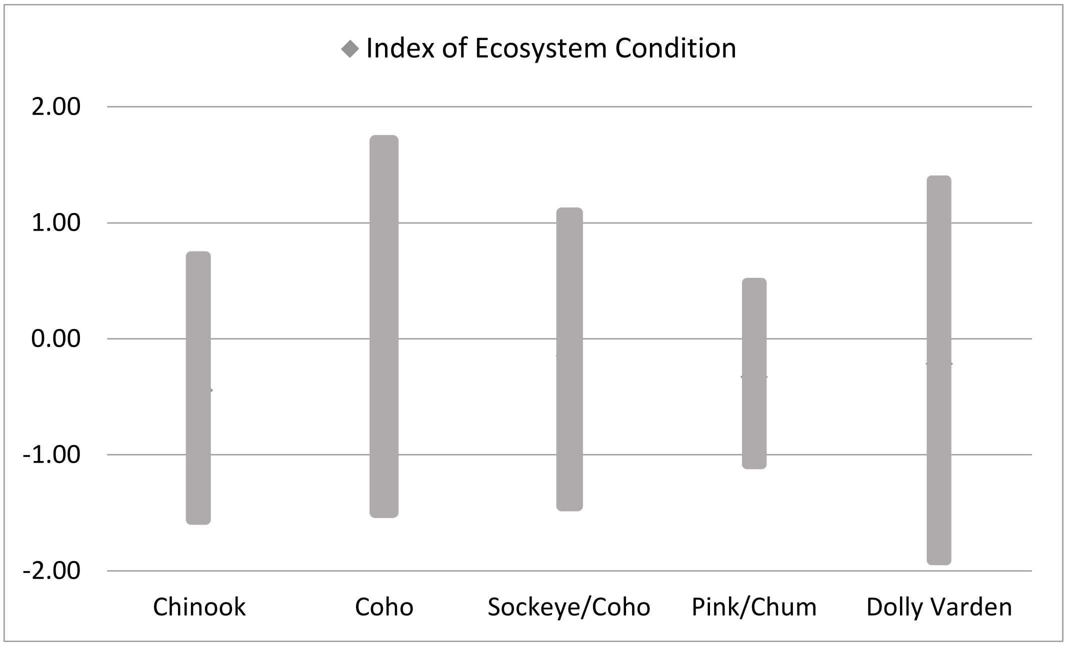


Figure 11. Overall aquatic ecosystem condition index scores (solid diamonds) and associated range of possible values representing scoring uncertainty (vertical bars) for five aquatic ecosystems that occur within the Chugach National Forest

Information Needs

This evaluation of Chugach National Forest aquatic ecosystems was limited by the lack of information and findings from relevant analyses. Many of these limitations could be overcome if the following list of information-based actions is undertaken.

- Existing and additional aquatic habitat data need to be developed in a manner that will inform key aquatic ecosystem characteristics of the Chugach National Forest. This would require a comprehensive inventory of aquatic habitat that is specifically structured to address the production of key, economically important species (e.g., salmon).
- Long-term fish monitoring across the Chugach National Forest is needed to successfully assess aquatic ecosystem trends. Working with other state and Federal fishery resource management partners, a means to cooperatively develop and maintain long-term data sets, is needed.
- In recent years, Chinook salmon returning to the Kenai River have declined to the lowest levels ever recorded. Information is needed to provide a better understanding of how Chinook salmon use the aquatic habitat in the upper Kenai watershed.

In areas where there is heavy fishing pressure, human foot traffic can seriously damage riparian habitat and adversely impact the condition of the aquatic ecosystem. The severely damaged riparian habitat alongside the Russian River that has since been repaired is one example of this problem. There is no systematic survey or inventory of popular fishing areas to assess whether similar damage is occurring elsewhere. Should such an inventory be developed, not only would it help evaluate the aquatic ecosystem condition, it would also identify possible locations for future restoration and monitoring opportunities.

Aquatic Ecosystems—Riparian Areas and Wetlands

This section describes the riparian and wetland ecosystem evaluation. Specific items evaluated include key ecosystem characteristics by geographic area, drivers and stressors, and riparian and wetland condition and trends. This section also uses the national assessment approach from the Watershed Condition Framework (WCF) and the Forest Service Watershed Condition Classification (WCC) Technical Guide (Potyondy & Geier, 2010) to evaluate riparian and wetland conditions across the national forest. Ecosystem integrity is evaluated as well, and the remaining information needs are provided.

Relevant Information

- There are several recreation developments that are within riparian areas. Recent floods (September 2012) and historic floods have eroded existing recreational developments (e.g. campsites and picnic areas) located within or adjacent to riparian areas. These types of sites should be given priority when seeking to restore riparian and floodplain function.
- The majority of the riparian areas within the Chugach National Forest are in good condition (Class 1). Impacts to riparian and wetland vegetation within the national forest are limited and localized. These impacts primarily occur along roads, in places where fuelwood harvest and large scale mining have occurred, in high recreational use areas (i.e., along the Russian River), and in areas affected by spruce bark beetles. A number of watershed restoration projects have occurred since 2002 to improve the functions of streams and riparian areas in various portions of the national forest.
- An integrated riparian mapping GIS layer does not exist for the national forest. Such a layer would be beneficial for planning and managing development activities in these areas across the national forest.
- Recreational gold mining activities are damaging riparian integrity. Standards and guidelines could be strengthened to reduce riparian resource damage. The locations where recreational gold mining are allowed or encouraged could also be re-examined.

Ecosystems Being Evaluated

Riparian areas are the interface between terrestrial and aquatic ecosystems and are an integral part of watersheds. Riparian ecosystems are characterized by the presence of trees, shrubs, or herbaceous vegetation that require free or unbound water or conditions that are moister than surrounding areas. Typical examples include floodplains, streambanks, lakeshores, tidal flats and sloughs, saltwater marshes, estuaries, freshwater ponds, marshes, bogs, muskegs, and forested wetlands. Riparian ecosystems are generally inclusive of wetlands.

Properly functioning riparian and wetland areas improve water quality, reduce erosion, filter sediment, capture bedload, stabilize streambanks, and act as a sink for atmospheric carbon. Riparian vegetation is a source of nourishment for many animals, from insects to mammals, including the organic matter that is an important source of nourishment to aquatic organisms. It also aids in providing leaf litter and terrestrial invertebrates to streams. Additionally, healthy riparian and wetland areas provide diverse habitats for fish, wildlife, waterfowl, and other species, many of which are obligates to this ecosystem for all or part of their life cycle. Riparian areas also provide travel corridors for wildlife, refugia for some species, and can provide essential temperature moderation.

Riparian areas are typified by continual change and periodic major disturbances from flooding, channel sinuosity, erosion, and periods of anaerobic submersion. Organisms within the riparian zone have special adaptations to respond to these changing and challenging conditions and some, such as beavers, may have a profound influence on the hydrology, and species composition within riparian zones.

An important ecological benefit of riparian areas is the production and input of wood into aquatic systems in rivers. Large woody debris in streams dissipates energy, stabilizes streambanks and captures sediment and nutrients. It also provides refugia for instream plants, fish, animals and aquatic insects; increases habitat complexity; and serves as unique microhabitats for species that use down wood components, including important arthropods that feed salmon and birds.

Within the Chugach National Forest, it is often hard to distinguish where riparian ecosystems differ from other forest vegetation. Riparian ecosystems are more easily delineated in regions with limited water availability. However, water (precipitation) is generally very abundant within the Chugach National Forest. Generally, annual precipitation (P) exceeds vegetation water losses to potential evapotranspiration (PET); however, some studies on the Kenai Peninsula have documented recent changes and accelerated losses of wetlands (drying habitats) associated with increased evapotranspiration as a direct result of increased mean summer temperatures since the 1970s (Berg, Henry, Fastie, DeVolder, & Matsuoka, 2006; Berg, Hillman, Dial, & DeRuwe, 2009; Klein, Berg, & Dial, 2005).

High water availability within the national forest also results in a great abundance and variety of wetlands. Wetlands are defined in the 1987 Corps of Engineers Wetlands Delineation Manual (US DOD, 1989): “Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and under normal circumstances do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, bogs, and similar areas.” The U.S. Fish and Wildlife Service has completed wetlands mapping of all of the Chugach National Forest and portions of the rest of Alaska. Approximately 1.44 million acres of the national forest is classified as wetland.

Total wetlands as inventoried by the National Wetlands Inventory using the Cowardin system (Cowardin, 1979) cover about 23 percent of the national forest. More than half of these wetlands are in the Copper River Delta geographic area. The Copper River Delta is the largest contiguous wetland on the Pacific coast of North America. There are 700,000 acres of wetlands plus associated uplands, and the area is a two million acre management unit that provides important fish and wildlife habitat. The Copper River Delta is recognized worldwide as an important conservation area. The complex riverine channels of the Copper River Delta provide spawning and rearing habitat for all five Pacific salmon species. In addition, some of the northernmost populations of cutthroat trout occur in the numerous small, clear-water streams. Nearly the entire world’s population of western sandpiper and Pacific dunlin use this area as a stopover site during spring migration. Six to 10 percent of the world’s trumpeter swan population nests on the Copper River Delta. Fifty to 70 percent of all Tule white-fronted geese stage here in the fall. One hundred percent of the world’s dusky Canada geese nest here. More than 10 million waterfowl and shorebirds use it as either a staging or breeding area. The Copper River Delta is the largest Forest Service managed Alaska key coastal wetland. The ecosystem services, natural capital, and fish and wildlife resources that this wetland provides is recognized by the Forest Service and by national and international agencies. See also Terrestrial Ecosystems—Wildlife.

Table 20 displays mapped wetlands by system type within the national forest administrative boundary and for each geographic area. Estuarine wetlands are generally those in the intertidal zone that have a brackish (part salt water and part fresh water) component. Riverine wetlands include wetlands within fresh water river channels. Lacustrine wetlands are defined as those wetlands and deepwater habitats in lakes deeper than about 6.5 feet and larger than 20 acres. Palustrine wetlands are generally small ponds, upland marshes, bogs, small muskegs and fens, and forested wetlands. Marine wetlands are those along the marine shoreline, including beaches, rocky shores, lagoons, and shallow reefs. Not displayed in this table are subtidal and deepwater estuarine and subtidal and deepwater marine environments.

Table 20. Wetland acres for each system within the Chugach National Forest and each geographic area

Wetland System	Wetland Acres			
	Geographic Areas			National Forest Totals
	Copper River Delta	Kenai Peninsula	Prince William Sound	
Estuarine	159,271	111,777	86,995	**358,042**
Lacustrine	37,582	28,983	28,959	**95,524**
Palustrine	355,834	39,674	367,433	**762,941**
Riverine	176,874	8,927	6,254	**192,054**
Marine	22,221	26	10,251	**32,498**
Totals	**751,782**	**189,386**	**499,891**	**1,441,059**

Data are from the USFWS National Wetlands Inventory and does not include subtidal, deep water, and the fiords of Prince William Sound, which are not managed by the Forest Service. Acreages are based on all lands within the outer boundary of the Chugach National Forest (this includes lands of other ownership within the national forest matrix) (USFWS, 1979).

Key Ecosystem Characteristics

Riparian area and wetland condition was one of the attribute indicators for the WCC assessment. As part of this effort, function and condition of native riparian vegetation along streams, water bodies, and wetlands was evaluated for the Chugach National Forest. Data sources for this analysis include resource specialist knowledge of local riparian conditions, information from various landscape assessments completed between 2000 and 2010, the FACTS GIS database delineating areas of past riparian harvest, Alaska-wide insects GIS database delineating areas of spruce bark beetle infestation, and Chugach National Forest corporate GIS database (legacy water features, streams).

Riparian areas and wetland function and condition were evaluated based on the parameters outlined in the WCC (Potyondy & Geier, 2010). The attributes evaluated include:

- Diverse age-class distribution of native riparian/wetland vegetation (recruitment for maintenance and recovery)
- Diverse composition of native riparian/wetland vegetation (for maintenance and recovery)
- Presence of native species that indicated maintenance of riparian/wetland soil moisture characteristics and connectivity between the riparian/wetland vegetation and the water table typical of riparian/wetland systems in the area
- Streambank native vegetation (with plants or plant communities that have root masses capable of withstanding high streamflow events)
- Native riparian/wetland vegetation adequately covers and protects the banks and dissipates energy during high flows
- Plant vigor: the presence of plant communities that will provide an adequate source of coarse and/or large woody material (for maintenance and recovery)

Based on the condition of these attributes, riparian/wetland areas were then rated into three classes: Class 1 (good, functioning properly); Class 2 (fair, functioning at risk); and Class 3 (poor, functionally impaired) (see table 21).

Table 21. Riparian/wetland vegetation condition rating rule set (Potyondy & Geier, 2010)

Attribute	Riparian/Wetland Vegetation Condition Indicator		
	Class 1 (good, functioning properly)	**Class 2 (fair, functioning at risk)**	**Class 3 (poor, functionally impaired)**
Vegetation condition	Native mid to late seral vegetation appropriate to site potential dominates the plant communities and is vigorous, healthy, and diverse in age, structure, cover and composition on more than 80 percent of the riparian/wetland areas in the watershed. Sufficient reproduction of native species appropriate to the site is occurring to ensure sustainability. Mesic herbaceous plant communities occupy most of their site potential. Vegetation is in dynamic equilibrium appropriate to the stream or wetland system.	Native vegetation demonstrates a moderate loss of vigor, reproduction, and growth, or it changes in composition, especially in areas most susceptible to human impact. Areas displaying light to moderate impact to structure, reproduction, composition, and cover may occupy 25 to 80 percent of the overall riparian area with only a few areas displaying significant impacts. Up to 25 percent of the species cover or composition occurs from early seral species and/or there exist some localized but relatively small areas where early seral vegetation dominates, but the communities across the watershed are still dominated by mid to late seral vegetation. Xeric herbaceous communities exist where water relationships have been altered but they are relatively small and localized, generally are not continuous across large areas, and do not dominate across the watershed.	Native vegetation is vigorous, healthy, and diverse in age, structure, cover, and composition on less than 25 percent of the riparian/wetland areas in the watershed. Native vegetation demonstrates a noticeable loss of vigor, reproduction, growth, and changes in composition as compared to the site's potential communities throughout the area most susceptible to human impact. In these areas, cover and composition are strongly reflective of early seral species dominance although late- and mid-seral species will be present, especially in pockets. Mesic-dependent herbaceous vegetation is limited in extent with many lower terraces dominated by xeric species most commonly associated with uplands. Reproduction of mid and late seral species is very limited. For much of the area, the water table is disconnected from the riparian area and the vegetation reflects loss of available soil water.

Drivers and Stressors

The primary system drivers and stressors to riparian and wetland areas include increased population and/or national forest use, potential decreased salmon stocks, glacial retreat, earthquakes and the anticipated overarching effects of climate change.

Impacts to riparian and wetland areas from increased population and/or national forest use could include increased placer mining, gravel extraction and development, increased water storage or diversions (hydroelectric facilities), new road construction, increased recreational use (particularly OHV use and angler developed trails), and the potential for increased introduction of invasive species (both terrestrial and aquatic) (Haufler, Mehl, & Yeats, 2010). Overall, human activity tends to concentrate in riparian areas. Riparian areas offer scenic qualities, fishing and trapping opportunities, flatter topography (on lower reaches) and the potential of travel (boats, float planes). Riparian areas within the Chugach National Forest have few impacts due to reduced access, steep topography and high gradient stream systems. Lower reaches of some major waterways are bounded by roads, railroads, and trails in localized areas where access is easier; there impacts to riparian areas are more prevalent.

Potential decreases in salmon stocks may also reduce the productivity of riparian ecosystems. Spawning Pacific salmon contribute marine-derived nutrients to riparian ecosystems, which fertilize and enhance riparian production (Bartz & Naiman, 2005; Gende, Miller, & Hood, 2007; Helfield & Naiman, 2001). A decrease in these ocean derived nutrients may decrease the health and vigor of riparian vegetation over time.

Earthquakes may also play a role as a system driver and stressor for wetlands by changing water table elevations. The 1964 earthquake profoundly affected wetlands across the Chugach National Forest. Tectonic subsidence in some areas, such as Cook Inlet and parts of eastern Prince William Sound, resulted in locally elevated ocean levels introducing saltwater to freshwater ecosystems. Conversely, in areas of tectonic uplift, such as the Copper River Delta and most of Prince William Sound, previous saltwater influenced wetlands converted to freshwater. The earthquake also drained 700,000 acres of wetlands in a matter of minutes (Kuntzsch, personal communication, 2014). Wetlands in these affected areas of earthquake uplift and subsidence will be adapting for the next 200 to 400 years. The change from productive saltwater marshes to less productive freshwater systems has had impacts on vegetation and wildlife, most notably the dusky Canada goose (see At Risk Species—Potential Species of Conservation Concern section).

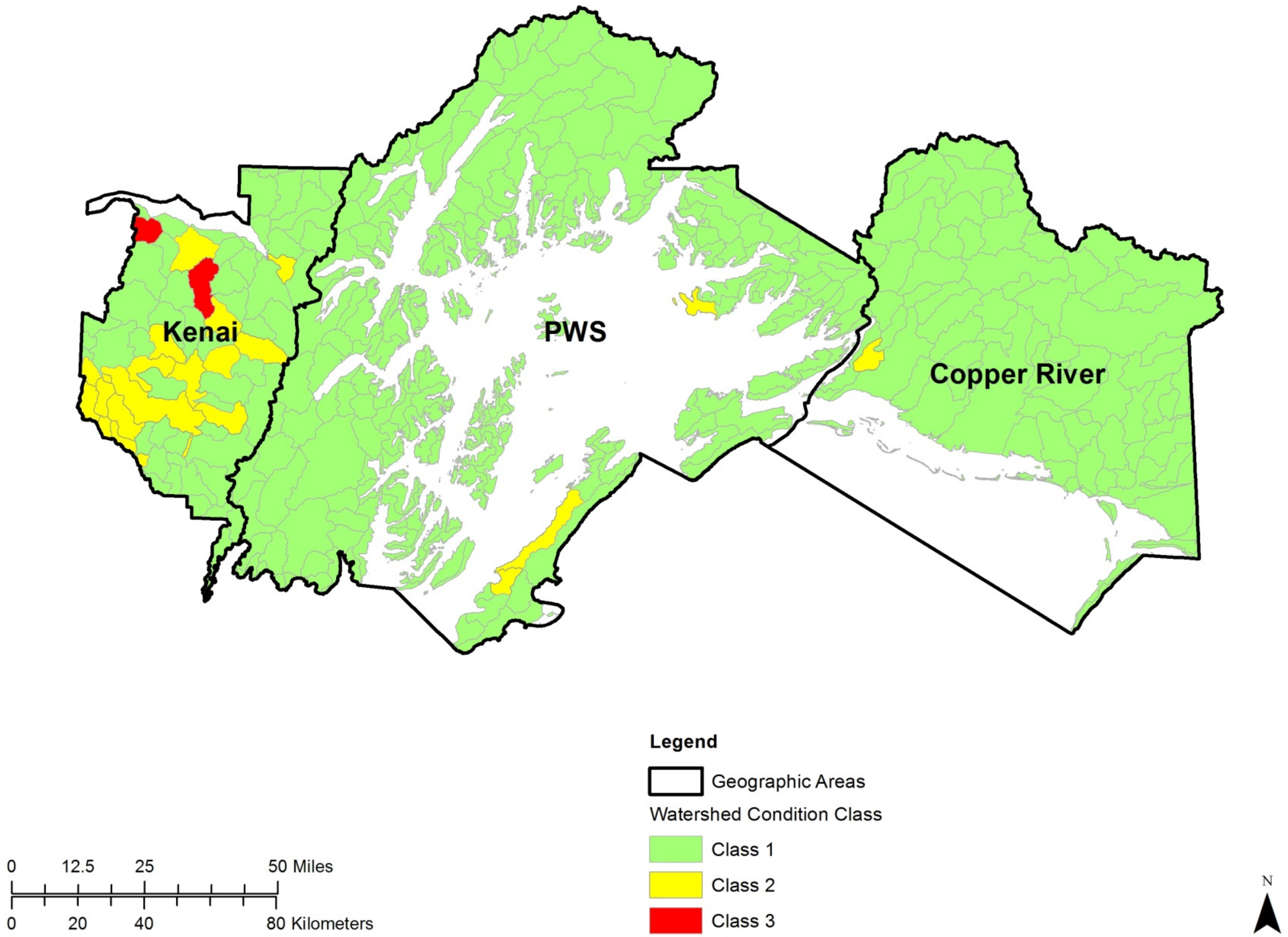
Impacts to riparian and wetland areas from climate change are discussed in the Climate Change section.

Condition and Trends

The Forest Service classified riparian area and wetland conditions for 275 HUC 6 watersheds as part of the WCF using the process outlined in the WCC. The results of the WCC for riparian and wetland condition ratings for the Chugach National Forest are displayed in table 22 and map 4.

Table 22. Riparian and wetland condition ratings for the Chugach National Forest (MacFarlane, Zemke, Kelly, Hodges, & DeVelice, 2011)

Rating	Watersheds
Class 1 (good, functioning properly)	253
Class 2 (fair, functioning at risk)	20
Class 3 (poor, functionally impaired)	2



Map 4. Chugach National Forest watersheds with riparian and wetland impacts by WCC.

Table 23 displays the detailed results of the WCC. Overall, national forest riparian area and wetland conditions are good and functioning properly. The majority of riparian and wetland areas within the Chugach National Forest are unmanaged and not developed. Impacts to riparian area and wetland vegetation are limited. These impacts primarily occur along roads, in OHV use areas, in places where timber harvest and large scale mining have occurred, in high recreational use areas (i.e., Russian River), and in areas affected by the spruce bark beetle infestation during the 1990s. More than 80 percent of the riparian/wetland impacted watersheds within the national forest are on the Kenai Peninsula where human population and use is greater and the effects of spruce bark beetle is more common.

Placer mining within the national forest is generally located within riparian areas. Placer mining activity can involve removing riparian vegetation and processing the gravel substrates found within these riparian areas. Placer mining activities have led to heavy sediment loads in the stream channels, loss of vegetation and soil, and in some cases alteration of stream channel and flood plain function. Streams within the national forest particularly affected by placer mining activities include Resurrection Creek and its tributary Palmer Creek, Bear, Sixmile, Mills, Juneau, Canyon, Cooper, Bertha, Lynx, Silvertip, Gulch, Quartz, and Falls creeks (near Crown Point). Lower Resurrection Creek is impacted by historic and ongoing large scale placer mining activities. Although stream and riparian restoration was conducted on one mile of Resurrection Creek in 2005 and 2006, the vegetation in this reach will take a number of years before it reaches maturity and is able to function naturally. Similar impacts from historic mining have occurred on Cooper Creek.

Recreational gold panning and suction dredging activities also occur within riparian areas. These operations are only authorized to occur within active stream channels, unvegetated abandoned stream beds or unvegetated gravel bars. However, certain systems such as Resurrection Creek and Six-mile Creek, where recreational mining is encouraged (Huber & Kurtak, 2010), are exhibiting mining that extends into the vegetated stream banks causing damage to riparian function and integrity. For instance, in Resurrection Creek, the stream channel has widened up to 20 feet due to a loss of stream banks from these activities. Standards and guidelines could be strengthened to reduce riparian resource damage. The locations where recreational gold mining is allowed or encouraged could also be re-examined.

Past timber harvest on recently acquired lands in Prince William Sound has impacted riparian vegetation where riparian buffers were not adequate (areas on Knowles Head Peninsula and Montague Island). This riparian harvest has resulted in a reduction of large woody debris recruitment into streams, which affects channel form, nutrient inputs, cover, and habitat complexity, as well as riparian vegetation diversity. Habitat complexity and diversity is important for wildlife, birds, fish, and invertebrates. The spruce bark beetle infestation of the 1990s has impacted numerous riparian spruce forests on the Kenai Peninsula and reduced streamside spruce cover. These impacts include loss of riparian vigor, reproduction, and growth, as well as changes in composition. Mortality of spruce has resulted in short-term increases in large woody debris to streams. In the long-term, these areas will have limited large woody debris recruitment and loss of streamside shading.

Roads and trails have impacted riparian and wetland areas where they are located immediately adjacent to streams or water bodies. Their effects include contributions of road derived pollutants, introduction of invasive species, barriers to movement for both terrestrial and aquatic species and loss of wetland connectivity. Some, such as the Seward Highway and the Alaska Railroad, have changed the flow of water in and out of wetlands to the extent that they have converted some estuarine habitats into freshwater habitats resulting in changed riparian vegetation and wetland communities. Wetland damage, such as compaction, erosion, loss of vegetation, and creation of seedbeds for invasive species, also exists from

OHV use on unauthorized trails (user created), particularly on the Copper River Delta and on Hawkins and Hinchinbrook islands.

Table 23. Attribute rankings for the Riparian/Wetland Vegetation indicator within the Chugach National Forest (MacFarlane, Zemke, Kelly, Hodges, & DeVelice, 2011)

Geographic Area	HUC	Watershed Name	Rating*	Comments
Copper River Delta	190201041604	Eyak Lake	2	Roads and development impact riparian vegetation along Eyak Lake and Eyak River.
Kenai Peninsula	190203020304	Portage Creek	2	Much of Portage Creek riparian corridor impacted by highway, railroad, and gravel extraction.
	190203020404	Bench Creek	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203020407	East Fork Sixmile Creek	3	Spruce in riparian floodplains heavily impacted by spruce bark beetle, numerous dead trees.
	190203020408	Walker Creek-Sixmile Creek	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203020504	Lower Resurrection Creek	3	Three miles of Resurrection Creek riparian corridor severely impacted by past and present placer mining, 1 mile of 2005-2006 Phase I restored area has not yet reached maturity. Spruce in remaining riparian floodplains impacted by spruce bark beetle, numerous dead trees.
	190203021001	Headwaters Trail Creek	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203021003	Outlet Trail Creek	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203021007	Trail Lake-Trail River	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203021102	Headwaters Quartz Creek	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203021104	Outlet Quartz Creek	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203021203	Ptarmigan Lake-Ptarmigan Creek	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203021205	Kenai Lake	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203021402	Cooper Lake	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203021403	Stetson Creek-Cooper Creek	2	Lower 1 mile of Cooper Creek riparian corridor impacted by historic placer mining. Spruce impacted by spruce bark beetle.
	190203021404	Headwaters Russian River	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees.
	190203021405	Outlet Russian River	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees, mostly upstream of Lower Russian Lake.
	190203021406	Jean Creek-Kenai River	2	Spruce in riparian floodplain impacted by spruce bark beetle, numerous dead trees. Some impacts to riparian from Sterling Highway proximity.

Geographic Area	HUC	Watershed Name	Rating*	Comments
Prince William Sound	190202011201	Goose Island-Frontal Prince William Sound	2	Knowles Head timber harvest occurred over some riparian and wetland areas and caused some blowdown in riparian area.
	190202020503	Headwaters Resurrection River	2	Spruce in riparian floodplains heavily impacted by spruce bark beetle, numerous dead trees.
	190202030406	Montague Island-Frontal Prince William Sound	2	Timber harvest occurred in the 1960s and 1970s with no buffers on many streams.
	190202030407	Hanning Bay-Frontal Montague Strait	2	Timber harvest occurred in the 1960s and 1970s with no buffers on many streams.

*All watersheds within the Chugach National Forest received a rating of 1 except for those displayed in this table.

Riparian and Wetland Area Integrity

Riparian and wetland area conditions reflect a range of variation from the natural condition (functioning properly) to degraded (severely altered state or impaired). Riparian and wetland areas that are functioning properly exist when adequate native vegetation, landform, or large woody debris is present within its natural range of variation. Riparian and wetland areas exemplify variability and adaptation in their fully functional state. Consistent with stream process group, a functional system will:

- Filter sediment, capture bedload, and aid in floodplain development
- Improve flood-water retention and ground-water recharge
- Develop root masses that stabilize streambanks against cutting action
- Develop diverse ponding and channel characteristics to provide habitat and water depth, duration, and temperature necessary for fish production, waterfowl breeding, and other uses
- Support greater biodiversity

In general, the greater departure from the natural state, the more impaired the riparian area is likely to be.

Healthy, properly functioning riparian and wetland areas generally exhibit strong integrity, are more resilient to stressors, and have a greater adaptive capacity. It is anticipated that the trend of strong integrity for the 92 percent of Chugach National Forest riparian areas in good condition will continue. Ultimately, it will be important for Forest Service management to maintain and improve habitat complexity and diversity to ensure resilient species.

A number of watershed restoration projects have occurred within the national forest during the last decade. These improvements have included large scale stream and riparian restoration projects (i.e., Resurrection and Daves creeks) and riparian thinning projects (i.e., Hinchinbrook Island and Knowles Head). These projects have improved the functions of streams and riparian areas associated with impacts from past or historic land management and current activities. Continuing to restore these watersheds, riparian areas, and wetlands will sustain and improve integrity.

Impacts to riparian and wetland areas that affect integrity if not addressed through management include:

- Erosion, sedimentation, and wetland damage from OHV routes forestwide
- Erosion, sedimentation, and wetland damage from user trails (foot and OHV) in the Copper River Delta area
- Stress on streambanks along the Russian River, despite management efforts to restore and protect banks
- Increased use and development needs in riparian areas

- Damage from designated and undesignated campsites and outhouses located within riparian areas
- Damage to riparian areas from commercial mining activities
- Damage from recreational gold panning and sluicing operations, such as digging in banks rather than in active channels as currently allowed
- Stress on streambanks associated with increased back country trail use or use by pack animals
- Trash and plastics (see Marine and Terrestrial Garbage and Debris)
- Introduced species through waders, intentional pet release, off-site bait, and organisms that attach to boats, fishing gear, or float planes

Mechanisms are in place to mitigate the impacts and activities that affect stream banks, wetlands, and riparian areas across the national forest. These include best management practices (BMPs), reclamation, and access control. However, in order to better assess potential impacts to riparian areas as described previously, an integrated riparian mapping GIS layer could be developed. Such a layer would be beneficial for planning and managing development activities.

Terrestrial Ecosystems—Soils

This section of the assessment includes a characterization of the status of soil resources and soil quality. Specifically, this section is used to identify and describe available information on soils and sites, current inventories of soil conditions and improvement needs, and important attributes or characteristics of soils and sites that are susceptible to degradation.

Relevant Information

- Other than finalizing the existing soil monitoring protocol, there is no apparent need to change the management direction of the 2002 Forest Plan relating to soil management based on currently available data.

Key Ecosystem Characteristics

Historically, the National Hierarchical Framework of Ecological Units (Cleland, et al., 1997) has been used by the Forest Service as the basis for mapping landscapes, soils, and vegetation. Ecological classification and mapping systems stratify landscapes at multiple scales, thereby providing a better understanding of the arrangement, pattern, and capabilities of ecosystems. Classification and mapping at the landscape scale uses Landtype Association (LTA) levels. Landtype associations depict broad patterns of soil families or subgroups, the potential natural vegetation (PNV) series, and, on occasion, show successional dynamics (Winthers, et al., 2005). The next finer scale of classification and mapping is the land-unit scale, which represents the most detailed levels of the national hierarchy. These are commonly mapped as Landtypes and Landtype Phases. These depict patterns of soil families or series and PNV subseries and plant associations (Winthers, et al., 2005). Most soil resource inventories are mapped at this scale.

These inventories, in combination with other standard GIS resource layers, provide the basis for selecting suitable areas for major kinds of land-use activities, identifying areas that need more intensive investigation, evaluating various land management alternatives, classifying vegetation and habitat, and predicting the effects of a given activity on resource health or condition.

The current inventory of the soil resource was done at the landscape level and mapped as an LTA inventory. Other, more intensive land-unit mapping efforts, including soil surveys, have taken place where management occurs along the road system. These inventory efforts have been completed at different scales of mapping, intensity, and data collection. In some areas where there is little to no field evaluation, the inventory relied on map and aerial photo interpretation. Soils information in these inventories may be outdated and consequently may not follow current Forest Service or National Cooperative Soil Survey (NCSS) protocol or taxonomy. To date, comprehensive forestwide landtype mapping (or soil resource inventory) has not been completed.

The 2002 Forest Plan final environmental impact statement (FEIS) used LTA information to generally describe the soil resources at a very broad scale and describe general processes that affect soil condition and productivity. There are eight reoccurring LTAs within the Chugach National Forest (Davidson, 1998a; Davidson, 1998b). Table 24 displays the acres of these LTAs by geographic area, including all ownerships. A map of LTAs across the national forest is in the map package appendix. General soil characteristics for these LTAs follow:

- *Glaciers and ice fields*: Some surface deposited soil (ice and rocks dominate).
- *Mountain summits*: Shallow coarse textured soil between rock outcrops. These soils are sensitive to disturbance because they are thin and easily displaced.

- *Mountain side slopes*: Medium textured soil with moderate amounts of coarse fragments often with substantial ongoing erosion.
- *Depositional slopes*: Both deep, well drained, medium textured soil with variable amounts of coarse fragments and areas of fine textured soil that pond water and form wetlands.
- *Glacial moraines*: Poorly to well-drained soils with coarse fragments consisting of non-sorted gravel, cobbles, and stones in a moderate to fine textured matrix. Poorly drained and somewhat poorly drained soils can be highly susceptible to compaction due to wetness.
- *Coastal landscapes*: Both deep, excessively drained sand on beaches and dunes exposed to continuous erosion and deep, poorly drained silts on tidal flats.
- *Fluvial valley bottom outwash*: Dominated by deep, stratified soils with rounded coarse fragments. Pond water or wetlands may occur on fine textured soil. High water tables are common.
- *Hills and plateaus*: Both coarse to medium textured soil with 15 to 65 percent coarse fragments and organic soils in basins between hills where the organic material rests on glacial till or bedrock.

Table 24. Distribution of LTAs by geographic areas of the Chugach National Forest (includes all landownership)

LTA Name	Geographic Area						Totals	
	Copper River Delta		Kenai Peninsula		Prince William Sound			
	acres	percent	acres	percent	acres	percent	acres	percent
Glaciers and ice fields	866,462	40.0	147,933	12.0	1,243,188	41.1	**2,257,583**	**35.1**
Mountain summits	196,933	9.1	407,011	32.9	606,713	20.0	**1,210,657**	**18.8**
Mountain side slopes	242,541	11.2	367,319	29.7	519,807	17.2	**1,129,667**	**17.6**
Depositional slopes	33,586	1.6	124,141	10.0	15,030	0.5	**172,757**	**2.7**
Glacial moraines	47,929	2.2	5,237	0.4	8,493	0.3	**61,659**	**1.0**
Coastal landscapes	334,296	15.4	1,513	0.1	9,491	0.3	**345,300**	**5.4**
Fluvial valley bottom outwash	328,240	15.2	45,839	3.7	33,840	1.1	**407,919**	**6.3**
Hills and plateaus	116,451	5.4	137,127	11.1	590,415	19.5	**843,993**	**13.1**
Totals	**2,166,438**	**100.0**	**1,236,120**	**100.0**	**3,026,977**	**100.0**	**6,429,535**	**100.0**

The 2002 Forest Plan FEIS identifies the most productive soils within the national forest as moderately well drained to well-drained with a medium texture. They are found on fluvial valley bottoms and on depositional slopes. Soils on these land types in the Prince William Sound are more productive than those in the Kenai Peninsula because of more moderate temperatures and greater precipitation.

Organic matter/wetlands

Organic layers thicker than 15.7 inches (40 centimeters) are classified as organic soils and are indicative of wetlands. Total wetlands as inventoried by the National Wetlands Inventory using the Cowardin system (Cowardin, 1979) are about 23 percent of the national forest. Wetlands are considered components or inclusions in the LTA mapping and some of the other, more intensive soil resource inventories and are not specifically identified in these inventories.

Soil quality

Soil is a basic component of the environment. Most living things depend on soil for their initial source of nutrients. Soil absorbs and holds nutrient rich water, releasing it at varying rates to supply nutrients for microorganisms and plants that become food sources and habitat for larger animals and people.

The capability of current soil conditions to support the full range of ecosystem functions and human uses can be described as soil quality. The Soil Science Society of America (2013) has defined soil quality as, "The capacity of a soil to function within ecosystem boundaries to sustain biological productivity, maintain environmental quality, and promote plant and animal health." In order to protect soil quality, it is important to recognize that there are numerous kinds of soils and that the properties of a soil affect a wide variety of ecosystems within the Chugach National Forest.

Key soil properties needed to support ecosystem integrity can be impacted by soil disturbance. The 2002 Forest Plan and regional and national directives identified concerns for ground disturbing activities, including those that compact soil and reduce porosity, affect water flow and aeration, displace surface soils, and cause nutrient and organic matter losses. Forestwide, key soil properties related to these potential impacts include bulk density, porosity, presence of forest floor and A horizons, and effective ground cover. Key characteristics of wetlands include hydric soils, hydrophytic vegetation, and wetland hydrology.

Terrestrial Ecosystems—Soils Condition and Trends

The 2002 Forest Plan places disturbance caps on management activities with the goal of maintaining the productivity of the land.

The primary goal of soil management within the national forest is to maintain soil quality. This process includes inventorying soils, vegetation, and landscape characteristics to identify and locate the soils, making interpretations for appropriate Forest Service management activities, and assuring soil recommendations are implemented.

The 2002 Forest Plan, Chief's appeal decision (USDA, 2004b), and subsequent documents (USDA, 2010a) resulted in two monitoring questions related to soils. The questions are:

1. What is the level of ground disturbing activity?
2. What is the effect of off highway vehicle (OHV) use on the soil and vegetation resources?

In 2010, a decision was made to combine the OHV and ground disturbing monitoring into one protocol. The Monitoring Guide for Chugach National Forest Revised Land and Resource Management Plan (USDA, 2011a) identifies monitoring items for evaluating how well the plan is being implemented and the effect on resources. The monitoring question for soil resources became: "Is Forestwide soil quality decreasing over time due to ground disturbing activities (e.g., OHV and snowmachine use, concentrated foot traffic, fuel reduction activities, road and trail construction)?" As of 2014, this soil monitoring protocol was still not finalized.

Soil resource monitoring to evaluate the level of ground disturbing activity was conducted once in 2009. Results indicated that less than one percent of the area surveyed was disturbed and none of it rated as detrimentally disturbed. Effects of OHV use on soils were evaluated in 2008. At that time, several areas within the Copper River Delta were identified in the 2008 Monitoring Report as having increased disturbance levels. No further soil disturbance monitoring has been conducted.

Terrestrial Ecosystems—Vegetation

This section describes the terrestrial ecosystems evaluation for the Chugach National Forest, including vegetation diversity and system drivers and stressors. Conditions and trends are described, ecosystem integrity is assessed, and information needs are identified. See the Terrestrial Ecosystems—Wildlife section for a discussion of the wildlife component of the terrestrial ecosystem.

Relevant Information

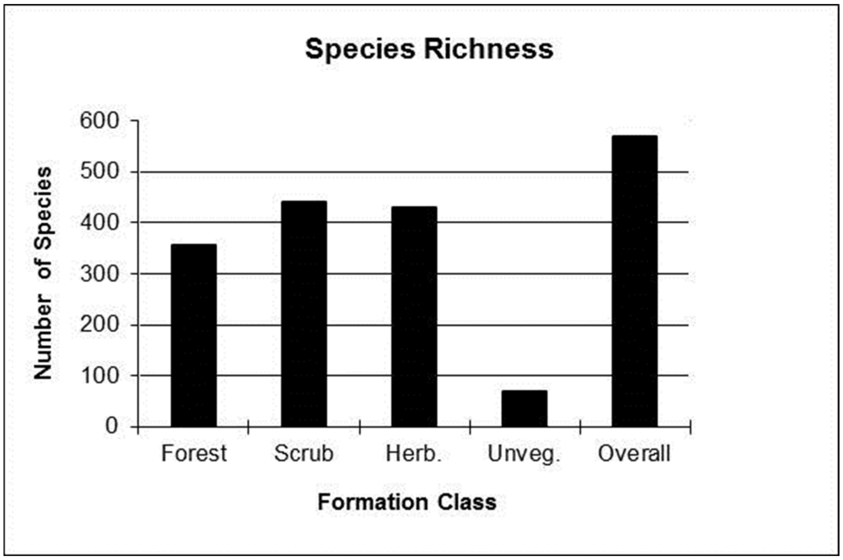
- Invasive plants have increased in number particularly in areas of human disturbance.
- The total area of infestation of highly invasive terrestrial plant species for the Chugach National Forest is estimated at less than 1,000 acres. About 86 percent of the non-native plant occurrences are located on the Kenai Peninsula. Focused treatments on less than 1,000 acres would limit the spread of highly invasive species known to occur within the Chugach National Forest.
- The spread of *Elodea* spp. (waterweed), a fish tank plant, is an emerging issue. It grows at lake margins and in sloughs on the Copper River Delta and in lakes on the Kenai National Wildlife Refuge. Recent Forest Service invasive species surveys reveal that the plant is spreading to new lakes and known populations are growing in size. This plant spreads very quickly, forming dense mats of floating and submerged leaves that can clog waterways and damage aquatic ecosystems.
- Initial modeling suggests that the Chugach National Forest will have variable ecological responses to climate change. The least change could occur in the coastal rainforests of Prince William Sound and the Copper River Delta, which are expected to remain as rainforests.
- The richness and diversity of the native vegetation within the Chugach National Forest likely provides a high level of resistance and resilience in response to climate change.

Terrestrial Ecosystems—Vegetation Key Ecosystem Characteristics

Vegetation diversity

The Chugach National Forest features a wide array of terrestrial plant communities. As described by DeVelice et al. (1999), the interaction of complex topography, varied climate, and periodic disturbance coupled with numerous plant species has resulted in a rich vegetation mosaic. The range of vascular plant (e.g., seed bearing plants and ferns) species richness (total number of species) across the national forest varies from less than 70 species in sparsely vegetated areas to more than 440 in shrublands (see figure 12 part A). More than 560 vascular plant species have been documented forestwide, equaling about one-third of the flora of Alaska. Additionally, more than 280 community types have been documented in the national forest (see figure 12 part B).

(A)*



(B)

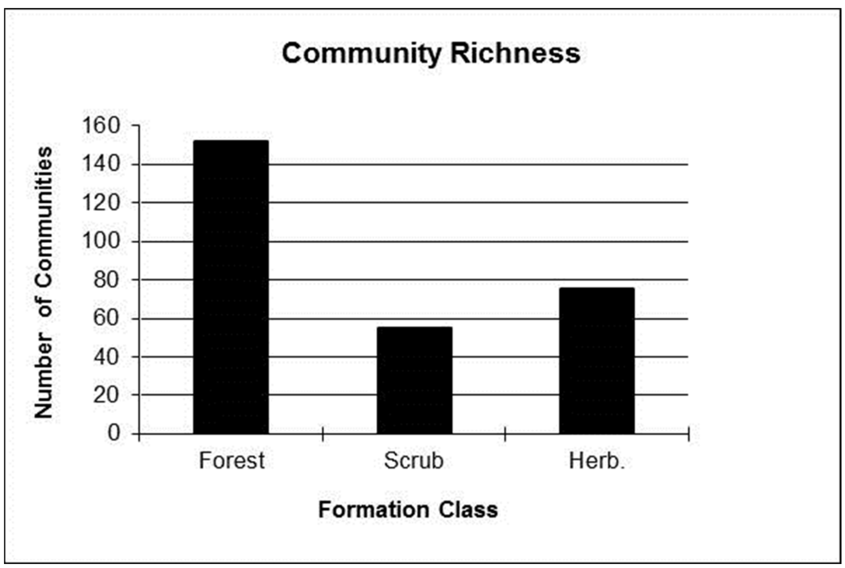


Figure 12. Vascular plant species richness (A) and plant community richness (B) by broad classes of forest, shrub, and herbaceous vegetation across the Chugach National Forest (DeVelice, et al., 1999)
*Unveg. indicates vegetation cover is less than 15 percent

DeVelice (2012a) evaluated existing land cover/vegetation maps for accuracy and utility for land management planning applications within the Chugach National Forest. The National Land Cover Database (NLCD) was found to be the best available classification spanning the national forest. Accuracy of NLCD in the Coastal Rainforest region of southcentral and southeast Alaska, including the area of the Chugach National Forest, was estimated at about 88 percent by Selkowitz and Stehman (2011).

The NLCD describes 19 land cover classes in Alaska. These land cover types are aggregated into one of five broad groupings: snow/ice/barren, shrubland, forested water, and herbaceous. Detailed descriptions of the 19 NLCD classes are in table 25. The approximate distribution of land cover across the Chugach National Forest is 43.0 percent snow/ice/barren, 30.0 percent shrubland, 22.7 percent forested, 2.7 percent water and 1.5 percent herbaceous. The approximate distribution of land cover across the Chugach National Forest and by geographic area in each of the five broad classes is displayed in the vegetation assessment map in the map package appendix and in table 26. The Kenai Peninsula, Prince William Sound, and Copper River Delta represent 20, 48, and 32 percent of the total acreage, respectively.

Table 25. NLCD class descriptions (Selkowitz & Stehman, 2011) for the 19 classes represented in Alaska*

Class ID	Aggregate	Description
12	Snow/ice/barren	**Perennial ice/snow:** All areas characterized by a perennial cover of ice and/or snow, generally greater than 25% of total cover.
21	Snow/ice/barren	**Developed, open space:** Includes areas with a mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20% of total cover. These areas most commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes.
22	Snow/ice/barren	**Developed, low intensity:** Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 20 to 49% of total cover. These areas most commonly include single-family housing units.
23	Snow/ice/barren	**Developed, medium intensity:** Includes areas with a mixture of constructed materials and vegetation. Impervious surfaces account for 50 to 79% of the total cover. These areas most commonly include single-family housing units.
24	Snow/ice/barren	**Developed, high intensity:** Includes highly developed areas where people reside or work in high numbers. Examples include apartment complexes, row houses, and commercial/industrial. Impervious surfaces account for 80 to 100% of the total cover.
81	Snow/ice/barren	**Pasture/hay:** Areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops, typically on a perennial cycle. Pasture/hay vegetation accounts for greater than 20% of total vegetation.
82	Snow/ice/barren	**Cultivated crops:** Areas used for the production of annual crops, such as corn, soybeans, vegetables, tobacco, and cotton, and also perennial woody crops such as orchards and vineyards. Crop vegetation accounts for greater than 20% of total vegetation. This class also includes all land being actively tilled.
31	Snow/ice/barren	**Barren land (rock/sand/clay):** Barren areas of bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits, and other accumulations of earthen material. Generally, vegetation accounts for less than 15% of total cover.
51	Shrubland	**Dwarf scrub:** Alaska only areas dominated by shrubs less than 20 cm tall with shrub canopy typically greater than 20% of total vegetation. This type is often co-associated with grasses, sedges, herbs, and non-vascular vegetation.
52	Shrubland	**Shrub/scrub:** Areas dominated by shrubs; less than 5 meters tall with shrub canopy typically greater than 20% of total vegetation. This class includes true shrubs, young trees in an early successional stage, or trees stunted from environmental conditions.
90	Shrubland	**Woody wetlands:** Areas where forest or shrubland vegetation accounts for greater than 20% of vegetation cover and the soil or substrate is periodically saturated with or covered with water.

Class ID	Aggregate	Description
41	Forested	**Deciduous forest:** Areas dominated by trees generally greater than 5-m tall, and greater than 20% of total vegetation cover. More than 75% of the tree species shed foliage simultaneously in response to seasonal change.
42	Forested	**Evergreen forest:** Areas dominated by trees generally greater than 5 meters tall, and greater than 20% of total vegetation cover. More than 75% of the tree species maintain their leaves all year. Canopy is never without green foliage.
43	Forested	**Mixed forest:** Areas dominated by trees generally greater than 5-m tall, and greater than 20% of total vegetation cover. Neither deciduous nor evergreen species are greater than 75% of total tree cover.
11	Water	**Open water:** All areas of open water, generally with less than 25% cover of vegetation or soil.
71	Herbaceous	**Grassland/herbaceous:** Areas dominated by graminoid or herbaceous vegetation, generally greater than 80% of total vegetation. These areas are not subject to intensive management, such as tilling, but can be utilized for grazing.
72	Herbaceous	**Sedge/herbaceous:** Alaska only areas dominated by sedges and forbs, generally greater than 80% of total vegetation. This type can occur with significant other grasses or other grass like plants, and includes sedge tundra, and sedge tussock tundra.
95	Herbaceous	**Emergent herbaceous wetlands:** Areas where perennial herbaceous vegetation accounts for greater than 80% of vegetation cover and the soil or substrate is periodically saturated with or covered with water.
74	Not applicable	**Moss:** Alaska only areas dominated by mosses, generally greater than 80% of total vegetation (note: not mapped within the boundary of the Chugach National Forest).

Table 26. Acreage by aggregated NLCD classes within the outer boundary of the Chugach National Forest, including lands of other ownership

Landcover Class	Acreage and Percent			Percent by Geographic Area		
	Hectares	Acres	Percent	Kenai Peninsula	Prince William Sound	Copper River Delta
Snow/Ice/Barren						
Perennial ice/snow	682,084	1,685,463	26.7	16.5	32.0	25.1
Developed	1,916	4,735	0.1	0.2	0.0	0.1
Barren land	416,267	1,028,616	16.3	16.6	12.6	21.6
Subtotals	*1,100,267*	*2,718,814*	*43.0*	*33.4*	*44.6*	*46.8*
Shrubland						
Dwarf shrub	71,872	177,598	2.8	14.1	0.0	0.0
Shrub/scrub	537,232	1,327,527	21.0	30.0	20.1	16.8
Woody wetlands	157,851	390,058	6.2	1.1	3.5	13.4
Subtotals	*766,955*	*1,895,184*	*30.0*	*45.2*	*23.6*	*30.2*
Forested						
Deciduous forest	33,546	82,893	1.3	1.4	0.8	2.0
Evergreen forest	541,957	1,339,204	21.2	15.9	28.9	13.0
Mixed forest	4,682	11,570	0.2	0.9	0.0	0.0
Subtotals	580,185	1,433,667	22.7	18.2	29.7	15.0
Water						
Open water	69,855	172,615	2.7	2.6	1.8	4.2
Herbaceous						
Herbaceous	7,121	17,597	0.3	0.1	0.3	0.4
Emergent herbaceous wetlands	31,411	77,617	1.2	0.5	0.1	3.4
Subtotals	*38,532*	*95,214*	*1.5*	*0.6*	*0.4*	*3.8*
Totals	**2,555,794**	**6,315,494**	**100**	**100**	**100**	**100**

Vegetation by geographic area

The 2002 Forest Plan FEIS summarized ecological diversity based primarily on land cover/vegetation types, vegetation structure, and a bioenvironmental classification comprised of generalized climate, land cover, and landform. The Kenai Peninsula, the Prince William Sound, and the Copper River Delta were considered (see figure 13). Some characteristic plants of these areas by broad land cover class are summarized here. DeVelice et al. (1999) and Boggs (2000) provide detailed descriptions of the vegetation composition and structure across the Chugach National Forest.

Snow, ice, and barren

Predominant plants within the mostly non-vegetated rock and ice dominated upper elevations of the Chugach and Saint Elias mountains are lichens and dwarf shrubs (e.g., crowberry, Steller's cassiope, luetkea, and bog blueberry).

Forested

The greatest percentage of forested cover occurs on Prince William Sound at about 30 percent (see table 26 and the vegetation assessment map in the map package appendix). Forests of Prince William Sound and the Copper River Delta are temperate rainforests while the Kenai Peninsula forests are transitional between boreal forests and temperate rainforests. Characteristic evergreen trees are Lutz spruce (hybrid between white and Sitka spruces) and occasional black spruce on the Kenai Peninsula, mountain hemlock on the Kenai Peninsula and Prince William Sound, and Sitka spruce and western hemlock in the Prince William Sound and Copper River Delta. Prince William Sound is the home to the northwestern range limits of western hemlock and yellow-cedar. The mountain hemlock of the Kenai Peninsula and Prince William Sound occurs primarily on side slopes at low to mid elevations while the spruces of the Chugach National Forest may dominate on both valley bottoms and side slopes. On the Copper River Delta, the forests frequently occur as strings of trees (especially on slough levees) between adjacent open wetlands.

Kenai paper birch is a dominant deciduous tree species and a major component of the mixed forests of the Kenai Peninsula, and quaking aspen forests occur sporadically on southern side slopes. Black cottonwood is commonly found in the valley bottoms of the Kenai Peninsula and on the Copper River Delta. Deciduous forests are least common in Prince William Sound with occasional occurrences of black cottonwood.

Early blueberry and devil’s club are common undergrowth species of the forests of the Chugach National Forest. Bluejoint reedgrass, lowbush cranberry, crowberry, and Schreber’s feathermoss are especially common on the Kenai Peninsula. Rusty menziesia, wood fern, and splendid feathermoss are common both on the Kenai Peninsula and in Prince William Sound. Copperbush, deer cabbage, Pacific reedgrass, and gooseneck mosses are common in Prince William Sound. Salmonberry and skunk cabbage are common on both Prince William Sound and the Copper River Delta. The black cottonwood forests of the Copper River Delta often have an undergrowth of Sitka alder and willow.

Shrubland and herbaceous vegetation

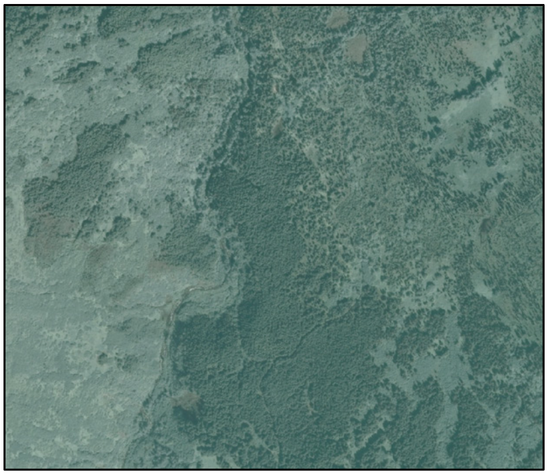
The Kenai Peninsula has the greatest percentage of shrubland cover at about 45 percent, and the Copper River Delta has the greatest percentage of herbaceous cover at about 4 percent (see table 26 and figure 13). Sitka alder is a characteristic shrubland species of all three geographic areas.

On the Kenai Peninsula, the non-forested slopes below the alpine zone are often characterized by alternating stringers of tall shrubs dominated by Sitka alder and rich herbaceous communities with such species as tall fireweed, bluejoint reedgrass, northern geranium, and lady fern. In Prince William Sound, tall shrubland dominated by Sitka alder and salmonberry characterize avalanche chutes and beach fringe areas. Characteristic dominants of the Copper River Delta shrublands include sweetgale, Sitka alder, Barclay willow, and Sitka willow.

Characteristic species of the low shrubland and herbaceous communities of both the Kenai Peninsula and Prince William Sound include crowberry, Steller’s cassiope, bog blueberry, luetkea, and bluejoint reedgrass. In addition, white mountain-avens and rough fescue are common on the Kenai Peninsula and Aleutian mountain heath, tall cotton grass, tufted bulrush, beach rye, Lyngbye’s sedge, fewflower sedge, manyflower sedge, and sphagnum mosses are common on Prince William Sound.

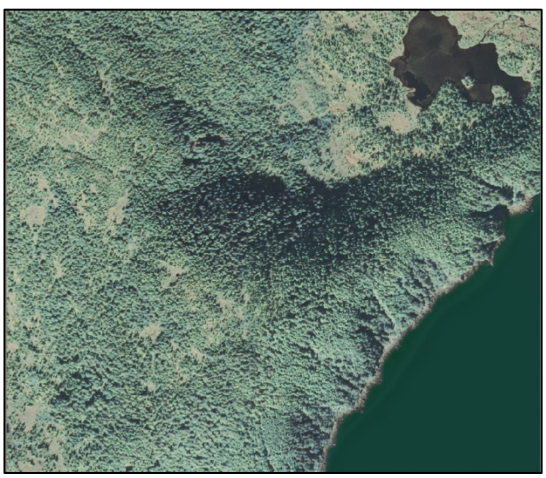
Dominant wetland herbaceous communities of the Copper River Delta include swamp horsetail, marsh fivefinger, buckbean, Lyngbye’s sedge, Sitka sedge, burreed, yellow pondlily, dwarf alkaligrass, Pacific silverweed, Nootka lupine, tall fireweed, and beach rye.

Lynx Creek, Kenai Peninsula



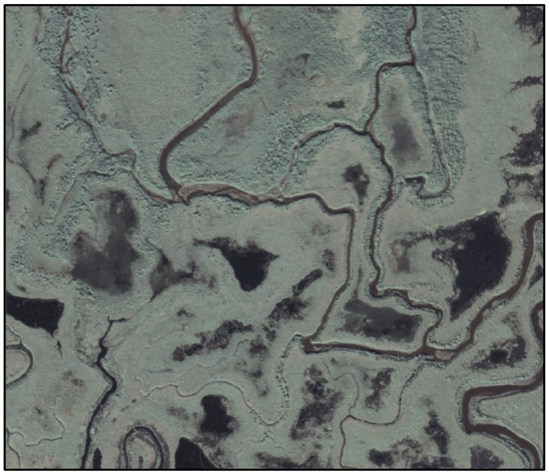
Forests
mountain hemlock, Lutz spruce, mountain hemlock-Lutz spruce, paper birch, black cottonwood, Lutz spruce-paper birch, and Lutz spruce-black cottonwood
Shrublands
willows and Sitka alder
Herbaceous
mesic graminoid and mesic forb

Peak Island, Prince William Sound



Forests
western hemlock, western hemlock-Sitka spruce, mountain hemlock, and mountain hemlock-western hemlock
Shrublands
ericaceous shrub bog

Copper River Delta south of the Sheridan River



Shrublands
Sitka alder, Sitka alder-willow, and sweetgale
Herbaceous
mesic graminoid, wet graminoid, mesic forb, wet forb, and freshwater aquatic herbaceous

Figure 13. Examples of vegetation patterns in the Kenai Peninsula, Prince William Sound, and Copper River Delta geographic areas. The dimension of each is about 0.73 mile (width) by 0.63 mile (height).

Vegetation pattern across the landscape

Fragstats 4.1 (McGarigal & Marks, 1995; McGarigal, Cushman, & Ene, 2012) was used to summarize the spatial pattern of vegetation (as mapped by NLCD) across the Chugach National Forest. Analyses were done forestwide and for the three geographic areas. A selection of nine metrics was used in the analysis. Summaries of the highlights of the estimates for these metrics follow.

Total area

This is a measure of landscape composition, specifically, how much of the landscape is comprised of a particular patch type.

Perennial ice/snow is the most abundant class forestwide covering more than 1,680,300 acres (680,000 hectares) Perennial ice/snow is also the most abundant class on Prince William Sound and on the Copper River Delta (more than 963,700 and 494,200 acres (390,000 and 200,000 hectares), respectively). On the Kenai Peninsula, shrub/scrub is most abundant at more than 370,700 acres (150,000 hectares).

Percentage of landscape

Like total area, this is a measure of landscape composition. However, percentage of landscape is a relative measure and is useful for comparing landscapes of varying sizes.

Forestwide, the perennial ice/snow, evergreen forest, and shrub/scrub classes individually exceed 20 percent of the landscape (and total 69 percent). Perennial ice/snow, evergreen forest, and shrub/scrub classes also individually exceed 20 percent of the Prince William Sound landscape (and total 81 percent). Perennial ice/snow and barren land are the only classes individually exceeding 20 percent of the Copper River Delta landscape (and total about 47 percent). On the Kenai Peninsula, the only class exceeding 20 percent of the landscape is shrub/scrub (30 percent).

The combined acreage in the developed classes (i.e., NLCD classes 21, 22, 23, 24, 81, and 82 of table 25) total about 0.1 percent of the forestwide landscape (about 0.2 percent of the Kenai Peninsula). This suggests that about 99.9 percent of the landcover pattern across the Chugach National Forest is primarily reflective of non-intensive management/development. As such, the summary results presented here may be regarded as representing natural process generated landcover conditions.

Patch density

This measure expresses the number of patches on a per unit area basis that facilitates comparisons among landscapes of varying size.

The shrub/scrub class has the highest patch density forestwide and in each of the three geographic areas, exceeding 1.5 patches/247.5 acres (100 hectares) in all cases. The only other class exceeding 1.5 patches/247.5 acres threshold is open water in Prince William Sound.

Largest patch index

This measure quantifies the percentage of total landscape area comprised by the largest patch. As such, it is a simple measure of dominance.

Perennial ice/snow form the largest patch forestwide and within the Prince William Sound and Copper River Delta geographic areas (about 8, 16, and 8 percent of each area, respectively). On the Kenai Peninsula, the largest patch is shrub/scrub (about 14 percent).

Edge density

This measure reports edge length on a per unit area basis that facilitates comparison among landscapes of varying size.

Shrub/scrub vegetation has the highest edge density forestwide and on each of three geographic areas (exceeding 131 feet/2.5 acres (40 meters/hectare) in all cases). Edge density also exceeds 131 feet/2.5 acres (40 meters/hectare) in evergreen forests forestwide (about 144 feet/2.5 acres (44 meters/hectare)) and in Prince William Sound (about 183 feet/2.5 acres (56 meters/hectare)).

Landscape shape index

This index provides a standardized measure of total edge or edge density that adjusts for the size of the landscape.

As with edge density, shrub/scrub vegetation has the highest landscape shape index forestwide and for each of three geographic areas. This is followed by evergreen forests both forestwide and in Prince William Sound.

Perimeter-area fractal dimension

This measure reflects shape complexity across a range of spatial scales (patch sizes). It approaches one for shapes with very simple perimeters, such as squares, and approaches two for shapes with highly convoluted perimeters.

The two classes representing greater than 10 percent of each respective landscape forestwide and the three geographic areas with the largest difference in perimeter-area fractal dimension are perennial ice/snow (lower fractal dimension, simpler perimeter) and shrub/scrub (higher fractal dimension, more convoluted perimeter). The forestwide values are 1.42 and 1.64. Values are 1.39 and 1.61 for the Kenai Peninsula; 1.44 and 1.64 for Prince William Sound; and 1.41 and 1.65 for the Copper River Delta.

Patch cohesion

This index measures the physical connectedness of the corresponding patch type. The index approaches zero as the proportion of the landscape comprised of the class of interest decreases and becomes increasingly subdivided and less physically connected. The index increases as the proportion of the landscape comprised of the focal class increases.

The patch cohesion index varies from about 60 to 100 percent across the Chugach National Forest. The index exceeds 90 percent for 11 of 18 classes forestwide, 10 of 18 classes on the Kenai Peninsula, 6 of 15 classes in Prince William Sound, and 9 of 15 classes on the Copper River Delta. This suggests that most landcover classes are highly connected within the Chugach National Forest, but this is less so in Prince William Sound (with abundant islands, and thus a more subdivided landscape).

Normalized landscape shape index

This is the normalized version of the landscape shape index (LSI) and provides a measure of class aggregation or clumpiness. The normalization essentially rescales LSI to the minimum and maximum values possible for any class area. The index equals zero when the landscape consists of a single square or maximally compact (i.e., almost square) patch of the corresponding type. The index increases as the patch type becomes increasingly disaggregated and is 1 when the patch type is maximally disaggregated (i.e., a checkerboard).

Forestwide, the normalized landscape shape index varies from 0.05 (highly aggregated) for the perennial snow/ice class to 0.62 (moderately disaggregated) for the sedge/herbaceous class. Similarly, on the Kenai Peninsula, the index varies from 0.06 for the perennial snow/ice class to 0.63 for the sedge/herbaceous class. In Prince William Sound and on the Copper River Delta, the index varies from 0.04 and 0.06 for the perennial snow/ice class to 0.63 and 0.67 for the mixed forest class, respectively.

Terrestrial Ecosystems—Vegetation Drivers and Stressors

Composition and production of an ecosystem is a function of species interactions and biotic responses to environmental drivers. The primary environmental regimes affecting organisms include moisture, temperature, radiation, nutrients, and biotic (Nix, 1982). These regimes are a function of the interaction of climate, topography, soils, and vegetation. Disturbances, both natural and human-caused, further modify ecosystem composition, structure, and succession.

One item of particular note in regard to nutrient regimes in the Chugach National Forest is the role of salmon. Salmon transport marine-derived nitrogen to the streams in which they reproduce. Trees and shrubs near spawning streams have been found to derive about 23 percent of their nitrogen from salmon (Helfield & Naiman, 2001). As a result of this nutrient subsidy, growth rates in plants have been found to be significantly increased near spawning streams. This may act as a positive feedback mechanism by which salmon borne nutrients improve spawning and rearing habitat for subsequent salmon generations and maintain the long-term productivity of river corridors (Helfield & Naiman, 2001).

Natural Disturbance Regimes

Ecological patterns across the national forest are primarily the result of natural processes. Natural disturbances within the national forest include natural fire ignited by lightning, native insect and disease outbreaks, earthquakes, volcanic ash fall, snow avalanches, landslides, windthrow, glacial action, floods, and beaver activity.

Natural fire

Owing to the generally cool, moist climate and low incidence of lightning, natural fires are infrequent within the Chugach National Forest. When fire does occur, it is usually during drought or dry periods resulting in intense fires. This generally results in stand replacement since most plant species present are not adapted to survive fire. As noted in the 2002 Forest Plan FEIS, fire has been an important disturbance process on the Kenai Peninsula geographic area (USDA, 2002c). Radiocarbon dates of charcoal layer samples from soils at scattered locations in the Kenai Mountains ranged from 3,010 to 570 years before present. This indicated a long time between fire intervals (average of 600 years) (Potkin, 1997).

Biophysical settings are environmental descriptors used for determining a landscape's natural fire regimes and vegetation characteristics (Barrett, et al., 2010). According to Fire Regime Condition Class, the following 10 biophysical settings are represented within the Chugach National Forest (along with the estimated mean fire return interval and characteristic fire severity) (NWCG, 2014):

- Black spruce southcentral: 80 to 200 year interval; 90 percent overstory replacement
- Coastal boreal transition forest: 600 to 800 year interval; 90 percent overstory replacement
- Coastal forests: 600 to 3,000 year interval; 90 percent overstory replacement
- Kenai Mountains hemlock: 600 to 3,000 year interval; 80 percent overstory replacement
- Riparian spruce hardwood-Kenai: 650 year mean interval; 10 percent overstory replacement
- Dwarf scrub tundra: 500 to 1,000 year interval; 90 percent replacement
- Persistent shrub south: 900 year mean interval; 70 percent replacement
- Dry herbaceous meadow: 170 year mean interval; 85 percent replacement
- Mesic herbaceous meadow: 350 year mean interval; 70 percent replacement
- Non-forested wetland: 1,000 year mean interval; 60 percent replacement

Native insect and disease outbreaks

A spruce bark beetle (*Dendroctonus rufipennis*) infestation killed the majority of mature spruce trees across at least 40,000 acres (16,000 hectares) of the Kenai Peninsula geographic area. The infestation began in the 1950s and peaked in the 1990s (USDA, 2012b). Based on tree core evidence, Berg et al. (2006) found that a spruce bark beetle infestation occurred on the Kenai Peninsula in the late nineteenth century, similar to the recent outbreak in magnitude and size. Since much of the mature spruce on the Kenai Peninsula has already been killed by spruce bark beetles, few acres of further infestation are expected in coming decades. The 2011 R10 Forest Health Protection Report (Mulvey & Lamb, 2012) states that spruce bark beetle activity had declined to the lowest level in 35 years.

Results of annual monitoring of insect and disease activity in Alaska forests are provided in reports by the Forest Health Protection unit of State and Private Forestry. Based on these reports, the area affected by insects and diseases varies from year to year across Alaska. From 2002 through 2012, 22 different diseases and insect pests damaged approximately 523,000 acres in southcentral Alaska, including the Chugach National Forest (see table 27) (Lundquist, Winton, Wurtz, & Heutte, 2013). The number of acres affected varied from about 107,000 acres in 2004 to about 2,000 acres in 2008. Phloem feeders (primarily spruce bark beetles) accounted for 18 percent of the affected landscape, diseases occurred on 15 percent, hardwood defoliators affected 62 percent, and conifer defoliators affected 5 percent.

Insects and disease disturbance to vegetation can generate early seral habitat and alter habitat diversity, such as edge habitat and microhabitats important to many wildlife species. In addition, single tree mortality caused by heart rot fungi is important in creating canopy gaps (Hennon, 1995).

Table 27. Acres of forest damage mapped by aerial surveys in the broader southcentral Alaska landscape that includes the Chugach National Forest (Lundquist, Winton, Wurtz, & Heutte, 2013)

Agent	**Acres of Forest Damage Mapped by Aerial Survey by Year**											
	2002	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**Totals All Years**
Spruce bark beetle	10,560	18,399	6,443	8,102	13,565	18,636		8,401	3,652	5,873	1,245	94,876
Ips engraver beetle	32			187	107	82						408
Total spruce mortality	**10,592**	**18,399**	**6,443**	**8,289**	**13,672**	**18,718**	**0**	**8,401**	**3,652**	**5,873**	**1,245**	**95,284**
Alder dieback			5,692						17,038	55,780	26	78,536
Spruce broom rust					11					4		15
Spruce needle rust									14	24		38
Total disease	**0**	**0**	**5,692**	**0**	**11**	**0**	**0**	**0**	**17,052**	**55,808**	**26**	**78,589**
Alder defoliation	0		163	1,840	1,883			223		24,210	13,569	41,888
Alder leaf roller	623	1,616	27	0	113							2,379
Aspen defoliation				77						14		91
Aspen Leaf Miner	0	9	21		1,385	593		4,213	3,330	17		9,568
Betula nana defoliation										3,952		3,952
Birch defoliation	0		127	396	368				1,409	13,678	4,406	20,384
Birch Leaf Miner	29,692	31,902	93,240	28,477								183,311
Birch leaf roller	46	1,613	107	5,648	276							7,690
Cottonwood defoliation	235	11,228		1,051		91		659	221	8,530	384	22,399
Cottonwood Leafroller	46	71	147		4,342							4,606
Hardwood defoliation		14		864						3,324	2,210	6,412
Large aspen tortrix			404		1,639	170			136	116		2,465
Spear-marked black moth								14,309	157			14,466
Willow defoliation	1	55		11	1,492	44	3		916	514	443	3,479
Total hardwood defoliation	**30,643.0**	**46,508**	**94,236**	**38,364**	**11,498**	**898**	**3**	**19,404**	**6,169**	**54,355**	**21,012**	**323,090**

Agent	Acres of Forest Damage Mapped by Aerial Survey by Year											
	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Totals All Years
Black-headed budworm	3,004	1,267	105	1,401	522	6,810	1,994	647				15,750
Conifer defoliation			229	2,183						1,629		4,041
Spruce needle aphid		48		5,054		648						5,750
Total conifer defoliation	**3,004**	**1,315**	**334**	**8,638**	**522**	**7,458**	**1,994**	**647**	**0**	**1,629**	**0**	**25,541**
Total all agents	**44,239**	**66,222**	**106,705**	**55,291**	**25,703**	**27,074**	**1,997**	**28,452**	**26,873**	**117,665**	**22,283**	**522,504**

Earthquakes

As a result of the Great Alaska Earthquake in 1964, which uplifted the Copper River Delta between 6 and 11 feet, some low elevation vegetation changed from a system dominated primarily by graminoids and forbs to a mosaic of forb-graminoid wetlands with patches of woody vegetation (DeVelice, Boudreau, Wertheim, Hubbard, & Czarnecki, 2001). Mudflats that were subtidal prior to the earthquake are becoming tidal marsh, and woody plants are becoming more dominant on the uplifted tidal marsh. These changes to wetland communities are important to many waterfowl on the Copper River Delta, particularly the dusky Canada goose. Vegetation changes also resulted in saltwater inundated areas due to the tsunami waves associated with the earthquake.

Earthquakes of the magnitude of the Great Alaska Earthquake occur at a frequency of perhaps once every 300 to 800 years in southcentral Alaska. However, earthquakes of lesser magnitude but capable of causing landslides and other environmental disturbances occur at a much higher frequency.

Volcanic ash fall

Volcanic activity is common in the coastal mountains west of the Chugach National Forest. Ash fall from this activity sometimes travels to the national forest and accumulates on the vegetation, which can cause stem breakage, inhibit transpiration and photosynthesis, and alter growth. In some cases, the ash can cause an increase in production due to mulching and fertilizing effects.

Snow avalanches

The vegetation pattern on many mountain slopes of the Chugach National Forest is shaped by snow avalanches (DeVelice personal observation; see figure 14). Many locations otherwise capable of supporting forest vegetation are maintained in shrubland and herbaceous states by periodic snow avalanches. Avalanches are a common cause of death of Dall’s sheep and mountain goats.

In addition to contributing to avalanches, snow and ice accumulations on stems and branches can cause breakage resulting in fine scale alterations to vegetation composition and structure.

Figure 14. View of vegetation pattern on mountain slopes above Summit Lake on the Kenai Peninsula. The predominance of shrubland and herbaceous vegetation is largely maintained by periodic snow avalanches. The mountain hemlock forests at left are on a slope where avalanches are rare. This pattern is widespread within the Chugach National Forest.

Landslides

Landslides are not a common occurrence in the Chugach National Forest. They occur most frequently on steep slopes with soils that have a layer restrictive to downward water flow, usually bedrock or compact till. Natural landslides have been noted in Prince William Sound and scattered across the Kenai Peninsula. Landslides associated with past logging activity have been noted on Montague Island and in the Knowles Head area in Prince William Sound. Localized landslides can be important to wildlife diversity by creating small scale patches of early seral vegetation.

Windthrow

Windthrow is important in forest succession within the Chugach National Forest but has not been rigorously documented. In the forests of southeast Alaska, which are similar to at least some of the forests of the Chugach National Forest, Nowacki and Kramer (1998) and Kramer et al. (2001) found a continuum of wind disturbance intensity grading from small-scale canopy gaps predominating in wind-protected areas to stand replacement in areas exposed to large-scale wind events. The pattern of windthrow in southeast Alaska was found to be predictable based on exposure to prevailing storm winds, slope, elevation, soil stability, and landform (Kramer, Hansen, & Taper, 2001). In addition, windthrow and tree breakage caused by wind can strongly increase spruce bark beetle and wood borer activity (Burnside, et al., 2011; Gardiner, 1975; Holsten, Their, Munson, & Gibson, 1999) and permit entry of stain and decay fungi.

Glacial action

Within the Chugach National Forest, 43 percent of the landcover classified as snow, ice, or barren is covered by glaciers. Some glaciers are retreating while others are advancing. Glacial action can have a profound effect on the landscape by abrading rock and debris with their advance, leaving behind initially unvegetated terrain as they melt.

Floods

Stream flows within the Chugach National Forest are primarily influenced by natural processes since the majority of the national forest is undeveloped (USDA, 2012b)). Stream flows are primarily dependent on runoff from snowmelt, rainfall, and glacial melt and vary by watershed size, climate, and the presence of glaciers. Processes causing changes in stream flows include glacial melting, temperature and precipitation fluctuations, geomorphic channel changes, and glacial outburst floods. Flooding is an important hydrologic and ecological function that maintains healthy hyporheic zones (subsurface volume of sediment and porous space adjacent to a stream through which water readily exchanges) and aquatic diversity.

Beaver activity

Beavers have a profound effect on the landcover composition of some areas of the Copper River Delta (DeVelice, DeLapp, & Wei, 2001a).

Non-natural disturbances and stressors

Most of the human activity on the Chugach National Forest occurs along railroads; powerlines; developed and decommissioned roads and trails; and areas open to snowmachines, skiing, heli-skiing, and OHVs. Additional human disturbances occur around water developments, rivers used by boaters and anglers, beaches and boat launches, and small developments, such as electronic transmission sites, cabins, airplane landing strips, dispersed campsites, signs, and fences. Human activity and use varies greatly by season, extent, and duration. Because many of these activities do not require permits from the Forest Service, it is difficult to estimate the amount or extent of use.

Soil disturbance

The 2002 Forest Plan FEIS noted five major activities that expose mineral soil and reduce soil productivity. These are road construction, vegetation treatment, placer mining, recreational development, and trampling vegetation, which exposed soils adjacent to streams. Landslides have occurred in some areas where roads have cut a portion of the retaining slope, in areas where vegetation treatment has occurred on steep slopes with shallow soil over bedrock, and in areas of road construction on unstable soils on steep slopes with saturated soil.

Human-caused fire

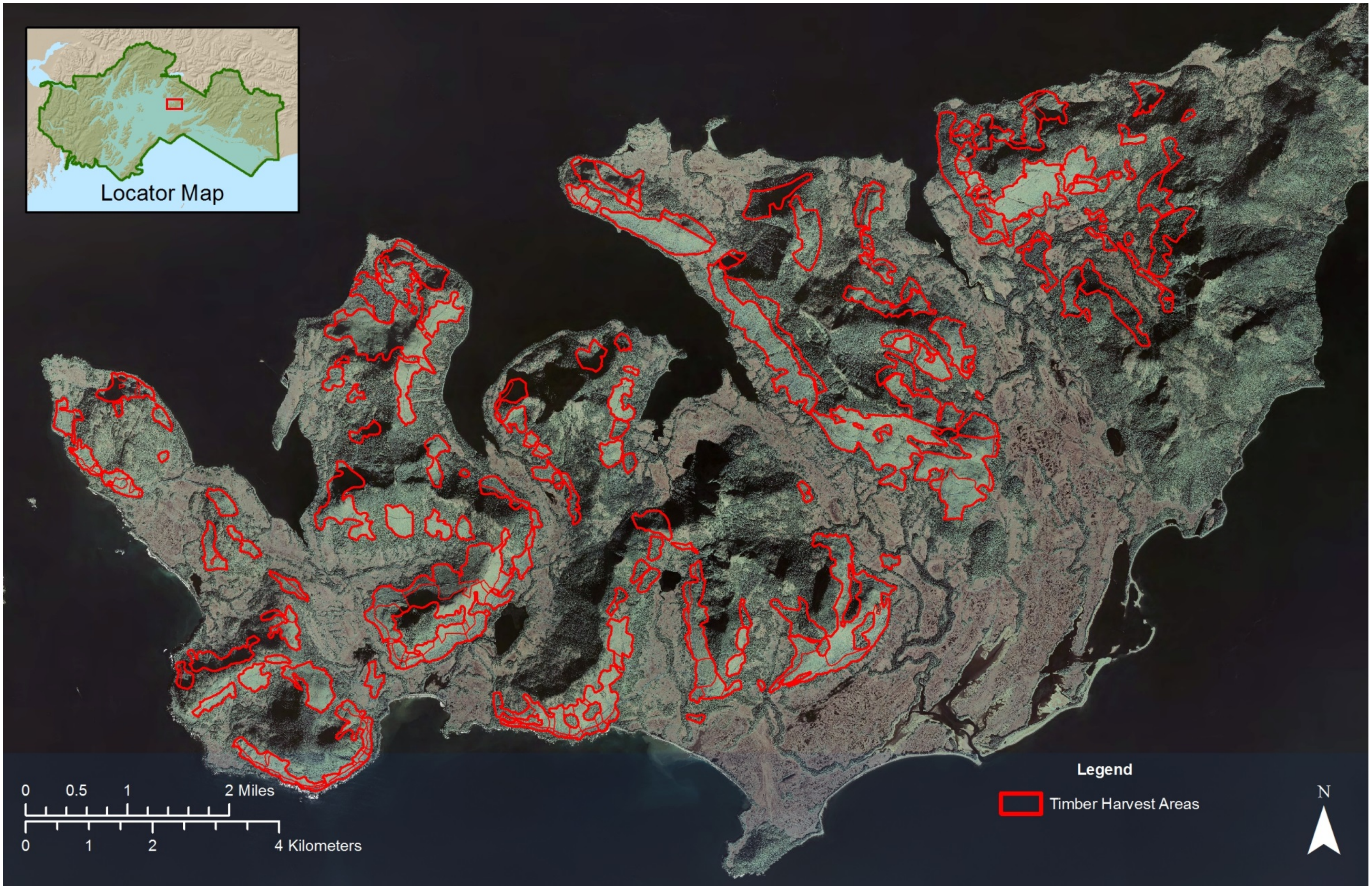
The present forest vegetation pattern on the Kenai Peninsula geographic area reflects human-caused fires that occurred during the last 100 years or so, creating areas of early successional plant communities, including large stands of broadleaved forests. About 1,400 fires burned a combined 75,000 acres (30,350 hectares) on the Kenai Peninsula geographic area from 1914 to 1997 (Potkin, 1997). Human-caused ignitions account for more than 99 percent of these fires (see the Fire Management section). Alaska Natives have been present in southcentral Alaska for thousands of years, but there is no evidence that they used fire as a land management tool (Berg, personal communication, 2013).

Vegetation treatments

The largest amount of ongoing vegetation treatment within the Chugach National Forest is hazardous fuel reduction on the Kenai Peninsula, where an average of about 875 acres is treated annually (a range of about 400 to 1,500 acres from 2004 through 2013). Treatments consist of removal, thinning, pruning, piling, and burning especially in the wildland/urban interface, high use areas, and transportation routes.

Wildlife habitat improvement, forest vegetation establishment and improvement, and invasive plant treatment projects also occur within the national forest. Based on data in the Forest Service Activity Tracking System (FACTS) and on file, annual forest vegetation establishment and improvement acreage ranged from about 200 to 680 acres and annual invasive plant control from 25 to 120 acres from 2004 through 2013.

Very little timber harvest occurs within the Chugach National Forest. Most of the recent logging occurred in the 1990s on private lands within the national forest matrix. Some of those logged lands are now National Forest System lands, i.e., much of the Knowles Head Peninsula in Prince William Sound (see map 5).



Map 5. Timber harvest on the Knowles Head Peninsula, Prince William Sound. The areas delineated in red total about 7,340 acres (2,970 ha)

Invasive species

A species is considered to be invasive if it meets two criteria: (1) it is non-native to the ecosystem under consideration, and (2) its introduction causes, or is likely to cause, economic or environmental harm or harm to human health (Executive Order 13112). Invasive species can endanger native species and threaten ecosystem services and resources, including clean water, recreational opportunities, sustained production of wood products, fish and wildlife habitat, and human health and safety (USDA, 2013). Adverse effects from invasive species can be exacerbated by interactions with fire, native pests, weather events, human actions, and environmental change. (Pimentel, et al., 2001) estimated damage from invasive species worldwide totals more than 1.4 trillion dollars per year (about 5 percent of the global economy).

Invasive plants

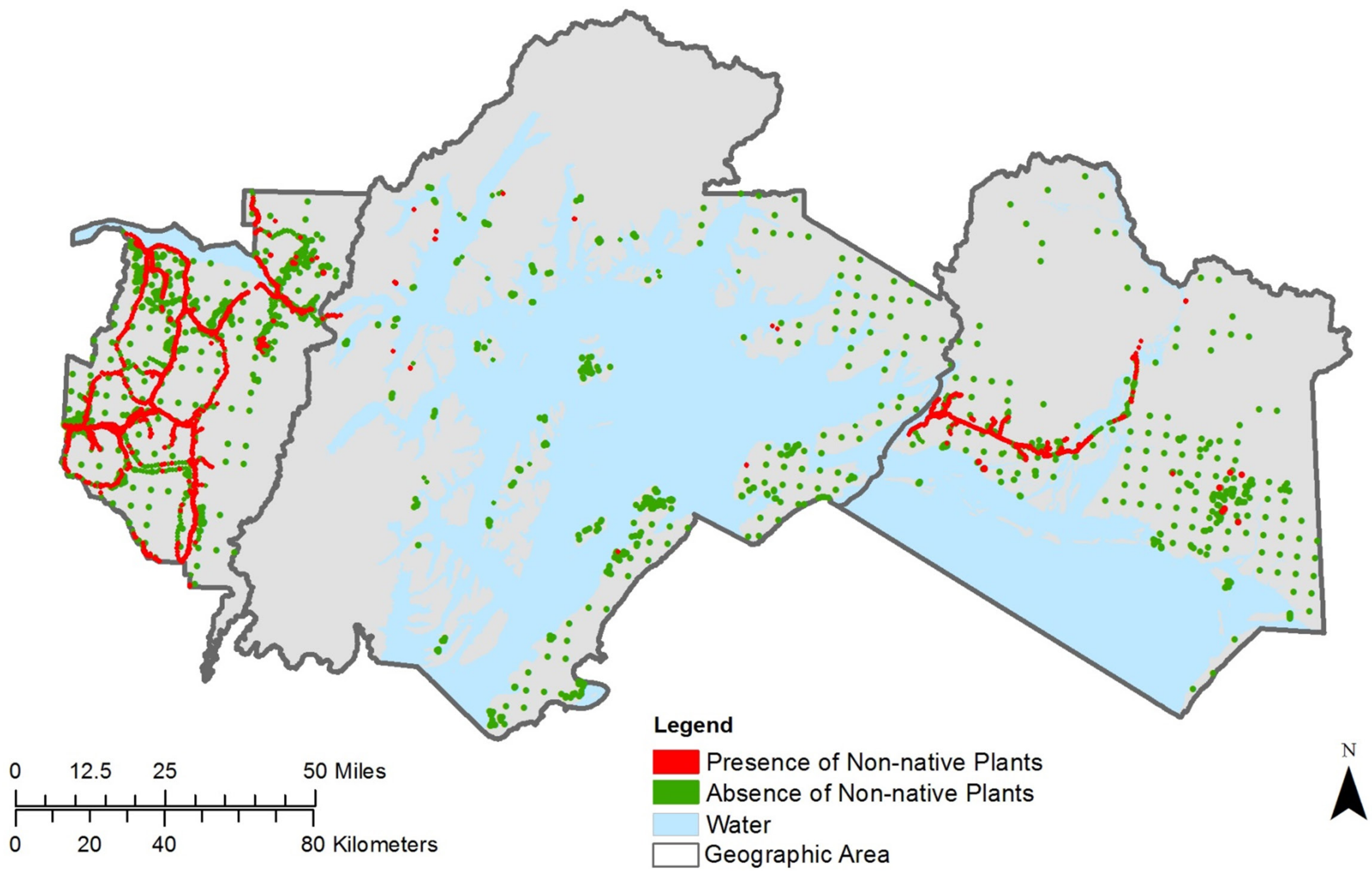
Most non-native plant occurrences within the national forest are in areas of intensive human-caused disturbance. Non-native plants have been found on about 71 percent of the sites sampled on road edges, facilities, trailheads, mineral material sites, trails, and shorelines of the Chugach National Forest (based on NRIS TESP-Invasive Species data; see table 28). In contrast, about one percent of backcountry sites sampled have non-native plants present (based on Chugach National Forest ecology plot and FIA data; see table 28). About 86 percent of occurrences of non-native plants within the national forest are on the Kenai Peninsula (based on combined NRIS TESP-Invasive Species data, Chugach National Forest Ecology plot data, and FIA data; see table 28 and map 6).

Non-native plants within the Chugach National Forest have been given an invasiveness rank on a scale of zero to 100. Species ranked 70 or greater on this scale are considered to be highly invasive. Of the 92 non-native plant species currently documented within the boundary of the Chugach National Forest, 11 are considered highly invasive (see table 29). None of these highly invasive species have been found in the backcountry (Carlson, et al., 2008). Of the 5.4 million acres of National Forest System lands, the total area of infestation of highly invasive plants is estimated at less than 1,000 acres (400 hectares) (DeVelice, Nawrocki, Charnon, & Mohatt, 2012).

Table 28. Summary of non-native plant species occurrences within the boundary of the Chugach National Forest based on data in NRIS TESP-Invasive Species, Forest Inventory and Analysis (FIA), and the Chugach National Forest Ecology Program vegetation plot databases

Data Variable	**Geographic Area**			**National Forest Totals**
	Kenai Peninsula	**Prince William Sound**	**Copper River Delta**	
All Data				
Occurrence records	9,362	70	1,424	10,856
Non-occurrence records	1,748	705	835	3,288
Sum	11,110	775	2,259	14,144
Percent of forestwide occurrences	86.2%	0.6%	13.1%	100%
Front Country Records				
Occurrence records	9,355	70	1,403	10,828
Non-occurrence records	481	25	155	661
Sum	9,836	95	1,558	11,489
Percent of sum	95.1%	73.7%	90.1%	94.2%
Front Country Sites				
Occurrence sites	1,260	25	309	1,594
Non-occurrence sites	481	25	155	661
Sum	1,741	50	464	2,255
Percent of sum	72.4%	50.0%	66.6%	70.7%
Backcountry Sites				
Occurrence sites	7	0	20	27
Non-occurrence sites	1,267	680	680	2,627
Sum	1,274	680	700	2,654
Percent of sum	0.5%	0.0%	2.9%	1.0%
Number of Species				
Non-native species	84	22	43	92
Highly invasive species	8	5*	6	11

*All five occurrences of highly invasive species in Prince William Sound are in the Whittier area.



Map 6. Non-native plant species occurrence (red dots) and non-occurrence (green dots) records currently documented on the Chugach National Forest. The Kenai Peninsula, Prince William Sound, and Copper River Delta geographic areas are also displayed (left to right, respectively).

Table 29. Non-native plant species currently documented within the Chugach National Forest with invasiveness ranks ≥ 70 (highly invasive) (AKNHP, 2013).

Scientific Name	Common Name	Rank	Quantity*	Area
Cirsium arvense	Canada thistle	76	6	Girdwood
Elodea spp.	Waterweed	79	21	Copper River Delta
Hieracium aurantiacum	Orange hawkweed	79	16	Kenai Peninsula and Cordova
Lupinus polyphyllus	Bigleaf lupine	71	36	Kenai Peninsula, Whittier, and Copper River Delta**
Melilotus alba	White sweetclover	81	32	Kenai Peninsula, Whittier, and Cordova
Phalaris arundinacea	Reed canarygrass	83	31	Kenai Peninsula, Whittier, and Copper River Delta
Polygonum x bohemicum	Bohemian knotweed	87	0	Cordova (not yet entered in NRIS)
Prunus padus	European bird cherry	74	1	Kenai Peninsula (near Hope)
Rosa rugosa	Rugosa rose	72	1	Whittier
Sochus arvensis	Perennial sowthistle	73	1	Kenai Peninsula (Hope Wye); eradicated from site
Vicia cracca	Bird vetch	73	35	Kenai Peninsula and Whittier

*Number of populations reported in NRIS TESP-Invasive Species out of 10,828 non-native plant species occurrence records within the boundary of the Chugach National Forest.
**Bigleaf lupine may be native in some locations within the Chugach National Forest.

Because invasive plants have relatively limited distributions within the Chugach National Forest, managers are in a unique position to prevent the introduction and spread of invasive plants and to eradicate small populations before they spread. However, effects of changing climate, increasing levels of disturbance (both natural and human-caused), and increasing tourism and population growth make the national forest vulnerable to the introduction and spread of invasive plants.

The spread of *Elodea* spp. (waterweed), a fish tank plant, is an emerging issue. It grows at lake margins and in sloughs on the Copper River Delta and in lakes on the Kenai National Wildlife Refuge (populations are also known from Fairbanks and Anchorage). Recent Forest Service invasive species surveys reveal that the plant is spreading to new lakes and known populations are growing in size. This plant spreads very quickly, forming dense mats of floating and submerged leaves that can clog waterways and damage aquatic ecosystems. Agencies and communities are in early stages of cooperating to respond to the problem of *Elodea*.

Invasive insects and pathogens

The most invasive non-native insect within the Chugach National Forest is the amber-marked birch leaf miner (*Profenusa thomsoni*). It was first discovered in Anchorage in 1996 and has spread across the Matanuska-Susitna Valley. Infestations have also been documented in Fairbanks, Haines, Skagway, and a large part of the Kenai Peninsula (Holsten, Hennon, Trummer, Kruse, Schultz, & Lundquist, 2009). Occurrences are very much localized within the Chugach National Forest (Alaska Wildland Fire Coordinating Group, 2010) (Ludquist, personal communication, 2013). Since monitoring began in 2006, amber-marked birch leaf miner activity has been decreasing in the Anchorage area (Lundquist, Reich, & Tuffly, 2012; Mulvey & Lamb, 2012).

The green alder sawfly (*Monsoma pulveratum*) has been found actively defoliating thin-leaf alder (*Alnus tenuifolia*) in Anchorage, Kenai, Seward, and in the Matanuska-Susitna Valley (Kruse, Zogas, Hard, & Lisuzzo, 2010).

Terrestrial Ecosystems—Vegetation Condition and Trends

Terrestrial ecosystem integrity

The natural range of variation (NRV) is an analysis tool for assessing the ecological integrity of selected key ecosystem characteristics. Perhaps the best available information for understanding NRV in vegetation composition for periods greater than the last 200 years are variations in fossil pollen abundances preserved in peat deposits. The minimum age of the most recent deglaciation in the area of the Chugach National Forest is about 9,000 to 10,000 years (Ager, 2001). Tundra and shrub vegetation developed early, with many species coming from islands of unglaciated terrain within southcentral Alaska. Most boreal forest plants migrated into southcentral Alaska from unglaciated interior Alaska (USGS, 2013). Coastal forest conifers migrated into the area from southeast Alaska (Peteet, 1986).

Local vegetation currently in the Tern Lake area of the Kenai Peninsula developed within the past 2,500 years (Ager, 2001). In the Girdwood area, forests similar to those of today have dominated for at least the past 2,700 years (Ager, Carrara, & McGeehin, 2010). Development of forest communities in Prince William Sound similar to those of today took place during the past 2,000 years (Heusser, 1983). Based on these data, the past 2,500 years may be a useful reference period for evaluating NRV across the national forest.

Baseline studies to describe NRV are rare for the Chugach National Forest. Therefore, only general patterns of historical ecology can be described. An intensive analysis of NRV is not warranted given the limited potential influence of management activities on most characteristics of the terrestrial system. Current vegetation across the national forest is primarily the result of natural processes. Mohatt and Werstak (2012) calculated differences in vegetation indices from 2002 and 2011 satellite imagery. No changes exceeding the monitoring protocol threshold of 20 percent over contiguous areas larger than 4,942 acres were detected.

Romme et al. (2012) summarize a framework for applying NRV concepts to land management. If the conditions of key ecosystem characteristics today are similar to conditions of the past, then there may be no concern regarding the ecological integrity of those characteristics. However, some characteristics that were ecologically common in the past may be socially unacceptable today. For example, the spruce tree mortality associated with the recent spruce bark beetle infestation has resulted in socially unacceptable levels of hazardous fuels accumulation in some areas, even though the outbreak is similar to those seen in the past (see Native Insect and Disease Outbreaks section). Management actions to reduce hazardous fuels are ongoing, especially in the wildland urban interface (Kenai Peninsula Borough, 2004). These treatments result in more socially acceptable ecological conditions, particularly reduced fire risk for a number of years. The treatments also produce ecological features that were rare in the past, including tree stumps, removal of tree boles from forests, and ground disturbance from roads and skid trails.

The expansion of invasive plant populations is one key ecosystem characteristic current condition that was likely uncommon prior to development (e.g., roads, railroads, and trails). Since invasive plants are relatively rare in natural communities of the Chugach National Forest at this time, they likely do not pose an immediate threat to ecological integrity but do pose perhaps one of the larger long term threats if left untended. Climate change could further increase the rates of establishment and spread of invasive plants. Management actions to prevent the introduction and spread of invasive plants and to reduce areas of current infestation are ongoing (DeVelice, Charnon, Bella, & Shephard, 2005).

Changes in vegetation composition and structure have occurred or are occurring within the national forest with effects on terrestrial ecosystem condition. A majority of these changes would be expected based on evaluation of trajectory of the systems as they develop following the last glacial maximum. With current management, there is little direct human influence to the vegetation on about 96 percent of the national forest. Key ecosystem characteristics of terrestrial vegetation are functioning in a way that continues to contribute strongly to ecosystem integrity and sustainability within the plan area.

Terrestrial Ecosystems—Carbon Stocks

Carbon stocks are defined as the amount or quantity of carbon contained in a carbon pool. For the purpose of carbon stock assessment for National Forest System land management planning, carbon pools do not include carbon in fossil fuel resources, lakes or rivers, emissions from agency operations, or public use of National Forest System lands (such as emissions from vehicles and facilities). A carbon pool is any natural region or zone or any artificial holding area containing an accumulation of carbon or carbon-bearing compounds or having the potential to accumulate such substances. Carbon pools may include live and dead above ground carbon, soil carbon including coarse roots, and harvested wood products.

All estimates referenced are in metric units, i.e., hectares (ha), kilograms (kg), metric tons (1,000 kg, denoted t), millions of metric tons (denoted Mt), and t/ha.

Relevant Information

- Live trees in the forests of the Chugach National Forest are currently a carbon sink (store more carbon than they release), sequestering an estimated 150 thousand metric tons aboveground per year. The magnitude of carbon release from the decomposition of dead trees is presently unknown forestwide.
- Compared to the 1999 to 2003 time period, overall aboveground live tree carbon within the national forest increased 4.6 percent during the 2004 to 2010 time period.
- The total carbon pool within the boundary of the Chugach National Forest (excluding carbon in the ocean) is estimated at about 493 Mt (millions of metric tons). There is about 6.5 times more carbon estimated to be belowground (428 Mt) than aboveground (66 Mt). By geographic area, the greatest amount of both belowground and aboveground carbon is estimated in Prince William Sound, followed by the Copper River Delta, and then the Kenai Peninsula.

Aboveground Carbon

Estimates of aboveground carbon in forest trees (Barrett T. , 2014), forest vegetation, shrubland vegetation, and herbaceous vegetation are summarized here. Belowground carbon estimates are at the end of this section.

Forest Tree Carbon

Barrett (2014) provides information on the storage and change of aboveground carbon in live and dead trees within forest vegetation of the Chugach National Forest. The estimates are derived from remeasured inventory plots installed by the Forest Inventory and Analysis (FIA) program. These data primarily represent unmanaged forest conditions as less than three percent of the plots had a record of past silivicultural activity. Excluding the wilderness study area, the carbon stores reported by Barrett (2014) is 98.9 t/ha of forest vegetation. Tree carbon is split as 84 percent live trees, 6 percent snags, and 10 percent downed logs. By geographic area, carbon densities are estimated at 75.2, 103.4, and 118.8 t/ha for the Kenai Peninsula, Prince William Sound, and Copper River Delta, respectively. Barrett (2014) also provides carbon mass information broken down by species and forest type.

In addition, to assess change, Barrett (2014) compares live and dead tree carbon for inventories from two time periods: 1999 to 2003 and 2004 to 2010. There was an overall increase in live tree carbon of 4.6 percent between the two time periods. These figures are equivalent to an annual increase of 0.8 percent, 150 thousand metric tons per year for forest vegetation, and 619 kilograms per forest hectare per year. Also, Andersen (2011) reported that, in white spruce stands on the Kenai Peninsula, about 47 percent of the above-ground carbon in trees is stored in snags primarily killed by the spruce bark beetles in the 1990s.

When carbon is removed from forests through harvest, a portion of the harvested carbon is stored in wood products, often for many decades. Loeffler et al. (2012) estimated carbon storage in harvested wood products (HWP) for the Alaska Region of the Forest Service. The HWP carbon pool is now in a period of negative net annual stock change regionwide because the decay of products harvested between 1909 and 2011 exceeds additions of carbon to the pool through harvest. Total forest carbon, on the other hand, is a function of both HWP and ecosystem carbon, which may have increased in the study area during the study period (Loeffler, et al., 2012).

Forest, Shrubland, and Herbaceous Vegetation Carbon

Estimated carbon stores for forest, shrubland, and herbaceous vegetation in the three geographic areas are displayed in table 30. The forest, shrubland, and herbaceous vegetation groupings are aggregates of NLCD classes (see table 31). Estimates of carbon stores for forest vegetation by geographic area are totals for trees reported by Barrett (2014) plus weighted average totals for other plants (non-trees) in closed and open needleleaf forests in southeast Alaska reported by Mead (1998). The biomass values from Mead (1998) were multiplied by 0.5 to convert to carbon mass. Carbon stores for shrubland vegetation (see table 30) were estimated by weighted averaging totals in tall shrub and low shrub classes reported by Mead (1998). The estimates of carbon stores for herbaceous vegetation were also from Mead (1998). Values from Mead (1998) were further scaled proportionally to the geographic area totals from Barrett (2014).

Use of biomass values from Mead (2000) from southwest Alaska were considered for use in the Kenai Peninsula geographic area estimates but were rejected since they are much less than Kenai Peninsula values in Barrett (2014). For example, the tree carbon stores reported by Barrett (2014) for the Kenai Peninsula geographic area is 75.2 t/ha whereas the tree carbon densities in forest types in Mead (2000) that are also common on the Kenai are all less than 15 t/ha.

Table 30. Estimates of carbon stores (t/ha) rounded to the nearest whole number by forest, shrubland, and herbaceous vegetation in the geographic areas

Vegetation	Geographic Area		
	Copper River Delta	Kenai Peninsula	Prince William Sound
Forest	121	77	105
Shrubland	7	4	6
Herbaceous	1	1	1

Table 31. Aggregation of NLCD classes into the forest, shrubland, and herbaceous vegetation groupings used in the estimation of carbon stocks

Vegetation	NLCD Classes
Forest	Evergreen forest
	Deciduous forest
	Mixed forest
Shrubland	Shrub/scrub
	Dwarf shrub
	Woody wetlands
Herbaceous	Grassland/herbaceous
	Sedge/herbaceous
	Emergent herbaceous wetlands

Table 32 displays estimates of land area and carbon pool by vegetation class and geographic area. The acreage values are area of forest, shrubland, and herbaceous vegetation (from NLCD using the table 31 aggregation) within the outer boundary of the Chugach National Forest. Ownerships within the boundary that are lands of other ownership are included.

Table 32. Land area and estimated carbon pool (Mt) by forest, shrubland, and herbaceous vegetation in the Kenai Peninsula, Prince William Sound, and Copper River Delta geographic areas

Vegetation	Land Area (ha)				Carbon Pool (Mt)			
	Copper River Delta	Kenai Peninsula	Prince William Sound	National Forest Totals	Copper River Delta	Kenai Peninsula	Prince William Sound	National Forest Totals
Forest	122,934	92,783	372,798	**588,515**	14.88	7.14	39.14	**61.16**
Shrubland	249,599	230,728	291,988	**772,315**	1.75	0.92	1.75	**4.42**
Herbaceous	33,993	4,180	5,226	**43,400**	0.03	0.004	0.01	**0.04**
Totals	**406,526**	**327,691**	**670,012**	**1,404,230**	**16.66**	**8.07**	**40.90**	**65.63**

The total amount of carbon held in aboveground vegetation within the boundary of the Chugach National Forest is estimated to be about 66 Mt. Nearly 60 percent of this pool resides in forest vegetation in the Prince William Sound geographic area. As a caveat, it is likely that NLCD is classifying more shrubland to forest than FIA does, so the carbon mass values are probably lower for NLCD forestland than for FIA forestland (Barrett, personal communication, 2013).

Carbon Sink or Carbon Source

Processes that release CO_2 into the atmosphere are called carbon sources, while processes that absorb it are called carbon sinks. A sink absorbs more carbon that it gives off, while a source emits more than it absorbs. The only pool of carbon within the national forest for which carbon sequestration rates have been estimated is live trees. Barrett (2014) indicates that live trees in the forests of the Chugach National Forest are currently a carbon sink, sequestering an estimated 150 thousand metric tons per year. The magnitude of carbon release from the decomposition of dead trees is presently unknown forestwide. The decomposition rate of dead spruce trees (snags and logs) on the Kenai Peninsula is estimated at less than two percent per year (Harmon, Fasth, Yatskov, Sexton, & Trummer, 2005).

Future Trend in Sequestering and Storing Carbon

With existing plan guidance, live trees within the national forest will likely continue to sequester carbon unless there is an increase in large-scale disturbance. The 2002 Forest Plan does not have an allowable sale quantity for commercial timber sales, and there is little harvesting of trees for personal use fuelwood, lumber/house logs, commercial fuelwood, wildlife habitat improvement, and special forest products. Current levels and trends in harvesting timber, fuelwood, and special forest products in the national forest are summarized in the Timber section in chapter 3. Recovery from the spruce bark beetle infestation could be contributing to biomass and carbon increases on the Kenai Peninsula.

The magnitude of potential effects of climate change on carbon pools across the Chugach National Forest is not currently well known. Current understanding, however, suggests that the temperate coastal rainforest, which dominates carbon storage for the Chugach National Forest is unlikely to change dramatically during the next 20 to 50 years. Temperate coastal rainforests rarely experience fire. The trends described previously for carbon sequestration represent a reasonable scenario for trends in carbon sequestration during the planning period within the national forest.

Opportunity to influence trends

The largest pool of aboveground carbon within the Chugach National Forest is in the forests of Prince William Sound (see table 33) and a large portion of this geographic area is in the wilderness study area (see the designated areas and areas recommended for designation map in the map package appendix). The wilderness study area is managed to maintain the wilderness characteristic of the area. Continuing such management of the wilderness study area would likely contribute towards maintaining the large carbon pool in Prince William Sound. Similarly, since 2002 Forest Plan direction limits vegetation management to management area prescription categories 3, 4, and 5 (4 percent of the national forest), continuing such management would likely maintain carbon pools forestwide.

The spruce bark beetle infestation referred to previously has resulted in extensive hazardous fuels accumulation and altered potential for large wildfires (potential source of carbon to the atmosphere). In response to the fuels situation on the Kenai Peninsula, an interagency committee of Federal, state, local, and Alaska Native land managers developed an action plan for fire prevention and protection, hazardous fuels reduction, ecosystem restoration, and community assistance (Kenai Peninsula Borough, 2004). As part of this action plan, mechanical and prescribed fire fuel reduction is occurring on about 100,000 acres (40,468 hectares) of the entire Kenai Peninsula with much of the effort occurring outside the national forest.

Influences on carbon stocks

Biomass and carbon accumulation is a function of environmental drivers, especially moisture, nutrient, temperature, radiation, and disturbance, such as fire, avalanches, landslides, wind throw, floods, and insect or disease outbreaks, interacting with biota. Assessing system drivers and stressors on vegetation is considered previously. Forest Service management has limited capability to affect most of these variables across broad areas. As referred to previously, hazardous fuel reduction is ongoing in response to the spruce bark beetle infestation on the Kenai Peninsula. Much of that fuel reduction involves burning of mechanically piled wood. Such burning is an immediate source of carbon to the atmosphere.

Belowground (Soil) Carbon

Current concerns regarding carbon cycling have focused attention on the role of forests and soils in the storage and cycling of carbon in many key biomes. Carbon accrues in forest ecosystems through photosynthesis and cycles within the system until it is lost through respiration, decomposition, or as dissolved organic carbon. Large quantities of carbon are stored in the soil and forest floor, and soil usually represents a larger carbon pool than above-ground biomass on forest and woodland sites, particularly in northern climes. Soil carbon accumulates in cooler temperate, boreal, and arctic environments. This makes soil carbon assessment more important in those systems. Estimates prepared by the USGS for the conterminous United States indicate that total soil organic carbon storage is 73 PgC (billion metric tons), and total forest biomass carbon is 17 PgC (Sundquist, Ackerman, Bliss, Kellndorfer, Reeves, & Rollins, 2009).

Soil organic carbon includes carbon compounds in the forest floor litter layer, and the mineral soil to a depth of one meter (or depth to bedrock if the soil is shallower than one meter). In the case of organic soils, the entire depth of the soil to a meter or more may be composed entirely of partially decomposed plant materials.

Methods

Soil organic carbon (SOC) was estimated for the Chugach National Forest using data from the NRCS Revised Alaska State Soil Survey Geographic Database (STATSGO, *in publication*).

The input data for soil carbon stock (kg/m^2) was obtained from STATSGO. STATSGO values are based on SOC content determined for each horizon by lab analysis or estimates of SOC based on lab data from similar soils and horizons in a given major land resource area (Nield, personal communication, 2013). Where available, SOC values for a representative soil from map unit components from STATSGO were used to generate SOC values for that particular soil component. These values were corrected for bulk density and coarse fragment content (Nield, personal communication, 2013). This allowed a range of SOC values for all map units identified in the STATSGO map of Alaska, as most soil map units had multiple components. This value is an estimate based on 100 centimeters depth, including the forest floor duff layer.

Weighted averages for the soil map unit components were compiled to calculate carbon stocks. The contribution of any component was dependent on the carbon concentration and the area occupied by the component in the soil map unit. This approach minimized the chance that minor components with large carbon concentrations were not considered within larger areas of small carbon concentration. In a similar manner, the landtype association (LTA) carbon stock was derived from the weighted average of the component soil map unit averages within the LTA.

A GIS exercise was then completed that overlaid and analyzed the STATSGO map of Alaska with the LTAs for the Chugach National Forest. The soil carbon estimates were summarized by LTA. Each LTA has estimated minimum, maximum, and weighted average C content. The total land area in each LTA was multiplied by the average carbon content for that LTA to obtain estimated soil carbon totals by LTA.

Results

Table 33 displays a summary of the soil organic carbon within the Chugach National Forest. Total belowground carbon in the Chugach National Forest, excluding carbon in the ocean is estimated to be 427.6 Mt. By geographic area, the estimated soil organic carbon is 103.04 Mt on the Kenai Peninsula, 217.6 Mt in Prince William Sound, and 121.37 Mt on the Copper River Delta (see table 34).

Table 33. Summary of minimum, maximum, weighted average, and estimated total soil organic carbon zero to 39 inches (zero to 100 centimeters) stored in landtype associations of the Chugach National Forest

LTA	LTA Name	Acres	Estimated Soil Carbon				
			Min	Max	Avg.	LTA Total	percent
			lbs./ac	lbs./ac	t/ha	Mt	
00	Glaciers and Icefields	2,257,583	0.28	87.51	25	22.54	5.1
10	Mountain Summits	1,210,656	0.43	166.40	152	74.44	16.8
30	Mountain sideslopes	1,129,667	0.40	166.40	245	111.94	25.3
40	Depositional slopes	172,757	0.40	166.40	210	14.72	3.3
60	Glacial Moraines	61,659	1.60	87.51	194	4.84	1.1
70	Coastal Landscapes	345,300	0.40	161.41	90	12.55	2.8
80	Fluvial valley bottom outwash	407,920	0.40	166.40	218	36.10	8.2
90	Hills and Plateaus	843,993	0.40	166.40	413	141.40	32
CW	Clear water	46,280	0.55	166.40	191	3.58	0.8
GW	Glacial water	119,830	1.60	166.40	113	5.49	1.2
SW	Ocean salt water	2,989,184	0.40	166.40	12	14.84	3.4
Totals		**9,584,830**	**NA**	**NA**	**NA**	**442.44**	**100**

Note: Acreage figures are derived from the LTA GIS layer and may be different than other acreage values displayed for other resources. All total carbon values are based on present acreage figures.

Table 34. Summary of stored estimated total organic carbon for the Kenai Peninsula, Prince William Sound, and Copper River Delta geographic areas of the Chugach National Forest

LTA	LTA Name	Copper River Delta		Kenai Peninsula		Prince William Sound	
		acres	Mt	acres	Mt	acres	Mt
00	Glaciers and icefields	866,462	8.64	147,933	1.48	1,243,188	12.4
10	Mountain summits	196,933	12.1	407,011	25.02	606,713	37.29
30	Mountain sideslopes	242,541	24.01	367,319	36.36	519,807	51.46
40	Depositional slopes	33,586	2.86	124,141	10.57	15,030	1.28
60	Glacial moraines	47,929	3.77	5,237	0.41	8,493	0.67
70	Coastal landscapes	334,296	12.14	1,513	0.05	9,491	0.34
80	Fluvial valley bottom outwash	328,240	29	45,839	4.05	33,840	2.99
90	Hills and plateaus	116,451	19.48	137,127	22.94	590,415	98.77
CW	Clear water	5,974	0.46	23,773	1.84	16,534	1.28
GW	Glacial water	118,987	5.44	844	0.04	0	0
SW	Ocean salt water	695,622	3.45	55,863	0.28	2,237,699	11.11
Totals		**2,987,021**	**121.37**	**1,316,599**	**103.04**	**5,281,210**	**217.6**

Three LTAs make up 75 percent of the total soil organic carbon storage in the national forest (see table 34). The mountain summit, mountain sideslopes, and hills and plateaus LTAs dominate the carbon storage for the Chugach National Forest. The lowest storage is in clear water LTAs, which have soil carbon storage similar to moraines and glacial water. The soil organic carbon in the water LTAs is derived from map units that contain scrub vegetation, flood plains, and subaqueous vegetation soils. These areas, while not extensive, do contain fairly dense carbon stocks in some cases.

Implications

Forest soil carbon storage is a significant component of the global carbon cycle. Soil carbon is important for sustaining forest productivity. Carbon or soil organic matter (SOM) has numerous interactions with other soil properties and supports essential ecosystem functions (Grigal & Vance, 2000; Jurgensen, et al., 1997; Nave, Vance, Swanston, & Curtis, 2010; Powers, et al., 2005) including:

- Nutrient cycling, by providing sustenance for populations of soil fauna and fungi active in decomposition; nearly all nitrogen and phosphorous in forms available to plants comes from organic matter
- Contributing much of the soil's cation exchange capacity, and binding harmful metals
- Maintaining soil structure, which influences aggregate stability, gas exchange, water infiltration, and storage, buffers fluctuations in soil temperature; aggregate stability and macropore structure help limit compaction and erosion
- Providing specialized microsites with accumulations of SOM required by certain plant species for germination and root development

Carbon compounds are inherently unstable and owe their abundance in soil to biological and physical environmental influences that protect carbon and limit the rate of decomposition (Schmidt, et al., 2011). Large quantities of SOM accumulate in environments, such as wetlands, where the rate of decomposition is limited by a lack of oxygen, and high-altitude and high latitude sites where temperatures are limiting. Globally, about 98.5 percent of the carbon in peatlands is in peat versus about 1.5 percent in vegetation (Gorham, 1991). Peatlands are common within the Chugach National Forest. Forest Service management practices can alter the amount and types of SOM, but because inherent soil or site characteristics sometimes compensate for or mitigate the effects of SOM change, the direct impacts on productivity may be unclear.

Terrestrial Ecosystems—Wildlife

This section describes the wildlife component of the terrestrial ecosystem, including wildlife diversity and system drivers and stressors, for the Chugach National Forest. Key ecosystem characteristics and wildlife conditions and trends are described, ecosystem integrity is assessed, and information needs are identified.

Relevant Information

- The complement of wildlife within the national forest is currently thought to retain the native species, populations, and communities that were here historically.
- The national forest retains all the species, habitats and ecological processes necessary to support a healthy ecosystem. The national forest supports intact ecosystems of sufficient size, quality, and distribution to support historic native species, and few species are currently classified as at-risk.
- Healthy ecological functions still occur, such as predator-prey relationships, pollination, seed dispersal, wildlife movement between patches of habitat, and breeding for the species that live entirely within the national forest.

Terrestrial Ecosystems—Wildlife Key Characteristics

This document uses wildlife, species, and animals as generic terms to describe the mammals, birds, amphibians, and invertebrates that occur within the national forest. Wildlife occurrences, distributions, and communities within the national forest reflect the biotic and abiotic conditions of their landscape. Many of these general characteristics are described in the other sections of this chapter. Wildlife inter-relationships occur at the species, population, community, and ecosystem levels, and function differently depending on the scale and timelines evaluated. Humans are also part of relationships related to wildlife.

In general, many ecological factors that help to describe the ecological integrity of wildlife populations are not well-known (Doak, Gross, & Morris, 2005; MacKenzie, 2005; Morrison, Marcot, & Mannan, 2006; Murray & Patterson, 2006; Peters, Pielke, Sr., & Bestelmeyer, 2004). This lack of data is even more pronounced in Alaska (ADF&G, 2006).

MacDonald and Cook (1996) stated:

> "*For systematists and biogeographers, Alaska remains one of North America's last frontiers…documentation of this complex region's biological diversity remains at the early stages of exploration and discovery. Even for such high-interest animals as mammals, basic information on distribution and taxonomic status has been limited, unfocused or inaccessible, resulting in only broad (Hall 1981; Manville and Young 1965) or popular (Dufrensne 1946; Reardent 1981) treatments…it is even more disturbing that we lack detailed and accurate information for making sound conservation evaluations and wise management decisions.*"

There has been tremendous progress since MacDonald and Cook's (1996) analysis of southeastern Alaska, although important information needs remain (see Information Needs). Technological advances, such as satellite tracking devices, DNA analysis, improved surveillance techniques like Unmanned Aerial Systems and powerful computerized modeling approaches, have been helping to fill these gaps (Morrison, Marcot, & Mannan, 2006; Hegel T. , Cushman, Evans, & Heuttman, 2010).

Diversity and patterns

Fragmentation and connectivity

The ability for animals to move across landscapes is important to maintain regional populations in the short term (Cushman, 2006; Fahrig, 2003) and for animals to shift their range in response to climate change or natural disturbances (Cushman, McRae, Adriaensen, Beier, Shirley, & Keller, 2013; Heller & Zavaleta, 2009). Evaluation of wildlife connectivity varies by species (Keitt, Urban, & Milne, 1997) and needs to be defined functionally (Ament, Callahan, McClure, Reuling, & Tabor, 2014). The patchiness, configuration, and spatial arrangements of habitats in a landscape are important considerations in determining ecological integrity (Keitt, Urban, & Milne, 1997) and need to be assessed at the correct scale: individual, species, population, community, or ecological function to address the objective (Theobald & Hobbs, 2001). Evaluations of wildlife connectivity also need to incorporate appropriate timelines for the question and frame connectivity evaluations in terms of the process of interest (i.e., dispersal, migration, range shifts, and genetic flow).

Connectivity at all scales can be altered by Forest Service management and other human activities. Roads and trails or bare surfaces are barriers to many species but may also provide corridors for animals or organisms well adapted to those cleared areas. Many predators are known to hunt along trails, roads, and powerlines, but impacts from direct contact with vehicles or from increased hunter access can decrease any advantages provided. Corridors or barriers can be created by fish structure installation or removal, mining, roads, trails, utility corridors, or high-use back country trails.

A comprehensive analysis of wildlife connectivity has not been conducted for the national forest; however, there are some obvious patterns. Wildlife species and populations within the national forest are naturally fragmented due to the complex geology, high proportion of islands, barrier mountain ranges, and snow fields. The Copper River Delta is isolated by mountains and glaciers that create barriers to large mammals, such as moose. Connectivity for large mammals may be compromised on the Kenai Peninsula due to the Sterling and Seward Highways, the railroad, developments, and natural topographic restrictions. The Portage Valley in the Kenai Peninsula geographic area is a documented pinch point where big game connectivity is reduced due to both natural topography and human-caused activities. Pelletier et al. (2014) define a pinch point as a narrow corridor where an organism must cross when moving through the landscape.

Many species experience fragmentation within the national forest due to islands, mountains, glaciers, snow fields, and water (see Terrestrial Ecosystems—Vegetation). Isolation from other species, such as predators or competitors, can be an advantage to some species. Fragmentation that restricts the movement of predatory mammals to many of the islands on Prince William Sound has provided shorebirds and marine mammals safe areas for resting and breeding. Many of the larger islands support brown bears but not black bears or Sitka black-tailed deer. Few support wolves. Mink, river otters, weasels, and other predatory mammals have been documented on some islands and bird populations have been affected. Although connectivity associated with islands is reduced for many large mammals, connectivity remains for birds and sea mammals that travel by air or water.

No national forest wildlife populations are thought to be at risk due to isolation or fragmentation. However, the highly dynamic nature of avalanches, earthquakes, and glacial melting, combined with increasing human activity on flatter accessible areas, increases the chances of adverse changes to wildlife movement such that populations may be affected. In general, isolated populations are more susceptible to extirpation.

Populations on islands and in disjointed areas are vulnerable to the introduction of off-site species that could change competition, predator-prey relationships, and habitat conditions. Peters et al. (2004) stated that over-connectedness can also alter ecosystem function by facilitating the spread of pathogenic outbreaks. Over-connectedness can result from Forest Service activities, such as removing barriers for fish, which would allow fish and other organisms into streams previously protected from predation and competition. This can change the aquatic community structure such that native wildlife populations (frogs or invertebrates) might be adversely changed and ecological function compromised. Many islands in

Prince William Sound provide protected habitat for nesting birds, but those birds could be adversely affected if transplants, bridges, or ferry connections provide passage for mammalian predators that otherwise couldn't access that habitat. Over-connectedness can expose wildlife communities to diseases and pathogens for which they have not developed resistance. The 1964 earthquake uplifted dusky Canada goose habitat and made the wetlands more accessible to mammalian predators, predominantly bears. The Forest Service partnered with others to install artificial nest islands to provide dusky Canada geese with protection from the increase in terrestrial predators resulting from the uplift (see At-risk Species).

Species diversity

The Forest Service has not conducted a comprehensive wildlife species inventory, although a national forest bird list was developed by Isleib (1984). Species lists vary depending on the data included by the compiler, so numbers of species on such lists should be used with caution. Some compilers include only species that meet all their life requirements on the landscape being analyzed. Some lists include sub-species and variants (although recent DNA studies and museum research have documented some misidentifications). Others include migrants or part-year residents or non-breeding individuals. Some compilers include accidentals or incidental observations of species out of their published distributional range. These accidentals may include birds that have been blown into the area due to weather. Many species lists use observational data, which can miss cryptic, nocturnal, or obscure species. Other compilers use general habitat or species distribution information that may or may not be field verified. Lists often fail to rigorously evaluate some species, such as amphibians or invertebrates, or include rare, fossorial, and other species that are difficult to locate or identify.

That said, such lists can be useful to highlight general habitat and distributional patterns and can be used to identify apparent range disruptions, local extirpations, or changes to historic information. Comparison of lists and historical observations can point out discrepancies and the need to conduct further surveys and/or do more detailed evaluations. The Alaska Natural Heritage Program (AKNHP) has species compilations by habitats that can be a useful starting point. An August 2013 analysis of wildlife distributions expected within the national forest indicated at least 50 species of mammals should be supported. AKNHP was unable to categorize land ownership, so a broader geographic area than the national forest was used. Mammals were distributed by these broad geographic areas: 46 on the Kenai Peninsula, 43 on Prince William Sound, and 43 on the Copper River Delta. The same analysis for birds indicated that at least 178 species of birds are expected within the national forest: 165 on the Kenai Peninsula, 172 on Prince William Sound, and 159 on the Copper River Delta. Two amphibians occur within the national forest: the wood frog and boreal toad (Ream, 2013; ADF&G, 2006).

By comparison, the Kenai National Refuge (USFWS, 2014a), which is adjacent to National Forest System lands on the Kenai Peninsula and has slightly different habitat types, has a July 17, 2014 species checklist that includes 34 mammals, 154 birds, and 1 amphibian.

Functional redundancy is high within the national forest. For example, there are multiple species of prey, allowing predators to switch prey in times of prey scarcity, and there are multiple browse species, allowing moose to switch food sources to avoid excess toxins. The national forest retains all the species, habitats and ecological processes necessary to support a healthy ecosystem (see the other sections in this chapter). The national forest supports intact ecosystems of sufficient size, quality, and distribution to support historic native species, and few species are currently classified as at-risk. Healthy ecological functions still occur, such as predator-prey relationships, pollination, seed dispersal, wildlife movement between patches of habitat, and breeding for the species that live entirely within the national forest. However, even functional systems need maintenance and monitoring to ensure the risks of natural disturbances, human development within or outside the national forest, and other threats do not change the balance (see Drivers and Stressors).

Wildlife ecological highlights by geographic area

Black and brown bears (Reimchen, 2001), river otters (Ben-Davis, Bowyer, Duffy, Roby, & Schell, 1998), and bald eagles occur in all three geographic areas of the national forest and provide important nutrient transferring functions by moving salmon and other fish to uplands. Moose, deer, snowshoe hares, and other browsing animals influence vegetation by differentially selecting some species over others. Bumblebees and other pollinators occur forestwide.

Landbirds occur across all geographic areas. Landbirds comprise the largest and most ecologically diverse component of Alaska's avifauna and include raptors, grouse, woodpeckers, flycatchers, jays, chickadees, thrushes, warblers, hummingbirds, and sparrows among others (USFWS, 1999; USFWS, 2001). Boreal Partners in Flight (USFWS, 1999) identified nearly 75 percent of Alaska's landbirds as migratory.

Invertebrates also inhabit all geographic areas. They provide services in the ecosystem, such as breaking down materials, recycling nutrients, aerating soil, serving as food for wildlife and fish, and pollinating plants. Invertebrate diversity and occupancy is not well understood or documented. Invertebrates can be influenced by vegetation management or habitat improvement.

Prince William Sound

The national forest provides essential habitat for a variety of sea mammals during pupping and molting season, mostly in the Prince William Sound geographic area. Of particular note are harbor seals. Harbor seals live primarily in marine environments but occasionally haulout on National Forest System lands. Undisturbed island areas are important haulout sites. Tidewater glacial fiords provide protected feeding areas. Sea lions haul out in several areas in the Prince William Sound geographic area (see At-risk Species).

The national forest provides migratory habitat for approximately 5 million shorebirds (Powers, Bishop, Grabowski, & Peterson, 2002), that pass through during the spring and fall, primarily on the Copper River Delta and wetlands within the Prince William Sound geographic area. These important feeding areas are used for a few weeks each spring and fall by flocks of hundreds of thousands of shorebirds (some estimate up to 1.1 million birds). Each flock stays for less than a week during spring migration from late April to mid-May. The birds are able to double their body weight on the insects, small mollusks, and other invertebrates in the intertidal zone during the few days on the Copper River Delta. Those food stores allow the birds to fly nearly non-stop to the northern tundra of Alaska and Canada and begin nesting. Almost the entire North American western sandpiper population, for example, passes through the Copper River Delta during migration. Nesting species include (but are not limited to) dusky Canada goose (see At-risk Species), trumpeter swan, American widgeon, northern pintail, green-winged teal, northern shoveler, red-throated loon, horned grebe, short-billed dowitcher, least sandpiper, greater yellowlegs, common snipe, red-necked phalarope, spotted sandpiper, and semi-palmated plover. Less common Copper River Delta breeders include red-necked grebe, blue-winged teal, dunlin, and lesser yellowlegs. The Copper River Delta supports nearly the entire nesting population of dusky Canada geese (Bromley & Rothe, 2003).

The Prince William Sound geographic area provides important aquatic, riparian, wetland, and estuary habitat for both shorebirds and waterfowl. Islands and standing rocks provide protected habitat for colonial and ground-nesting species. Many of these islands are relatively free of mammalian predators, though some of the larger islands are home to fur-bearing predators introduced by fur-farms from the mid-1700s through the 1950s. Humans can unknowingly trample or disturb nests since many eggs are cryptically colored and difficult to see. Undisturbed beaches are particularly important to nesting birds during the breeding season.

Kenai Peninsula

The Kenai Peninsula geographic area is bordered on the east by a marine shoreline and the Prince William Sound. The upland habitat is a transition zone between coastal and boreal forest and supports the Portage Valley wetland, the second largest wetland within the national forest. The Kenai Peninsula has scattered wetlands and riparian areas, primarily due to high water tables. Important to primary and secondary cavity dwellers, dead trees are common throughout the Kenai Peninsula primarily due to mortality from spruce bark beetles. Wetland and riparian areas provide excellent habitat for waterfowl and waterbirds, including tundra swans and arctic terns. The steep mountains of the Kenai Peninsula provide habitat for Dall's sheep and mountain goats. The Kenai Peninsula also supports brown bears, black bears, wolves, lynx, wolverines, moose, and caribou. Sitka black-tailed deer have been incidentally noted.

Species Diversity

Information available to the Forest Service suggests that the national forest retains all historic terrestrial species, including birds, mammals, predators, and scavengers. There have been distributional, quantitative, and community shifts over time, based on geological disturbances; successional changes; human-caused landscape disturbances, such as the Exxon Valdez oil spill and fire; succession of vegetation; and soil development. Except for a few species, such as dusky Canada geese, wildlife that have been evaluated after the Exxon Valdez oil spill, and some game populations, these changes have not been quantified. There is one species listed in compliance with the Endangered Species Act that occurs within the national forest: the Steller sea lion. The western distinct population segment (DPS) of Steller sea lions is listed as threatened throughout its range, which includes Prince William Sound, and critical habitat is designated within the national forest (see chapter 3). There are no documented changes in the numbers of native wildlife species within the national forest since the 2002 Forest Plan, but species occurrences or distributions have not been thoroughly evaluated. The status of some species has changed (see chapter 3), most notably Kittlitz's murrelet (which was delisted by USFWS as a candidate in the last status review) (see At-Risk Species; see Information Needs).

The abiotic and biotic descriptions in the aquatic, riparian, and terrestrial vegetation sections provide broad habitat information using vegetative types and landscapes. For many wildlife species, however, the Forest Service lacks detailed site- and species-specific habitat association data that would be necessary to define species use, habitat requirements, or habitat deficiencies (see Information Needs).

Extirpations and intended or inadvertent introductions

The complement of wildlife within the national forest is currently thought to retain the native species, populations, and communities that were here historically. However, there have been periods of die-offs, local extirpations, relocations, and intended or unintended introductions. Transplants have been effective in some cases to meet wildlife objectives but also have the potential for unintended consequences. Paul (2009) summarizes wildlife relocations across Alaska and discusses current ADF&G policy on translocations. Specific to the national forest, there have been some noteworthy extirpations, relocations, and introductions.

Woodland caribou (*Rangifer trarandus stoneii*) were present on the Kenai Peninsula (based on available historic records) prior to 1912 when they were extirpated due to a combination of overhunting and habitat loss from human-caused fires (USFWS, 2012a). Little was known of the range and habitat use of these endemic caribou, and they probably were not numerous (ADF&G, USDA, USFWS, 2003). Caribou were reintroduced in a series of translocations from 1965 to 1986. There were five herds established from those transfers, and four remain. The Kenai Mountain herd within the national forest was established as a result of the 1965 translocation (ADF&G, USDA, USFWS, 2003).

Wolves were extirpated from the Kenai Peninsula by 1912, partially due to poisoning, bounties, intentional predator control, reductions in prey due to market hunting, and human-caused fire (Peterson, Wollington, & Bailey, 1984). They were absent for more than 50 years until they recolonized the habitat on their own in the 1960s (Bangs, Spraker, Bailey, & Berns, 1982; Peterson, Wollington, & Bailey, 1984).

Sitka black-tailed deer (Sitka deer) were introduced to Hawkins and Hinchinbrook Islands by the Cordova Chamber of Commerce in several small transplants between 1916 and 1923. Sitka deer swim readily and have moved to other places within the national forest. The Chugach National Forest is the northernmost range for Sitka deer, which are native to coastal southeast Alaska and Canada, generally in old or mixed-age forests less than 1,500 feet in elevation (Paul, 2009). Côté et al. (2004) documented the impacts to vegetation from high populations of deer in similar habitats in southeast Alaska. Selective over-utilization of some vegetative species simplified the forest conditions to the detriment of birds and other wildlife in the system. The impact of introduced deer on islands where they previously have not occurred has not been evaluated. Snow depth, hunting, and weather at the extremes of their distributional range may keep Sitka deer from reaching populations levels that would severely influence vegetation within the national forest.

Wood bison are not native to the Chugach National Forest but are currently pastured at the Alaska Wildlife Conservation Center at Portage (under a special use permit) where the animals are being raised for reintroduction to areas of their historic distribution in interior Alaska beginning in 2015. Wood bison will not be released within the national forest.

Mountain, ocean, and glacial barriers around the Copper River Delta kept moose populations from moving into the area on their own. Moose were introduced to the Copper River Delta in a series of translocations of 23 calves between 1949 and 1958. They have become a highly-desirable meat source for hunters and subsistence users. Moose have influenced vegetation composition and structure in this area, but to date, no adverse consequences to ecological processes or the wildlife community have been observed. Habitat on the Copper River Delta is similar to moose habitat outside the Copper River Delta. The introduction area lies within the overall natural distribution range of moose. A small number of animals were the source of the introductions, but genetic diversity is apparently not an issue in this isolated population. Isolated populations have the risk of in-breeding. Inbreeding increases the chance of adverse genetic modification, leading to poor fitness or survival.

Reindeer were introduced in the western Kenai Peninsula and across Alaska in the early 1900s as an attempt to meet demands of miners for meat and hides (Isto, 2012). The effort on the Kenai Peninsula was unsuccessful for a combination of factors related to economics, logistics, and harsh Alaskan conditions. No reindeer strains are thought to exist within the national forest.

Foxes, primarily non-native silver and blue fox from Europe, were introduced to nearly every accessible island with beach access in Alaska, including those within the Chugach National Forest, starting with Russian fur traders beginning in the 1750s and continuing with commercial trappers as late as World War II (ADF&G, 2006; Isto, 2012; Paul, 2009). Native furbearers, such as mink, marten, beaver, and muskrat, were also moved to islands where they did not naturally occur (Paul, 2009), and prey species, including rabbits and rats, were also moved to islands in order to feed the introduced fur bearers. This practice continued during territorial days with considerable impact to native wildlife on the islands where these predators did not previously exist. The last fur farm permitted within the national forest was in the early 1900s (Isto, 2012). Most fur farms were abandoned in the 1930s and many foxes died from disease and starvation. The long-term ecological consequences of the fur farm era have not been evaluated for the national forest.

Mink were transplanted to some islands that are now part of the national forest, including Naked Island. It is unknown if mink were already present at the time (Irons, Bixler, & Roby, 2013). Their high predation rates on pigeon guillemots documented by Irons (2013) on Naked Island are similar to the predation rates on bird islands in Europe where mink were introduced (Bonesi & Palazon, 2007; Nordstrom, Hogmander, Laine, Nummelin, Laanetu, & Korpimaki, 2003). USFWS partnered with APHIS and the Forest Service to reduce the number of mink on Naked Island to help recover pigeon guillemot populations. Pigeon guillemots were adversely affected by the Exxon Valdez oil spill.

No intentional introductions have occurred since the 2002 Forest Plan was approved, but inadvertent introductions have been reported with increasing frequency since then as noted. The extent and degree of these unintentional introductions have not been rigorously quantified in most cases, nor are the consequences of their addition to the ecosystem fully known. Animal invasions occur in both aquatic and terrestrial environments.

In the terrestrial environment, relatively few animal species were considered highly invasive or threatening to ecosystem health and integrity in a review conducted in 2005 (Schrader & Hennon, 2005). Gotthardt and Walton (2011) conducted a more recent analysis. The Forest Service has not done surveys for invasive or non-native wildlife, but some species evaluated by Schrader and Hennon (2005) and Gotthardt and Walton (2011) have been confirmed near the national forest. Because these species are primarily found in association with human habituation, Anchorage, Girdwood and the other small communities within or adjacent to the Chugach National Forest provide greater potential for range expansion, and their presence on parts of the national forest is likely.

Gotthardt and Walton (2011) evaluated 23 invasive animal and aquatic species known to occur within Alaska’s national forests and provided invasiveness scores. Ten mammal and bird species were evaluated and ranked in terms of invasiveness and only two species, the Norway rat and house mouse, were categorized as high risk invasive species (Gotthardt & Walton, 2011). Norway rats have been enormously detrimental in coastal ecosystems where they are responsible for severely reducing or extirpating native ground nesting seabirds, burrow nesting seabirds, and shorebirds (Ebbert & Byrd, 2002; Kurle, Croll, & Tershy, 2008; Major, Jones, Charetted, & Diamond, 2006).

No surveys have been conducted within the national forest for non-native earthworms and none have been confirmed, but they have been documented within the nearby Kenai National Wildlife Refuge (Saltmarsh, 2012) and are likely to also occur within the national forest. Saltmarsh found that 90 percent of road sites and 80 percent of boat launches (of a total 70 sampling sites) contained earthworms, and 50 percent of low human impact sites were occupied. She concluded that road use and construction and abandoned bait may be mechanisms for earthworm introductions within the wildlife refuge. Roads, boots, topsoil, and equipment can transport earthworms or their eggs. Costello et al. (2011) documented that earthworms spread rapidly in logged areas of the Tongass National Forest. Earthworms submerged in water can remain viable for up to six days, making streams a vector for their spread (Costello, Tiegs, & Lamberti, 2011). They can also remain viable for a certain time in the guts of fish. Use of earthworms as bait is another likely vector and could be one of the main concerns for the national forest, which has few roads or other means for earthworm transfer.

Earthworms introduced in this part of Alaska are primarily from Europe or Asia. An earthworm native to the Queen Charlotte Islands in British Columbia has been documented in southeast Alaska, but it is unknown whether the species moved 124 miles (200 kilometers) north on its own or was transported by humans. Recent literature describes the harmful effects of earthworms in habitats where they did not previously exist (Bohlen, et al., 2004; Costello, Tiegs, & Lamberti, 2011). Earthworms accelerate the decay of leaf litter and may change nutrient cycles and soil characteristics such that plant and invertebrate communities change and biodiversity declines.

Garter snakes have been documented in the Chugach State Park adjacent to the Chugach National Forest.

Feral cats can be devastating to native bird and small mammal populations. They are common in communities adjacent to and could occur within the national forest, but they have not been confirmed.

Once invasive/non-native animals become commonly reported, they are often too established on the landscape to control. The Forest Service has an active invasive plant control program for the Chugach National Forest, but has no similar program for the control of non-native wildlife or invasive organisms.

Terrestrial Ecosystems—Wildlife Drivers and Stressors

The processes that affect wildlife individuals, species, populations, and communities are complex and interactive. All animals compete for food, mates, and space. Each species requires a range of conditions that will provide them with the food, shelter, breeding, and dispersal conditions they need to survive and reproduce. Reduced fitness, curtailed reproduction, or mortality can result at the individual, population, or community scale if the amount, quality, or accessibility of essential habitat requirements are lacking.

The habitat parameters required to support wildlife are different for each species and for different life-stages (e.g., breeding, denning, winter range, etc.). The suite of biological and physical parameters necessary to support life history requirements for each species can be described as a habitat association. Habitat associations can be used to assess the occurrence and distribution of a species. Analysis of habitat quantity, quality, and distribution can help determine if and how management actions might affect the status and trend of that species or habitat. Habitat associations often include parameters that have been described in the aquatic, riparian, wetland, and terrestrial vegetation sections but also require details, such as vegetative species, successional stage, microhabitats, temperature, water availability, structural components, branches of a certain size, and special features, such as cavities or holes. Some of these parameters are not always measured in enough detail to define that vegetative/physical type as habitat for a particular species.

Not all habitats and habitat components are equally important. Nor do all wildlife life requirements equally influence survival and reproduction. There are several phases of life and seasons when wildlife is particularly vulnerable to habitat loss, disturbance, or community imbalance. Reproductive, migratory/dispersal, and wintering habitat are three of the most essential habitats influencing fitness, survival, and reproduction.

Birthing/young rearing

The sensitive time for giving birth and raising young can be predictable for many species and the most vulnerable time is fairly short. During this crucial period, parents generally have limited mobility and high energy demands as they need to feed their young and themselves and provide protection from predators or competitors. They are generally restricted to small areas until the young are able to move more freely. Protecting the small areas around nests, dens and other important rearing areas when animals are most vulnerable can help ensure successful reproduction.

Winter habitat

Times of severe weather and low food supplies within the national forest are usually during winter for most species. Generally, winter is stressful for wildlife. Snow, ice, cold, and winds can make travel difficult, energetically costly, or impossible. Leaves on trees and branches that would provide cover and security from predators have been shed. Vegetation dies in winter or becomes dormant or snow-covered. It no longer provides nutrients necessary to maintain body weight. Most big game animals survive the winter starvation period by going into the dormant season with fat accumulated during the summer when food is more plentiful. They typically alter their food source.

Caribou, for instance, switch from succulent shrubs and forbs to lichens because they maintain some nutritional value during dormant periods. Caribou in the Kenai Mountain herd typically move to higher elevations in winter to avoid predators and take advantage of wind-swept ridges.

Moose switch from leaves and forbs to branches. They don't gain significant energy from such marginal food sources, but it reduces the degree of weight loss. Many plants defend themselves by going dormant and developing toxic compounds. Browsers compensate for the toxic properties in plants by switching species often during the season. They can tolerate a certain level of tannins, but must find other species to avoid significant adverse effects. Therefore, a wide variety of food plants within the winter range is important to maintain browsers over winter.

Bears, for instance, will go into a period of hyperphagia in the fall. They can ingest more than 20,000 calories a day to gain enough fat to carry them through the winter denning period. Interestingly, a survival strategy of bears is to give birth in the dens during estivation and winter. Cubs can nurse in the dens, protected from other bears and predators, until they grow enough to be somewhat mobile when their mother emerges from her den a few months later.

Predators and furbearers often benefit by feeding on vulnerable prey species or animals that have died due to starvation or weather. They are also impacted by the temperatures and constrained movement. Much of their energy goes to the development of thick fur coats to protect them from severe temperatures and winds. Furbearers are targeted by trappers and hunters in winter who seek to harvest them when their fur is in this prime condition (see hunting/trapping).

Moose, Dall's sheep, mountain goats, deer, and most other wildlife try to maintain the body fat essential for their survival through the winter by reducing movement, finding shelter from winds and cold temperatures, and avoiding disturbance. Amphibians survive by burrowing into mud and going dormant. Bears estivate (a type of hibernation) in dens, and do not eat for months. Many birds and whales migrate thousands of miles to find better food sources. Winter recreational activities can have significant impacts to wildlife in winter by causing them to burn extra calories to avoid or tolerate people and activities. Activities that change habitat accessibility can be both advantageous or harmful depending on the extent of the activity on the landscape, the timing and degree of use on that trail, the amount of time people are using the trail (skiers take a longer time to cover the same ground as a snowmobile), and the species. Moose may use snowmobile and ski trails for easier movement through their habitat. Wolves also use these compacted areas for access to moose. Animals can be attracted to roads and railroads for easier movement, but suffer high mortality from car and train collisions (see Disturbance).

Dispersal/migratory habitat

Young animals that leave their birthing area and fend for themselves for the first time are extremely vulnerable. Mortality exceeds 50 percent in studies of post-fledging birds. Post-fledging survival in raptors can be less than 25 percent. The availability of accessible prey at the time of fledging is an important factor related to post-fledgling survival. For instance, for goshawks, Weins et al. (2006) suggested that management practices that provide abundant prey while concurrently providing forest structural conditions to allow goshawks to access prey within their breeding areas should benefit juvenile survival.

Migratory habitat is particularly important in the Copper River Delta geographic area for shorebirds and waterfowl. The migratory season is very short, but the habitat provided by the Chugach National Forest is essential to the survival and reproduction of many of these animals.

Competition occurs among animals of the same species and among different species. Animals compete for food, cover, and mates within the same species, and different species compete for limited resources.

They make energetic trade-offs between protection from predators and other competitors, finding food, or seeking mates. Different species (or individuals) practice different adaptive strategies to make them successful at surviving and reproducing. They follow different strategies that allow them to use their environment and adapt to changes, whether that be natural disturbances such as those typical within the national forest (avalanches, floods, earthquakes, fire, drought, weather extremes, deep snow, or excessive temperatures), or disturbances related to human activities.

Wildlife populations within the national forest are still influenced by natural predator-prey inter-relationships. The reduction of predators in much of the United States has altered this natural ecosystem process for many national forests in the contiguous 48 states; this has largely not occurred on the Chugach National Forest. An example of a natural predator-prey relationship is lynx and snowshoe hare. They are cyclic in their response to populations of each other. When snowshoe hares become too numerous, they can over-utilize their food supply and concurrently cause increases in lynx populations. Over-hunting by lynx and starvation in snowshoe hares decrease snowshoe hare populations and lynx populations crash in response. Lynx will move far out of their typical range, and many will die. Fewer snowshoe hares allow vegetation to recover. Snowshoe hare reproduction increases with the increase in food and reduction in predators and the pattern repeats.

Environmental stressors

Stressors include avalanches; earthquakes; floods/tsunamis; drought and other extreme weather events (high snow, snow of unnaturally long duration, excessively high or low temperatures, winds); changes in normal weather patterns that bring precipitation or temperature changes during vulnerable periods (such as nesting); and epidemics (e.g., rabies and insect infestations). The locations, size, patterns, intensity, and frequency of most of these natural environmental disturbances are described in other sections of this assessment. The wildlife communities currently present within the national forest reflect their historic ability to adapt to these natural disturbances. Small scale extirpations (local extinctions) can (and have) occurred on a temporal scale, but if a source population is nearby and connectivity is adequate to facilitate their dispersal, the affected wildlife populations or communities can recover. Impacted wildlife can emigrate to more favorable habitat and possibly recolonize the disturbed area after it recovers.

Hunting and trapping

Hunting and trapping are important human-related drivers of wildlife populations (see chapter 3). ADF&G and the Federal subsistence program follow principles of sustained yield, and most hunting/trapping is designed to be compensatory (rather than additive) to natural mortality. Harvest that intentionally or inadvertently over-utilizes females can have significant impacts on populations. High female harvest can have the greatest impact on species with low reproductive rates like black and brown bears, Dall's sheep, and mountain goats, but harvest of females can also be a management tool to quickly reduce overpopulation. Overharvest of males can result in low male to female ratios resulting in less-successful reproduction; this has been a recent concern resulting in moose hunting regulatory changes on portions of the Kenai Peninsula. Determining sex of some species can be difficult in the field. It can take many years for a population/herd to recover from the overharvest of females in species with low reproductive rates. Another stressor related to harvest is unreported/illegal kills (poaching). ADF&G biologists usually estimate unreported kills in their management reports as a safety measure so hunting quotas do not exceed sustainable levels. Habitat loss, degradation, and conversion are primary stressors related to human use. Habitat loss is not only the loss or degradation of vegetation or space within a development footprint, but also may include disturbance factors or barriers that preclude wildlife from accessing habitat across a much larger area. Changes to habitat can alter the wildlife using that habitat, making it more suitable for some species with inadvertent impacts to others. The ecological consequences of vegetative changes can be reduced when the interactive effects are fully considered and mitigated. The

Forest Service has a staff of interdisciplinary specialists who are trained to evaluate management treatments at various scales, using available information and resources.

Vegetation treatments have affected a relatively small portion of the national forest, but many have occurred in accessible areas that may also be relatively more important to wildlife. As such, those impacts may have a higher impact on the ecological integrity of wildlife than the percentages suggest (see chapter 3).

ADF&G (2006) provides a partial summary of risks that are particularly relevant to Alaskan wildlife habitat, populations, and communities related to human activities. The lack of information and analytical tools is one of the biggest challenges to maintaining ecosystem integrity (ADF&G, 2006). Alaska shares the world-wide challenge of protecting and conserving natural biotic communities and ecologic function with increasing human use (ADF&G, 2006).

Human-caused fire

Most Chugach National Forest wildland fires occur within the Kenai Peninsula geographic area during spring or late summer when fuels are driest. The Copper River Delta and Prince William Sound geographic areas are usually too wet to support fire. The spring dry season for the Kenai Peninsula is during the breeding season for many wildlife species. Fires on the Kenai Peninsula geographic area from 1914 to 1997 (Potkin, 1997) converted older forest to earlier seral conditions. The younger vegetation was favored by moose, but only after burned vegetation began to re-sprout. The fires killed many of the larger trees and destroyed lichens, temporarily modifying breeding habitat for forest land birds and reducing winter food for caribou.

Introduced, nonindigenous, and invasive species and diseases and pathogens

Nonindigenous wildlife within the national forest is described in the diversity section. Introduced and invasive species increase the risk of exposure to diseases and pathogens that can directly kill large numbers of animals or reduce fitness to the extent that populations can decline or even become extirpated.

Diseases and pathogens influence the health of individuals and sometimes populations. The Chugach National Forest is currently free of three serious pathogens that are severely affecting other parts of the world. The H5N1 HPAI avian flu was first noted in commercial waterfowl production areas in Asia. It has spread and adapted to cause illness and death in domestic and wild birds and occasional mammals, including humans. As of 2013, no HPAI has been documented in Alaska.

Another severe wildlife pathogen is white nose syndrome (WNS), a fungal infestation (*Pseudogymnoascus destructans*) of primarily cave-dwelling bats. First documented in 2008 in the northeastern United States, the pathogen has affected more than 55 million colonial bats in the eastern half of the United States and has spread as far west as Oklahoma as of June 2013. WNS has not been documented in Alaska. The Chugach National Forest has one documented bat species, the little brown bat. WNS has continued to expand west and north from the east coast (USGS, 2014b).

West Nile virus (WNV) is a pathogen that can cause disease in both humans and animals. ADF&G reported that 200 human deaths have occurred from 4,000 human cases nationwide. Horses and certain birds are particularly vulnerable to observable illness or death. It was first detected in the western hemisphere in New York in 1999 and is spread by certain types of mosquitoes. The virus is viable in a bird for a short period of time. The relationship between birds coming from infected areas and their exposure to Alaska mosquitos suggests that WNV could be spread locally only by the appropriate mosquito species. These species are currently not common in Alaska.

Pathogens are a major cause of worldwide amphibian declines (Wake & Vredenburg, 2008). One of the most serious is the aquatic fungus *Batrachochytrium dendrobatidis* (BD), otherwise known as chytrid, which has been linked with extirpations of boreal toad populations (Hossack, Lowe, Ware, & Corn, 2013). Fragmentation and drought can magnify the spread of disease by increasing the density of hosts and increasing transmission rates (Hossack, Lowe, Ware, & Corn, 2013). Chytrid fungus has been documented in wood frogs on the Kenai Peninsula (MacDonald, 2010). Growth abnormalities in wood frogs have also been documented: 7.9 percent of individuals on the Kenai Refuge had abnormalities (Reeves, Batrachochytrium dendrobatidis in wood frogs (Rana sylvatica) from three national wildlife refuges in Alaska., 2008b), and abnormalities were correlated with proximity to roads, suggesting chemical contamination or possibly that roads may be facilitating predators, parasites, or pathogens (Reeves, Road proximity increases risk of skeletal abnormalities in wood frogs from national wildlife refuges in Alaska, 2008a).

Dall's sheep are highly susceptible to *Protostrongylus stilesi*, or sheep lungworm, carried by domestic sheep and goats, including those used as pack animals (Kutz, Hoberg, Nagy, Polley, & Elkin, 2004). The pathogen is lethal to sheep. Pneumonia epizootics have caused the extinction of many populations of closely related bighorn sheep (Wehausen, Kelley, & Ramey, 2011). The risk is so significant that ADF&G (2014a) has restricted the use of domestic goats or domestic sheep as pack animals while hunting sheep, mountain goat, or musk ox. The restriction does not apply to recreational use. Forest Service management could help prevent exposure by building in restrictions related to the use of pack animals within the national forest.

Invasive species often hitch a ride on cargo, boats, planes, and boots that have been to infested areas. Coordinating with other agencies to inspect and clean vehicles, sterilize of boots and waders, implement immediate eradication treatments when new invasive species are reported (before they get established), and educate staff and the public about identification and risks can be effective in helping manage invasive species.

Pollution, pesticides, and chemical spills

Human generated waste is accumulating worldwide at increasing rates. In marine ecosystems, plastics are the most significant waste product affecting species. Plastics account for 60 to 80 percent of marine debris (Derraik, 2002). Most of the plastic waste in Alaskan waters is from fishing debris (Hess, Ribic, & Vining, 1999). In March 2011, a tsunami resulting from a powerful earthquake in Japan washed vast quantities of debris into the Pacific Ocean. An aerial survey of marine debris in Prince William Sound was conducted by NOAA in 2012. The survey found a range of marine debris density along the shoreline.

Among tsunami debris are appliances, shipping containers, docks, boats, tires, fishing gear, building supplies, unlabeled chemicals, and parts of buildings. Nets and fishing debris can snag or entangle wildlife leading to injury and sometimes death. Perhaps the most damaging tsunami debris is the plastic building foam and various types of Styrofoam. The foam and plastics are compounds that do not break down into harmless organic materials. Instead, they break into smaller and smaller particles and are often ingested by birds and invertebrate organisms. Foam particles are non-digestible and can lead to an animal or bird starving with a stomach full of plastic. Plastics also contain polychlorinated biphenyls (PCBs), thought to contribute to reproductive abnormalities, death, increased disease and/or disruptive hormone levels (Derraik, 2002).

Wastewater effluent commonly discharged from domestic and industrial sources, known as point-source pollution, impacts aquatic life and the terrestrial species that depend on them as food sources (ADF&G, 2006). Pollution can affect any life stage, leading to increased mortality and reduced reproduction and growth. Domestic wastewater sources include community septage and sewage, wastes from oil and gas development, mining, seafood processing, timber harvest, run-off from roads and utility corridors, and effluent from cruise ships and boats (see Aquatic). Nonpoint source water pollution is the primary cause of water pollution in Alaska according to ADF&G (2006).

Pesticides include fungicides, insecticides, herbicides, rodenticides, piscicides, sanitizers and disinfectants, wood preservatives, pet products, biocides, mosquito repellents, bear deterrents, marine anti-fouling materials, paints, etc. (ADF&G, 2006). All pesticides sold in Alaska must be state and EPA registered. Pesticides are important for many reasons and are an effective tool to kill invasive weeds that threaten wildlife habitat. Pesticides can harm or kill birds and mammals if they ingest granules, baits, or treated seeds, consume treated crops, drink or use contaminated water, feed on pesticide-contaminated prey or are directly exposed to spray. Long term exposure to pesticides can lead to reproductive failure, deformities, and changes in behavior that can be difficult to detect. DDE was linked to severe peregrine declines in Alaska several decades ago. Although DDT has been banned and peregrines have rebounded, DDE and DDT can still be detected in Alaska (Anthony, Miles , Estes, & Isaacs, 1999; Rocque & Winker, 2004). Pesticides that are banned in the United States are still routinely used in wintering areas of Alaskan migratory birds (ADF&G, 2006). Newer pesticides are available that have short bioactive lifetimes, are specifically targeted to the defined use, and are applied with careful mitigations. It can take considerable investment to choose pesticides with minimal non-targeted impacts, but the results can be more favorable to wildlife likely to be in the treatment area. Garbage and discarded human waste is a problem for terrestrial species and ecosystems as well. Use of bear-resistant dumpsters is encouraged in the vicinity of the national forest. Fish waste from the Russian River during salmon runs is an attractant to bears, eagles, and other wildlife species. Bears and a wide variety of other species, including moose, gulls, ravens, jays, furbearers, and rodents, will seek out and eat human foods. Entrapment from plastic six-pack can holders, narrow mouthed bottles, discarded fishing line, and other debris can cause injury and death. The rapid habituation of bears to human foods can result in bear-human encounters and safety problems. Populations of ravens, gulls, and eagles can become more numerous around such artificial food sources, changing the natural predator prey-balance (Powell & Bacensto, 2009; Weiser, 2010).

Wildlife, particularly in the Prince William Sound geographic area, was affected by the 1989 Exxon Valdez oil spill. The 1994 Exxon Valdez Oil Spill Restoration Plan (EVOS Trustee Council, 1996) described the dozens of species and services affected by the spill and identified recovery objectives that needed to be met for each of the species and services in order for them to be classified as recovered. The Exxon Valdez Oil Spill Trustee Council facilitated millions of dollars of research, monitoring and restoration/recovery projects since the spill to help recover species that were injured.

Progress toward restoring ecosystems to pre-spill conditions has been made. Monitoring, restoring, and improving resources affected by the spill is ongoing. Some lingering oil remains on the landscape in subsurface beach habitat. The USDA Forest Service is an active member of the Exxon Valdez Oil Spill Trustee Council. Table 35 displays the most recent recovery status of species and services (EVOS Trustee Council, 2010). In late 2014, the Exxon Valdez Oil Spill Trustee Council re-evaluated the status of species and services injured by the oil spill. An updated list will be posted online.

Table 35. Overview of the status of injured resources and services monitored in the Exxon Valdez Oil Spill Restoration Plan (EVOS Trustee Council, 2010)

Resource	2010 Status
Archaeological resources	Recovered
Bald eagles	Recovered
Barrow's goldeneye	Recovering
Black oystercatchers	Recovering
Clams	Recovering
Common loons	Recovered
Common murres	Recovered
Cormorants	Recovered
Cutthroat trout	Very likely recovered
Designated wilderness areas	Recovering
Dolly Varden char	Recovered
Harbor seals	Recovered
Harlequin ducks	Recovering
Intertidal communities	Recovering
Killer whales-AB	Recovering
Killer whales-AT1	Not recovering
Kittlitz's murrelets	Unknown
Marbled murrelets	Unknown
Mussels	Recovering
Pacific herring	Not recovering
Pigeon guillemots	Not recovering
Pink salmon	Recovered
River otters	Recovered
Rockfish	Very likely recovered
Sea otters	Recovering
Sediments	Recovering
Sockeye salmon	Recovered
Subtidal communities	Very likely recovered
Human service	2010 Status
Commercial fishing	Recovering
Passive use	Recovering
Recreation and tourism	Recovering
Subsistence use	Recovering

The Forest Service acquired lands at Knowles Head near Cordova with money from the Exxon Valdez oil spill settlement. Acquired lands are to be managed with the goals of maintaining the land in perpetuity for the maintenance of conservation values and restoring or enhancing injured resources. Conservation values include the amenities and attributes of natural resources, including fish and wildlife habitats.

Increased human access, roads, railroads, trails, and motor vehicle recreation

Development and infrastructure, including roads, dams, mines, powerlines, and developed recreation sites affect wildlife movement and use of habitat. Developments can remove or alter habitat and displace animals from essential areas. The design of developments can create inadvertent mortality hazards. For instance, windows in buildings are one of the greatest contributors to bird mortality worldwide. Communication towers, high tension wires, wind turbines, and uncapped pipes on developed facilities can also kill birds (USDA, 2005).

Many species of birds, especially the small insect-eaters, migrate at night. Migrating and nocturnal birds use the light from the moon and stars and the setting sun for navigation during migration. Light pollution hides their navigational aids and can pull birds off track, contributing to increased mortality. There are places adjacent to the national forest, such as Anchorage, Girdwood, Cordova, Whittier, and infrastructure along roads that have altered habitat in ways that likely influence wildlife movements, behavior, and survival.

National forest habitat loss has resulted from development, including mines, powerlines, roads and trails, railroads, cell towers, dams, buildings, trails and cabins, and vegetative treatments as described elsewhere in this Assessment.

Although developments and altered habitat make up a small proportion of the total area of the national forest, they tend to concentrate along riparian areas and shorelines, and in flatter, more accessible areas. These flatter and more accessible areas tend to be the most important and productive habitats for wildlife and plants. The direct loss of habitat is a relatively small percent of national forest area but is thought to be a much larger proportion of suitable habitat for many species.

Mitigating known risks and incorporating habitat enhancement opportunities should be considered when planning new developments. Developments and infrastructure can enhance habitat for some species by creating missing habitat components, such as snags, down wood, and nesting platforms. Similarly, a development that increases availability and access to human food or other attractants may contribute to localized population increases of nuisance wildlife. Implementing thoughtful wildlife design criteria can reduce potential for unwanted outcomes.

Disturbance, displacement, habituation, and behavioral stressors

The behavioral response of wildlife to disturbance is a major driver affecting populations and communities. It is one of the stressors most likely to be influenced by Forest Service activities. Disturbance can be noise, activity, vibrations, colors, light, or shadows. The intensity, duration, severity, and frequency of disturbance are factors that affect the significance of the disturbance. Seldom is there an accurate evaluation of the intensity, duration, severity, or frequency of disturbance events.

Animals often respond most directly to the types of disturbances that cause (or could cause) them harm. The significance of animal response to disturbance is influenced by the fitness, age, and reproductive state of the animal when they are disturbed, the availability of suitable habitat outside the disturbed areas, the season of year, and the tolerance of that animal to the disturbance. Response can take the form of avoidance. Avoiding essential habitats can be detrimental to fitness, survival, and recovery. Animals may flee an activity perceived as harmful. Fleeing is an energetic cost that can be harmful to the survival of an animal and that can make them more vulnerable to predators. Moving from familiar territory into unknown territory increases chances of predation or competition with other animals already present. If the fleeing and avoidance significantly reduce the time an animal spends feeding itself or its young or prevents an animal from resting to retain body fat, survival and reproduction will be reduced.

Animals may also respond aggressively to perceived threats and disturbance by attacking or charging. For instance, brown bears with cubs may attack hikers and recreationists if they are surprised and if they perceive the actions of the person(s) as harmful. Moose cows may attack by slashing with their hooves if they are disturbed. When humans defend themselves against such attacks, the animal is often killed, and any young-at-side are orphaned to die later.

The behavioral response of wildlife to stimuli is complicated by a tendency of some animals to habituate to that activity. Habituation occurs when an animal is repeatedly exposed to stimuli where no direct harm results. Habituation is more likely to occur if the timing, location, and frequency of the disturbance is predictable. Habituation is a coping mechanism that can be helpful to an animal by allowing them to tolerate activity that would otherwise cause them to flee or react. If an animal can habituate to a stimulus that leads to no harm, the energetic effect of that disturbance is reduced significantly. Habituation can be harmful in the case of bears that learn that people are often associated with food and perceive that food can be obtained without harm to them. They lose their natural avoidance behavior around people and can start approaching people in dangerous ways. Bears at the Russian River are attracted to fish waste, garbage, and other human-related food sources such that their behavior changes and they become habituated. Habituated animals are still wild and can be dangerous. If animals are killed because of habituation to human food, those areas can become mortality sinks, sometimes to the extent that population levels are affected at a broader scale.

Food conditioning is the term that describes changes in an animal’s normal behavior caused by their attraction to human food sources. Food conditioning can occur in most animals. Garbage and fish waste can cause unnaturally high concentrations of gulls and eagles. Domestic crops or landscaping/road byways can be attractive to moose and cause them to move into areas they would normally avoid. Habituation to traffic can lead an animal to have a false sense of security when crossing roads and mortality can result if they misjudge traffic. Some stimuli are so intense that animals seldom habituate. Blasting and sonic booms are examples that many wildlife cannot tolerate without high stress response.

Disturbance response is often not clearly observed. An animal may experience high agitation due to noise or activity such that their heart and breathing rate are accelerated, stress hormones are abnormally elevated for extended periods of time, or high energy is spent on hyper-alert behavior. An outside observer might see the animal standing calmly and not realize that the animal is experiencing stress. The costs of such chronic stress may have direct links to survival and fitness. The effect of chronic stress is gaining more research and consideration, because it can be deleterious on individuals and wildlife populations.

Some aspects of disturbance can be easily mitigated or avoided. Examples include:

- Planning activities outside of sensitive seasons (particularly breeding and wintering)
- Avoiding essential habitats when susceptible wildlife are present
- Concentrating disturbance to smaller footprints on the landscape
- Making non-harmful disturbances more predictable (to encourage healthy habituation)
- Ensuring refugia habitat is nearby when disturbance activities are likely to cause an animal to avoid essential habitat or flee from disturbance
- Buffering noises, vibrations, or color

Climate change

A 2004 Arctic Climate Impact Assessment (ACIA) report summarized projected climate change impacts on systems. Wetlands and bogs are drying in boreal landscapes and this effect is likely to accelerate. Boreal toads, wood frogs, freshwater shorebirds, and aquatic invertebrates and are particularly vulnerable to this change. Precipitation may increase along marine shorelines, and weather predictability is changing. Melting glaciers and ice fields are likely to improve connectivity, creating interactions between organisms that may lead to increased risk of disease and pathogens and significant changes to historic competitive and predator-prey relationships. Ocean salinity and pH are already changing, and influencing the marine environment which is important to many birds, sea mammals and predators. Forage fish populations have declined in Alaska, and impacts to animals dependent upon them are already being noted (see Aquatic - Fish). Species ranges are projected to shift northward on both land and sea. Insect infestations have occurred on the Kenai and fire risks have increased (see Terrestrial-Vegetation and Fire) which may be influenced by climate change.

Information Needs

Available information on wildlife in Alaska focuses on game species and economically important fish species. Migratory landbirds, raptors, shorebirds, and waterbirds have the greatest amount of data of all taxa evaluated (ADF&G, 2006). There is limited scientific information on the non-game wildlife of the Chugach National Forest, including invertebrates, amphibians, fish, birds, and smaller mammals.

Invasive and non-native animal presence within the national forest is not well-documented and therefore is difficult to evaluate in terms of risk or need for control.

Preferred or essential habitats of nongame species are generally uncharacterized in Alaska, so meaningful habitat models cannot be developed, especially at the national forest level. Distributions of many small terrestrial mammals remain unknown except for anecdotal information and isolated studies in localized areas. There is a need for genetic relationships among island endemics and their taxonomic status in order to evaluate long term functional connectivity. Models based on adequate land cover information may be the best approach to gain some of this information.

Detailed habitat use regarding water quantity needs and dispersal pathways for amphibians within the national Forest have not been documented. Amphibian distributions currently rely on anecdotal information in most cases.

There is an absence of general and site-specific knowledge about terrestrial invertebrates. The habitat use and distribution of most species remain unknown except for anecdotal information and small localized studies.

At Risk Species—Threatened, Endangered, Proposed and Candidate Species

In Alaska, the USFWS and the National Marine Fisheries Service (NMFS) share responsibility for implementing the Endangered Species Act of 1973 (16 USC 1531 et seq.; 50 CFR 226.202) and the Marine Mammal Protection Act of 1972 (16 USC 1361). Each agency has responsibility for discreet taxa. A current list of federally listed species relevant to the plan area and planning process was obtained from the regulatory agencies (NMFS, 2013i; USFWS, 2012c).

This section reviews information regarding the ecology and distribution of federally recognized threatened, endangered, proposed, or candidate species and current threats to their conservation and recovery.

Relevant Information

- The Steller sea lion is the only free ranging federally listed species known to occur on National Forest System lands within the planning area. The western distinct population (DPS) segment of Steller sea lion is designated as an endangered species and has critical habitat designated for two rookeries and seven haul out sites on NFS lands in Prince William Sound.

Current Condition

The following federally listed vertebrate species (see tables 36, 37, and 38) have the potential to occur within the plan area. Because most are exclusive to the marine environment, only the Steller sea lion will receive further evaluation. There are no federally listed or delisted plant species known to occur in the plan area. The only plant federally listed or proposed by the USFWS in Alaska is *Polystichum aleuticum*, which is endangered and only known to occur on Adak Island in the central Aleutian Islands.

Table 36. Endangered species with potential to occur in the plan area

Species	Relevant Range
Aleutian shield fern (*Polystichum aleuticum*) (USFWS, 2012d)	Adak Island, Aleutian Islands
Bowhead whale (*Balaena mysticetus*) (NMFS, 2013a)	Arctic Ocean and adjacent seas
Cook Inlet beluga whale (*Delphinapterus leucas)* (NMFS, 2012a)	Cook Inlet
Blue whale (*Balaenoptera musculus*) (NMFS, 2013b)	Gulf of Alaska, North Pacific Ocean
Fin whale (*Balaenoptera physalus)* (NMFS, 2013c)	Gulf of Alaska, North Pacific Ocean
Humpback whale (*Megaptera novaeangliae)* (NMFS, 2013d)	Gulf of Alaska, North Pacific Ocean
Leatherback sea turtle *(Dermochelys coriacea)* (NMFS, 2013e)	Gulf of Alaska, North Pacific Ocean
North Pacific right whale (*Eubalaena japonica)* (NMFS, 2013f)	Gulf of Alaska, North Pacific Ocean
Sperm whale (*Physeter macrocephalus)* (NMFS, 2013g)	Gulf of Alaska, North Pacific Ocean
Sei whale *(Balaenoptera borealis)* (NMFS, 2012b)	Gulf of Alaska, North Pacific Ocean
Short-tailed albatross *(Phoebastria albatrus)* (NMFS, 2014)	North Pacific Ocean
Steller sea lion (*Eumetopias jubatus*) west of 144 degrees (NMFS, 2008)	Gulf of Alaska, North Pacific Ocean
Western North Pacific gray whale *(Eschrichtius robustus);* (NMFS, 2013h)	Coastal waters North Pacific Ocean

Table 37. Threatened species with potential to occur in the plan area

Species	Relevant Range
Northern sea otter (*Enhydra lutris kenyoni*) (Southwestern Alaska population) (USFWS, 2014c)	Gulf of Alaska, North Pacific Ocean
Wood bison (*Bison bison athabascae*)	Captive herd only

Table 38. Candidate for Listing Species with potential to occur in the plan area

Species	Relevant Range
Yellow-Billed Loon (*Gavia adamsii*) (USFWS, 2014d)	Breeds in arctic tundra lakes, winters in Prince William Sound and southeastern Alaska

Steller sea lion (*Eumetopias jubatus*)

Population and demographics

The U.S. population of Steller sea lions was listed as threatened in compliance with the ESA on April 5, 1990 (55 FR 126451). In 1997, the NMFS recognized two distinct population segments (DPS) of Steller sea lions: the western DPS was reclassified as endangered and the eastern DPS was maintained as a threatened species at that time (62 FR 24345; 62 FR 30772). The Chugach National Forest is within the range of the western DPS. The western DPS declined by 75 percent between 1976 and 1990 and decreased another 40 percent between 1991 and 2000, although the most recent available data suggest that the overall trend for the western DPS, through 2007, is either stable or slightly declining (NMFS, 2008).

Suitable habitat

Female sea lions appear to select places for giving birth (rookeries) that are gently sloping and protected from waves. Females with pups begin dispersing from rookeries to haulouts when the pups are about 2.5 months-of-age. Haulout is the term used to describe terrestrial areas used by adult sea lions during times other than the breeding season and by non-breeding adults and subadults throughout the year. Sites used as rookeries in the breeding season may also be used as haulouts during other times of year. Some haulouts are used year-round while others only on a seasonal basis (NMFS, 2008).

Critical habitat was designated on August 27, 1993, based on the location of terrestrial rookery and haulout sites, spatial extent of foraging trips, and prey availability (58 FR 45269). Currently, NMFS has identified two rookeries and seven haulouts as critical habitat within the Chugach National Forest (50 CFR 226.202). Steller sea lion critical habitat includes a 20 nautical mile buffer that may incorporate specific fishery management measures around all major haulouts and rookeries, as well as a terrestrial zone that extends 3,000 feet inland from the base point of each identified rookery and haulout and an air zone that extends 3,000 feet above the terrestrial zone of each rookery and haulout, measured vertically from sea level.

The 2002 Forest Plan requires Forest Service managers to “design and locate facilities or apply seasonal restrictions on human activities when necessary and appropriate to reduce disturbance in important habitat areas, such as birthing areas, nesting areas and winter ranges,” including those identified for the Steller sea lion. All projects must comply with requirements of the ESA, MMPA and their implementing regulations as well as other applicable federal and state laws and Forest Service policy. In addition, the 2002 Forest Plan directs the Forest Service to “manage human activities within 750 feet of any hauled out sea lion or seal on land areas to avoid disturbance.”

Predator, competitor, and risk factors

Critical habitat with associated buffer zones and fishery management measures were designed to reduce potential for direct human caused mortality and indirect mortality and injury caused by disturbance, as well as localized competition for Pacific cod and Atka mackerel, important Steller sea lion prey species (NMFS, 2008).

The 2008 threats assessment for the western DPS concluded that threats from Alaska Native subsistence harvest, illegal shooting, entanglement in marine debris, disease, and disturbance from vessel traffic and scientific research were relatively minor (NMFS, 2008) but that a great deal of uncertainty remained about the magnitude and likelihood of competition with fisheries, environmental variability, incidental take by fisheries, toxic substances and predation by killer whales as potential threats to recovery of the western DPS (NMFS, 2008). Of these potential threats to species recovery, most are outside the scope of Forest Service management.

At Risk Species—Potential Species of Conservation Concern

A species of conservation concern (SCC) is a species, other than federally recognized threatened, endangered, proposed, or candidate species, that is known to occur in the plan area and for which the regional forester has determined that the best available scientific information indicates substantial concern about its capability to persist over the long term in the plan area (36 CFR 219.9 (c)). Potential SCC are identified and evaluated here. The regional forester shall identify the SCC for the plan area in coordination with the responsible official following completion of the assessment and during development of the revised plan.

In addition to ensuring presence within the plan area, potential SCC were also evaluated based on their rarity at multiple scales and identified threats to their viability and/or persistence at those scales. These threats were then assessed relative to the plan area and the potential for Forest Service management to affect conservation against those threats. Many species were considered for evaluation, but only a few met sufficient criteria as potential SCC for more in-depth analysis.

An initial group of species evaluated as potential SCCs was developed from a review of 133 plant and animal species with status ranks of G/T 1-2 on the NatureServe ranking system. G1 species are considered Critically Imperiled, At very high risk of extinction due to extreme rarity (often 5 or fewer populations), very steep declines, or other factors, and G2 is considered Imperiled, At high risk of extinction due to very restricted range, very few populations (often 20 or fewer), steep declines, or other factors. The status of intraspecific taxa (subspecies or varieties) is indicated by a T rank following the species' global or G rank. A query of the NatureServe system (NatureServe, 2012) and the Alaska Natural Heritage Program (AKNHP, 2012/2013a) provided updated NatureServe rankings. Most of the critically imperiled or imperiled species on the state list do not occur within the plan area and were not given further consideration. Those that were known to occur within the plan area and for which their capability to persist over the long-term in the plan area was in question were evaluated further. These evaluation forms are part of the project record.

Relevant Information

After evaluating the various lists of at-risk species, the potential species of conservation concern have been narrowed to include two birds and five plants: dusky Canada goose, Kittlitz's murrelet, Aleutian cress (Eschscholtz's little nightmare), sessileleaf scurvygrass, spotted lady's slipper orchid, pale poppy, and Unalaska mist-maid. In coordination with the responsible official, the regional forester will determine the final list of SCC for the plan area following completion of the assessment and during development of the revised plan.

Scientific Information from Agencies and Organizations

Evaluation of information and species data made available by USFWS, ADF&G, AKNHP and other sources provided background for identifying and evaluating potential SCC and their conservation needs. To ensure a thorough consideration of species as potential SCC, species found on other watch lists were also evaluated against the SCC evaluation criteria. For vertebrates, the Checklist of Alaska Birds (Gibson, Gill, Heini, Lang, Tobish, & Withow, 2012), the AKNHP species tracking lists for birds, mammals, reptiles, and amphibians (AKNHP 2012/2013b, c, d) and USFWS Birds of Conservation Concern BCR 5 (USFWS, Birds of Conservation Concern; BCR 5 Northwest Forest Plan Forests (Northern Pacific Forest-U.S. portions only), 2008) were consulted, as well as the Audubon Alaska WatchList 2010 (Kirchhoff & Padula, 2010). The 2006 ADF&G publication, Our Wealth Maintained: A Strategy for Conserving Alaska's Diverse Wildlife and Fish Resources, identified the species of greatest conservation need, which included amphibians and reptiles, marine fish, marine invertebrates, seabirds, marine mammals, terrestrial mammals, landbirds, raptors, terrestrial invertebrates, waterbirds, shorebirds, freshwater fish, and freshwater invertebrates, and was also referenced when developing a species list for further consideration. For plants, the newly updated AKNHP Rare Vascular Plant list was consulted (AKNHP, 2012/2013a); this update was a cooperative venture between the AKNHP and Alaska flora experts from an array of agencies and institutions, including the Forest Service.

Alaska Region Regional Forester's Sensitive Species List

A review of the Regional Forester's Sensitive Species List (USDA, 2009) was also conducted. The list includes 17 plants, 1 lichen, and 5 birds. The Alaska Region updated the sensitive species list in 2009. No fish or mammals were found to warrant designation as a sensitive species at that time. This 2009 update resulted from a thorough analysis of existing information relative to native fish, wildlife and plant distribution, abundance, dispersal capability, population trend, life history and demographics, known distribution, suitability and vulnerability of suitable habitats (Goldstein, Martin, & Stensvold, 2009). Information from this recent update as well as subsequent information was used for evaluation of these species as potential SCC. An evaluation form was prepared for each species considered in 2009 and updated for current sensitive species. These evaluation forms are part of the project record for this assessment. Species were evaluated based on criteria provided in 36 CFR 219.9 and associated Forest Service direction (USDA, 2005).

Vertebrates on the Alaska Region Regional Forester's Sensitive Species List

Queen Charlotte goshawk (*Accipiter gentilis laingi*)
Kittlitz's murrelet (*Brachyramphus brevirostris*)
Black oystercatcher (*Haematopus bachmani*)
Dusky Canada goose (*Branta canadensis occidentalis*)
Aleutian tern (*Sterna aleutica/Onychoprion aleuticus*)

Plants and lichen on the Alaska Region Regional Forester's Sensitive Species List

Aleutian cress (Eschscholtz's little nightmare) (*Aphragmus eschscholtzianus*)
Moosewort fern (*Botrychium tunux*)
Spatulate moonwort fern (*Botrychium spathulatum*)
Moonwort, no common name (*Botrychium yaaxudakeit*)
Edible thistle (*Cirsium edule var. macounii*)
Sessileleaf scurvygrass (*Cochlearia sessilifolia*)
Spotted lady's slipper (*Cypripedium guttatum*)
Mountain lady's slipper (*Cypripedium montanum*)
Large yellow lady's slipper (*Cypripedium parviflorum var. pubescens*)
Calder's loveage (*Ligusticum calderi*)
Lichen, no common name (*Lobaria amplissima*)
Pale poppy (*Papaver alboroseum*)
Alaska rein orchid (*Piperia unalascensis*)
Lesser round-leaved orchid (*Platanthera orbiculata*)
Kruckeberg's swordfern (*Polystichum kruckebergii*)
Unalaska mist-maid (*Romanzoffia unalaschcensis*)
Henderson's checkermallow (*Sidalcea hendersonii*)
Dune tansy (*Tanacetum bipinnatum subsp. huronense*)

At Risk Vertebrates—Potential Species of Conservation Concern

Discussions about vertebrate species and concerns for their ability to persist over the long term that are known to occur in the plan area follow. These species have been identified for consideration as potential SCC.

Dusky Canada goose *(Branta canadensis occidentalis)* G5T3, State Ranking S3B

Population and Demographics

Dusky Canada geese occur within the plan area, are currently (as of September 2012) on the Regional Forester's Sensitive Species list (USDA, 2009), and are ranked red on Audubon Alaska's WatchList (Kirchhoff & Padula, 2010) because of their declining abundance. Dusky Canada geese nest primarily on the Copper River Delta and winter in the Pacific Northwest along with several other sub-species of Canada geese (*Branta canadensis*) and the smaller bodied species of cackling geese (*Branta hutchinsii*). Unlike dusky geese, the abundance of other geese, especially the cackling goose (*B. h. minima*), have increased dramatically on the wintering grounds causing significant economic losses to Oregon and Washington agricultural interests. Washington, Oregon, and Alaska have implemented regulations to allow for an incidental harvest of dusky geese in order to provide for sufficient harvest of the more abundant geese to minimize crop depredation. Subspecies of Canada and cackling geese are difficult to distinguish from one another under hunting conditions, requiring regulations that allow for a small incidental harvest of dusky geese. However, the harvest of dusky geese remains far below levels set by the Pacific Flyway Council due to extensive outreach and education and intensive harvest management programs. The incidental harvest of dusky Canada geese has allowed hunting seasons to remain open for other species, greatly reducing economic losses.

Annual dusky Canada geese productivity on the Copper River Delta is often significantly reduced by predation of adults, nests, and goslings. Since 1984, the Forest Service has partnered with various organizations, including Ducks Unlimited, Washington Department of Wildlife and Fish, Oregon Department of Fish and Wildlife, ADF&G, USFWS, the National Fish and Wildlife Foundation, and others to install artificial nest islands (ANI) to improve reproduction, help balance the age structure to a more normal distribution of young to adults, and to reduce predation of young and adults. The program has been successful in providing consistent annual recruitment into the dusky Canada goose population. Use of ANIs has steadily increased and is predicted to increase in the future. From 1984 to 2012, nest success on artificial islands has averaged 65 percent, nearly twice the rate found at natural sites in the area (USDA, 2012a). The Pacific Flyway Council identifies the ANI as one of the best known tools to maintain populations of this species.

Suitable habitat

Dusky Canada geese winter in nutrient-rich, agricultural cropland where they acquire large fat reserves important in meeting the energy needs of migration and reproduction. Aerial surveys of the Copper River Delta during the spring breeding grounds indicate that dusky Canada geese may be increasing on glacial outwash plain habitats, where historically nests were found in low densities, and decreasing in uplift marsh habitats, where nest densities were medium to high (Eldridge USFWS, unpublished data). Long term sustainability of dusky Canada geese may be dependent upon continued ANI work, but the long term plant succession models (DeVelice, DeLapp, & Wei, 2001a) predict that many of the current ponds will eventually turn into sphagnum moss bogs with continued shrub encroachment.

Predator, competitor, and risk factors

The dusky Canada goose population was overhunted in the 1950s and experienced periodic tidal flooding of nesting sites pre-1964. Following the1964 Great Alaska Earthquake, which uplifted the Copper River

Delta up to 11 feet, much of their saltwater marsh habitat underwent extensive changes due to loss of tidal flooding, increased drainage, and reduced salinity. Succession of vegetation has been increasing in the uplift area, and trees and shrubs are becoming more prominent, making the nesting geese more susceptible to terrestrial and avian predators. Bald eagles have increased on the nesting grounds in response to habitat change and are a primary predator of dusky Canada geese and their eggs, especially in years when their preferred prey of eulachon, a small anadromous fish, are scarce during the nesting period.

Summary

Dusky Canada geese were identified as having potential concerns for viability or distribution within the Chugach National Forest in 2002 and were designated as a management indicator species for monitoring population trends, habitat characteristics, and changes (USDA, 2002b). The Forest Service has not developed standards or guidelines specific to the management of this species, but guidance was provided within the Waterfowl and Shorebird Habitats Management section (USDA, 2002b). The relevant existing information and summary of the status of ecosystem integrity provided previously and more extensively within the project record indicate vulnerability of this species and a concern about the species' capability to persist within the plan area.

Kittlitz's murrelet (*Brachyramphus brevirostris*) G2 S2

Population and demographics

Present-day populations of Kittlitz's murrelet occupy a large range and are geographically clustered, usually in remote areas that are difficult to reach and survey. Many areas of their range have not yet been systematically surveyed or are under-represented by existing survey efforts (USFWS, 2013). Records indicate that Kittlitz's murrelets in Prince William Sound (four percent of rangewide population estimate) had declined by 84 percent between 1989 and 1995, owing in large part to the 1989 Exxon Valdez oil spill (USFWS, 2011b). There is uncertainty regarding the status and trend of Kittlitz's murrelets within Prince William Sound. Since 2000, populations appear to be either stable or declining and are projected to continue to decline at a much slower rate (USFWS, 2013).

Suitable habitat

Kittlitz's murrelets are solitary nesters and most are found in association with tidewater glaciers during the breeding season, but breeding has also been documented throughout their range in areas where glaciers no longer exist. Offshore, Kittlitz's murrelets occur primarily in Alaska state waters (zero to 3 nautical miles (nm) from shore), and within the U.S. Exclusive Economic Zone (3 to 200 nm from shore) in southern and northwestern Alaska. Onshore, this species is found on lands managed by the Forest Service, USFWS, National Park Service, the State of Alaska, Native lands, and Department of Defense lands (USFWS, 2011b). Kittlitz's murrelets are known to nest on lands within the Chugach National Forest. Throughout their range, barren areas, which are characterized by bare rock, gravel, sand, silt, or clay with little or no green vegetation present, appear to be the preferred nesting habitat (USFWS, 2013). The Kittlitz's murrelet disperses nests across the landscape and relies on cryptic coloration and behavior to avoid predator detection. On the mainland in south-coastal Alaska, nunataks appear to be favorable habitats presumably because of their isolation from terrestrial predators (Kissling, unpublished data, 2013). These habitats are not limited to within the Chugach National Forest or typically affected by Forest Service management.

Predator, competitor, and risk factors

The loss of tidewater glaciers is a threat to the species and the magnitude of that threat is high because of the rate of change in the glaciers (USFWS, 2011b). The USFWS identified poor nest success as the underlying reason for the population decline since the oil spill. Petroleum hydrocarbons in marine waters are considered among the most potentially harmful contaminants to marine birds and their prey. The Kittlitz's murrelet is considered highly vulnerable to marine oil pollution because this species spends most of its annual cycle at sea, forages by diving and pursuing prey, and is typically found in areas of greatest potential risk for this hazard.

Summary

The USFWS named the Kittlitz's murrelet as a candidate for protection in compliance with the ESA in 2004. In October 2013, the USFWS published their 12-Month Finding on a Petition to List Kittlitz's murrelet as an endangered or threatened species and found "that listing the Kittlitz's murrelet is not warranted at this time." This finding removed the murrelet from candidate status (Federal Register Vol. 78, No. 192, 2013). Based on the analysis, the USFWS (2013) found "that the stressors are not of sufficient imminence, intensity, or magnitude to indicate that the Kittlitz's murrelet is in danger of extinction (endangered), or likely to become endangered within the foreseeable future (threatened), throughout all of its range," which includes the plan area. Kittlitz's murrelet habitat is not limited to within the Chugach National Forest or typically affected by Forest Service management.

Black oystercatcher *(Haematopus bachmani*) G5 S2S3

Black oystercatchers occur over a broad geographic range. They occupy coastal habitats from the west Aleutian Islands to the east along the coast and coastal islands of Alaska to Morro Bay, California, and on offshore islands to Baja California. Oystercatchers in the plan area nest during the spring and summer and largely migrate from the plan area for wintering (Andres & Falxa, 1995; Gill, Hatch, & Lanctot, 2004; Tessler, Johnson, Andres, Thomas, & Lanctot, 2010). Dominant threats to the species include oil spills and other aquatic pollution, changes in prey as a result of climate change (e.g., ocean pH, increased storm activity), and disturbance (particularly of nesting birds) by human activity on shorelines (largely associated with recreation).

This large shorebird has demonstrated resilience to major ecological disturbance following the Exxon Valdez oil spill. Furthermore, the species demonstrated an ability to disperse into, occupy, and increase in new habitat following the development of open shore habitat on Middleton Island resulting from the 1964 earthquake (Gill, Hatch, & Lanctot, 2004). There is no evidence that significant areas of potential habitat are unoccupied in the plan area or that densities are low relative to the ecological capacity of the species. The most substantial management threat, recreation activities, appear to negatively influence a limited number of birds (Poe, Goldstein, Brown, & Andres, 2009), and this activity largely influences a portion of oystercatcher life history that is not dominant in population growth (Caswell, 1989). Potential changes in ocean conditions associated with climate change represent the threat of greatest concern but the direction and rate of change in conditions that influence the oystercatcher are unclear at this time (IPCC, 2007). Much of the coastal area occupied in the plan area is strongly influenced by glacial input, which will influence the marine response to climate on coasts of the Chugach National Forest and therefore the level of threat (e.g., pH changes), but the direction and intensity of response is unknown.

Summary

This species is migratory, with limited distribution within the plan area. Current population and nesting success within the plan area are based on casual observations. There is currently not enough information to determine status. There are no identified site specific threats to persistence within the plan area. This summary is developed from a more complete evaluation filed in the project record.

Aleutian tern (*Sterna aleutica*/*Onychoprion aleuticus*) G4 S3B

Until recently, the Aleutian tern was placed in the large genus *Sterna,* which included most terns. In 2006, the American Ornithologists' Union reclassified this species based on genetic sequence comparisons. It is now in the genus *Onychoprion,* which includes three other brown-backed tern species. The Aleutian tern breeds only in Alaska and eastern Siberia. It nests in coastal colonies that are distributed over a wide range. Nesting occurs in a variety of habitats (e.g., islands, shrub-tundra, grass or sedge meadows, and freshwater and coastal marshes). The primary diet consists of small fish, which are caught in a variety of ways. The tern may search for fish from the air and swoop down to pick them from the surface, hover and dive to shallow depths, or sit on the surface and dip. They are skilled fliers and can take insects out of the air while flying.

The world population is between 17,000 and 20,000 individuals. The breeding population estimate for Alaska is 9,500 birds. On the south and east side of Kodiak Island, Aleutian terns have declined from 1,559 individuals in the late 1970s to two birds in 2002. Because terns are known to shift nesting locations between years, trends are difficult to evaluate. Primary causes of mortality and factors that regulate populations are predation, inclement weather during chick rearing, and human disturbance at nesting sites (USFWS, 2006a).

Summary

This species is migratory, with limited distribution within the plan area. Current population and nesting success within the plan area are based on casual observations. There currently is not enough information to determine status. There are no identified site specific threats to persistence within the plan area. This summary is developed from a more complete evaluation filed in the project record.

At Risk Invertebrates—Potential Species of Conservation Concern

Alaska invertebrates with potential concern total 23 species. Evaluations of these species determined that none were known to occur within the Chugach National Forest and most were of limited range occurring well away from the national forest.

At Risk Plants—Potential Species of Conservation Concern

Discussions about plant species and concerns for their ability to persist over the long term that are known to occur in the plan area follow. These species have been identified for consideration as potential SCC.

Aleutian cress (*Aphragmus eschscholtzianus* Andrz. ex DC.) G3, RFSS

Population and demographics

Eschscholtz's little nightmare is distributed from the Aleutians east along the Alaska Range and Wrangell St. Elias Mountains to the southern Yukon and into the Tatschenshini River area of British Columbia. There are 57 known populations scattered over a large geographic area (AKNHP, 2012/2013a). Only one population is known within the Chugach National Forest. It occurs in the upper end of Palmer Creek Valley on the Seward Ranger District (collected by J.A. Calder in 1951). This population was relocated by Forest Service botanists in 2011 during Aleutian cress rare plant surveys.

Suitable habitat

Alpine tundra; on moist, bouldery, solifluction slopes; wet mossy seeps; wet seepage areas among rocks; snow melt areas (University of Alaska, Fairbanks Herbarium Data (ALA)); and fine gravel saturated by snow melt water (Rollins, 1993).

Predator, competitor, and risk factors

The habitat for this plant is fragile and is slow to recover from disturbance. Some of this habitat is being damaged by communications sites, recreation activities, and minerals activities. The known *Aphragmus* populations are located in an area of historic mining activity in the Palmer Creek Valley. The area is identified as Most Favorable, Developable on the mineral potential map (see the map package appendix). Climate change may lead to changes in habitat that could extirpate the plant from the Chugach National Forest (Carlson & Cortes-Burns, 2012).

Summary

A. eschscholtzianus is known from only one area within the Chugach National Forest. Specific threats to the plant in the national forest include potential minerals activity and climate change.

Sessileleaf scurvygrass (*Cochlearia sessilifolia* Rollins) G1G2Q S2Q, RFSS

Population and demographics

Sessileleaf scurvygrass is endemic to south coastal Alaska. It is known from Nuka Bay in Kenai Fjords National Park (Arctos, 2012); Shoup Bay; Valdez tide flats (AKNHP, 2008); and Kodiak and Sitkalidak Islands (Arctos, 2012; Lipkin & Murray, 1997). Twelve populations have been documented globally. Within the Chugach National Forest, it is documented on the east end of Hawkins Island and on the north shore and near the head of Port Fidalgo (AKNHP, 2012/2013a).

The plant is currently recognized as it was originally named in 1941 by Rollins as *C. sessilifolia* (Al-Shehbaz & Koch, 2010). This is a narrow endemic species of south coastal Alaska known from Kodiak and Sitkalidak Islands, eastern Kenai Peninsula, and Prince William Sound. Twelve populations have been documented globally. Approximately half of the known populations are found on private lands. Within the national forest it is documented from the east end of Hawkins Island and on the north shore and near the head of Port Fildago (AKNHP, 2012/2013a). Some question persists as to the appropriate taxonomic rank for this plant; some authors (Hulten, 1968; Welsh, 1974) have considered this plant a variety of the more common *C. groenlandica*, while more recent treatments (Al-Shehbaz & Koch, 2010; Rollins, 1993) maintain species-level rank.

Suitable habitat

The plant grows in low energy estuarine sites, in the intertidal zone, on gravel bars or spits, generally inundated at high tide (Al-Shehbaz & Koch, 2010; Rollins, 1993). Habitat or population connectivity is limited due to separation of low energy estuarine sites. This habitat is naturally distributed as isolated patches with limited opportunity for dispersal among patches. Some local populations may have been extirpated due to sea level changes resulting from earthquakes or during tsunamis.

Predator, competitor, and risk factors

Sessileleaf scurvygrass is rare throughout its range and abundance is low. Populations in high use recreation areas are vulnerable to invasive species, dragging boats across beaches and other ground disturbing actions.

Summary

Al-Shehbaz and Koch (2010) state that this plant is of conservation concern worldwide. Specific threats include damage resulting from potential heavy recreational uses of beaches and sudden sea level changes.

Spotted lady's slipper orchid (*Cypripedium guttatum* Sw.) G5S4

Population and demographics

The spotted lady's slipper is widespread in temperate/boreal Eastern Europe, Asia, across the Aleutians, and through the Alaska Range east to the Yukon and Northwest Territories. Hulten (1943) does not indicate any plants in southern Alaska east of Kodiak Island, yet in 1968, he indicates a site on the Kenai Peninsula, and Sheviak (2002) includes the Kenai Peninsula on the range map in Flora of North America. The Chugach National Forest is at the southern edge of the plant's North American range.

Suitable habitat

Open shrubby areas, open forests, and mixed forb meadows are habitat for this species. The specimen from the Chugach National Forest (Portage area) grew at the edge of a small pond in an open area adjacent to shrubs.

Predator, competitor, and risk factors

A single, small population of less than 10 plants was known in Portage within the Chugach National Forest until it was wiped out with the creation of a gravel pit in 2001. The nearest known population is north of Palmer, about 62 miles (100 kilometers) north of Portage (Arctos, 2012). Potential habitat in the Portage area has been modified by construction projects and construction of gravel pits and roads. Any undocumented populations may be vulnerable to flower pickers and plant collectors, particularly in areas near roads.

Summary

This species is widely distributed outside and north of the Chugach National Forest with no known populations within the national forest boundary.

Pale poppy (*Papaver alboroseum* Hult) G3G4, RFSS

Population and demographics

The pale poppy is distributed from western to southcentral Alaska, into north central British Columbia (E-Flora BC, 2012/2013). There are about 40 element occurrences documented in the AKNHP and Arctos databases (2012), including several locations within the Kenai Peninsula geographic area. Kiger and Murray (1997) indicate that the plant is infrequent at scattered sites within its range and note that the plant is abundant in the Portage Glacier area.

Suitable habitat

The pale poppy requires an open, well-drained habitat created or maintained by occasional disturbances. Human disturbances, such as stabilized road sides, railroad track beds, and old gravel pits, may provide suitable habitat.

Predator, competitor, and risk factors

While some human disturbance may help maintain suitable open habitat, repeated disturbance, as in the Portage Valley, may have affected the plant's ability to reproduce (Charnon, 2007). Habitat suitability analysis suggests minimal change in areas of highly suitable habitat under future climate scenarios (Carlson & Cortes-Burns, 2012). Invasive plants are flourishing in some areas of pale poppy habitat and are shading out the poppies. Some populations are vulnerable to flower pickers and plant collectors.

Summary

This species is widely distributed. Current information does not indicate substantial concern about the species' capability to persist over the long term in the plan area.

Unalaska mist-maid (*Romanzoffia unalaschcensis* Cham.) G3S3S4

Population and demographics

The Unalaska mist-maid is rare across its range, which extends from the eastern Aleutians across the south coast to southeastern Alaska. The Tongass National Forest provides the eastern edge of its range. Twenty-six of the 34 known Alaska occurrences are located from Kodiak Island west to the Aleutians (Arctos, 2012). This plant is extremely rare within the Chugach National Forest, known from only two locations: Cape St. Elias on Kayak Island, and at Hawkins Creek on Hawkins Island.

Suitable habitat

This plant grows in gravelly areas along streams, and on ledges and crevices in rock outcrops, often along the coast.

Predator, competitor, and risk factors

There is a potential decline in the Unalaska mist-maid's habitat quality and quantity due to road construction, hydroelectric projects, minerals activities, stream restoration projects, and fisheries projects.

Summary

This species is widely distributed in Alaska with limited distribution within the plan area. There are no identified site specific threats to persistence within the plan area.

Climate Change

The composition, structure, and function of an ecosystem is a product of species interactions and both biotic and abiotic responses to environmental drivers. Recent and increasing climate change effects represent the most pervasive environmental alteration affecting the Chugach National Forest. Understanding the consequences of current and future climate change within the national forest requires understanding current patterns in the context of the long-term climate trajectory of the region—many ecosystems of the region are still changing in response to ecological development since the last glacial maximum. The climate in southcentral Alaska is warming with an increase in mean temperature of 3 degrees F having been recorded since 1949 and an additional increase of 4 to 8 degrees F projected by 2100 (Stewart, Kunkel, Stevens, Sun, & Walsh, 2013). There is uncertainty about the magnitude but not the direction of temperature changes that may occur in the area.

A Climate Change Vulnerability Assessment is underway in collaboration with multiple agencies and organizations for the broader southcentral Alaska region that includes the Chugach National Forest (Hayward, Colt, McTeague, & Hollingsworth, in prep.). This assessment examines key biophysical features of the region that influence resource management decisions. Some of the findings stated here are the same as will be reported in the Climate Change Vulnerability Assessment.

Relevant Information

Snow and Ice Recent and Anticipated Changes

- Chugach National Forest glaciers are currently losing about 1.45 mi^3 (6 km^3) of ice per year; half of this loss comes from Columbia Glacier.
- During the past decade, almost all glaciers surveyed within the Chugach National Forest have been losing mass, including glaciers that have advancing termini.
- Columbia Glacier will likely retreat another 9.3 miles (15 km) during the next 20 years before stabilizing.
- Climate modeling suggests that significant warming may occur with increased precipitation but decreased snowfall at lower elevations; increased glacial melt and loss of snowpack may occur with less of a spring surge and greater runoff during winter months; and increasing summer season length may occur with some areas that freeze regularly no longer doing so (Fresco, 2012).

Aquatic Ecosystems Recent and Anticipated Changes

- Climate change within the Chugach National Forest and on surrounding lands may increase flood frequency and magnitude, speed glacial recession, and change the timing of peak and low flows.
- Changes in timing and magnitude of freshwater delivery to the Gulf of Alaska may impact coastal circulation as well as biogeochemical fluxes to near shore marine ecosystems and the eastern North Pacific Ocean.
- Impacts from climate change to non-consumptive national forest water resources include affects to timing, locations, and use of recreational activities, such as whitewater rafting, skiing, fishing, and glacier viewing.
- Impacts from climate change to consumptive national forest water resources include changes in the timing and amounts of water available for water storage, silt loads, and hydropower generation.
- Across the Chugach National Forest, the watersheds most vulnerable to significant shifts in hydrologic processes and associated disruption to the ecology of salmon populations were distributed around periphery of Prince William Sound.
- Based on modeling results, the salmon habitat and species distributions will be vulnerable to climate change. During the next 50 years, as the warm water and cold water boundaries change along the

Alaska coastline, the specific habitat suitability for salmon species may dramatically affect the distributions that are currently observed.
- Impacts from climate change to Chugach National Forest riparian and wetland areas could include increased bank erosion due to increased flood frequency and magnitude, changes in water table associated with changes in low flows and glacial snowmelt contribution, increased stream temperatures, and increased fire potential in some locations in the region.

Terrestrial Ecosystems Recent and Anticipated Changes

- Wildlife species richness and functional redundancy is within expectations for a northern geographic region. Much of the habitat retains natural connectivity, which will allow populations to move as habitat conditions change. The intact nature of the systems suggests a high degree of resilience to climate change.
- Migratory species may be challenged by changes in phenology and more frequent extreme weather events. Changes in phenology have occurred in the past that suggest species are resilient to similar changes.
- Aquatic invertebrates will be affected by warmer water temperatures associated with climate change, and the two amphibians that occur within the national forest, the wood frog and boreal toad, may be impacted as they rely on these invertebrates for food.
- Initial modeling suggests that Chugach National Forest vegetation will have variable ecological responses to climate change. Perhaps the least change will be in the temperate coastal rainforests of the Copper River Delta and the Prince William Sound, which are expected to remain as rainforests.
- The richness and diversity of Chugach National Forest native vegetation likely provides a high level of resistance and resilience in response to change.
- Invasive species pose one of the larger long term threats to ecological integrity. Effects of changing climate, increasing levels of disturbance (both natural and human caused), and increasing tourism and population growth make the national forest vulnerable to introduction and expansion of invasive species. There is an opportunity to develop additional standards and guidelines associated with early detection and rapid response to invasive species.
- Climate change may lead to extirpation of the rare *Aphragmus eschscholtzianus* (Aleutian cress) from the national forest. By 2060, no location within the national forest is predicted to provide highly suitable climatic conditions for Aleutian cress, but suitable habitat is likely to occur north of the Chugach National Forest and state-wide distribution may expand.

Snow and Ice

In a statewide report on Alaska glaciers, Arendt et al. (2002) report glacier thinning from 1995 to 2001 was more than twice as fast as that measured on the same glaciers from 1950 to 1995. The authors state that the “losses are nearly double the estimated annual loss from the entire Greenland Ice Sheet during the same time period” and “form the largest glaciological contribution to rising sea level yet measured.”

Extremely high rates of snow accumulation that occur in maritime climate of the Chugach National Forest result in substantial, short-term variability of glacier mass change in the area. Furthermore, increased precipitation rates at high elevations will likely result in increased glacial accumulation in upper regions while glacial melt at lower elevations results in a substantial net loss of glacial mass.

Climate change is likely to affect the role of snow and ice in the landscapes and hydrology of the Chugach National Forest because temperature and precipitation partially determine when, where, and how much snow falls and melts.

On average, snowfall in the region will likely decline most in late autumn (October to November) and at lower elevations; precipitation falling during this period will likely occur more often as rain.

From October to March and between sea level and 1,000 meters, the number of days with snowfall will likely decline substantially from historical rates; precipitation will fall instead as rain.

Compared to the period from 1971 to 2000, results of modeling suggest a decrease in the percentage of the landscape that is snow dominant. Most of this change would occur at lower elevations.

Aquatic Ecosystems—Watersheds

Climate is an important ecological driver for watersheds and water resources. Consequently, climate change will have a strong influence on future watersheds and aquatic ecosystems.

The most significant effects of climate change to watersheds will be anticipated increased temperatures and changes to the amount, timing, and type of precipitation, such as rain and snow. These temperature and precipitation changes may influence the amount and timing of water quantity and water quality.

Impacts to national forest water resources on water quantity from climate change may include glacial recession, changes in the timing and magnitude of flows, such as increased flood frequency and magnitude and the amount and timing of mean, peak and low flows, increase in fire potential in some locations, and conversion of watersheds from glacial and snow-melt dominated to snow-melt dominated and rain dominated (Fresco, 2012; Haufler, Mehl, & Yeats, 2010). Those changes in hydrologic regime will affect timing and magnitude of discharges, may affect glacial outburst floods, and will change contributions of freshwater discharge into the Gulf of Alaska (Neal, Hood, & Smikrud, 2010) potentially affecting ocean productivity and salmon abundances, water quality, and may affect other multiple uses of water resources.

The Climate Change Vulnerability Assessment identified watersheds vulnerable to shifts in their hydrologic regime (e.g., such as snow-pack dominated watersheds shifting to more snow transitional dominated watersheds). Table 39 and map 7, both taken from the Climate Change Vulnerability Assessment, illustrate the extent of change in watershed precipitation regimes and glacial cover illustrated in the assessment. Results of this assessment identify approximately 8.5 percent of national forest watersheds as likely to change within the next 30 to 50 years. These anticipated changes will be shifts from snow-dominated watersheds to transitional snow-dominated watersheds. The majority of the watersheds exhibiting these expected hydrologic regime changes are located along the southern coastline that rings Prince William Sound. Anticipated affects from these hydrologic regime shifts on the hydrograph may include a shift in peak flows from early summer (June and early July) to late spring (May and June) and decreased flows resulting from less snowpack. Additionally, these watersheds will have an increased peak flow in the autumn, which in some cases may be greater than the peak flow in May and June due to a shift in precipitation falling as rain rather than snow. There may also be slightly higher flows throughout the winter than currently exists within these watersheds due to more precipitation falling as rain than snow. Results of the assessment identified that approximately 13 percent of this will occur in the non-glacial clearwater watersheds, 10 percent will occur within the transitional glacial watersheds, and less than 2 percent will occur within the glacial watersheds. Additionally, it is anticipated that some transitional glacial watersheds may have a shift in their hydrographs as their peak mid-summer flows (July and August) and daily diurnal flow pattern diminish with receding glaciers and some glacial watersheds may have increased mid-summer flows (July and August) and diurnal flows as more melt occurs with the receding glaciers and increased temperatures.

Table 39. Classification of 720 watersheds in the assessment region based on glacial cover and snowpack for current conditions (1971 to 2000) and glacial coverage and snowpack projected from a climate scenario for the period of 2030 to 2059

Snowpack Index	Time Period	Glaciers		
		Clearwater	Transitional Glacial	Glacial
Snow dominant	Current	260	74	251
	Future	212	65	247
Transitional snow	Current	113	17	5
	Future	161	26	9
Rain dominant	Current	zero	zero	zero
	Future	Zero	zero	zero

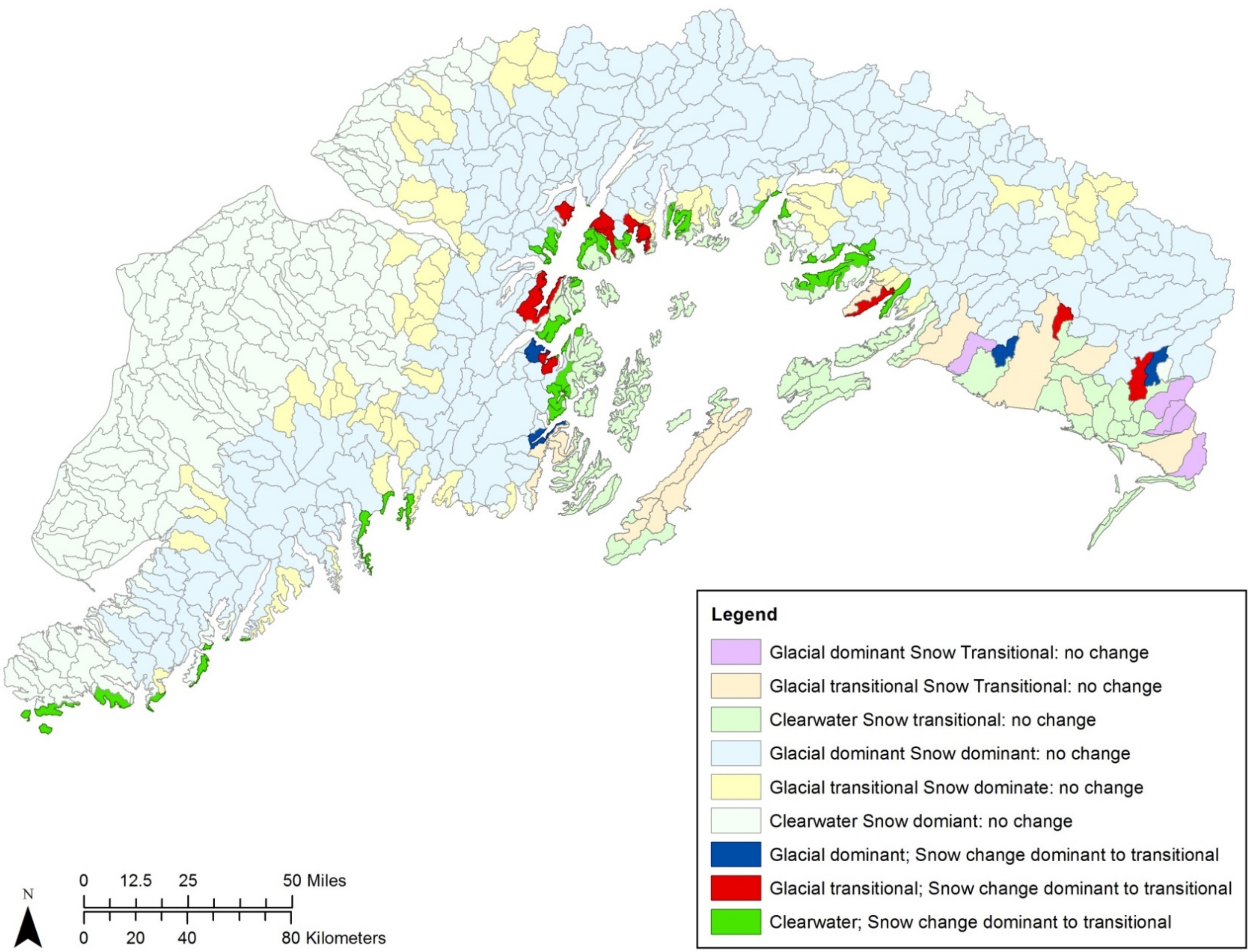
Impacts to national forest water quality from climate change may include increased flood frequency and magnitude leading to increased erosion and heightened turbidity levels from bank erosion, rain-on-snow events and landslides, and increased stream temperatures, and increased erosion and sedimentation from increased fire potential may occur in watersheds on the Kenai Peninsula (Fresco, 2012; Haufler, Mehl, & Yeats, 2010). However, climate change may also improve water quality by lessening turbidity in some watersheds as glaciers retreat.

Aquatic Ecosystems—Fish

Salmon and their associated ecosystems are sensitive to climatic variations and the possible effects are many and complex (Bryant, 2009). Climate change will alter the ecological function with warmer temperatures and changes in stream hydrology in ways that will impact salmon. For example, it is expected that warming water temperatures will accelerate the rate at which salmon eggs develop in gravel and this will result in a timing change for hatching and emergence of young salmon that may be too early relative to the optimum ecological window for survival and growth. To counter this effect salmon will need to genetically adapt to later spawn timing or a slower incubation metabolism. It is also expected that, up to a certain point, warmer ocean temperatures may improve the growth and survival of salmon in this region. In the recent past, periods of colder ocean temperature have been less favorable to survival of Alaska salmon than when ocean temperatures were warmer (Mantua, 2009).

The net effect of climate change on both freshwater and marine systems may cause a shift in the current mix of aquatic ecosystems present within the Chugach National Forest. It may also result in the expansion of certain species that are now relatively uncommon, such as steelhead and cutthroat trout.

It was determined that 61 out of 720 watersheds in southcentral Alaska would be most vulnerable to climate change based on the results of the temperature scenarios modeling in the Climate Change Vulnerability Assessment (see table 39 and map 7) (Hayward, Colt, McTeague, & Hollingsworth, in prep.). In this study, vulnerable is used as an identifier for those places where the changes in hydrologic processes are expected to be the most significant based on modeling results and the potential disruption to salmon populations. Most frequently it represents watersheds where the primary precipitation form was expected to shift from a snow-dominated classification to a snow-rain transition classification. The geographic distribution of these vulnerable watersheds across the study area was non-random, with the majority of these watersheds ringing the mainland shoreline of Prince William Sound.



Map 7. Climate change scenario demonstrating current and future conditions of the planning area using HUC 6 watersheds.

Hayward et al. (in prep) also report the findings from a climate scenario model for pink and chum salmon populations in Prince William Sound. They modeled an overall potential 26 percent increase in the production wild pink salmon during the next 50 years. However, the individual response among the 173 populations modeled was variable and included a number of populations where production levels were projected to decline. There did not appear to be any distinct geographic clusters of populations within Prince William Sound where the projected trends were consistently up or down.

For chum salmon, Hayward et al. (in prep) modeled an overall potential decline of 34 percent during the same time period, although there was a higher degree of uncertainty in this conclusion because the projections for individual populations were highly variable and drawn from a much smaller sample of only 16 populations. Unlike for pink salmon, there appeared to be a pattern among the chum salmon populations with those from the western portion of Prince William Sound projected to decrease in production and those from the eastern portion projected to increase.

Riparian Areas and Wetlands

Impacts to riparian and wetland areas from climate change within the Chugach National Forest could include increased bank erosion due to increased flood frequency and magnitude, changes in water table associated with changes in low flows and glacial snowmelt contribution, increased stream temperatures, and an increased fire potential in some locations (Haufler, Mehl, & Yeats, 2010). Glacial recession may also create new habitats, such as additional wetlands. Increased stream temperatures will likely have an effect on life histories of aquatic invertebrates, which may have a ripple effect through the system that will improve habitat for salmon in some instances and result in poorer habitat in others. Climate change projections for southern coastal Alaska indicate that the area should receive increased precipitation (Fresco, 2012). However, this increase may be offset by the increase in summer temperatures decreasing the precipitation to potential evapotranspiration (P-PET) ratio, particularly on the western Kenai Peninsula. This may result in some wetland drying, an effect that has already been observed on the Kenai Peninsula (Berg, Hillman, Dial, & DeRuwe, 2009; Klein, Berg, & Dial, 2005).

Terrestrial Ecosystem—Vegetation

Changes in vegetation composition and structure have occurred or are occurring within the Chugach National Forest as a result of changing climate. A majority of these changes would be expected based on evaluation of trajectory of the systems as they develop following the last glacial maximum. Under current management practices, there is little direct human influence to the vegetation across about 96 percent of the national forest.

The magnitude of potential effects of climate change on ecosystem composition and structure across the Chugach National Forest is not known. Initial modeling suggests that the national forest will experience variable ecological responses to climate change. Perhaps the least change will be in the temperate coastal rainforests of the Copper River Delta and Prince William Sound, which are expected to remain as rainforests with similar composition and structure.

For the Kenai Peninsula, Dial et al. (2007) reports expansion of shrubland and forest at the boundary between forest and tundra commensurate with recent warming. In addition, Berg et al. (2006) interpret a run of warm summers since 1987 as setting the stage for the large scale infestation of the spruce bark beetle that occurred in the 1990s. As mentioned earlier, since much of the mature spruce on the Kenai Peninsula has already been killed by spruce bark beetle, few acres of further infestation are expected in coming decades due to the limited supply of susceptible host material. However, a changing climate might enable extension of the outbreak into remaining areas of mature, susceptible spruce.

As described by DeVelice et al. (1999), more than 560 vascular plant species have been recorded within the Chugach National Forest, equating to about one-third of the total flora of Alaska. Additionally, more than 280 vegetation community types have been documented. The richness and diversity of native vegetation is likely to provide resistance and resilience in response to environmental change.

One key ecosystem characteristic/current condition that was likely uncommon prior to the development of human caused disturbances (e.g., roads and trails) is the expansion of non-native invasive species. Since invasive species are relatively rare in natural communities within the Chugach National Forest at this time, they likely do not pose an immediate threat to ecological integrity but do pose perhaps one of the larger long term threats if left untended. Climate change could further increase the rates of establishment and spread of invasive plants. In addition, increasing levels of disturbance (both natural and human caused) and increasing tourism and population growth make the national forest vulnerable to expansion of invasive species. Management actions designed to prevent the introduction and spread of invasive species and reducing areas of current infestation are being implemented under the direction of the 2002 Forest Plan and following the national strategy for invasive species (DeVelice, Charnon, Bella, & Shephard, 2005).

Terrestrial Ecosystems—Wildlife

Vertebrates and invertebrates may respond to changing climate and differing phenological patterns in ways difficult to predict (Heintzman & Solomon, 2005). Wildlife responses to predicted changing plant phenology, different predator/prey patterns, drying of some terrestrial communities, changes in ocean pH, variation in insect populations, and new species mixes all could interact to create population and community changes; these changes have not been evaluated. The Chugach National Forest has a diverse flora and fauna and significant ecological redundancy. Much of the habitat has and will retain a high level of natural connectivity, which will allow populations to move to more favorable habitat as climate changes.

The Chugach National Forest supports intact ecosystems of sufficient spatial extent to support ecological functions, such as pollination, seed dispersal, and wildlife movement between patches of habitat. Some migratory species may be challenged by changes to invertebrate phenology if prey abundance peaks before or after migrants visit stopover sites, or if severe weather alters migration. Species that use disjunct areas for winter and summer may be challenged during transitions if the distance between seasonal habitats becomes greater. However, historical ecology demonstrates that migrating species have been exposed to similar climate shifts in the past and persisted through the transition (Wiens, Hayward, Safford, & Giffen, 2012).

Existing species may be affected by invasive species and diseases in ways we cannot anticipate. Similarly, the potential response of birds, amphibians, and other wildlife to rapid climate change is unknown and difficult to assess. In general, however, critical challenges posed by climate change have not been identified for any particular terrestrial animal taxa within the Chugach National Forest for the planning period. Because assessment of the consequences of climate change is ongoing, changes in vegetation, snow, glaciers, and other features will continue to be evaluated for the national forest with an eye toward identifying particular management concerns.

Carbon Sequestration

Barrett (2014) provides information on the storage and change of aboveground carbon in live and dead trees within forest vegetation of the national forest. The Chugach National Forest live tree carbon pool of 26 million tons and its 165 thousand tons per year of net accumulation of live tree carbon is a significant carbon sink. From the first inventory (1999 to 2003) to the second inventory (2004 to 2010), there has been a 4.6 percent increase in carbon mass in live trees within the Chugach National Forest. Mechanisms leading to the increase in live carbon storage are not clear. Climate or the increase in the atmospheric carbon dioxide could be contributing to greater biomass storage or long-term patterns in forests.

At-Risk Species

Alaska, like other northern environments, has lower biodiversity than other geographic areas and therefore, smaller numbers of at-risk species (Flather, Knowles, & Kendall, 1998). Designated threatened, endangered, and candidate species all are tied exclusively to the marine environment except the Steller sea lion. The consequences of climate change on any of these species have not been examined.

Currently seven species are considered potential species of conservation concern: dusky Canada goose, Kittlitz's murrelet, Aleutian cress, sessileleaf scurvygrass, spotted lady's slipper orchid, pale poppy, and Unalaska mist-maid. The potential plant species of conservation concern are being evaluated (to differing extents) in the Climate Change Vulnerability Assessment (Hayward et al. in prep). In a similar effort using habitat suitability modeling, Carlson and Cortes-Burns (2012) estimated distributions for a selection of rare plants in Alaska. Although present elsewhere in Alaska and the Yukon, *Aphragmus eschscholtzianus* (Aleutian cress) is known in only one area within the Chugach National Forest. Climate change may lead to extirpation from the national forest but the species is expected to expand its distribution to the north.

Potential changes in ocean conditions associated with climate change represent a potential threat to black oystercatchers and other at-risk species with strong associations to marine environments, but the direction and rate of change are unclear at this time (IPCC, 2007).

Fire

The majority of wildland fires that occur within the Chugach National Forest take place on the Kenai Peninsula near communities and public concentration areas (e.g., campgrounds) and along roads, trails, and waterways as a result of human activities. With an ever increasing number of people using the national forest, the risk of human-caused fires is expected to increase. The predominance of coastal rainforest on the Chugach National Forest and the low frequency of fire in this system suggest that climate change will have minimal effects on fire within the national forest. Neighboring lands, particularly the western Kenai Peninsula, will likely experience increased fire frequency and intensity.

Cultural Resources

Climate change may cause both harmful and beneficial effects to cultural resources within the Chugach National Forest. Potential harmful effects include damage or destruction to fragile resource sites in coastal areas caused by increased severity of storms and associated storm surges. A potential beneficial effect is that warming may reveal more high elevation cultural resources as ice retreats, thereby increasing knowledge of prehistoric cultures.

Recreation

Literature on potential climate change impacts to tourism and recreation continues to grow (Hamilton & Tol, 2004; Richardson & Loomis, 2004; Shaw & Loomis, 2008), providing a foundation to assess this topic at finer spatial scales or in local settings. The climate assessment currently in preparation will provide some insight into potential effects of climate change. Changes in the portion of the year with snow cover, changes in the number of rainy days, changes in sport-fish abundance, and changes in viewsheds resulting from glacier melt are elements that may influence recreation opportunities and visitor satisfaction. The vulnerability assessment describes expected changes in these elements as a consequence of climate change.

Education and Research

The presence of large expanses of intact ecosystems within the Chugach National Forest provides abundant opportunities to study the effects of climate change on natural systems.

- In May 2013, the Forest Service and the University of Alaska Anchorage co-hosted Classrooms for Climate: A Symposium on the Changing Chugach, Northern Ecosystems, and the Implications for Science & Society. More than 250 participants gathered, bringing together partners in climate inquiry, education, and management. One project that developed from the symposium engages stakeholder communities in a dialogue on their perspectives on the roles and contributions that the Chugach landscape offers in terms of economic, social, and cultural services. Another project evaluates ecosystem services most at risk due to predicted changes in the region's climate, relative to the key economic sectors and socio-cultural systems.
- The Pacific Northwest Research Station, in collaboration with Loyola, Michigan State, Notre Dame and Oregon State universities, was recently awarded a two-year National Fish and Wildlife Federation grant to investigate the effects of climate change on the Copper River Delta.
- Wolverine Glacier is one of three benchmark glaciers studied by USGS and is valued as an indicator of glacial response to climate change (Josberger, Bidlake, March, & O'Neel, 2009) and is within the Wolverine Glacier Research Natural Area (RNA).
- Researchers (Hennon, personal communication, 2013) have been documenting the response of yellow-cedar populations to climate and climate change at Cedar Bay in Prince William Sound.
- Extensive glaciological research is ongoing in the Columbia Glacier-Granite Cove area of Prince William Sound, particularly as it relates to climate change and rapid retreat of the glacier.

Chapter 3 Cultural, Social, and Economic Benefits and Uses

Introduction

Chapter 2 summarized the existing conditions, trends, and long term sustainability of the ecosystems found within the Chugach National Forest planning area. This chapter identifies the resources, multiple uses, and services of the planning area that provide benefits to people either directly or indirectly. Topics evaluated include: cultural resources and areas of tribal importance; land status and use patterns including access; designated areas; recreation and scenic character; social and economic conditions; ecosystem services and natural resource uses. This chapter is different from chapter 2 in that the focus is on the resources used and enjoyed by people.

This chapter focuses on three questions:

1. Which resources are commonly used by the public?
2. What are conditions and trends associated with these uses?
3. What is the contribution of these goods and services to social and economic sustainability?

Cultural Resources and Uses

For thousands of years, the lands that are today recognized as the Chugach National Forest have been inhabited by Alaska Natives. Today, the Kenai Peninsula is home to Dena'ina Athabaskan Indians, and the coastal areas of Prince William Sound are occupied by the Chugach Eskimo and Eyak Indians. Although Russian contact was made with Chugach Eskimo in Prince William Sound in 1741, no direct contact occurred again between Alaska Natives and Europeans until 1778. The 2002 Forest Plan FEIS (USDA, 2002c) provides an overview that summarizes millennia of Alaska Native prehistory, early historic period contact with Russia, and the historic era since the United States purchase of Alaska from Russia. The prehistoric and historic overview in the 2002 Forest Plan FEIS is sufficient for the current assessment process.

Protection and management of cultural and historic resources provide expanded knowledge and understanding of history, cultural and spiritual connections to heritage, scientific data about past cultures or historical conditions, and tourism that benefits rural economies. The value of historic properties on national forests is derived from the public's recognition that these nonrenewable resources are important and should be protected. Section 106 of the National Historic Preservation Act (NHPA) mandates that the impact of federally funded or permitted activities on historic properties, also referred to here as cultural resources, be considered prior to initiation of management activities. Section 110 of the NHPA directs Federal land managers to inventory, evaluate, and preserve cultural resources that are eligible (and nominate) and listed on the National Register of Historic Places (NRHP).

Relevant Information

- Partnerships with Tribes and other parties are essential for the preservation and management of cultural resources within the national forest and within the broader planning area.
- The Forest Service identifies, evaluates, and resolves potential effects to significant cultural resources that may be caused by implementation of management activities.

- Cultural resource management activities are conducted on accessible areas of the national forest. Cultural resource inventories have generally not been conducted in remote areas.
- Less than 10 percent of recorded sites within the national forest have been evaluated per the criteria of the NRHP.
- Condition assessments and preservation actions have not been identified and implemented for the 29 Priority Heritage Assets.
- Records and geospatial data for cultural resources across the national forest are incomplete.
- The Forest Service may need to develop a strategy to investigate and monitor potential effects of climate change (e.g. rising sea levels, receding glaciers) to cultural resources.
- Declining budgets limit the ability of the Forest Service to inventory and manage cultural resources, including records and artifacts collected from prehistoric and historic sites across the national forest.
- The effects of climate change may cause both harmful and beneficial effects to cultural resources. Potential harmful effects include damage or destruction to fragile resource sites in coastal areas caused by increased severity of storms or rising sea levels. A potential beneficial effect is that warming may reveal more high elevation cultural resources as ice retreats, thereby increasing knowledge of prehistoric cultures.

Cultural Resources

The full extent of cultural resources within the Chugach National Forest is largely unknown. Due to the remote and rugged nature of the landscape and resulting limited accessibility, approximately two percent of the national forest has been surveyed. The majority of the inventory within the national forest has taken place along the modern and historic road corridors and trail systems in the Kenai Peninsula and in Prince William Sound near Cordova and along the shoreline.

The 2002 Forest Plan provides some data about cultural resource sites that were known at the time, indicating 1,048 sites had been recorded for the national forest as of December 1999. As of February 2013, the National Resource Management Heritage records database indicates 2,373 recorded sites within the Chugach National Forest. This database indicates 228 sites, or less than 10 percent, of the recorded sites within the national forest have been evaluated for significance consistent with the NRHP, leaving more than 90 percent of the recorded sites to be evaluated. Table 40 displays heritage resources status by ranger district and the national forest.

Table 40. National Resource Management Heritage database for the Chugach National Forest

Location	Listed	Eligible	Not Eligible	Unevaluated	Totals
Forestwide	0	0	0	3	**3**
Seward Ranger District	6	117	45	799	**967**
Glacier Ranger District	2	22	14	583	**618**
Cordova Ranger District	10	12	1	762	**785**
Totals	**18**	**150**	**60**	**2,147**	**2,373**

Eighteen sites are listed on the National Register of Historic Places, with an additional 150 sites recognized as eligible for listing. Examples of these sites include the Sqilantnu Archaeological District along the Russian and Kenai rivers within the Seward Ranger District, the Iditarod National Historic Trail within the Seward and Glacier Ranger Districts, and the Cordova post office and court house within the Cordova Ranger District.

Since 2007, the Forest Service has identified 29 priority heritage assets (PHAs) from among the 168 listed and eligible sites. Distinct to the Forest Service, PHAs are prehistoric and historic sites that are selected by the Forest Service to address specific needs, such as protection, stabilization, and rehabilitation. Current PHAs across the national forest include 10 within the Seward Ranger District, 10 within the Glacier Ranger District, and 9 within the Cordova Ranger District.

Some cultural resource sites previously managed by the Chugach National Forest are now owned and managed by Alaska Native corporations. Under the provisions of section 14(h)(1) of the Alaska Native Claims Settlement Act, regional ANCSA corporations have selected historically significant sites throughout the plan area. The laws and regulations pertaining to this provision of ANCSA allow regional corporations to obtain fee title to existing cemetery sites and historical places and provide that lands conveyed under this provision will be maintained and preserved solely as cemetery sites or historical places by the regional corporation.

Under the selection rights provided by ANCSA 14(h)(1), Chugach Alaska Corporation (CAC) has identified, for conveyance, ancestrally historic places within the boundaries of the Chugach National Forest. To date, not all of CAC's ANCSA 14(h)(1) selections have been surveyed or conveyed.

As of 2002, another ANCSA regional corporation, Cook Inlet Region, Incorporated (CIRI), had selected lands on the Kenai Peninsula for conveyance under the provisions of ANCSA 14(h)(1). However, these selections were relinquished in 2012 through implementation of the Russian River Land Act (P.L. 107-362), which provides for the protection of cultural resources and transferred ownership of historically significant lands.

Through implementation of the Russian River Land Act, CIRI released its remaining ANCSA 14(h)(1) land selections in the area in exchange for certain lands and interests, including a patent transferring restricted title to a 20-acre parcel within the Chugach National Forest near the intersection of the Sterling Highway with the Kenai River, a deed to cultural artifacts on 513 acres of the Kenai National Wildlife Refuge, and interim conveyance of a 42-acre tract within the Chugach National Forest, north of the confluence of the Russian and Kenai Rivers. This tract will be patented after survey. The relinquishment of CIRI's land selections unencumbered approximately 2,000 acres of Kenai National Wildlife Refuge and Chugach National Forest lands.

Other significant cultural resource sites within the Chugach National Forest include those designated by Congress. These include the Iditarod National Historic Trail, partially within both the Seward Ranger District and Glacier Ranger District; the Kenai Mountain-Turnagain Arm National Heritage Area within both the Seward Ranger District and Glacier Ranger District; and the Bering Expedition Landing Site (NHL), both within the Cordova Ranger District with the first located on Chugach Alaska Corporation lands and the latter located within the national forest on Kayak Island.

Condition and Trends of Cultural Resources

The Forest Service primarily manages cultural resources in compliance with Section 106 of the NHPA. That is, cultural resources are routinely identified and inspected during project development, and if they are found to be present, they typically would be avoided during implementation.

With Forest Service archeologists applying most of their time to project review (Section 106), less time is available for the management of PHAs and inventory of National Forest System lands (Section 110). Since the inception of PHAs in 2007, the Forest Service has not been able to visit the most remote sites and there is no evidence that condition assessments are developed or that preservation measures are applied to these property types.

Artifacts and records assembled from past research on prehistoric and historic sites across the national forest are stored across the national forest, sometimes with insufficient environmental controls and in unsecure locations. Inventory of these collections are outdated with no records of inspections having been conducted during the past 10 years or more.

The effects of climate change may cause both harmful and beneficial effects to cultural resources. Potential harmful effects include damage or destruction to fragile resource sites in coastal areas caused by increased severity of storms or rising sea levels. A potential beneficial effect is that warming may reveal more high elevation cultural resources as ice retreats, thereby increasing knowledge of prehistoric cultures.

The Chugach National Forest program does not have the funds necessary to fully inventory cultural resources and to conduct inspections of and preservation actions on existing cultural resources as prescribed by Section 110 of the NHPA.

Increased collaboration with tribal parties and other parties is helping the Forest Service to manage cultural resources. An example is the partnership between the Kenaitze Indian Tribe, Cook Inlet Region Incorporated, USFWS, and the Forest Service established under the Russian River Lands Act to manage the Sqilantnu Archaeological District. In this case, the parties are working together to develop a management plan for future uses, preservation goals, and the storage, protection, dissemination, and interpretation of cultural materials for the benefit of the public.

Information Needs

The Chugach National Forest corporate database for cultural resource management, including geospatial information, is inconsistent and incomplete. The Chugach National Forest needs to update its inventory of cultural materials in its collection.

Areas of Tribal Importance

This section identifies the Tribes and Alaska Native Corporations that the Chugach National Forest coordinates with for their use in the plan area. These entities have certain rights related to their use of the national forest and have several areas of particular importance that may be affected by Forest Service management activities.

Relevant Information

- Alaska Natives value and utilize natural and cultural resources on the national forest landscape.
- Forest Service managers and appropriate staff consult with Alaska Native Tribes and Corporations on matters of traditional and contemporary importance during national forest program planning and implementation.
- The Forest Service could include additional plan components that continue to honor and reflect the importance of sites and places sacred to Alaska's Native people.

Tribes and Alaska Native Corporations associated with the Chugach National Forest

Tribes and Alaska Native Corporations within and adjacent to the plan area are displayed in the following table.

Table 41. Tribes and Alaska Native Corporations within and adjacent to the plan area

Federally Recognized Tribes	Village Corporation	Regional Corporation
Chenega Bay IRA Council	Chenega Corporation	Chugach Alaska Corporation
Native Village of Nanwalek	English Bay Corporation	
Native Village of Eyak	Eyak Corporation	
Native Village of Port Graham	Port Graham Corporation	
Native Village of Tatitlek	Tatitlek Corporation	
Chickaloon Native Village	Chickaloon-Moose Creek Native Association	Cook Inlet Region Incorporated
Eklutna Native Village	Eklutna, Incorporated	
Kenaitze Indian Tribe	Kenai Native Association, Incorporated	
Knik Tribe	Knikatnu, Incorporated	
Ninilchik Village	Ninilchik, Incorporated	
Village of Salamatoff	Salamatoff Native Association, Incorporated	
Seldovia Village Tribe	Seldovia Native Association	
Native Village of Tyonek	Tyonek Native Corporation	

Existing Tribal rights

Alaska Native tribes have legal rights established by the National Historic Preservation Act of 1966 (NHPA), the American Indian Religious Freedom Act of 1978 (AIRFA), the Archeological Resources Protection Act of 1979 (ARPA), Alaska National Interest Lands Conservation Act of 1980 (ANILCA), the Native American Graves Protection and Repatriation Act of 1990 (NAGPRA), Executive Order 13007 (1996), and Executive Order 13175 (2000).

Beyond mention of Section 810 of ANILCA, the 2002 Forest Plan does not identify or discuss Forest Service responsibilities pertaining to resources, areas, or matters that would be of tribal importance. Likewise, it does not identify or discuss protection of cultural and spiritual sites beyond mention of the listed laws and executive orders. However, the 2012 amendment to the 2002 Forest Plan replaced the heritage standard with language acknowledging the memorandum of understanding between the Forest Service, Kenaitze Indian Tribe, and Cook Inlet Region Incorporated for the Russian River Land Act and the Sqilantnu Archaeological District.

In December 2012, the USDA Office of Tribal Relations and the Forest Service issued a report to the Secretary of Agriculture regarding a review and recommendations on USDA policy and procedures about sacred sites. A Forest Service national group is currently working on implementation of the recommendations. Subsequently, the Departments of Defense, Interior, Agriculture, Energy, and the Advisory Council on Historic Preservation entered into a memorandum of understanding, based on Executive Order 13007, to improve the protection of and tribal access to sacred sites through enhanced and improved interdepartmental coordination and collaboration. The Forest Service Office of Tribal Relations is working with the interdepartmental working group to evaluate existing authorities, identify existing training programs for agency staff, and develop guidance for the implementation of this effort.

Areas of known Tribal importance

Interested and affected Tribes and Alaska Native Corporations have identified several resources within the Chugach National Forest that are of tribal importance. Subsistence resources include wildlife, fish, forest products, and wild edible plants and their habitats. Cultural resources include the Russian River and Sqilantnu Archaeological District, Palugvik Archaeological District, all ANCSA 14(h)(1) historic site selections that have been conveyed and those that remain in application status, all known prehistoric sites, and many early historic sites.

Conditions and Trends of Resources that Affect Areas of Tribal Importance and Tribal Rights

Through current consultations, the Forest Service has learned that Alaska Natives are concerned about improving environmental conditions that affect fish and wildlife habitat and improving access to areas where subsistence foods are traditionally harvested (see the Subsistence section).

Information Needs

Sites and areas within the national forest, other than the 14(h)(1) sites, that are sacred to Alaska Natives are mostly unknown.

Land Status and Ownership

Relevant Information

- Due, in part, to the land conveyances authorized by the Alaska Statehood Act and Alaska Native Claims Settlement Act, land ownership patterns in the Chugach National Forest continue to change. About one-quarter of the lands within the boundary of the national forest are now owned by other individuals or entities.
- Five Alaska Native corporations own lands surrounded by or adjacent to National Forest System lands within the Chugach National Forest boundary; many others own lands within the broader plan area. Nearly a half-million acres of former National Forest System lands extending across the three geographic areas of the national forest are now owned by Alaska Native corporations and thousands more have been selected by to fulfill land entitlements established by the Alaska Native Claims Settlement Act.
- The 2002 forest plan does not provide a monitoring and evaluation strategy for the more than 80,000 acres of surface conservation and timber easements held by the Forest Service. The Forest Service could consider a monitoring program for these interests.

Existing patterns of land status and ownership within and near the plan area

Ownership and land status patterns within the Chugach National Forest reflect the area's rich cultural and natural history.

Lands within the national forest are believed to have been occupied by humans for more than 10,000 years. Many first nations people, including Aleut, Chugach Eskimo, and Ahtna Athabaskan Indian, currently live within the plan area.

The United States acquired Alaska from Russia in 1867. In 1892, President Benjamin Harrison designated the first federal forest reserve in Alaska, the Afognak Forest and Fish Culture Reserve. A 1907 presidential proclamation created the Chugach National Forest and a 1908 executive order combined the Chugach National Forest with the Afognak Reserve.

Significant changes in ownership patterns followed enactment of the Alaska Statehood Act in 1958 and the Alaska Native Claims Settlement Act in 1971. These acts provided land selection rights to the new state and to ANCSA Corporations, and many lands within the national forest were selected.

In 1980, ANILCA changed the boundary of the Chugach National Forest and added lands on the Copper River Delta. ANILCA also affected the status of lands within the national forest, designating the Nellie Juan-College Fiord WSA in Prince William Sound and directing that lands within the Copper River Delta be managed for fish and wildlife and their habitat. These designations are discussed in greater detail in the Wilderness Study Area subsection within the Designated Areas section of this chapter.

In 1989, the Exxon Valdez oil spill occurred in Prince William Sound. Since that time, the Forest Service has acquired many large private parcels within the spill area, as well as thousands of acres of surface conservation easements, to provide habitat for the recovery of natural resources affected by the oil spill.

Land status

Private lands within and near the plan area are managed by several ANCSA regional and village corporations as well as other individuals and entities. These private lands are zoned or managed for a variety of purposes, including individual, community, or shareholder services.

Public lands within and near the plan area include lands managed by other agencies and also certain state, borough, and municipality lands. Federal public lands, such as the Kenai Fjords National Park and Wrangell-St. Elias National Park, share a border with the national forest. Two national wildlife refuges, the Kenai National Wildlife Refuge, which borders the Chugach National Forest to the west, and the Kodiak National Wildlife Refuge are near the plan area. The Bering Glacier Research Natural Area, managed by the Bureau of Land Management, borders the national forest to the east. State lands within the plan area include state parks and special management areas, such as the Kenai River and Prince William Sound special management areas. The Kenai Peninsula Borough manages some public lands in and around the plan area, while other public lands are located within the Municipality of Anchorage or in cities and unincorporated communities throughout Prince William Sound.

The land status designations of these public areas vary, but in general, most of these lands are managed for purposes related to conservation or recreation. The management status of the approximately 3,364,097 acres of water included within the national forest boundary varies depending on the agency or agencies responsible for managing a particular resource or use.

Most National Forest System lands within the plan area are open to mineral entry; however, certain lands have been withdrawn from entry by congressional action or administrative order. As of March 16, 2011, 9,403 acres within the Chugach National Forest had been withdrawn for recreation purposes, 4,615 acres for mineral development, and 214 acres for other purposes. Certain lands on the Copper River Delta were withdrawn by section 502 of ANILCA. Land status within this area, as well as other specially designated areas like the Nellie Juan-College Fiord WSA, is discussed in other sections of this assessment (see the Designated Areas section).

In addition to guidance contained in planning documents, the management status of public lands within the plan area is informed by documents associated with the establishment or designation of those lands for a particular purpose (proclamations, legislation, or executive orders), or by documents associated with the acquisition of those lands or interests from a private landowner (e.g., a patent or deed). In general, land status of both public and private lands within the plan area is largely informed by the terms of the land conveyance document. For example, the approximately 101,661 acres purchased by the Forest Service after the Exxon Valdez oil spill are managed, pursuant to the deeds, for purposes associated with restoration, and certain restrictions apply to their use. The conveyance documents for certain lands and interests in lands that were once part of the National Forest System but have since been transferred to state or private ownership similarly contain special terms that affect land status (e.g., public access easement reservations).

Ownership

Within the boundary of the Chugach National Forest, approximately 5,417,172 acres are National Forest System lands and approximately 900,680 acres are owned by other individuals or entities (USDA, 2012/2014). Please note that the acreage figures differ slightly from those in table 42. Table 42 includes data collected in 2011, while the acreage figures cited in the text were published in 2014. Other major landowners include the state of Alaska, ANCSA regional and village corporations, the Alaska Railroad, municipalities, cities, towns, and private individuals. The land status map in the map package appendix displays the land status and ownership within the boundary.

Statehood and Alaska Native Claims Settlement Act conveyances

Some National Forest System lands within the Chugach National Forest have been selected and are being transferred to state or private ownership as a result of the Alaska Statehood Act and ANCSA. The national forest experienced a net decrease between 2002 and 2012 of nearly 13,000 acres of National Forest System lands, due, in part, to conveyances authorized by the Alaska Statehood Act and ANCSA (USDA, 2002d). Special land status is accorded to National Forest System lands selected by the state or Alaska Native regional or village corporations under these acts during the interim period between selection and conveyance. For example, the state's concurrence is required before the Forest Service may authorize certain activities on National Forest System lands selected by the state.

Ownership of the surface and subsurface estate is split for certain lands within the plan area as a result of the transfer of ANCSA selections and other conveyances and acquisitions that affect only the surface or subsurface estate. In some cases, the subsurface estate is owned by another party while the surface is part of the National Forest System and is administered by the Forest Service. As of 2011, the subsurface estate of approximately 114,055 acres of National Forest System lands within the plan area was owned by another entity. Table 42 displays the acreage, status, and ownership of lands within the national forest boundary.

Table 42. Acreage by land status and ownership within the Chugach National Forest

Ownership	Acres
Alaska Railroad (approximate)	3,357
Chugach Alaska Corporation (CAC) conveyed	199,980
CAC selected national forest	2,150
CIRI selected national forest	961
Chenega conveyed	39,279
Dual selection	6,593
Eyak conveyed	91,008
Eyak selected national forest	10,796
Municipality, city, town, or private	12,719
National forest	5,105,836
National forest and CAC or state of Alaska (reserved mineral rights)	119,042
State conveyed (current ownership unknown)	401,912
State selected national forest	57,855
Tatitlek conveyed	97,354
Tatitlek selected national forest	72,146
Village overselected lands	4,700
Water	3,364,097

Partial interests

Various owners hold partial land interests within the plan area, such as mineral rights or conservation easements. Since the Exxon Valdez oil spill in 1989, the Forest Service has acquired from Native village corporations, conservation easements and timber conservation easements affecting thousands of acres of land, for the purpose of maintaining habitat important to the restoration of resources or services that were injured or reduced by the spill. On lands affected by the timber conservation easements, the Native village corporations generally retain all rights of surface ownership, except for the right to harvest timber. On Native village corporation lands affected by the conservation easements, the easements prevent uses of the property that will materially impair or interfere with its conservation values.

The 2002 forest plan provides management area direction for lands and interests in lands purchased with the goals of maintaining conservation values and restoring or enhancing injured resources from the Exxon Valdez oil spill. The 2002 plan does not, however, provide a monitoring and evaluation strategy for these lands or interests in lands. Because the surface conservation easements and timber conservation easements affect non-National Forest System lands, traditional national forest management activities generally do not provide opportunities to monitor the condition of these lands. The Forest Service could develop a monitoring program to help ensure that the protective covenants of the easements are being met.

Rights-of-way and easements affect both private and public lands throughout the plan area. The Forest Service has reserved or acquired rights-of-way needed for public access and has granted private or other public entities rights-of-way for access across National Forest System lands. Special agreements have in part driven existing patterns of partial land ownership interests in the plan area. For example, an agreement executed on January 7, 1983, between the Forest Service, the state, and what is now CAC, provided for the reservation of several public access easements on lands to be conveyed to CAC and gave a right of access to CAC across National Forest System lands for access to the Bering River Coal Fields.

Condition and Trends in Land Status and Ownership

Ongoing implementation of the Alaska Statehood Act and ANCSA continues to produce changing land status and ownership patterns within the plan area. Social, economic, and ecological conditions within the broader landscape inform land status and ownership patterns; the Forest Service seeks to consolidate National Forest System lands where possible, to reserve or acquire public access easements where needed, and to include terms and conditions associated with the conservation of ecological resources where appropriate. Land ownership and status has also, in part, been driven by certain events, such as the Exxon Valdez oil spill, which prompted the acquisition of lands and interests in lands for resource recovery purposes.

Contribution to Social, Economic, and Ecological Sustainability

In 2002, opportunities for the consolidation of National Forest System lands to improve management effectiveness were limited by a lack of willing sellers and ongoing conveyances. Similar conditions exist today. Increasingly diverse ownership has the potential to affect social and economic conditions (for example, by providing challenges associated with access to National Forest System lands for subsistence purposes), as well as the potential to affect ecological conditions (an increasing number of utility and access corridors could increase the potential for spread of invasive species). These potential effects are discussed in other sections, as appropriate.

Information Needs

Data contained in table 42 should be updated to reflect the current status of acquired, selected and conveyed lands. Ownership data could be disaggregated by geographic area to support a more complete evaluation of status and trends.

Land Use

Special use permits allow occupancy or use of National Forest System lands under various authorities, including, but not limited to, the Organic Administration Act, Section 7 of the Granger-Thye Act, Title V, Federal Land Policy and Management Act, Alaska National Interest Lands Conservation Act, and the Act of May 26, 2000. The Forest Service currently administers approximately 330 special use authorizations, including 23 isolated cabins, 1 year round residence, 2 ANILCA cabins, 2 ANILCA shelters, 138 outfitter/guide permits, 6 recreation events, 2 fish hatcheries, 8 power lines and FERC-related activities, 7 telephone lines, 2 fiber optic cable, 31 electronic sites, 2 campground concessionaire, 12 roads, 3 resort, and 58 other various land use permits issued. Additionally the Forest Service administers an average of 15 temporary permits issued for filming or other short-term uses, therefore an exact number of permits issued at any one point in time can vary depending on the number of temporary authorizations issued.

Utility Corridors and Facilities

Five power line special use authorizations (SUAs) are currently issued. Two are issued to Chugach Electric Association, and one each is issued to Homer Electric, Cordova Electric Cooperative, and the City of Seward. There are three permits for FERC related hydropower activities, a hydropower dam on Cooper Lake, and two investigative study permits for hydropower feasibility on Grant Lake and Snyder Falls.

There are seven SUAs for telephone lines issued. There are two SUAs each issued to TelAlaska, and Alaska Communication Systems, and one each issued to GCI Communication Corporation, Yukon Telephone Company, and Cordova Telephone Cooperative.

There are two SUAs for fiber optic cable, one each issued to Cordova Telephone Cooperative, Inc. and TelAlaska.

Fish Hatcheries

There are two fish hatcheries under SUAs to the ADF&G. Both the Main Bay Hatchery and the Cannery Creek Hatchery are within the Glacier Ranger District.

The Main Bay Hatchery is a state-owned hatchery built in 1981 by the ADF&G Fisheries Rehabilitation, Enhancement and Development (FRED) Division as a chum salmon hatchery. It is in Main Bay in Prince William Sound approximately 40 miles southeast of Whittier. Prince William Sound Aquaculture Corporation (PWSAC) manages and operates the facility for ADF&G.

The Cannery Creek Hatchery is a state-owned hatchery built in 1978 by the ADF&G FRED Division as a pink and chum salmon hatchery. It is in the Unakwik Inlet in Prince William Sound, approximately 40 miles east of Whittier. This facility is also managed and operated by PWSAC for ADF&G.

The infrastructure's contribution to social, economic, and ecological sustainability is found in the Economic Impact of the Prince William Sound Aquaculture Corporation 2012 document (McDowell Group, Inc., 2012).

Communication Sites

There are 31 electronic site SUAs issued. Some communication sites have more than one permit holder. The 18 communication sites that are under SUA include:

1. Naked Island (5 SUAs), Glacier Ranger District
2. Point Pigot (1 SUA), Glacier Ranger District

3. Begich, Boggs Visitor Center roof top (2 SUAs), Glacier Ranger District
4. Portage Passage (behind RR depot) (1 SUA), Glacier Ranger District
5. Mount Thomas (1 SUA), Cordova Ranger District
6. Potato Point (1 SUA), Cordova Ranger District
7. Hitchinbrook Island (1 SUA), Cordova Ranger District
8. Heney Ridge (3 SUA), Cordova Ranger District
9. Johnstone Point (1 SUA), Cordova Ranger District
10. Jack Peak (1 SUA), Cordova Ranger District
11. 22 Mile (1 SUA), Cordova Ranger District
12. Windy Point (3 SUA), Seward Ranger District
13. Tern Lake (2 SUA), Seward Ranger District
14. Tern Peak (1 SUA), Seward Ranger District
15. Cecil Rhode Mt. (1 SUA), Seward Ranger District
16. Cooper Mountain (4 SUA), Seward Ranger District
17. Hope Mountain (1 SUA), Seward Ranger District
18. Sheep (Wilcott) Mountain (1 SUA), Seward Ranger District

There are communication site management plans for Naked Island, Point Pigot, Potato Point, Hitchinbrook Island, Johnstone Point, Jack Peak, 22 Mile, Windy Point, Tern Lake, Cooper Mountain, Hope Mountain, and Sheep (Wilcott) Mountain.

Trends in Land Use

There is a continued interest in conducting various forms of research in Prince William Sound and on the Kenai Peninsula. There has been an increase in interest to film within the national forest, including filming for various television programs, travel guides, and other ski/adventure related videos. The number of structures authorized within the national forest has remained constant; however, some of the existing infrastructure has been authorized for more than 30 years, and there is an increase in significant maintenance projects to address at the aging facilities. The transmission line on the Kenai Peninsula is currently undergoing a rebuild to replace existing line and structures that are 45-plus years old. Both Main Bay and Cannery Creek hatcheries have been in place for 30-plus years and are undergoing reconstruction of their aging facilities. Interest in establishing new communication sites has increased.

Infrastructure

Relevant Information

- Since 2005, fluctuating budgets have made it difficult to accomplish all the required annual maintenance on the Forest Service's administrative facilities. Only critical health and safety annual maintenance items are funded.
- Nearly 2.2 million dollars of maintenance is deferred for administrative facilities.

Administrative Facilities

The Facilities Master Plan for the Chugach National Forest provides current inventory information, analysis, and a plan of action for Forest Service managers.

Since 2002, the Forest Service has constructed a new office, two new housing complexes, installed a new modular office, and replaced three paint/fuel storage buildings with four new hazardous materials buildings. The Forest Service has also removed two facilities at the Whittier site, transferred the triplex located on Kodiak Island to the USFWS, and removed 11 administrative cabins.

The Forest Service currently manages 78 administrative facilities in three ranger districts. The Cordova Ranger District has 16 administrative buildings (14 in Cordova and 2 in Prince William Sound), the Glacier Ranger District has 13 administrative facilities in Girdwood and Portage Valley (all within the Kenai Peninsula geographic area), and the Seward Ranger District has 49 administrative buildings on sites next to Kenai Lake and in Seward (45 on the Kenai Peninsula).

The Chugach National Forest also has an office in Anchorage that provides administrative and technical support to each of the ranger districts. It is co-located with the Alaska Region's State and Private Forestry Office and the Pacific Northwest Research Station's Anchorage Forestry Sciences Lab in a leased facility.

Since 2005, fluctuating budgets have made it so that only critical health and safety annual maintenance items are funded. Nearly 2.2 million dollars of deferred maintenance is needed on the facilities. These are repair or replacement costs due to maintenance that was not performed when needed.

Water storage and dams

Information on water-related infrastructure is described in the Watershed and Hydroelectric Resources sections of this assessment.

Transportation corridors

Information on transportation-related infrastructure, including roads, trails, and boat ramps, is in the Recreation and Scenic Character section.

Utility corridors

See the Utility Corridors discussion.

Contribution to Social, Economic, and Ecological Sustainability

No studies have attempted to quantify or describe the direct benefits of Chugach National Forest infrastructure to social, economic, and ecological sustainability. Despite this, it is valuable to recognize and describe how the infrastructure plays a role in sustaining both the natural and cultural resources of the Chugach National Forest as well as the communities located inside and around the boundary of the national forest.

Utility corridors contribute to social, economic and ecological sustainability by transmitting power generated from renewable sources, such as hydropower, wind, and hydrokinetic.

Access Patterns

Most information for access is found in the Recreation and Scenic Character section, including information on roads, trails, motor vehicle and non-motorized access, and off-road vehicle access. This section provides information for non-recreational access, including access to and through private lands, and other administratively authorized access.

Relevant Information

- Public access continues to be affected by lands that are owned by other entities and by ongoing conveyances associated with ANCSA and the Alaska Statehood Act. Particular access challenges exist with regard to those lands of other ownership situated along roads, coastlines, or other access corridors.
- There are opportunities to maintain landscape scale connectivity across mixed ownerships where natural systems, such as watersheds and wildlife corridors, are shared.

Access to private lands

ANILCA provides statutory authority for access to non-federal lands located within the boundaries of public lands administered by the BLM and the Forest Service. ANILCA Section 1323 granted non-federal landowners, whose ownership lies within the boundaries of the National Forest System or is surrounded by public lands administered by the BLM in Alaska, the statutory right of access over public lands when such Federal lands are needed to provide for the reasonable use and enjoyment of non-federal lands. Section 1323(a) of ANILCA applies to National Forest System lands throughout the United States, and Section 1323(b) applies only to public lands administered by the BLM in Alaska.

1. An ANILCA access situation exists where National Forest System lands are the only reasonable option available for the landowner to access their land for its reasonable use and enjoyment. In such cases, the Forest Service is obligated by the statute to grant reasonable access.
2. A landowner’s statutory right of access is limited to that which is adequate to secure to the owner the reasonable use and enjoyment of the subject non-federal land. The right of access is also subject to the reasonable rules and regulations set by the Secretary of Agriculture, as applicable.
3. The Forest Service, as the responsible land management agency, has discretion to determine the location, design, type, and extent of access that will be granted across Federal land, consistent with the provisions of ANILCA.
4. Forest Service regulations implementing Section 1323(a) of ANILCA are found at 36 CFR 251, Subpart D.
5. In ANILCA access cases, the responsible agency will grant the actual access authorization under special use authority of Title V of the Federal Land Policy and Management Act of 1976 (FLPMA). A Forest Service decision to grant access must be made in compliance with the National Environmental Policy Act of 1969 (NEPA). Access authorizations must be conditioned to assure that the use and occupancy of Federal lands for access purposes is exercised in a manner that complies with all applicable laws and regulations, including NHPA and ESA.

Access to public lands and open space connections

The 2002 Forest Plan recognized that lands owned or managed by other entities within the plan area served as barriers to those seeking access to National Forest System lands. Public access continues to be affected by lands that are owned by other entities and by ongoing conveyances associated with ANCSA and the Alaska Statehood Act. Particular access challenges exist with regard to those lands of other ownership situated along roads, coastlines, or other access corridors. As of 2002, the Forest Service had not been actively acquiring rights-of-way, easements, fee simple title, or other interest in lands to obtain legal rights of access to all National Forest System lands. Since 2002, the Forest Service has been actively working to acquire interests in land, such as trail easements, to ensure public rights of access; the Forest Service has acquired 28 permanent or temporary rights-of-way for roads, trails, or other access facilities, such as bridges or parking lots. Of these acquired rights-of-way, seven have secured perpetual access to the Chugach National Forest. About 13 miles of road and trail access was gained through acquisition of these perpetual 17(b) easements.

Since 2002, additional 17(b) easements were established to provide access through lands conveyed to ANCSA corporations. The majority of 17(b) easements are on the Copper River Delta. During trails validation in 2006 and 2007, it was determined that not all ANCSA 17(b) easements would be considered National Forest System Trails (NFSTs) and thus not receive regular maintenance. Currently 25 17(b) easements are considered NFSTs, while 33 of them are not. The use of motorcycles and OHVs are allowed on 17(b) easements but may not be compatible with trail design or with topographic or environmental conditions. Motor vehicle use may or may not be allowed on the public lands that the easement leads to. As a result, only easements that are maintained for motor vehicle use are shown on the Forest Service's annual Motor Vehicle Use Map.

The plan area includes private lands that are currently maintained in a natural state (timber or conservation easements limit the development of approximately 80,430 acres). Much of the plan area is surrounded by other public land units managed for conservation purposes. Because natural systems, such as watersheds and wildlife corridors, are shared between these ownerships, significant opportunities exist to maintain landscape scale connectivity. See the Recreation and Scenic Character section for more information on the recreation opportunities found in these surrounding public lands.

Access to land-based special use permit areas

Special use permits authorize land based uses throughout the plan area. Power lines authorized on the Kenai Peninsula require motor vehicle access to the rights-of-way. These access points require mitigation to prevent unauthorized access. The isolated cabins authorized under ANILCA §1303. (a) are accessible by river. Some of the communication sites have road access, while others are accessible via helicopter. Much of the land based use authorized for Prince William Sound is via boat, including ANILCA set-net camps, research camps, fish hatcheries, and a fish weir. Access for research camps and other activities within the plan area on the Kenai Peninsula is generally via the Alaska Railroad, the road, snowmobile, and by foot.

Contribution to Social, Economic, and Ecological Conditions

Communities and businesses in and near the national forest rely on utility corridors and communication sites. Dams and hatcheries support fish populations which in turn support subsistence, sport, and commercial fishing within and beyond the boundary of the Chugach National Forest.

Information Needs

Land status and ownership data (see table 42) should be updated to reflect the current status of National Forest System Lands conveyed to Alaska Native corporations or the state under ANCSA and the Alaska Statehood Act. Ownership data could be disaggregated by geographic area to support a more complete evaluation of status and trends.

Designated Areas

A designated area is an area or feature identified and managed to maintain its unique special character or purpose. Some categories of designated areas may be designated only by statute and some categories may be established administratively in the land management planning process or by other administrative processes of the Federal executive branch (36 CFR §219.19).

This section of the assessment describes existing statutorily and administratively designated areas located within the Chugach National Forest, as well as any identified potential need and opportunity for additional designated areas. Statutorily designated areas are designated by Congressional act or Presidential executive order. Administratively designated areas can be recommended by the responsible official, but are designated by the Secretary of Agriculture, Secretary of the Interior, Secretary of Transportation, Federal Highways Administration, Chief of the Forest Service, or regional forester.

Existing designated areas within the Chugach National Forest (see the designated areas and areas recommended for designation map in the map package appendix) include wilderness study areas, wild and scenic rivers, national heritage areas, national historic landmarks, national historic trails, areas designated by ANILCA, inventoried roadless areas, national recreation trails, research natural areas, and scenic byways.

Relevant Information

- Two new designated areas have been created since 2002: the Kenai Mountains-Turnagain Arm National Heritage Area on the Kenai Peninsula and the Alaska Marine Highway Scenic Byway in Prince William Sound.
- Attributes of wilderness character, including undeveloped landscapes and opportunities for solitude and primitive recreation, vary within the Nellie-Juan-College Fiord WSA according to location and season.
- The Kenaitze Indian Tribe and Cook Inlet Region Inc. have expressed a desire to nominate the Sqilantnu Archaeological District within the Seward Ranger District to the National Historic Landmark Program.
- The Palugvik Site National Historic Landmark property was conveyed to Chugach Alaska Corporation on May 14, 2013, in compliance with ANCSA 14(h)(1).
- Since 2004, the Forest Service has identified 186 miles of trail to be managed as part of the Iditarod National Historic Trail, including management direction consistent with the Comprehensive Management Plan for the Iditarod National Historic Trail.

Wilderness Areas

There are no designated wilderness areas within the Chugach National Forest.

Wilderness Study Areas

A wilderness study area (WSA) is National Forest System lands designated by Congress for further study before congressional designation (or not) as a wilderness area. The Forest Service implements policies to manage WSAs to preserve wilderness characteristics.

In 1980, ANILCA (P.L. 96-487, Title VII, Sec. 704) established the Nellie Juan-College Fiord WSA. The WSA includes 1,968,730 acres of National Forest System lands, 22,550 acres of Forest Service public easements, and 206,890 acres of private lands surrounding western Prince William Sound (see the designated areas map and areas recommended for designation map in the map package appendix). WSAs are managed to maintain their wilderness character while recognizing and allowing for the specific exemptions in ANILCA.

The most comprehensive analysis of wilderness character in the WSA is in the 2012 Chugach National Forest Wilderness Character Monitoring Report. Results of this monitoring effort suggest that:

- Overall natural conditions prevail in the WSA with few non-native species observed (one animal; one invertebrate; and few plant species)
- No management actions are occurring that would affect the untrammeled quality of the WSA
- Much of the WSA lacks evidence of human development
- Many opportunities for solitude and primitive recreation are present

Since wilderness character monitoring was not initiated until 2012, trend information specific to the WSA is not available. Recent studies and field observations, however, do lend themselves to identifying trends and conditions that may have influenced the wilderness character of the WSA. Recent studies done in Prince William Sound suggest boat use has substantially increased in western Prince William Sound since the opening of the Anton Anderson Memorial Tunnel in 2000 (Poe, Gimblett, & Itami, 2010; Wolfe, 2007). Results from these studies identify outfitter/guide use, visitor use, and vessel density as highest in WSA locations closest to Whittier and fish hatcheries. Also, Forest Service staff members have observed and documented the use of mechanized equipment and motor vehicles either for access or participation in other activities, which has an impact on wilderness character. The primary activities documented in these observations include use of snowmachines, chainsaws, and helicopters. Snowmachine use, which is allowed in the WSA for purposes of subsistence and traditional activities, has been documented in the WSA between Whittier and Blackstone Bay and within areas accessible from the Nellie Juan Lake area. The Forest Service is currently working to better understand the location and extent of snowmachine use in the WSA. Also, the use of chainsaws for felling both live and dead trees has been reported in the WSA, especially near shore. Finally, unauthorized flightseeing helicopter landings have recently been documented on lands around Columbia Bay.

Potential need and opportunity designated wilderness areas or for additional WSAs

All inventoried roadless areas (16 units) within the Chugach National Forest were reviewed for wilderness area potential as part of the 2002 plan revision. It is the most thorough and recent wilderness assessment for the national forest. The 2002 Forest Plan Record of Decision (ROD) (USDA, 2002b) recommended 1,412,230 acres for wilderness area designation, all within the Nellie Juan-College Fiord WSA. Several areas within the WSA were excluded from recommendation for reasons described in the ROD, including:

- Expected increase in visitation as a result of the completion of the Anton Anderson Memorial Tunnel
- Potential for heli-skiing in the Columbia Glacier basin
- Commercial fishery at Main Bay
- Input from the villages of Tatitlek and Chenega Bay
- Possible allowances for mineral exploration and development in areas such as Knight Island

The ROD did not recommend inclusion of any lands in the Bering Lake Roadless Area, citing the preference for more flexibility to manage recreation and fish and wildlife resources and to allow for development of mineral potential.

The 2012 Wilderness Character Monitoring Report describes variations in wilderness character within the WSA and may inform wilderness area potential and need in areas recommended and not recommended for wilderness area designation in 2002. The report indicates intact wilderness character in the Columbia Glacier drainage north of the Heather Island moraine due to the glacier's continuing rapid retreat, which creates unique scenic, scientific, recreational, educational, historic, and geologic features, as well as outstanding opportunities for solitude and primitive recreation. Some features are singular to Columbia Bay, including the glacier's fresh water discharge, which contributes more to global sea level rise than any other Alaskan glacier (Colgan, Pfeffer, Rajaram, Abdalati, & Balog, 2012), presenting unique educational opportunities and geologic features. In addition, since 2002 the Columbia Glacier has retreated to within a few miles of a portion of the WSA not recommended for wilderness area designation in the 2002 Forest Plan. Research predicts the glacier will retreat to well within the area during the next decade (Colgan, Pfeffer, Rajaram, Abdalati, & Balog, 2012).

Several other sources have also identified how visitors value wilderness character qualities in Prince William Sound, especially within the WSA, suggesting there is a need to protect and maintain these qualities (Poe, Gimblett, & Itami, 2010; USDA, 2011b; Wolfe, 2007).

Recent input from conservation groups and others during the development of this assessment indicates some level of public support for a wilderness area designation in and near the WSA. Little or no public support has been recorded for recommending wilderness area designations for lands not in or near the WSA. These preliminary observations may identify public preferences and concerns.

While the above sources address wilderness character in the WSA and may inform the potential and need for wilderness area designation in that area, little or no work has been done since 2002 to assess wilderness character elsewhere within the Chugach National Forest.

Known opportunities to highlight unique recreational or scenic areas

The 2002 analysis of Chugach National Forest inventoried roadless areas identified many areas that possess unique recreational and scenic qualities, such as natural conditions and opportunities for solitude that could be highlighted through wilderness designation. For detailed information on these areas, see the Recreation and Scenic Character section of this chapter. Within the WSA, Poe et al. (Poe, Gimblett, & Itami, 2010) identified four keystone recreational experiences that are exceptional or unique to Prince William Sound, including experiencing tidewater glaciers, finding solitude, hunting, and wildlife viewing. The WSA includes the largest number of tidewater glaciers in any one geographic region in Alaska, and the combination of terrestrial and marine wildlife, including birds, makes this area a destination for wildlife viewing.

Scientific or historical information suggesting a unique opportunity to highlight educational, historical, cultural, or research opportunities

Within the WSA, evidence of unique scientific and research opportunities was reflected by the recommendation of two and designation of one research natural area in the 2002 Forest Plan.

RNA management direction in the 2002 Forest Plan emphasizes non-manipulative research and maintenance of natural diversity and ecological processes and can be consistent with preserving wilderness character. Wilderness area designation can also provide a buffer of protection around RNAs to support the purpose of these areas. See the RNA section for more information on these areas.

Known important ecological roles potentially supported by special area designation

Special area designation has the potential to support important ecological roles throughout the planning area. These include the protection of shorebird, waterfowl, marine mammal, and salmon habitat in the Copper River region and the protection of brown bear, wolf, and salmon habitat on the Kenai Peninsula. Some of these roles already benefit from existing congressional designations, including the Kenai National Wildlife Refuge Wilderness Area on the Kenai Peninsula and the ANILCA Sec. 501(b) fish and wildlife habitat conservation designation for the Copper River Delta.

In Prince William Sound, special area designation could protect ecological roles associated with the direct interface of terrestrial and marine ecosystems among the region's numerous fiords, islands, and protected waters. Contributions of spawning salmon to wildlife and forest growth; of forest runoff to marine food webs supporting salmon, other fish, and marine mammals; and the delivery of nutrients to the ocean food web from tidewater glacier runoff all represent important ecological functions that could benefit from special area designation.

Specifically, the current WSA is thought to play a role in:

- Carbon sequestration (see Carbon Stocks section)
- The study and understanding of post-glacial plant succession
- Studying the northwest limits of the natural range of yellow-cedar (*Callitropsis nootkatensis*)

Contributions to economic, social, and ecological sustainability

Despite the limited awareness that the land is managed as a WSA, a robust recreation and tourism industry centered on wilderness character occurs in this part of the Chugach National Forest. It includes tour boats, boat rental shops, water taxis, outfitters, cruise ship visitation, and guided hunting, fishing, kayaking, and other activities (Fay, Colt, & White, 2010; Poe, Gimblett, & Itami, 2010). The industry is especially evident in gateway communities along the road system, including Whittier and Valdez, but it also supports economic activity in Anchorage and other communities (Fay, Colt, & White, 2010).

Wilderness area designation, similar to other area designations, provides additional protection to the resources that make the area distinctive and helps to make the area a more notable destination for visitors. Wilderness character in the WSA provides social benefits, including unique opportunities for education, subsistence, tradition, inspiration, research, time with family/friends, and opportunities for young people to experience nature. For instance, for the past three years, the Forest Service and Alaska Geographic have worked together to conduct youth expeditions to the WSA to introduce youth to wildlands in general and wilderness character specifically.

Existing Inventoried Roadless Areas

Inventoried roadless areas (IRAs) are defined as undeveloped areas typically exceeding 5,000 acres that meet the minimum criteria for wilderness consideration under the Wilderness Act. In 1972, the Forest Service initiated a review of National Forest System roadless areas larger than 5,000 acres to determine their suitability for inclusion in the National Wilderness Preservation System. The second and final review process, known as Roadless Area Review and Evaluation II (RARE II), resulted in a nationwide inventory of roadless areas. Since the completion of RARE II, Congress has designated some as wilderness areas, and additional reviews have been conducted through the land management planning process and other large-scale assessments. The 2001 Roadless Area Conservation Rule (36CFR§294) establishes prohibitions on road construction, road reconstruction, and timber harvesting in IRAs on National Forest System lands.

There is no single designation that applies to roadless area management. Roadless areas on the Chugach National Forest are managed through 2002 Forest Plan management area prescriptions and standards and guidelines. The common theme of these prescriptions is that they prohibit or limit road construction and timber harvest activities that would significantly alter the landscape.

Appendix C of the 2002 Forest Plan FEIS provides an extensive description of 16 IRAs totaling 5,434,710 acres, or approximately 99 percent of the national forest, that were inventoried in 1996. Roadless areas were evaluated on the basis of the area's capability and availability for wilderness designation and the need for wilderness designation (USDA, 2002e). As part of the inventory and wilderness needs evaluation process, areas within one-quarter mile of improved roads, small donuts created by roads surrounding a parcel of land, and lands of other ownership were excluded from the inventory, while lands selected but not yet conveyed were included.

Table 43 displays a list of the IRAs, acreages for 2002 and 2013, and the change in acreage. Acreage differences are due to ongoing land conveyances as some National Forest System lands within the Chugach National Forest are being transferred to state or private ownership as a result of the Alaska Statehood Act and ANCSA (see discussion in the Land Status and Ownership section above).

Table 43. Inventoried roadless areas within the Chugach National Forest

Roadless Area	2002 Acres	2013 Acres	Change in Acres
01 Resurrection	224,460	224,380	80
02 Boston Bar	53,590	53,520	70
03 Johnson Pass	153,020	152,390	630
04 Kenai Lake	212,960	197,990	14,970
05 Kenai Mountains	306,580	305,970	610
06 Twentymile	198,560	198,390	170
07 Nellie Juan	734,100	712,710	21,390
08 Prince William Sound Islands	119,520	118,300	1,220
09 College Fiord	1,129,610	1,113,460	16,150
10 Fidalgo-Gravina	316,660	255,300	61,030
11 Montague Island	205,270	204,830	440
12 Hinchinbrook-Hawkins Islands	144,470	136,040	8,430
13 Copper River Wetlands	88,650	82,880	5,770
14 Sheridan Glacier	231,810	222,850	8,960
15 Bering Lake	966,240	956,030	10,210
16 Tasnuna River	349,540	342,570	6,970
Total	**5,434,710**	**5,277,610**	**157,100**

Information Needs

Inventoried roadless areas will be assessed as part of the wilderness evaluation in the forest plan revision process. During this process, the acreage for each IRA will be updated to reflect changes due to recent or ongoing land conveyances.

Wild and Scenic Rivers

The National Wild and Scenic River System (NWSRS) is a system of free-flowing rivers designated by Congress. Wild and scenic rivers offer outstanding natural, heritage, or recreational features that are protected for future generations. During forest planning, the Forest Service evaluates rivers that cross National Forest System lands and recommends rivers suitable for inclusion in the NWSRS. Wild and scenic rivers are managed to protect their free-flowing characteristics and their particular outstandingly remarkable values.

For a river to be included in the NWSRS, it must meet the tests of eligibility and suitability. To be eligible, a river must be free flowing and possess river or river-related values that are judged to be outstandingly remarkable. To be suitable, the benefits of designation should outweigh the disadvantages. It involves considering the land ownership in the area; the land uses that would be affected; public, state, and local government interest in the river's designation; estimated costs; and any other issues raised during the planning process.

As of 2013, there are no designated wild and scenic rivers within the Chugach National Forest.

Potential need and opportunity for additional wild and scenic rivers

In 2002, all named rivers and glaciers (more than 760) and many unnamed rivers within the national forest were examined and evaluated to identify outstandingly remarkable river-related features that would make them eligible for inclusion in the NWSRS. Twenty-three rivers, in whole or in part, were found to be eligible for designation (see table 44).

The regional forester recommended nine of these eligible river segments to the Chief of the Forest Service as suitable for inclusion in the NWSRS, a total of 82.4 miles. Three river segments were recommended for wild designation, two for scenic designation, and four for recreational designation. Additional analysis conducted on additional rivers after the 2002 Forest Plan was appealed revealed that Child's Glacier was also eligible as a scenic river, so it has been managed in the same manner as the recommended river segments. Table 45 describes each river segment in terms of its recommended classification and outstandingly remarkable values.

Table 44. River segments within the Chugach National Forest determined eligible for inclusion in the National Wild and Scenic River System

River Name	Outstandingly Remarkable Value(s)	Wild	Scenic	Recreational
		miles		
Bear Creek	Geologic feature	0	0	3.4
Sixmile Creek	Recreational whitewater boating, scenery and visual features	0	5.7	0
East Fork Sixmile Creek	Recreational whitewater boating, scenery and visual features	0	5.6	0
Canyon Creek	Geologic feature	0	6.8	0
Snow River	Scenery and visual features	23.8	0	0
Twentymile River (complex)	Synergistic effects of combined special resource values	14.2	0	0
Palmer Creek	Scenery and visual features	0	10.9	0
Portage Lake and Glacier	Scenery and visual features, recreational values	4.7	2.3	0
Portage Creek	Scenery and visual features	0	0	6.2
Kenai River	Fisheries value	0	0	5.5
Russian River	Fisheries and prehistoric values	14.3	3.0	0
Columbia Glacier	Geologic feature	19	0	0
Coghill River	Fisheries, recreational values, scenery and visual features	11.5	0	0
Cascade Creek	Visual feature (waterfall)	2	0	0
Nellie Juan River	Recreational whitewater boating, scenery and visual features	25.1	0	0
Martin Glacier	Geologic feature	18	0	0
Martin River and Lake	Scenery and visual features, geologic feature, fisheries, recreational values	24.5	1.8	0
Alaganic Slough and unnamed tributary	Historic/cultural values	0	13	0

River Name	Outstandingly Remarkable Value(s)	Wild	Scenic	Recreational
		miles		
Copper River (lower; delta complex)	Scenery and visual features, historic and cultural values, fisheries and wildlife values, geologic feature	24.3	1	0
Copper River (upper)	Scenery and visual features, recreational values, fisheries values	51.3	0	0
Bering River and Lake	Scenery and visual features, recreational values, fisheries values	6.6	25.2	0
Katalla River	Fisheries values	4.8	7.1	0
Nellie Martin River	Fisheries value	0.4	1.6	0
Number 1 River	Recreational whitewater boating and geologic values.	6.7	0	0
Total river miles by potential classification		**251.2**	**84**	**15.1**
Total miles of eligible river segments		**350.3**		

Table 45. River segments within the Chugach National Forest determined both eligible and suitable and recommended in 2002 for inclusion in the National Wild and Scenic River System

River Segment	Miles	Classification	Outstandingly Remarkable Values
East Fork Sixmile Creek	5.6	Recreational	Recreation (white water boating), scenery and visual features
Sixmile Creek	5.7	Recreational	Recreation (white water boating), scenery and visual features
Portage Creek	6.2	Recreational	Scenery and visual features
Twentymile River	14.2	Scenic	Synergistic effects of combined special resource values
Russian River, lower	4.9	Recreational	Fisheries and heritage resource (prehistoric) values*
Russian River, upper	12.4	Wild	Fisheries and heritage resource (prehistoric) values
Snow River, lower	9.1	Scenic	Scenery and visual features
Snow River, upper	14.7	Wild	Scenery and visual features
Nellie Juan River, lower	9.6	Wild	Recreation (white water boating), scenery and visual features
Total	**82.4**		

*During the Forest Plan Review 2002-2012, an omission in the documentation of outstandingly remarkable river-related features in the eligibility evaluation for the lower Russian River was discovered. The evaluation clearly identifies recreation as one of its outstandingly remarkable river related features but neglected to identify it as such in the FEIS (USDA, 2002c).

To date, no further action has been taken on these recommendations. Congress has the authority to make decisions on designations to the NWSRS after approval of recommendations by the Chief of the Forest Service and the Secretary of Agriculture.

Since 2002, the nine recommended river segments and Childs Glacier have been managed according to the three management area prescriptions (wild river, scenic river, and recreational river) developed to protect their free flowing characteristics, tentative classification, and outstandingly remarkable values for which they were recommended.

Since 2002, the Forest Service has not conducted any additional studies to identify the need or opportunity to add rivers or glaciers to those already recommended, and no information needs have been identified.

Contribution of wild and scenic rivers to social, economic, and ecological sustainability

The benefits of wild and scenic rivers are multifaceted. They include providing managers with tools or mechanisms to protect free-flowing condition. Wild and scenic river designation, or recommendation, also provides for the protection of water quality and outstandingly remarkable values. Status as a WSR aids in making a river more attractive as a recreation and tourism destination. For instance, guided rafting on Sixmile Creek is the most popular commercial recreation opportunity within the Chugach National Forest. Also, fishing on the Russian River provides not only guided recreation opportunities but supports the broader Alaska tourism industry, including businesses in southcentral Alaska that provide services for anglers. Benefits, however, are not only economic. Benefits tend not to be only economic, however. One study looking at the perceptions of community benefits of two WSRs found that local citizens valued the rivers as a source of community pride, aesthetic beauty, and ecological integrity (Smith & Moore, 2011).

National Heritage Areas

The National Park Service (NPS), which is responsible for the National Heritage Area (NHA) program, describes NHAs as “places where natural, cultural, and historic resources combine to form a cohesive, nationally important landscape” (NPS, 2013). The designation of NHAs is generally a community-driven effort led and managed by local citizens and organizations.

There is one NHA within the Chugach National Forest, the Kenai Mountains-Turnagain Arm National Heritage Area (KMTA NHA), managed by the Kenai Mountains-Turnagain Arm Corridor Communities Association (KMTA-CCA). The KMTA NHA was established by Congress in 2009 and encompasses almost half of the Kenai Peninsula, stretching from the communities of Bird to Seward and from the eastern part of the Kenai National Wildlife Refuge to the western bays of Prince William Sound.

These boundaries overlay several other designated areas and areas recommended for designation, including the Iditarod National Historic Trail (INHT), the Seward Highway Scenic Byway/All-American Road, all of the rivers recommended for inclusion in the National Wild and Scenic River System, and the Resurrection Pass and Williwaw National Recreation Trails. The KMTA NHA focuses on the theme of transportation for mining and settlement, including Alaska Native use, gold rushes, contemporary placer mining, trail and wagon road development, the Iditarod National Historic Trail, railroad, and highway development. The goal of the Kenai Mountains-Turnagain Arm NHA is to recognize, preserve, and interpret the historic, scenic, and natural recreational resources and cultural landscapes of the Kenai Mountains-Turnagain Arm historic transportation corridor, and to promote and facilitate the public enjoyment of these resources. The NHA management plan, developed by the KMTA-CCA, was completed in January 2012 and has been submitted to the Secretary of the Interior for approval. The Forest Service played a key role in development of the management plan and is a sponsor of many of the NHA projects.

The 2002 Forest Plan includes goals and objectives for what was then known as the Kenai Mountains-Turnagain Arm Heritage Corridor. These goals and objectives directly tie in to the goal of the KMTA NHA described previously, and have guided the Forest Service’s participation in the management plan. Due to the remote and rugged nature of the landscape, the extent of the heritage resource base within the National Historic Area is still largely unknown. The NHA contains some of the most well-known heritage resources in the state, including the Alaska Railroad, the Iditarod National Historic Trail, and the Sqilantnu Archaeological District, so there are many opportunities to partner with KMTA-CCA on activities related to these sites and projects.

Potential need and opportunity for additional national heritage areas

As of 2014, no other areas within the Chugach National Forest have been identified or evaluated as potential NHAs.

Contribution of national heritage areas to social, economic, and ecological sustainability

A national study used six NHAs as a case study to estimate that NHAs contribute nearly 13 billion dollars to the economy and support 148,000 jobs (NPS, 2013). The NHA management plan for the KMTA NHA identifies goals and themes that help describe potential contributions to sustainability, of which a few are described here. First, the NHA is working to strengthen the sense of community in the towns within the area through their heritage resources. At the same time, this will help to promote the protection, as well as the enjoyment, of those heritage resources. NHA staff members have also developed a school curriculum called Trails Across Time to be used in Alaska studies programs to help students learn about the area's heritage in a place-based manner. Designation may help promote tourism in local communities, which would support small businesses and local museums. Lastly, the NHA is a valuable partner to local, state, and Federal land managers in managing the heritage resources of the area.

National Historic Landmarks

National Historic Landmarks (NHLs) are buildings, sites, structures, or objects that are recognized by the United States government for national-level historical significance. The Secretary of the Interior has the authority to formally record, and the National Park Service has the authority to administer these properties.

There are two NHLs within the boundary of the Chugach National Forest, though only one is on National Forest System lands. Both are in Prince William Sound and one is within the Cordova Ranger District.

The Bering Expedition Landing Site, located on Kayak Island, was designated a NHL on June 2, 1978. According to the NPS NHL Program, "Here [in 1741] naturalist Georg W. Steller, surgeon aboard Vitus Bering's St. Peter, made the first attempts at contact between Europeans and Alaskan natives. His investigations are among the first contributions to the West's knowledge of the natural and human history of the region." The precise landing site on Kayak Island is not known and no remains of the visit have been located on the island.

The Palugvik Site NHL, located on Hawkins Island, was designated a NHL on December 29, 1962. The NHL property constitutes a portion of the larger Palugvik Archaeological District, which is an area that provides evidence of long-established Chugach Eskimo traditional culture. Providing further information on the location and content of the district and NHL associated with Palugvik is restricted by the Secretary of the Interior pursuant to Section 304 of the National Historic Preservation Act, which provides for authority to withhold from disclosure to the public information that may cause significant invasion of privacy, risk harm to the resources, or impede the use of a traditional religious site by practitioners. The NHL property was conveyed to Chugach Alaska Corporation (an Alaska Native Settlement Claims Act regional corporation) on May 14, 2013, under authority of ANCSA 14(h)(1).

Potential need and opportunity for additional national historic landmarks

The Kenaitze Indian Tribe and Cook Inlet Region Inc. (respectively a federally recognized tribe and an Alaska Native Settlement Claims Act regional corporation) have expressed a desire to nominate the Sqilantnu Archaeological District in the Seward Ranger District to the NHL Program.

National Trails

The National Trails System was established by the National Trails System Act of 1968 as amended. The types of trails described in the legislation include national scenic trails, national historic trails, and national recreation trails. One national historic trail and two national recreation trails occur within the Chugach National Forest. National recreation trails, although administratively designated, are discussed here. There are no designated national scenic trails within the Chugach National Forest.

National historic trails

The National Trails System Act states the purpose of national historic trails is for the identification and protection of the historic route and its historic remnants and artifacts for public use and enjoyment. National historic trails may only be designated by Congress. The act, as amended in 1978, established the Iditarod National Historic Trail (INHT), which consists of a route approximately 2,400 miles long connecting Seward to Nome, including connecting trails, across multiple Federal, State, municipal, and private lands. The Bureau of Land Management, identified as the trail administrator for the INHT, led an extensive multi-agency/partner effort to develop the Iditarod National Historic Trail Seward to Nome Route Comprehensive Management Plan (CMP) (BLM, 1986).

Since 1986, several trail segments have been planned, constructed or reconstructed along the Seward-Girdwood INHT route by various Federal, state, or other entities, primarily near or through the communities of Seward and Girdwood, based on CMP recommendations.

In 2004, the Forest Service began an expansive project (Seward-to-Girdwood Iditarod National Historic Trail Project, also known as the INHT Southern Trek) to fully develop a commemorative route following the Seward-Girdwood segment of the INHT as described in the CMP. The decision was signed on January 23, 2004; however, connecting these existing trails is still ongoing. The selected alternative authorizes approximately186 miles of trail to be managed as part of the INHT providing opportunities for motor vehicle and non-motorized recreation in both winter and summer. The decision approves 82 miles of trail reconstruction, 77 miles of new trail construction, 32 major (greater than 20 feet) and 50 minor trail bridges, 8 new or reconstructed trailheads, interpretive signing at 36 trailheads, and construction of up to 6 new public use cabins. The INHT Southern Trek decision also established a corridor on Portage Lake for non-motorized watercraft, which modified an existing closure for the lake. In 2012, the State Office of History and Archeology submitted a nomination to the Secretary of the Interior to add the INHT to the National Register of Historic Places. Accomplishments from 2004 to 2014 include more than 180 miles of trail location, 65 miles of trail restoration and construction, installation of 7 major bridges and numerous minor bridges, construction of one new trailhead, and restoration of one historic cabin.

National recreation trails

The National Trails System Act states that national recreation trails are established to provide a variety of outdoor recreation uses in or reasonably accessible to urban areas. Unlike national scenic and historic trails, the Secretary of the Agriculture may establish and designate national recreation trails.

The Resurrection Pass and Williwaw Nature Trails are the two National Recreation Trails within the Chugach National Forest, both designated in 1979. The Resurrection Pass Trail is a 39-mile road accessible trail that links the communities of Hope and Cooper Landing. The trail is managed for non-motorized use in the summer and is a popular destination for hiking, backpacking, horseback riding, and mountain biking. There is both motor vehicle and non-motorized use in the winter. The Kenai Winter Access ROD signed in 2007 amended the 2002 Forest Plan and authorizes winter motor vehicle access every other winter from December 1 to April 30 (USDA, 2007a). There are seven public use cabins along the trail available for rent. These developed recreation sites receive some of the highest use of any cabins within the Chugach National Forest in both summer and winter. In 2013 and 2014, Seward Ranger District staff conducted a study of backcountry use on several trail systems on the Kenai Peninsula, including the Resurrection Pass Trail, to recommend ways to holistically manage guided and non-guided use, including offering additional guided opportunities.

The Williwaw Nature Trail within the Glacier Ranger District was a three-quarter mile interpretive loop trail in the Portage Valley when first designated. It was accessible from the Williwaw campground, with 14 interpretive stations where hikers could participate in interpretive or self-guided hikes to learn about fish, wildlife, glaciers, and other natural features. A bridge near the trailhead washed away, and the trail was reconstructed following a different route. Today, the Williwaw Nature Trail is 1.3 miles long and follows Williwaw Stream, a salmon spawning channel. The trail serves as an interpretive opportunity for both spawning salmon and fish habitat. The fish habitat was created by converting Portage Valley gravel borrow pits into lakes that serve as salmon habitat.

Potential need and opportunity for additional national trails

The Forest Service has not identified a specific need or opportunities for additional national trails. There may be potential for additional national recreation trails within the national forest, including the identification of additions to the national water trails system, which was established in 2012 by the Secretary of the Interior as a new class of national recreation trails. The long-distance nature of scenic and historic trails, and other specific requirements, makes it unlikely that any other of these types of trails would be designated within the Chugach National Forest.

Contribution of national trails to social, economic, and ecological sustainability

National trails provide a unique recreational experience by providing extended routes that link communities and offer multi-day or even multi-week opportunities. The section of the INHT that runs through the Chugach National Forest provides a sense of history for local communities and visitors, who may be drawn to trails with a national designation. Designation also creates partnering opportunities, such as working with the Iditarod Historic Trail Alliance, KMTA NHA staff, and the Seward Trailblazers. Designation identifies special historic features that make the trail exceptional, which helps to protect them by increasing public awareness and appreciation.

Research Natural Areas

A research natural area (RNA) is an area managed by the Forest Service in as near a natural condition as possible, which exemplifies typical or unique vegetation and associated biotic, soil, geologic, and aquatic features. The area is set aside to preserve a representative sample of an ecological community primarily for scientific and educational purposes; commercial and most public uses are not allowed. RNAs are selected from relatively undisturbed areas to represent the spectrum of natural ecosystems and special or unique characteristics of scientific importance. RNAs are managed with an emphasis on non-manipulative research, monitoring, education, and the maintenance of natural diversity, allowing natural physical and biological processes to prevail without human intervention.

Relevant Information

- There is an opportunity to review and compare areas having special or unique characteristics of scientific importance and to determine if such areas would enhance the spectrum of natural ecosystems within the existing research natural areas network.

Existing research natural areas

Of seven areas considered for RNA designation for the 2002 Forest Plan, four were selected in the record of decision in addition to the previously established Green Island RNA (see the designated areas and areas recommended for designation map in the map package appendix). The five RNAs total 21,500 acres and include:

1. Kenai Lake-Black Mountain (3,800 acres in the Kenai Peninsula geographic area)
   Contains a representative range of Sitka spruce-white spruce-Lutz spruce forest and a wide diversity of vegetation types (USDA, 2007c).
2. Wolverine Glacier (7,000 acres in the Prince William Sound geographic area)
   Represents a mid-elevation glacier with a diversity of tundra plant communities. Extensive glaciology research has occurred at the site since the mid-1960s. This area is within the Nellie Juan-College Fiord WSA (USDA, 2007e).
3. Green Island (2,500 acres in the Prince William Sound geographic area)
   Includes old-growth forests, beaches uplifted by the 1964 Great Alaska Earthquake, important haulout sites for harbor seals and Steller sea lions, marine bird colonies, and close linkages between terrestrial and highly productive marine environments (USDA, 1997).
4. Olsen Bay Creek (6,700 acres in the Prince William Sound geographic area)
   Non-manipulative anadromous fisheries research was conducted here for more than 50 years. The area also contains a wide diversity of lower and upper elevation vegetation types and landforms (USDA, 2007d).
5. Copper Sands (1,500 acres in the Copper River Delta geographic area)
   This area is a barrier island and includes breakwater sandbars. It is a site of active vegetation succession on sand dunes (USDA, 2007b).

The Forest Plan Review 2002-2012 reported that these RNAs are being managed in a manner consistent with the RNA prescription that focuses on allowing natural conditions to prevail, usually by eliminating or limiting human intervention.

Potential opportunity for additional research natural areas

There is an opportunity to review and compare the spectrum of natural ecosystems and special or unique characteristics of scientific importance.

Contribution to Social, Economic, and Ecological Sustainability

Because RNAs are managed in a natural state, they can function as a control when evaluating long-term effects and ecological change on more intensively managed areas. By encompassing a wide range of habitats, RNAs can provide habitat for little known or unknown forms of biological diversity, including insects, fungi, and soil organisms. In short, RNAs can function as biological repositories, safeguarding habitats, species, and natural processes for the future.

Heritage resources within RNAs are likely protected by the designation since ground-disturbing activities are limited. Management activities for recreation uses, habitat improvement, and resource development are not emphasized in RNAs. Recreation uses that interfere with the purpose of the RNA may be restricted and harvest of forest products is not allowed except for subsistence use as defined by ANILCA.

Scenic Byways

The National Scenic Byways (NSB) Program was established by the Intermodal Surface Transportation Efficiency Act of 1991, administered by the Federal Highways Administration (FHWA). The NSB program recognizes roads as national scenic byways or all-American roads based on their archaeological, cultural, historic, natural, recreational, and scenic qualities to “create a distinctive collection of American roads, their stories and treasured places.” To be designated as a national scenic byway, a road must significantly meet criteria for at least one of the above six intrinsic qualities. For the all-American roads designation, criteria must be met for multiple intrinsic qualities. There are 150 designated scenic byways and 31 all-American roads in 46 states. Similar to the NSB Program, each state has a scenic byways program, which is usually administered by the state's department of transportation.

Recognized for its scenic, natural, historical, and recreational values, the 127-mile Seward Highway holds triple designation: Alaska scenic byway, USDA Forest Service scenic byway, and all-American road. The Seward Highway was designated as an Alaska scenic highway in 1993, a national scenic byway in 1998, and as an all-American road in 2000.

The Alaska Marine Highway, spanning a length of 3,500 miles and connecting 33 communities along the coastline of southeast and southcentral Alaska, was designated by FHWA as an all-American road in 2005. All routes within the Alaska Marine Highway System (AMHS) are, collectively, an all-American road. It is also considered an Alaska scenic byway. The Alaska Marine Highway Scenic Byway was designated in 2002. The Alaska Marine Highway System Byway Corridor Partnership Plan (ADOT & PF, 2002) was developed as part of the designation process, with detailed actions described in plans created for separate segments of the Alaska Marine Highway.

The Prince William Sound and the Kenai Peninsula Segment Corridor Plan highlights the intermodal links in southcentral Alaska, including the Seward Highway and Alaska Railroad, and connections between the communities of Cordova, Valdez, Whittier, the Village of Chenega Bay, and Seward. ADOT (ADOT & PF, 2011b) reports a significant increase in passengers on segments in Prince William Sound during the past decade.

Potential Opportunity for Additional Scenic Byways

Three routes designated as state scenic byways provide access for national forest visitors. The Sterling Highway and Alaska Railroad on the Kenai Peninsula are surrounded by National Forest System lands as is the Copper River Highway on the Copper River Delta. All three of these routes provide access to Forest Service managed recreation sites, including campgrounds, cabins, and trailheads. State scenic byways are designated based on criteria very similar to that of the national program. They could be identified as potential additional designated national scenic byways.

Contribution of Scenic Byways to Social, Economic, and Ecological Sustainability

Designation as a scenic byway, like other designated areas, provides prestige and visibility to the route at a national or state level, which can help promote tourism and protect the resources that make the highways worthy of special recognition. Scenic byways also serve as a forum for partnerships and collaboration between public, private, and non-profit sectors. For instance, the Forest Service has worked as a partner with the Alaska Department of Transportation, the Alaska Railroad, local visitor bureaus, and travel industry representatives on marketing and implementation plans for the Seward Scenic Byway, leading to more efficient and effective management. Similar efforts have been undertaken for the AMHS Scenic Byway, as it connects numerous communities and provides access to and through many different state and Federal parks, refuges, and forests.

A literature review of several studies of scenic byway economic impacts found that most studies identified economic benefits from the byway but that conclusions about overall economic impacts are difficult to establish due to variable types and quality of methodology (Petraglia & Weisbrod, 2001).

Areas Designated by the Alaska National Interest Lands Conservation Act

This section describes existing conditions for statutorily designated areas within the plan area that are provided specific management direction by ANILCA. The section also provides information to support evaluation of possible future conditions and trends. Internal sources of information were referenced for current conditions.

Existing Conditions for ANILCA-Designated Areas

With ANILCA, Congress created, expanded, and revised Federal public lands across the state of Alaska. Section 501(a) of ANILCA added four areas totaling 1,893,390 acres to the Chugach National Forest: Nellie Juan, College Fiord, Copper/Rude River, and Controller Bay. In addition, Section 501(b) provides specific direction for the management of the Copper/Rude River addition, as well as existing National Forest System lands in the Copper and Bering rivers area.

Specifically, ANILCA states “that the conservation of fish and wildlife and their habitat shall be the primary purpose for the management” of the Copper, Bering, and Rude rivers area (a 501(b) area).

The 2002 Forest Plan includes direction for managing the fish and wildlife resources of the 501(b) area. Specifically, the plan includes three classes of 501(b) prescriptions that apply to lands within this area, each providing for the conservation of fish and wildlife and their habitats and a variety of multiple uses. All three prescriptions have fish and wildlife conservation as their primary goal (USDA, 2002a). Overall, these 501(b) prescriptions affect 1,563,950 acres.

Permits and authorizations for use of lands in the Copper River Management Area may only be issued with a determination that the authorized activity is consistent with conservation of fish, wildlife, and their habitat (36 CFR 24.22(a)). Section 502 of ANILCA withdrew the hardrock minerals within lands added by ANILCA to the Copper River area from location, entry, and patent under the United States mining laws.

Contribution to Ecological, Social, and Economic Sustainability

The 501(b) area is a productive coastal wetland that supports healthy runs of all five species of Pacific salmon. The Copper River watershed provides critical salmon spawning habitat, which sustains commercial fishing operations, canneries, sport, and subsistence fishing. The wild salmon harvest of the Copper River watershed is one of the most significant in the state of Alaska.

Bald eagles, shorebirds, seabirds, brown bear, black bear, wolf, moose, deer, mountain goats, and small furbearers also occur in the area. The State of Alaska has designated much of the 501(b) area a critical habitat area (AS 16.20.600). The area is used for hunting and wildlife viewing. Sport and subsistence harvest of moose in the area contributes considerably to the local rural subsistence lifestyle. Each spring, the Copper River Delta is a key stopover site for millions of migrating shorebirds and has been designated a Western Hemisphere Shorebird Reserve Hemispheric Site.

Conditions and Trends affecting the ANILCA Section 501 (b) Area

The 1964 earthquake uplifted certain lands within the 501(b) area by several feet. The resulting vegetation succession continues to alter habitat type and availability. Tidal marshes are being replaced with shrub and tree vegetation. This trend is expected to affect the capacity of the area to support certain wildlife populations in their current numbers and distribution.

Information Needs

This area is one of the largest contiguous wetlands on the Pacific Coast of North America. The relatively unfragmented nature of the Copper River Management Area provides a unique opportunity for scientific study. More information on fish and wildlife populations and their habitat would contribute to better understanding of current conditions and trends and inform management decisions in support of the goals of the ANILCA 501(b) designation.

Recreation and Scenic Character

This section provides an overview of the existing condition and, where information is readily available, trends, possible future conditions, and sustainability of the recreation and scenery resources within the Chugach National Forest. After the Relevant Information subsection, which provides a snapshot of selected key points related to recreation and scenery, an overview of Forest Service recreation and scenery management is provided. The next subsections describe the existing condition of recreation settings, scenery, and recreation opportunities by geographic area, including opportunities for guided activities, connecting people with nature, and for recreation on lands in other ownership. Recreation infrastructure and recreational access are two important components in delivering a suite of recreation opportunities, and these are described in more detail. Following that description, recreation use and trends are examined both at the state and national forest level, including areas where there are competing demands and/or user conflicts within the national forest. Where possible, recreation use information is provided by geographic area. Much of the available information is forestwide and is presented at that level. Lastly, this section will discuss whether recreation opportunities and scenic quality within the Chugach National Forest are sustainable, and how they contribute to the economic, ecological, and social sustainability in the plan area.

Relevant Information

- Eighty-two percent of respondents during the 2008 NVUM survey were very satisfied with the quality of their recreation experience.
- Ninety-five percent of respondents planned to return to Prince William Sound. Only 10 percent reported negative encounters with other users during their visit.
- Opportunities for connecting people with nature have evolved, expanded, and diversified across the national forest and in local communities.
- Motor vehicle use and non-motorized activities continue to generate interest.
- Limited monitoring of unauthorized motor vehicle use citations and public input indicate that current users generally understand where motor vehicle use is allowed. The number of citations decreased from more than 80 in 2006 and 2008 to 17 in 2011.
- Greater access to Prince William Sound and continued land conveyances have led to an increased concern of trespass on Alaska Native Corporation lands along the shoreline.
- There has been an observed diversification of summer and winter recreation activities on the Kenai Peninsula, with an increase in mountain biking, backcountry skiing, and trail running.
- Visitors to the Begich, Boggs Visitor Center during the past five years has decreased from 100,000 in 2010 to 69,000 in 2012, a 30 percent drop, primarily due to a reduction in use by commercial tours.
- An increase in boat and upland use in Prince William Sound is indicated by traffic through the Anton Anderson Memorial Tunnel to Whittier, which increased from 176,000 vehicles in 2002 to nearly 235,000 vehicles in 2010. Though use of the tunnel peaked in 2007 and has been decreasing since, use in 2012 is 25 percent greater than use in 2002.
- A decade-long study in Prince William Sound (Twardock, Monz, Smith, & Colt, 2010) found that campsites along beaches increased 27 percent and that total impacts at existing campsites expanded from 43 to more than 73 square meters.
- Demand is generally being met for Chugach National Forest recreation settings and opportunities, though the need for cabins and campgrounds in western Prince William Sound and the Kenai Peninsula during much of the summer remains unmet.
- The Forest Service could consider revising recreation use capacities and guided use allocation models used in the 2002 Forest Plan and developing a consistent approach to establishing capacities.
- The INHT and Whistle Stop projects have increased recreational access by providing new trails in the Kenai Mountains.

- The Kenai Winter Access Plan (USDA, 2007a) adjusted the areas open for winter motor vehicle access within the Seward Ranger District.
- The Copper River Highway has been closed since 2011 at mile 36 because of a bridge failure. It is uncertain when this bridge will be replaced, so road access to the Childs Glacier campground and day use site is currently unavailable.

Recreation and Scenery Management

Since 2002, the Forest Service's national approach to recreation management has evolved to provide settings and opportunities that are socially, economically, and environmentally sustainable for local residents and visitors alike. This approach is laid out in the Forest Service Framework for Sustainable Recreation (USDA, 2010c). The framework provides a vision, guiding principles, goals, and areas of focus for recreation management on National Forest System lands. The overall goal of sustainable recreation is to provide diverse natural and cultural recreation opportunities in cooperation with partners, while protecting the natural, cultural, and scenic environment for present and future generations. It also recognizes the challenges of operating and maintaining a system of recreation facilities and highlights the importance of considering financial sustainability when managing recreation resources.

The Forest Service uses a system called the Recreation Opportunity Spectrum (ROS) to describe different recreation settings across the national forest (see the ROS map in the map package appendix). The system describes settings in seven classes with specific, defined attributes (USDA, 1986). ROS classes range from highly modified and developed places to primitive, undeveloped settings. Attributes typically considered in describing the settings are scenic quality; type and degree of access; remoteness; level of development; social encounters; and the amount of on-site management. The seven different ROS classes are described in detail in the 2002 Forest Plan.

These ROS classes have also been used to establish recreation carrying capacities, where more developed settings allow for a higher number of people, based on a number of people in a given area at one time. The concept of capacity and its validity continues to be debated, as well as what factors should be used to determine capacity, but most recreation managers and researchers recognize the value of using capacities to maintain recreation settings and opportunities (Graefe, Cahill, & Bacon, 2011; Whittaker, Shelby, Manning, Cole, & Haas, 2011). Recreation use capacities for the 2002 Forest Plan were developed using ROS coefficients, which led to high theoretic capacities that do not likely represent levels of use that could be sustained without degrading recreation experiences and natural resources. Since 2002, the Forest Service has developed site-specific capacities for many areas across the national forest but has used different methodologies and approaches. It may be valuable to develop a consistent approach for establishing recreation use capacities and to re-assess theoretic capacities at the broad geographic area level. Also, allocations for guided recreation use in the 2002 Forest Plan range from 30 to 50 percent of total use, which is only reached in a handful of locations, particularly on rivers. In general, these allocations for guided use are too high and could be adjusted to better reflect recreational use patterns.

ROS, capacities, and sustainable recreation have helped guide Chugach National Forest recreation management in the past. However, there is a greater emphasis on recognizing the value of specific recreation sites and opportunities, the importance of financial sustainability, connecting people with nature, and the connection between cultural resources and nature-based recreation in this assessment.

The 2002 Forest Plan and FEIS provided an inventory of the ROS classes by acreage. More than 95 percent of the almost 5.4 million acres are in either the Primitive or Semi-Primitive classes, with developed Roaded Natural settings occurring along road corridors. Since 2002, project implementation has not changed ROS class acreage. Table 46 displays the current distribution of ROS classes by geographic area.

Table 46. Recreation opportunity spectrum classes (acres) for the Chugach National Forest

ROS Class	Copper River Delta	Kenai Peninsula	Prince William Sound	Totals
Primitive	1,334,973	5,952	1,166,189	2,507,114
Semi-primitive non-motorized	19,818	198,008	1,335,090	1,552,916
Semi-primitive non-motorized (winter motor vehicle use allowed)	112,760	523,588	83,341	719,689
Semi-primitive motor vehicle use allowed	189,702	365,329	22,011	577,042
Roaded natural	17,164	70,611	569	88,344
Roaded modified	0	649	0	649
Rural	0	6,623	0	6,623

Source: Chugach National Forest GIS database (2014).

The Forest Service also recognizes scenery as an important resource in and of itself. Since the late 1990s, the Forest Service has inventoried existing and desired scenery levels and included impacts to scenery as a consideration in program and project planning. Scenery in natural settings across the national forest is a key component of sustainable recreation management as it serves not only as a backdrop for all types of recreation, but also the primary resource for tourism.

Scenery is evaluated by a process called the Scenery Management System (SMS). This is a two-part process to: (1) assess current scenic conditions and identify the relative importance of the viewed landscape and (2) identify management goals and objectives for the viewed landscape. The first part involves defining and mapping five components to systematically describe the existing scenery and develop scenic classes. These five components follow and are explained in detail in the 2002 Forest Plan FEIS (USDA, 2002c):

1. Describe existing landscape character
2. Identify the existing scenic integrity
3. Identify the existing scenic attractiveness
4. Determine the concern levels and landscape visibility
5. Determine the scenic classes

The second part involves defining and mapping two components using information developed in the first part. These two components are:

1. Define landscape character goals
2. Map scenic integrity objectives

The valued attributes of the landscape character description are used as a frame of reference for determining the existing scenic integrity level (SIL). The SIL indicates the degree of intactness and wholeness of the landscape character, and helps locate and rank areas in need of scenic rehabilitation. It serves as a benchmark for monitoring landscapes to assess changes associated with planned management activities. Conversely, SIL is a measure of the degree of visible disruption of landscape character. A landscape with very minimal visual disruption is considered to have high SIL. Landscapes with increasingly incompatible scenic attributes are viewed as having diminished SIL. Six terms are used to describe the levels of existing scenic integrity, ranging from very high to unacceptably low. Most of the Chugach National Forest landscape has a very high scenic integrity level.

Recreation settings, scenic quality, and recreation opportunities

Copper River Delta

Spanning 700,000 acres, the Copper River Delta provides spectacular scenery, wildlife, massive valley glaciers, and wild and remote settings. It is an ideal location for primitive recreation. The Copper River Delta is much like Prince William Sound in that it is extremely wild and remote with extensive primitive and semi-primitive recreation opportunities. Along the 50-mile Copper River Highway connecting Cordova and Childs Glacier, the roaded natural ROS setting allows for relatively high use of facilities in a few areas. A railroad was constructed that ran along and through the Copper River Delta connecting the Kennicott mine to Cordova, which operated in the early 1900s (Kesti, et al., 2004). The Eyak people have called the Copper River Delta area home for millennia. The Copper River Delta was also the setting for ambitious European traders and American settlers and played a role in early Forest Service history. Scenic integrity within the Copper River Delta remains unchanged with the exception of private lands that have been logged, the Copper River Highway, and a cell phone tower at the junction of the Copper River Highway and the Copper River.

Developed facilities include six public use cabins and improved day use opportunities at four locations along the Copper River Highway. Developed sites are grouped in enclaves along the highway, with the land in-between left undeveloped. Two boat ramps provide access for water-based recreation opportunities to much of the Copper River Delta. Several trails provide opportunities to explore the wetlands, forests, and alpine zones of the Copper River Delta and also maintain access through lands of other ownership.

Important recreation sites include the Childs Glacier recreation site that was expanded to include pavilions, RV sites, and tent campsites in 2004. The highway has been closed at mile 36 since 2011 where the Copper River washed out a bridge, making the campground, at least temporarily, inaccessible by road, but still accessible by boat via the Copper River. Other sites include McKinley Trail cabin, trail, and mine, where visitors can explore remnants of an old mining operation and stay in the Forest Service's oldest public use cabin. At the Alaganik Slough boardwalk and boat ramp, visitors can watch wildlife and explore the Copper River Delta by boat.

Kenai Peninsula

The steep mountains, rivers, glaciers, and a relatively small road and trail system for the size of the land base means there are few access points to undeveloped backcountry areas. The result is concentrated use in valley bottoms or along corridors where access is available and there are recreation facilities. Recreation settings range from areas of major development and higher concentrations of people along the road and trail corridors to remote, undeveloped areas in the backcountry with little use and no development.

Much of the Kenai Peninsula scenery remains the same as it was before the 2002 Forest Plan. Noticeable deviations in the landscape character are concentrated along the existing travelways of the Kenai Peninsula and are associated with road construction and reconstruction. Additionally, the high voltage transmission line paralleling the Seward Highway reduces the scenic integrity in certain locations when viewed from the Seward Highway. Privately owned parcels along the road are gradually being developed. This development is a foreground to national forest views. Spruce beetle killed trees altered scenery in the 1990s and was a major issue during development of the last plan. Since then, however, vegetation management projects have removed much of the spruce beetle-killed trees and encouraged other plant material to grow. This diversified canopy increases the scenic quality of the area by making a texturally varying plant pallet.

The Kenai Peninsula offers a range of opportunities reasonably accessible to large numbers of people, including the residents of cities and towns in southcentral Alaska. Every year, hundreds of thousands of residents and tourists are attracted to the Kenai Peninsula by its scenery, world class sportfishing, opportunities for viewing fish and wildlife, and a multitude of recreation activities available along its trails, roads, and at developed facilities. Compared to the other two geographic areas, the Kenai Peninsula has a substantial infrastructure, including a major visitor center, 19 public use cabins, 14 campgrounds, and hundreds of miles of trail for both summer and winter recreation. Almost all of the major valleys have either a road, trail, or railroad. The Seward Highway National Scenic Byway and All-American Road, the only road heading south from Anchorage, winds along Turnagain Arm and through the heart of the eastern Kenai Peninsula, providing access to a variety of other roads, communities, and recreation facilities. Trails provide short to multi-day opportunities to explore the diverse types of landscapes in the area. Rivers and lakes across the area provide opportunities for motorboating and non-motorized boating. In the winter, snowmachining and cross-country skiing opportunities are among many of the winter opportunities found throughout the area. Community organizations have begun grooming the Trail River and Russian River campgrounds for cross-country skiing.

Several important recreation sites within the national forest are in this area. In the northeast portion of the Kenai Peninsula area is Portage Valley, which includes the Begich, Boggs Visitor Center, two campgrounds, and eight miles of trail, including the Trail of Blue Ice, Portage Creek, Portage Lake, and Portage Glacier. These sites are within 45 miles of Anchorage residents and provide a variety of relatively close day use and overnight opportunities. During the winter, Turnagain Pass on the Kenai Peninsula provides outstanding opportunities for motor vehicle use and non-motorized activities. Paralleling the Hope Highway, Sixmile Creek is a world-class whitewater destination with several sections of Class V rapids requiring a high level of skill to navigate. Further south along the Sterling Highway, the Russian River and its strong runs of sockeye salmon attracts nearly 100,000 local and visiting anglers from around the world every year, creating a very high concentration of anglers during the peak season. The Forest Service is working with other state and Federal agencies to manage the Russian and Kenai rivers confluence area, where human-bear interactions are very common. At the K'beq Interpretive Site, managed by the Kenaitze Indian Tribe in cooperation with the Forest Service, visitors can learn about the Athabascan Denai'na people and culture. Some of the important trails include the Resurrection Pass National Recreation Trail and the Johnson Pass, Russian Lakes, Lost Lake, Winner Creek, and Crow Pass trails.

Two major projects initiated since 2002 are expanding recreation opportunities and capacity on the Kenai Peninsula: the development of the INHT Southern Trek between Seward and Girdwood and the Whistle Stop Project. The purpose of the INHT Southern Trek project is to develop a commemorative route between Seward and Girdwood that provides winter and summer recreational opportunities and associated economic development opportunities. The Forest Service manages 186 miles of trails as part of the INHT, including construction or reconstruction of approximately 159 miles of trails. The project also allows for the construction of up to six new public use cabins. It also opened a corridor on Portage Lake for non-motorized boat travel, which was previously closed to all boat use except for one commercial tour boat. This project also highlights the rich cultural history of the Kenai Peninsula through interpretation along the trail and at associated sites (Benoit, et al., 2004).

The Whistle Stop Project is a partnership between the Alaska Railroad and Forest Service to develop new recreational opportunities along the railroad, which passes through the Kenai Mountains between Portage and Moose Pass. The project decision authorizes the construction of up to 5 whistle stops, 30 miles of trail, 6 public use cabins, a group campsite, and dispersed campsites (USDA, 2006). The Spencer Glacier Whistle Stop opened in 2007. Since then, more than 20,000 people have visited the site for hiking, camping, rafting, rock climbing, viewing Spencer Glacier, and learning about glacial geology and Alaska Railroad history. The Grandview Whistle Stop was completed in 2013.

Both of these projects are within the Kenai Mountains-Turnagain Arm National Heritage Area, which was designated by Congress in 2009. More information on the National Heritage Area is in the Designated Areas section.

Prince William Sound

One of the largest saltwater sounds in the world, Prince William Sound is a land of spectacular scenery. With the Chugach Mountains providing a backdrop of perennially snow covered peaks, the narrow fiords and tidewater glaciers, old growth forests, and alpine tundra create breath-taking scenery. Black bear, brown bear, mountain goats, Sitka black-tailed deer, nesting shorebirds, and haulouts for Steller sea lions all occur on land. In the marine waters orcas, humpback whales, Dall's porpoises, sea lions, harbor seals, and all five species of Pacific salmon occur. Like the Kenai Peninsula, Prince William Sound has been the home of Alaska Natives for thousands of years. Suqpiaq peoples harvested fish, wildlife, and other foods throughout Prince William Sound. Residents of Chenega Bay, Tatitlek, and the Native Village of Eyak continue these practices, along with other rural Alaska residents. Many of the most accessible spots along the shore have been used by boat-based travelers for hundreds or thousands of years. Early European explorers, traders, and settlers also traveled to and through Prince William Sound, giving us many of the place names currently used in the area (Charnon, et al., 2005).

Wild and remote with access by watercraft from nearby towns, floatplane or helicopter, recreation settings are primarily undeveloped and dispersed. Prince William Sound predominantly has primitive and semi-primitive recreation settings. The western half of Prince William Sound includes the 2.1 million acre Nellie Juan-College Fiord WSA designated in 1980, which is managed to provide opportunities for solitude and primitive-style recreation. Activities are generally marine-oriented, with the Chugach National Forest providing the backdrop for both water and land-based activities. Scenery in Prince William Sound for the most part looks undisturbed, much like it did when Captain Cook sailed these waters and recorded what he saw. Steep-walled canyons or fiords carved by glaciation, islands teaming with birds, and the rugged tree covered coast all offer great viewing opportunities. The exceptions to this are areas where timber harvest occurred on lands previously in private ownership.

The 1,800 miles of rugged, remote shoreline of Prince William Sound provide outstanding opportunities for a variety of day use and overnight recreation activities. Due to the challenges of accessing this vast landscape, opportunities for solitude can be found in almost every bay and cove, though areas in the vicinity of towns and main travel routes tend to have more motorboat and non-motorized boat use. Key experiences in Prince William Sound include viewing and camping near tidewater glaciers, viewing a diversity of terrestrial and marine wildlife, and hunting (Poe, Gimblett, & Itami, 2010). Over 250 primitive user-created campsites are spread across Prince William Sound, mostly in the western half with closer access from Whittier (Smith M. A., 2010). The Forest Service used local natural materials to improve a few of the more highly-used campsites to protect natural resources. Sixteen Forest Service cabins throughout Prince William Sound are accessed by boat or float plane, providing a destination or base for other activities, such as hunting, fishing, and backcountry skiing. The Alaska Marine Highway includes several segments that cross Prince William Sound and connect Whittier, Chenega Bay, Valdez, and Cordova.

Two important sites in Prince William Sound include Blackstone Bay and Columbia Glacier, which provide glacier viewing and backcountry camping relatively close to Whittier and Valdez, respectively. Both of these sites are in the WSA.

Guided opportunities

Recreating within many parts of the Chugach National Forest requires excellent outdoor skills and/or specialized equipment. Some people may not have the requisite skills or equipment yet still desire to participate in a particular activity or to visit a remote area of the national forest. Where such services are needed or desired, commercial outfitters and guides are present to assist people and enhance their recreation experience. Outfitters and guides operating within the national forest are required to have a special use permit authorizing them to provide commercial services to the public.

The Forest Service authorizes commercial activities via special use permits to facilitate the public's participation in recreation activities and to provide services that add value to a recreation activity. Some of the key opportunities provided by outfitter/guides within the Chugach National Forest include big game hunting, fishing, heli-skiing, whitewater rafting, and kayaking, along with a wide variety of other recreation activities. As of 2013, there are approximately 150 outfitters and guides that operate within the Chugach National Forest.

Three facilities are authorized as resorts under special use authorization. The Portage Glacier Lodge and Portage Glacier Cruises facility are both authorized on the Glacier Ranger District in Portage Valley. The Montague Island Lodge is authorized on the Cordova Ranger District, but has never been developed.

Copper River Delta

Hunting is the predominant use for outfitter/guide permits issued in the Copper River Delta area. Other authorized outfitter/guide use includes hiking and sightseeing experiences on the developed trails and recreation areas. There is one special use permit authorized for heli-skiing. Several Copper River guides are authorized to camp at sites along the shoreline during the summer months and provide access to the Childs Glacier Campground.

Kenai Peninsula

There are a wide variety of guided opportunities in the Kenai Peninsula area in both summer and winter. In the summer, some examples include viewing Portage Glacier by boat, rafting trips down Sixmile Creek and Placer River, jet boat tours up Twentymile River, ice climbing in Portage Valley and Spencer Glacier, hiking tours on several trails, tours of the Begich, Boggs Visitor Center, horseback riding, and helicopter supported dog sled tours to name a few. In the winter, snowmachine tours and heli-skiing are the most popular activities. Currently, the only guides operating on the Kenai River under special use permit with the Forest Service are those that leave the river and bring their clients above the high-water mark to fish or participate in other guided activities. Previously, guides were required to hold a permit to float the section of the river that crosses National Forest System lands.

Prince William Sound

Most special use permit holders operating in Prince William Sound enter the area through Whittier or Valdez. Most of the kayak supported camping and boat-based hiking and day uses under outfitter/guide permits are based out of Whittier and Valdez. Hunting is another outfitted and guided activity commonly occurring in Prince William Sound.

Recreation events

Recreation events are defined in the Code of Federal Regulations as a recreational activity conducted on National Forest System lands for which an entry or participation fee is charged. Several recreation events have been permitted annually within the Chugach National Forest. These include the Crow Pass Crossing, Lost Lake Run, and a triathlon near Seward to name a few. The Soggy Bottom 100-mile mountain bicycle race has occurred since 2003. The Resurrection Pass 50- and 100-mile ultramarathons are events held without a permit, as these races do not charge an entry fee. There may be other recreation events as well.

Opportunities for Connecting People and Nature

Chugach Children's Forest

In 2008, the national forest became a Children's Forest, a symbolic designation that created new and innovative opportunities for connecting Alaska's youth and communities with the outdoors. The Children's Forest builds these connections through innovative partnerships, particularly with Alaska Geographic, and community engagement. The four overarching themes of the Children's Forest, as stated in the project's strategic plan (USDA, 2010e) are:

1. Healthy outdoor activities and communities
2. Outdoor-oriented education and careers
3. Stewardship and civic participation
4. Understanding climate and environmental change and local solutions

A portion of the Portage Valley has become a youth-managed section of the national forest, where students work with natural resource managers to develop projects in the area. Dozens of students have also had extended experiences through expeditions to remote landscapes within the Chugach National Forest. Through the Chugach Children's Forest program, the Forest Service is increasing volunteer opportunities for stewards of all ages and helping to train the next generation of land managers through internship opportunities.

Naturewatch, Interpretation, and Conservation Education (NICE) program

Since 2002, the Forest Service's Naturewatch, Interpretation, and Conservation Education (NICE) program has changed significantly, increasing opportunities for interpretation and education where the Forest Service can leverage its resources through partnerships and reducing some programs that rely solely upon Forest Service staff and funding. These NICE programs complement recreation and watchable wildlife opportunities while increasing the public's understanding of natural and cultural history and the relation to land management techniques.

Chugach National Forest staff also organizes, leads, and/or participates in a number of events that highlight unique features in their respective communities. These events provide opportunities to connect with a diversity of community members and help develop knowledge, skills, and a sense of shared stewardship. Forest Service employees often collaborate with a variety of Federal, state, tribal, and local government, and non-profit organizations. For instance, employees have participated and supported tribal-related culture camps in all three geographic areas during the past decade.

Copper River Delta

The Forest Service has partnered with other state and Federal agencies, foreign governments, and non-profit organizations to develop the Copper River International Migratory Bird Initiative, or CRIMBI, to strengthen conservation of migratory birds along the entire flyway through effective international partnerships and action on the ground. Community events include the annual Shorebird Festival in May and the Fungus Festival in September.

Kenai Peninsula

The Begich, Boggs Visitor Center (BBVC) remains the top Chugach National Forest destination for the public to learn about the cultural and natural resources of the area, though visitation has declined during the past decade. Several improvements to the infrastructure at BBVC have taken place since 2002. In 2004, a classroom facility, the Portage Valley Learning Center, was added to the visitor center to increase educational opportunities. The theater was updated with a new projector, screen, and sound system in 2005 and a new movie about the Chugach National Forest was completed in 2013. The Whistle Stop partnership with the Alaska Railroad has also provided new opportunities to connect with the public. The Forest Service provided interpreters on board the Alaska Marine Highway ferries in Prince William Sound up to 2013. The BBVC season has also been reduced, eliminating winter hours of operation due to budget constraints.

The Forest Service has spearheaded an effort on the Russian River called the Streamwatch Program to reduce human-bear conflicts and natural resource damage at this highly used fishing destination by partnering with Federal, state, local, and non-profit organizations. This partnership has recently expanded to include the entire Kenai River corridor.

In 2010, the Forest Service and its partners initiated the Iditarod Trail to Every Classroom project (iTREC!) to develop place-based service learning opportunities in schools and communities along the Iditarod National Historic Trail. The yearlong professional development program provides teachers with place-based service learning skills to help today's youth become lifelong stewards of Alaska's public lands, natural resources, and cultural heritage. Teachers from Cordova have also participated in this training. Community events include Kid's Fishing Days, the Fungus Fair in Girdwood, and some one-time events, such as Budburst and BioBlitz in Portage Valley.

Prince William Sound

The interpretive partnerships that operate out of BBVC have expanded into Prince William Sound; interpretive guides now provide onboard interpretive programming for Major Marine Tours and Phillips Cruises and Tours.

The Crooked Creek Information Site in Valdez is open from Memorial Day to Labor Day and includes exhibits, bird viewing, and spawning salmon.

Opportunities on lands of other ownership

Alaska has about 168 million acres of land (about 46 percent of the state) that are managed for wildland recreation (AKDNR, 2009). Not surprisingly, there are numerous and diverse recreational opportunities on Federal, state, borough/municipality and private lands adjacent to the Chugach National Forest. These lands include state parks across the Kenai Peninsula, Prince William Sound, and Resurrection Bay along with the Kenai National Wildlife Refuge, Kenai Fjords National Park, Wrangell-St. Elias National Park, privately owned lodges in or near communities and on private lands, and a major ski resort in Girdwood.

Copper River Delta

The largest national park in the nation, Wrangell-St. Elias National Park, shares the Copper River as a boundary with the Chugach National Forest to the east. The park has more than 9 million acres of designated wilderness areas and totals 13.2 million acres. In 2011, the national park had only 65,000 visitors (NPS, 2012), meaning that there are outstanding opportunities for solitude and backcountry experiences. Fourteen cabins are available for rent. The Kennecott Mine National Historic Landmark is a destination for culture-based recreation. The park headquarters also features a visitor center.

Kenai Peninsula

Chugach State Park, located between Girdwood and Anchorage, offers the easiest access to wildland outdoor recreation for Anchorage residents. The park includes an extensive trail system, including approximately 20 miles of the INHT from Crow Pass to the Eagle River Nature Center, as well as two cabins and a rental yurt. There are also three campgrounds in the park, including the Bird Creek Campground along Turnagain Arm.

The Kenai River Special Management Area was created in 1984 and designated as a state park to manage one of the most heavily used freshwater fisheries in Alaska. As many as 100,000 or more anglers converge annually on the Russian and Kenai rivers to catch salmon for several weeks in the summer. The area is managed to protect natural and cultural resources and to manage Kenai River recreational and commercial uses, including public facilities.

The Kenai National Wildlife Refuge shares most of the western boundary of the Chugach National Forest, divided by the Russian River. Most of the lands immediately adjacent to the national forest are designated wilderness areas. The refuge maintains 110 miles of trails, and also provides visitors with several canoe routes, a unique opportunity in the area. Sixteen cabins are available for rent across the refuge. The USFWS and Forest Service work collaboratively to manage the Russian River fishery.

To the south of the refuge, Kenai Fjords National Park offers glacier viewing opportunities, hiking, and boat-based opportunities within easy access of Seward. The Exit Glacier area offers the only road and trails access in the park and also includes the Exit Glacier Nature Center, which provides interpretive materials on the cultural and natural resources of the park. Three public cabins are available for rent; two are accessible by boat and the third is only available in the winter.

The communities of Girdwood, Hope, Moose Pass, Cooper Landing, and Seward all provide additional opportunities for outdoor recreation, including lodges, trails, and outfitter and guiding businesses. The Alyeska Ski Resort and Hotel in Girdwood is the largest ski resort in Alaska, offering 1,500 acres of groomed and ungroomed skiing on 76 runs and 3,200 vertical feet (2,500 feet lift-accessible).

Several wildlife cruises, kayak trips, and fishing charters are offered out of Seward and Whittier during the summer. There are other lodging options, including the Summit Lake Lodge and a hut, formerly the Forest Service managed Manitoba Cabin, managed by the Alaska Huts Association along the Seward Highway corridor.

Prince William Sound

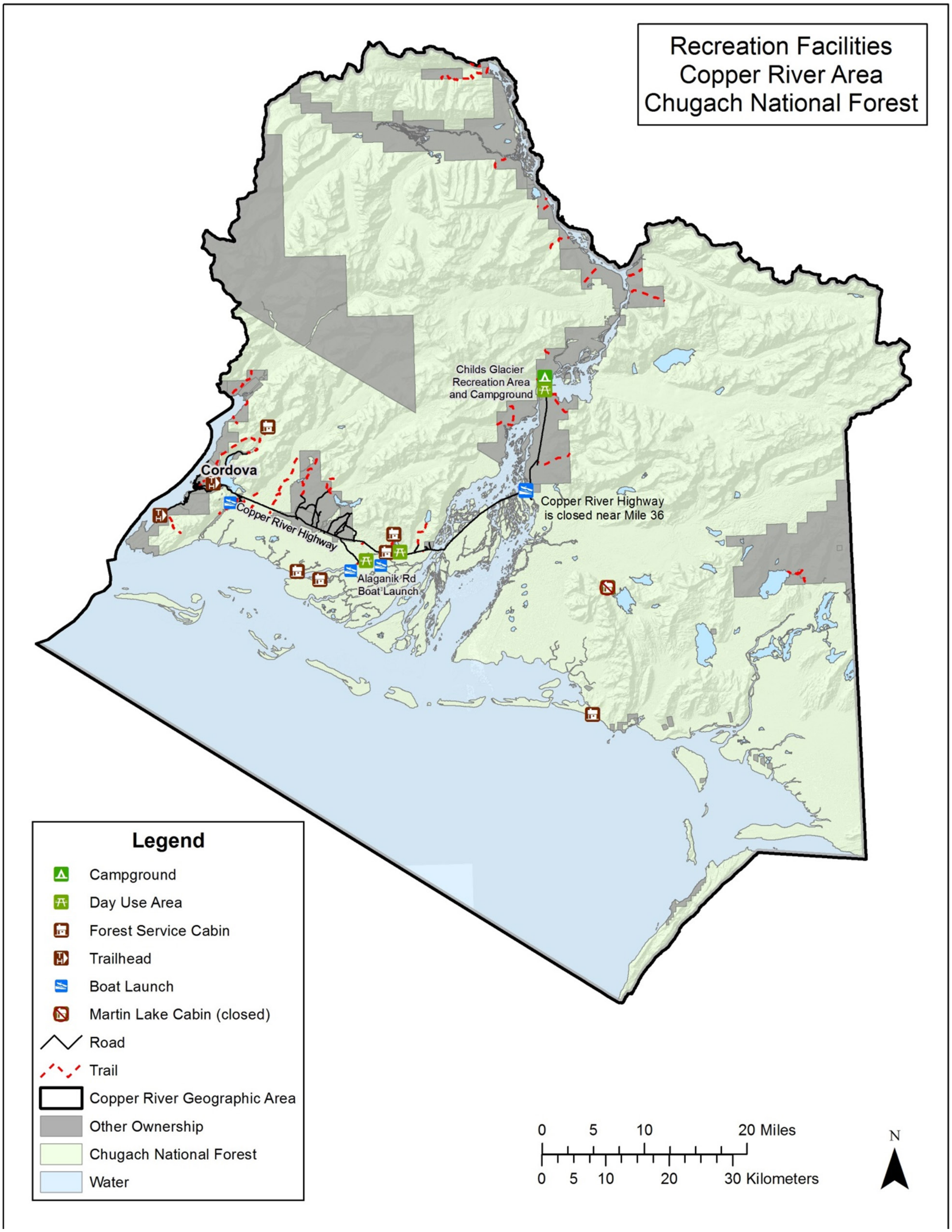
There are 14 marine state parks in Prince William Sound and 5 more are in Resurrection Bay outside of Seward. The management plan for these parks provides for some facilities as well as numerous natural areas to provide undeveloped recreation opportunities (AKDNR, 1995). Cabins are available for rent in parks closer to towns, including two near Valdez, one near Whittier, and four near Seward, as well as some constructed tent platforms at more popular campsites. These parks are accessible by boat or float plane. The state plans to construct three more cabins as part of a plan to help meet public demand for facilities in Prince William Sound and to develop a Prince William Sound Marine Trail, in cooperation with the Forest Service, which would run from Whittier to Valdez (Blackwell, personal communication, 2012). The Prince William Sound gateway communities of Whittier, Valdez, and Cordova provide overnight accommodations, equipment rentals, and guided opportunities for fishing, hunting, and sightseeing visitors. There is also a public use cabin built in 2011 in Iktua Bay owned by the Chenega Corporation.

Recreation Infrastructure and Access

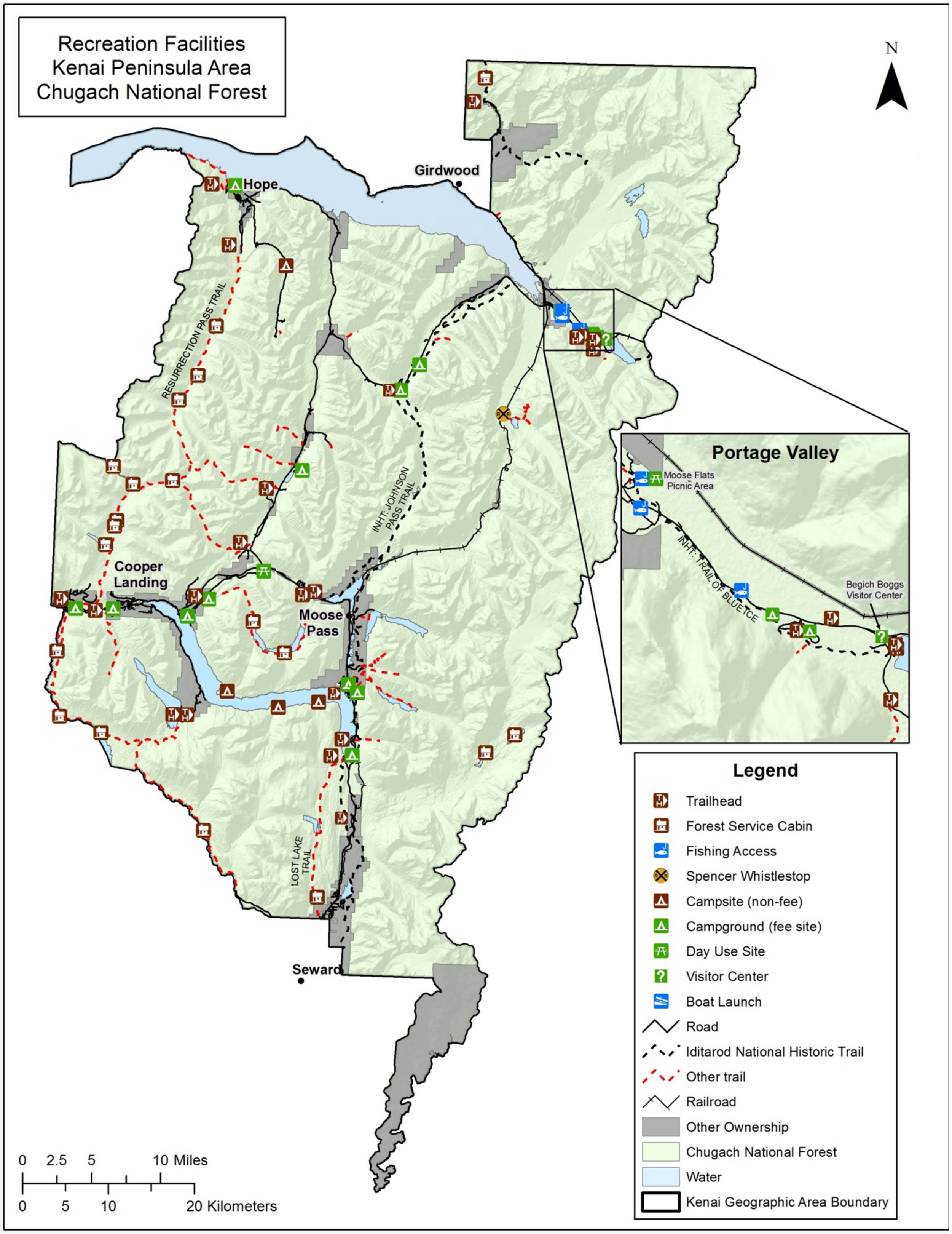
Recreation facilities

The Forest Service manages more than 100 recreation sites to provide a variety of recreation opportunities across the national forest. These sites include campgrounds, public use cabins, visitor centers and information sites, trailheads, boat ramps, and day use areas. Most of these, except for the public use cabins, are accessible along the existing road system. Cabins are found mostly in more remote backcountry settings and are accessible by trail, boat, or float plane. The following sections will provide a description of each type of recreation facility included in the Forest Service's Infra recreation site database. Capacity of the site is determined by the number of people a site can accommodate multiplied by the number of days the site is open for public use. People at one time (PAOT) days are used to represent the total capacity. The annual operations and maintenance costs, as well as the total amount of deferred maintenance, are provided for each type of recreation site. Operations and maintenance costs are established in Infra for each site based on tasks associated with its constructed features, such as a bulletin board, sign, toilet, or picnic table. Deferred maintenance is maintenance that was scheduled to be performed, whether on an annual or cyclical basis, but was delayed for some reason.

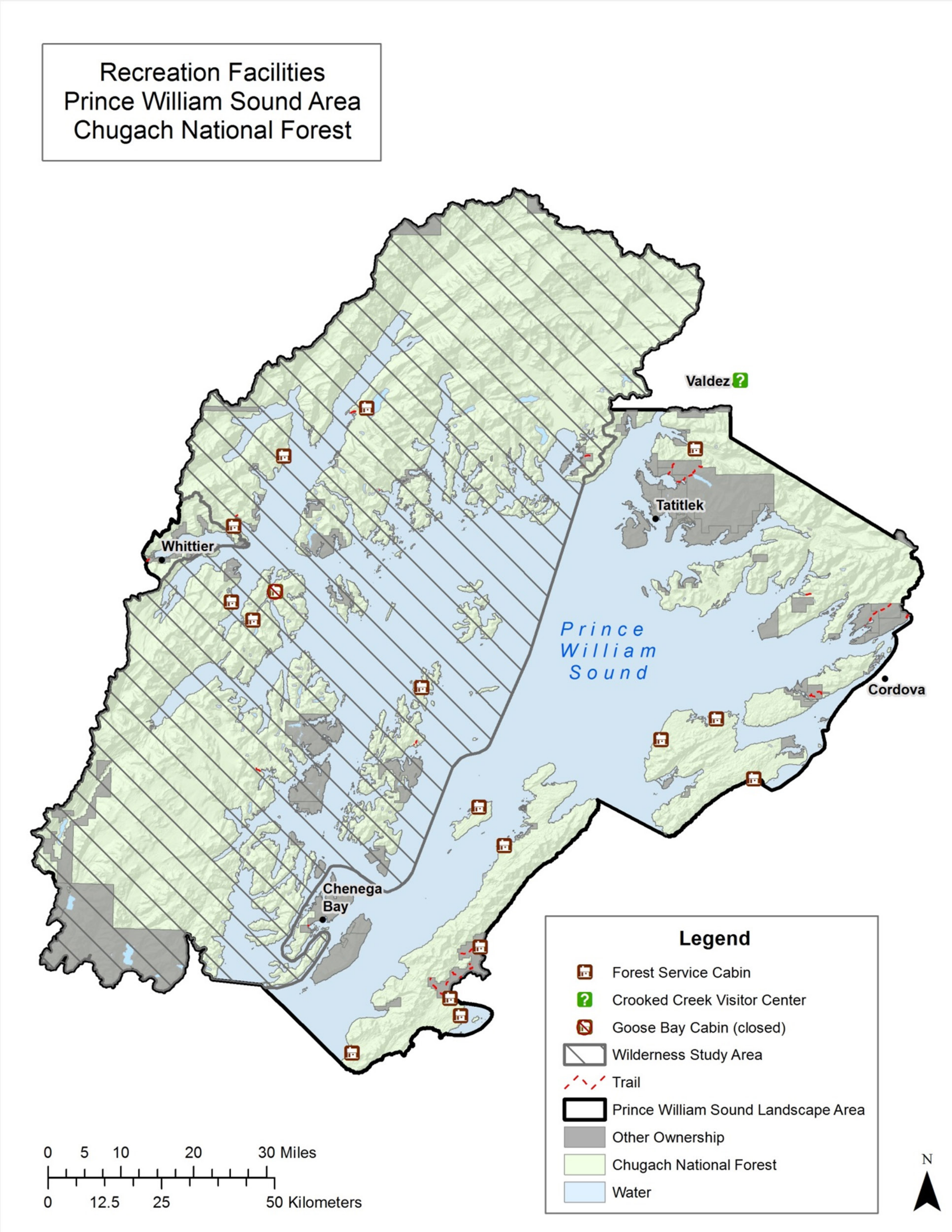
Maps 8, 9, and 10 display the locations of recreation facilities in each of the geographic areas.



Map 8. Recreation facilities in the Copper River Delta geographic area



Map 9. Recreation facilities in the Kenai Peninsula geographic area



Map 10. Recreation facilities in the Prince William Sound geographic area

Public Use Cabins

There are 41 cabins scattered across the Chugach National Forest that vary in size and style, with a capacity of six to eight people. Total PAOT days are 91,500. Most are equipped with propane or wood stoves, wooden furniture and bunks, and a separate outhouse. Although the 2002 Forest Plan and subsequent projects proposed the building of a number of new cabins, no additional cabins have been constructed since 2002. Instead, the Forest Service's emphasis has been placed on maintaining and replacing existing cabins. One new cabin is planned for construction in the near future as part of the Whistle Stop Project. The Alaska Huts Association currently has a planning permit to assess the feasibility of constructing and operating a facility near the Spencer Glacier Whistle Stop.

During the past 10 years, 17 cabins have been replaced or reconstructed through capital investment funds. As of 2012, two of the 41 cabins are not available to the public: Goose Bay Cabin and Martin Lake Cabin. These cabins sustained damage in the winter of 2011-12 due to record snowfall. The Resurrection River Cabin within the Kenai Peninsula is not available for reservations due to access problems caused by trail bridges failing, but is still open for use. The McKinley Trail Cabin near the Copper River Highway is the only historic cabin open for public use within the national forest.

The annual operations and maintenance (OM) costs to complete 100 percent of tasks for the Chugach National Forest cabin program is approximately 320,000 dollars, or an average of about 8,500 dollars per cabin. Cabins located in a remote setting that have high occupancy rates have higher annual OM costs. Cabins are available for nightly rent at a cost ranging from 25 to 45 dollars per night. Using 2012 as a benchmark, Chugach National Forest cabins generated 180,000 dollars in revenue, and the Forest Service spent approximately 280,000 dollars on OM, or about 88 percent of the total need. Cumulative deferred maintenance on cabins totals 398,000 dollars.

Campgrounds

There are 15 fee campgrounds within the Chugach National Forest. Fourteen are within the Kenai Peninsula, with a total of 419 campsites and more than 374,000 PAOT days between Memorial Day and Labor Day. These campgrounds are accessed via the state highways that cross through the national forest. The Childs Glacier Campground and day use area is located within the Copper River Delta at the end of the Copper River Highway and has 18 campsites and 64,000 PAOT days from Memorial Day to Labor Day. There are also three non-fee campgrounds without amenities, with an additional 12,000 PAOT days.

Two new campgrounds have been constructed since 2002: the Childs Glacier day use site was improved and expanded to include camping in 2004, and a new 25-person walk-in campsite was built at Spencer Glacier as part of the Whistle Stop Project. Tenderfoot, Trail River, and Porcupine campgrounds were all reconstructed since 2002 to bring facilities up to standard and to accommodate larger vehicles.

Since the mid-1990s, 13 of the campgrounds have been operated by a concessionaire through a special use permit to reduce OM costs at fee sites and to provide opportunities for private enterprise within the Chugach National Forest. Revenue generated from special use authorization fees are reinvested in the campgrounds, including annual and cyclical maintenance needs, as well as improvements. Childs Glacier and the Spencer Group campsites are operated by the Forest Service. The total annual OM need for 100 percent of tasks at campgrounds is 435,500 dollars. In fiscal year 2012, the Forest Service invested 236,000 dollars in annual OM at the campgrounds, or 54 percent of the total need. Cumulative deferred maintenance for campgrounds is 903,000 dollars. All campgrounds are available for public use, with services available the week prior to Memorial Day (if snow is melted) through Labor Day weekend. One loop of the Trail River Campground was closed in 2012 due to damage caused by flooding and was re-opened in 2013.

There are 57 recreation facility fee sites within the national forest. Table 47 displays these fee sites by type.

Table 47. Recreation facilities fee sites within the Chugach National Forest by geographic area

Geographic Area	Campgrounds	Cabin	Major Visitor Center
Kenai Peninsula	14	19	1 (BBVC)
Prince William Sound	0	16	0
Copper River Delta	1	6	0

Visitor Centers

The Chugach National Forest has one major visitor center, the Begich, Boggs Visitor Center, and one information site in Valdez, the Crooked Creek Information Site (CCIS). The BBVC facility is owned and operated by the Forest Service. Both facilities are generally open to the public between Memorial Day and Labor Day. The CCIS facility was replaced in 2011 and is owned by the City of Valdez and operated by the Forest Service through a 25-year lease agreement. Depending on the availability of funding, the BBVC has been open during weekends in the winter, as well as from early May to late September. Capacity at the BBVC is 206,000 PAOT days. At the CCIS, capacity is 17,250 PAOT days.

The BBVC has 335,000 dollars in deferred maintenance, while CCIS has 51,000 dollars. The CCIS deferred maintenance is from the displays, which are outdated and need to be replaced. Several repairs have been made to the BBVC over the past decade, eliminating approximately 250,000 dollars of deferred maintenance.

The BBVC is a fee site while the CCIS is a non-fee site. The fee charged at the BBVC for access to the film and exhibits was incrementally increased from 1 dollar in 2008 to 5 dollars in 2011 to help defray OM costs. The total annual OM need for the BBVC is 850,000 dollars, which includes maintenance of associated facilities, including a lift station, bunkhouse, and nearby vault toilets (477,000 dollars for the BBVC alone). One challenge with the BBVC is that the facility must be maintained throughout the entire year, even though it is only open to the public seasonally. Total CCIS annual OM need is 68,000 dollars. In fiscal year 2012, net revenue at the BBVC was 38,000 dollars. The Forest Service invested 340,000 dollars at the BBVC and 65,000 dollars at the CCIS in annual OM.

Non-fee Sites

There are 62 non-fee day use sites, including picnic areas, trailheads, boat ramps, fish and wildlife viewing sites, and interpretive sites within the Kenai Peninsula and Copper River Delta geographic areas (see table 48). These sites play an important role in providing a range of recreational opportunities. There are no non-fee sites within the Prince William Sound geographic area. All of the sites are accessible by road, with the exception of the Whistle Stop facilities, which are primarily reached by train. Sites vary in their level of development and capacity; some include vault toilets, shelters, and picnic tables, while others may only have a kiosk or interpretive panel. The Forest Service has improved several non-fee sites during the past decade and constructed three new sites as part of the ongoing development of the Whistle Stop and INHT Southern Trek projects.

Table 48. Recreation non-fee facilities within the Chugach National Forest by geographic area

Facility Type	Geographic Area			
	Kenai Peninsula	Prince William Sound	Copper River Delta	Totals
Trailhead	20	0	11	**31**
Day Use Site	7	0	3	**10**
Campground (non-fee)	4	0	0	**4**
Wildlife Viewing Site	2	0	0	**2**
Snowpark	1	0	0	**1**
Interpretive Site	3	0	8	**11**
Picnic Site	1	0	2	**3**
Totals	**38**	**0**	**24**	**64**

All of the non-fee sites are open for use. The total annual OM need to complete 100 percent of tasks for day use non-fee sites is 573,000 dollars. In fiscal year 2012, the Forest Service invested 296,000 dollars in annual OM at non-fee sites to accomplish all critical health and safety related maintenance and repairs, as well as some cyclical maintenance. Deferred maintenance for all of these sites combined is 915,494 dollars.

Recreation Access

This section provides an overview of existing recreation-related access and highlights changes since 2002, including an assessment of the roads and trails infrastructure. Information on other types of access can be found in the Land Use section. The annual operations and maintenance costs, as well as the total amount of deferred maintenance, are provided for this infrastructure. Operations and maintenance costs, including deferred maintenance, are established in Infra for each site based on tasks associated with its constructed features.

Developed access within the Chugach National Forest is limited. Most roads and trails are concentrated within the Kenai Peninsula. There are no public roads within Prince William Sound and only one main road and a few spur roads on the Copper River Delta. The Copper River Highway is not connected to the rest of the state’s road system; hence access to Cordova is via the Alaska State Marine Highway, commercial airline, and private aircraft and boats. The same applies to trails, with most occurring on the Kenai Peninsula and a few in Prince William Sound and the Copper River Delta. Access from the mainland to Prince William Sound is through Whittier, Valdez, and Cordova. In Prince William Sound, the protected marine waters provide access for all types of boats and float planes. Boat ramps, providing access to lakes and rivers, occur along the road system on the Kenai Peninsula and Copper River Delta. A series of easements also provide access through private land in the Copper River Delta. Lakes throughout the national forest provide access for floatplanes. In summer overland travel is very difficult without developed routes as glaciers and glacier streams, steep mountainous terrain, and dense alder thickets make travel very difficult even for the most adventurous (see the summer motor vehicle recreation access map in the map package appendix). In winter, access is better. With adequate snow cover, much of the national forest is accessible by snowmachine or skiing, as alder thickets and streams are no longer barriers to travel. Steep terrain still limits access in many areas, so different types of user groups are often concentrated in lower-lying areas (see the winter motor vehicle recreation access map in the map package appendix).

Access has not changed significantly since 2002 across much of the Chugach National Forest, though some differences are worth noting. The INHT and Whistle Stop projects have increased recreational access by providing new trails in the Kenai Mountains. Second, the Kenai Winter Access Plan (USDA, 2007a) adjusted the areas open for winter motor vehicle access within the Seward Ranger District. Third, the Copper River Highway has been closed since 2011 at mile 36 because of a bridge failure. It is uncertain when this bridge will be replaced, so road access to the Childs Glacier campground and day use site is currently unavailable. The campground and day use site remain open, however, with access currently provided by private boats or permitted outfitters and guides. Last, the Anton Anderson Memorial Tunnel, which provides road access to Whittier, was completed in 2000. Alaska department of transportation records show there has been a 25 percent increase in annual traffic from 2002 to 2010 (ADOT & PF, 2011b), which suggests there has been a similar increase in boat traffic in Prince William Sound.

Roads

The Forest Service classifies maintenance of National Forest System Roads (NFSRs) by five maintenance levels (ML): ML 1 through ML 5. ML 1 roads are closed to motor vehicle use. ML 2 roads are maintained for high-clearance motor vehicles. ML 3 through 5 roads are maintained for passage by standard passenger cars during the normal season of use with increasing degrees of user comfort and convenience with increasing MLs. Table 49 displays a summary of miles for each road ML (1 through 5). MLs 1, 2, and 3 roads are typically single lane roads with turn-outs. ML 1 and ML 2 roads are usually native surface or gravel and ML 3 roads are typically gravel surfaced. ML 4 and ML 5 roads are typically double lane roads with a well maintained gravel surface or pavement. Annual grading is performed on MLs 3 through 5 roads that get the most use. Brushing of roads occurs on a 5-year or longer rotating basis as needed on MLs 2 through 5 roads. Other maintenance activities include drainage system repairs (culverts, ditches) and pavement repairs (crack sealing, etc.).

The national forest road system consists of NFSRs as well as roads under different jurisdictions (state, county, municipality, special use permit holders, and others). There are a total 95 miles of NFSRs, and another 210 miles of state highways and major state roads throughout the Chugach National Forest (Seward, Sterling, Hope, and Copper River highways; Crow Creek Road; Portage Glacier Road; Snug Harbor Road; Primrose Landing; and Herman Leirer Road (formerly Exit Glacier Road)). These state highways and roads form the backbone of the road system, providing access to the NFSRs and most of the developed recreation sites. These include roads that provide only summer access and roads that provide both summer and winter access to National Forest System lands. The Motor Vehicle Use Map (MVUM) shows where and when NFSRs are open to the public. Seventy-five percent of these roads are on the Kenai Peninsula and the remaining 25 percent on the Copper River Delta. There are no NFSRs in Prince William Sound, and access to Forest Service lands is by state or local roads, boat, or plane. Almost all NFSRs are categorized as very low volume roads where the average daily traffic is 400 vehicles per day or less. Only seasonal use at Russian River Campground has been shown to exceed the very low volume classification.

The Chugach National Forest roads system has been reduced by two miles since 2002. The 2002 Forest Plan appendix B shows a total of 97 miles of inventoried road. In 2012, the Forest Service conducted a roads validation in an effort to obtain consistency between the 2002 Forest Plan, the Infra data, and the MVUM. The total number of NFSRs miles was subsequently reduced even with the addition of some small trailhead and day use roads. Data displayed for roads in table 49 is from the Infra roads database.

Table 49. Chugach National Forest road miles by maintenance level

Geographic Area	ML 1	ML 2	ML 3	ML 4	ML 5	Totals
Kenai Peninsula	3.8	21.9	34.8	10.6	0.2	**71.3**
Copper River Delta	5.6	4.9	13.2	0.0	0.0	**23.7**
Prince William Sound	0.0	0.0	0.0	0.0	0.0	**0.0**
Totals	**9.4**	**26.8**	**48.0**	**10.6**	**0.2**	**95.0**

The road system includes six road bridges. Refer to table 50. Two of these bridges (Sheridan Road and Tern Lake) were constructed to replace culverts through the Aquatic Organism Passage program. Palmer Creek Bridge 2 was closed in 2012 due to log stringer failure and discussion regarding replacement of this bridge is currently in progress. The process to begin replacement of the Trail River Bridge will begin as soon as funds become available. Bridges are inspected bi-annually in conformance with the National Bridge Inspection Standards.

Table 50. Chugach National Forest road system bridges

Bridge	Location	Type	Length	Year Built
Sheridan Road Bridge	Copper River Delta	Glulam Slab	46	2006
Tern Lake Bridge	Kenai Peninsula	Glulam Slab	41	2009
Trail River Bridge	Kenai Peninsula	Glulam Girder	142	1965
Milk Creek Bridge	Kenai Peninsula	Glulam Girder and Floorbeam	42	1980
Palmer Creek Bridge 1	Kenai Peninsula	Timber Frame	32	1957
Palmer Creek Bridge 2	Kenai Peninsula	Log Stringer	17	2000

Source: Chugach National Forest Infra Database (2014)

From 2009 through 2012, the Forest Service invested an average of 108,000 dollars per year for annual road and bridge maintenance (mainly road brushing and grading). In addition, the Forest Service spent approximately 50,000 dollars on road washout repair work on the Kenai Peninsula. In 2013, the Forest Service spent approximately 77,000 dollars on annual road and bridge maintenance and an additional 50,000 dollars on repairs due to late 2012 flooding damage. About two-thirds of the gravel surfaced roads will need new surfacing within the next five years or they will become increasingly difficult to maintain to passenger car comfort standards. All of the paved roads at present need some type of pavement repair or maintenance. In recent years, funding for roads maintenance has not been adequate to cover needed maintenance and repair work and is expected to decrease in the future.

Trails

Trails provide access to the vast areas of the Chugach National Forest without roads, typically beginning from an existing road or saltwater shore. Several trail systems also provide links to and between roads and communities, such as the 36-mile Resurrection Pass Trail that connects Cooper Landing and Hope. Access to fishing and hunting activities, Forest Service cabins, and winter skiing and snowmachining is facilitated with trails.

The Forest Service uses a trail class system of 1 to 5 that describes the different levels of development, with 1 being the least developed and 5 being the most developed. The Chugach National Forest has approximately 516 miles of NFSTs spread across the entire national forest, including both summer and winter trails. The system includes a variety of trail types, from very primitive to highly developed paved trails. There are 402 miles of summer trails and 114 miles of snow trails. Eighteen miles of summer trails and 86 miles of winter trails are open to motor vehicle use. While there are other unauthorized trails within the Chugach National Forest, NFSTs are the only trails that are maintained. Data on the amount, condition, and deferred maintenance for trails is from the Infra Trails database. Table 51 displays a summary of miles for each trail class by geographic area.

Table 51. Chugach National Forest snow and terra trail miles by geographic area trail class

Geographic Area	Trail Class							Totals
	Class 1	Class 2	Class 2 (Snow)	Class 3	Class 3 (Snow)	Class 4	Class 5	
	miles							
Copper River Delta	42	7	0	35	3	0.3	0.2	**87.5**
Kenai Peninsula	8	83	101	183	10	11	5	**401**
Prince William Sound	18	10	0	0	0	0	0	**28**
Totals	**68**	**100**	**101**	**218**	**13**	**11.3**	**5.2**	**516.5**

Since 2002, the Chugach National Forest trails system has had a net reduction of almost 40 miles. The 2002 Forest Plan FEIS showed a total of 555 miles of inventoried trail. In 2007, the Forest Service conducted a trails validation and subsequently reduced the number of miles of NFSTs to less than 500 miles. Since 2002, approximately 35 miles of new class 3 through 5 trails have been built on the Kenai Peninsula, including portions of the INHT Southern Trek, trails associated with the Whistle Stop project, and the 4.5-mile Trail of Blue Ice in Portage Valley. Other reconstruction projects were completed to improve the sustainability of the trails system and reduce deferred maintenance, including the Winner Creek Trail near Girdwood, Sheridan Glacier Trail on the Copper River Delta, Alice Smith and Crater Lake trails near Cordova, and the Hope Point Trail near Hope (completion scheduled in or after 2014). Total trail mileage is also subject to change based on results of trail condition surveys, which are done for each trail on a cyclical basis.

The trail system includes 145 trail bridges, ranging in size from 5 to 280 feet. Nine new bridges have been constructed since 2002 as part of the INHT and Whistle Stop Projects, including a 280-foot, single span wood truss bridge near the Spencer Glacier Whistle Stop.

Approximately 65 percent of Chugach National Forest trails meet all of the Forest Service National Trail Quality Standards. Table 52 displays the trails meeting standard by trail class. A number of flood events in 2011 and 2012 have impacted several trails near water bodies, including a portion of the Iditarod Trail near Seward and a segment of the Trail of Blue Ice in Portage Valley. Power Creek Trail near Cordova was damaged significantly during record snowfalls in the winter of 2011-12, was repaired in 2013 and 2014. Two bridges on the Resurrection River trail also failed during flood events in the mid-2000s and have not been replaced.

Table 52. Chugach National Forest snow and terra trail miles that meet standard by trail class and geographic area

Geographic Area	Trail Class							Totals
	Class 1	Class 2	Class 2 (Snow)	Class 3	Class 3 (Snow)	Class 4	Class 5	
	miles							
Kenai Peninsula	0	28	85	139	0	11	5	**268**
Prince William Sound	9	7	0	0	0	0	0	**16**
Copper River Delta	22	0	0	34	0	0.3	0.2	**56.5**
Totals	**31**	**35**	**85**	**173**	**0**	**11.3**	**5.2**	**340.5**

In 2012, the Forest Service invested approximately 870,000 dollars in trail maintenance. The deferred maintenance for trails totals 1.4 million dollars, mostly for trails on the Kenai Peninsula. Approximately 500,000 dollars of this deferred maintenance is identified for trail bridges in the Infra database, mostly for trail bridges on the Kenai Peninsula. A capital investment project was approved in 2002 that, if funded, would significantly reduce trail bridge deferred maintenance.

Off-road motor vehicle access

Tables 53 and 54 display acres open to summer and winter motor vehicle use across the national forest. During the summer, access for motor vehicle recreation is limited. The largest area within the Chugach National Forest open to summer motor vehicle recreation is in the Copper River Delta area north of the Copper River Highway, with access at mile 9 of the highway. Evidence of motor vehicle use in the area has been found across anadromous streams, suggesting the need to reassess management of summer motor vehicle access in this open area and possibly change the open area boundaries. There also are areas at miles 27 and 34 of the highway and several islands in eastern Prince William Sound that are open to OHV use on non-vegetated land. Motor vehicle use on navigable rivers is allowed. Motorized watercrafts are not allowed on Portage Lake, except for the M/V Ptarmigan which is authorized by a special use permit. Planes are generally allowed to land anywhere within the Chugach National Forest. There are more restrictions for helicopter landings, including a general prohibition in the WSA.

Table 53. Summer motor vehicle access within the Chugach National Forest (acres)

Type of Access	Geographic Area			Totals
	Kenai Peninsula	Prince William Sound	Copper River Delta	
Open to all motor vehicle use	0	94	163,323	163,417
Open to helicopters, closed to OHVs	257,264	5,022	421,052	683,338
Open to motor vehicle use in non-vegetated areas only	0	6,607	27,356	33,963
Open to motor vehicle use on designated routes only, open to helicopters	156,662	10,287	52	167,001
Totals	**413,926**	**22,010**	**611,783**	**1,047,719**

Source: Chugach National Forest GIS Database (2014)

During the winter, much of the national forest is open to snowmachine use as long as there is adequate snow, with exceptions identified in the 2002 Forest Plan, as amended by the Kenai Winter Access Plan (USDA, 2007a). Several areas have been identified for heli-skiing on the Kenai Peninsula and Copper

River Delta. The public has indicated that there is snowmachine use in an area closed to motor vehicles that is accessed from Valdez. Snowmachines also continue to access the western portion of the WSA between Whittier and Seward. The Forest Service is assessing use in the WSA to understand the extent of use in the area and is reviewing policy to determine how to manage such use in accordance with ANILCA access provisions.

Table 54. Winter motor vehicle access within the Chugach National Forest (acres)

Type of Access	Geographic Area			Totals
	Kenai Peninsula	Prince William Sound	Copper River Delta	
Open to all motor vehicle use	691,864	237,163	1,175,772	**2,104,799**
Open to snowmachines, closed to helicopters	0	0	389,602	**389,602**
Open to all motor vehicle use until March 31 (closed after March 31)	9,216	0	0	**9,216**
Open to helicopters, closed to snowmachines	23,340	0	0	**23,340**
Season on/season off; alternating year motor vehicle/non-motorized use	153,661	0	0	**153,661**
Totals	**878,081**	**237,163**	**1,565,374**	**2,680,618**

Source: Chugach National Forest GIS Database (2014)

Access to the land in Prince William Sound is primarily from the water, with recreation use concentrated along the shorelines mostly during the summer months. Whittier is the most popular point of access given its proximity to Anchorage, followed by Valdez and Cordova on the eastern side of the sound.

Recreational Use Trends (Demand)

The following section describes recreation activities and use levels within the Chugach National Forest during the past decade using readily available data sources. Forestwide information includes two iterations of the Forest Service National Visitor Use Monitoring (NVUM) survey conducted in 2001 and 2008 and 2002 Forest Plan monitoring results for developed and commercial recreation. Registration logs, transportation counts, and project-specific data also provide insight into use levels in specific areas. Because of the diversity of sources and methodologies, few conclusions on use trends are made. The NVUM survey methodology was changed between 2001 and 2008, as were the methods for calculating occupancy rates at developed recreation sites. Data on the amount of commercial recreation has only been consolidated for 2011 through 2013. Many of the other available data were gathered at a specific site for a specific project or facility for a limited amount of time, so do not show use for the entire span of the last decade. Keeping in mind these limitations and noting that few trends can be clearly explained, each of the sources provides insight into the types of activities people participate in and amount of recreation use within the national forest.

Recreation and tourism in Alaska

Studies conducted in the past decade show that participation in outdoor recreation is higher per capita in Alaska than in the rest of the United States and that activities that are currently popular will continue to be so in the future (Bowker, 2001; Hall, Heaton, & Druger, 2009). The Statewide Comprehensive Outdoor Recreation Plan (SCORP) (AKDNR, 2009) surveys Alaskans every five years to determine their outdoor recreation activities and what opportunities they would like to have available in the future. Results of the

2008 to 2012 survey show 96 percent of all respondents said parks and outdoor recreation is important to their lifestyle. The top three outdoor activities in the 2009 survey were hiking, fishing, and hunting.

Alaska's population is increasing, so demand for recreation by residents will also likely increase, assuming newcomers have the same desires to participate as do current residents. The five most common activities, scenic driving, wildlife viewing, biking, off-road driving, and fishing, are not expected to change between 2000 and 2020, though the biggest increase in percentage of people participating in an event are expected to be in backcountry skiing, canoeing and floating, tent camping, hiking, and biking (Bowker, 2001). Non-resident participation in fishing, wildlife viewing, and hunting are expected to significantly increase (Bowker, 2001).

Additional crowding at popular sites and growing conflict among different users may be an issue across Alaska, though most residents feel they have adequate access to outdoor recreation facilities and generally do not feel crowded (AKDNR, 2009). Facility condition and maintenance are significant concerns of residents. Winter sports participation is projected to increase, whereas there has been a decline elsewhere in the country. Southcentral and southeast Alaska are the most populated, and the heaviest recreation use from both residents and visitors occurs there.

Chugach National Forest use

NVUM results for the Chugach National Forest last round of surveys in fiscal year 2008 estimated 657,000 total site visits, and 498,000 national forest visits (a national forest visit may include more than one site visit) (USDA, 2010d). The first round of NVUM results estimated 903,505 total site visits and 630,000 national forest visits in 2001 (USDA, 2004c). As mentioned above, this does not necessarily reflect a downward trend as NVUM methods changed between the first and second rounds.

Visitation may also be inferred by various transportation-related statistics with routes to and through the Chugach National Forest (Fay, Colt, & White, 2010). The Anton Anderson Memorial Tunnel was opened in 2000 and provides road access to Whittier and Prince William Sound via the Portage Highway. Traffic totals for the tunnel increased 25 percent from 2002 to 2012, though use of the tunnel has declined from the peak in 2007 (ADOT & PF, 2011b). The Alaska Marine Highway has several segments that connect communities in Prince William Sound. Marine highway use has steadily increased since 2002 on the southwest segments, which includes Prince William Sound and the Aleutian Islands. Passengers increased from 50,216 in 2000 to 81,224 in 2011 (ADOT & PF, 2011a). Passengers on the Alaska Railroad's Coastal Classic and Glacier Discovery Trains, which run between Anchorage and Seward, totaled 57,763 in 2010, 71,699 in 2011, and 66,542 in 2012 (ARRC, 2013).

Several studies show that certain activities have remained popular between 2002 and 2012. In both 2001 and 2008, people recreating within the Chugach National Forest engaged most frequently in day use activities, including viewing scenery, hiking, relaxing, and viewing wildlife, which is similar to survey results across the nation (USDA, 2010d). Fishing is more common within the Chugach National Forest (20 percent) than at the national level (7.4 percent). Another 19 percent of NVUM participants listed fishing as an activity that they would have liked to have done during their stay but did not (White E. M., 2010). Other studies looking at activity patterns for visitors and Alaska residents also list viewing wildlife, hiking, and fishing as some of the most popular activities (AKDNR, 2009; Hall, Heaton, & Druger, 2009; McDowell Group, 2011). Day cruises and wildlife viewing are also the most popular commercially-guided activities for visitors to the Chugach National Forest, though these activities may not actually take place within the national forest (White & Stynes, 2010). Use projections out to 2020 predict that these uses will continue to be the most popular activities in Alaska (Bowker, 2001). Visitation to the BBVC, once the most visited attraction in southcentral Alaska, has been declining during the past decade. Based on door counter totals, there has been a 30 percent decrease in visitation to the BBVC, from a high of just 100,000 in 2010 to a low of 69,000 in 2012, at least partially due to a drastic reduction in use by commercial tours.

While day use accounts for most of the visitation to the Chugach National Forest, overnight use is also common and has remained relatively static during the past decade at cabins and developed campgrounds but may be increasing at backcountry campsites. Information on use at campgrounds and cabins is retrieved through the national reservation system and campground concessionaire records. Use at cabins during the high season (Memorial Day to Labor Day for most cabins) has been relatively stable from 2002 to 2012, averaging 60 percent occupancy during this period, with a high of 66 percent in 2005, and a low of 58 percent in 2008, 2009, and 2010. Cabins on the Kenai Peninsula and in western Prince William Sound generally had higher occupancy rates than cabins in eastern Prince William Sound and the Copper River Delta. During the peak season of use, however, many cabins are at nearly 100 percent occupancy. For the 14 campgrounds on the Kenai Peninsula from 2003 to 2012, average occupancy during the summer was 56 percent. The highest rate was in 2004 at 65 percent, and the lowest was 51 percent in 2009. Annual occupancy for cabins and campgrounds is displayed in table 55.

Observations and studies have found higher overnight use at certain backcountry campsites, particularly in Prince William Sound. Twardock et al. (2010) studied beaches consistently for more than a decade and found that the number of campsites increased by 27 percent and total impacts at existing campsites expanded from 43 square meters to more than 73. Some established campsites in Blackstone Bay and other popular areas were re-inforced with native materials to reduce further expansion of vegetation impacts. Backcountry rangers have also observed an increase in camping in the Lost Lake area near Seward, where there is potential for impacts to alpine vegetation. Management of backcountry camping is an area that may need further study and emphasis in the future.

Table 55. Chugach National Forest cabin and campground occupancy during the high and peak seasons*

Facility/ Geographic Area	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Cabins										
Kenai Peninsula	70%	68%	73%			69%	69%	70%	76%	76%
Prince William Sound	58%	62%	67%			52%	55%	53%	57%	48%
Copper River Delta	35%	34%	42%			42%	36%	35%	35%	29%
Campgrounds**										
Kenai Peninsula	62%	67%	62%	61%		53%	53%	53%	53%	53%

Blank cells indicate years where data is not readily available.
*High season is from Memorial Day to Labor Day for most facilities. Some cabins have different high seasons. Peak season includes three day weekends and all other weekends from Memorial Day and Labor Day.
**Overflow use at campgrounds was included in overall occupancy rates from 2003 to 2006, but not from 2008 to 2012. This accounts for at least some of the difference in occupancy rates during these periods.

As part of the 2008 round of NVUM surveys, participants were asked whether they participated in a commercially-guided activity during their visit to the Chugach National Forest. Among Alaska residents, guides and outfitters were used very infrequently. However, about 42 percent of non-resident visits included the use of a guide or outfitter at some point during the trip (White & Stynes, 2010). Monitoring in 2011 and 2012 provides some additional information about guided recreation preferences. Reported use by outfitters and guides during the summers of 2011 and 2012 show that the three most popular guided activities were rafting on the Kenai Peninsula, camping in Prince William Sound, and hiking on the Kenai Peninsula. The unit of measure for commercial use is the user day, which is one client for one day. Total user days reported between Memorial Day and Labor Day were 16,337 in 2011 and 14,801 in 2012. Use on the Kenai Peninsula accounts for about 70 percent of the total commercial activities within the national forest. Another important commercial activity, not factored in to the above numbers (because it is a winter activity) is helicopter assisted skiing, which occurs on the Kenai Peninsula and the Copper River Delta, totaling approximately 1,800 user days each year. Annual data for years prior to 2011 is still being consolidated.

Recreation use by different racial and ethnic groups

No studies have been done specifically looking at patterns and trends in participation by different racial and ethnic groups in outdoor recreation within the Chugach National Forest. The NVUM studies, however, do provide a demographic snapshot of visitor use. Comparing demographic data from NVUM and census data for the Municipality of Anchorage, Kenai Peninsula Borough, and the Valdez-Cordova census area provided in the Social and Economic Condition section of this assessment gives an indication of how well local populations of racial and ethnic groups are represented in Chugach National Forest visitor use. Results of this comparison show that the Asian and Pacific Islander population is relatively well-represented, while the Alaska Native and black/African-American population is underrepresented. The white population, at more than 93 percent of visitors compared to just more than 70 percent of the local population, is overrepresented.

There are likely many reasons for this, making it difficult to know why. First, geography may play a role, as Chugach National Forest recreation opportunities are almost an hour's drive from Anchorage, which is generally more diverse than other towns in the plan area, while a multitude of parks, trails, lakes, and facilities in Anchorage provide opportunities closer to home. More than 65 percent of NVUM respondents were from Anchorage zip codes, so distance and alternative opportunities have not prevented the majority of visitors from coming to the Chugach National Forest.

Activity preference may be another reason, as most of the recreational opportunities provided by national forests, including the Chugach National Forest, have traditionally been pursued disproportionately by white visitors. A few specific activities, however, are more likely to draw more racially and ethnically diverse users and may be linked to cultural values tied to the resource. For instance, a study of Eulachon subsistence/personal use in and near the Twentymile River during 2002 found that only 19 percent of respondents were Caucasian, while 24 percent were Filipino and 19 percent were Alaska Native (Spangler, Spangler, & Norcross, 2003). Subsistence-related activities, such as the Eulachon fishery or subsistence harvests in Prince William Sound, may draw a more diverse user group than those activities considered recreation, but might not be captured as a national forest visit well by NVUM data because of the location or timing of the activity.

Competing demands and user conflicts

Because the infrastructure and terrain concentrates recreation use on a relatively small part of the land base, meeting demand for both winter motor vehicle and non-motorized uses and activities has been an issue. It is not clear whether this has become a bigger issue since 2002 or not, though the Forest Service undertook multiple planning projects to manage motor vehicle and non-motorized access. An extensive planning effort to re-assess winter motor vehicle access on the Kenai Peninsula was completed in 2007, which led to a revised access management plan to provide motor vehicle access on Resurrection Pass every other year while preserving opportunities for quiet winter recreation. In general, the distribution of motor vehicle and non-motorized areas, particularly in the winter, has worked well, though it does not satisfy everyone. The Forest Service has collected data on unsolicited input concerning motor vehicle and non-motorized uses since 2010. Comments show a balance between desiring more motor vehicle opportunities and concerns about motor vehicle incursions into non-motorized use areas. The number of citations for unauthorized motor vehicles has decreased from 86 in 2006 to 17 in 2011. As mentioned in the Subsistence section of the assessment, there is also some tension created where motor vehicle access for subsistence purposes is allowed in an area that is not open for motor vehicle recreation, which also presents other management challenges. These comments have been echoed in recent public meetings and other input received during this assessment phase.

In addition to broader access management planning, the issue of motor vehicle and non-motorized recreation use has been significant in two other planning efforts on the Glacier Ranger District. The Three Rivers Management Plan (USDA, 2010f) and the Chugach Powder Guides Helicopter Skiing decision (USDA, 2004a) both attempted to balance the competing interests of non-motorized and motor vehicle user groups in areas on the Kenai Peninsula. Some conflicts between guided and non-guided hunters were identified, particularly in eastern Prince William Sound, possibly due to guides and other users not being aware of local norms (Poe, Gimblett, & Burcham, 2010). Conflicts between different types of river users were also found in studies of use on Twentymile River (USDA, 2010d) and Eyak River (Lang, 2010), particularly between anglers and motorized watercraft.

Another concern is trespass on Alaska Native Corporation (ANC) lands in Prince William Sound, which may have increased since 2002 as boat activity has increased from Whittier and additional lands along the shoreline have been conveyed. The Forest Service, in cooperation with ANCs, is working on strategies to eliminate trespass.

There is also evidence from public comments that conflicts are emerging between non-motorized groups, particularly horseback riders and mountain bikers, where use overlaps. The scope of this issue is not well understood. Another emerging conflict that has been identified involves trapping in popular winter recreation areas on the Kenai Peninsula.

Finally, it is important to recognize the potential impacts to and from wildlife as a result of recreation occurring in wildlife habitat. For instance, Goldstein et al. (2010) found some overlap between high-quality brown bear winter den habitat and recreation in the Turnagain Pass area, leading to some potential for disturbance of hibernating bears. The increase in winter recreation may also have an impact on mountain goats and Dall's sheep where activities overlap with habitat. Also, human-bear encounters, mostly on the Kenai Peninsula, have resulted in maulings and several bears killed in defense of life and property. This issue is discussed in more detail in other sections of the assessment.

Meeting the demand

Based on existing information, the Chugach National Forest generally seems to be meeting current demand for most outdoor recreation uses and current Alaska resident and non-resident visitors are satisfied with their experience. The overall satisfaction results from NVUM showed that almost 82 percent of the people who visited were very satisfied with the overall quality of their recreation experience. Another 14 percent were somewhat satisfied. Less than 1 percent expressed any level of dissatisfaction. The 2001 NVUM results are very similar, as the vast majority of visitors rated satisfaction of various items either good or very good, the two highest scores (USDA, 2004c). Survey results from user studies in Prince William Sound validated results from the NVUM report; current visitors are very satisfied with their experience, do not feel crowded, and are not being displaced due to negative encounters or crowding (Poe, Gimblett and Itami 2010; M. A. Smith 2010). Perception of crowding is another indicator used to describe visitor experience. Within the Chugach National Forest, NVUM results show that crowding is not perceived as a problem by the majority of visitors. On a scale of 1 (hardly anyone there) to 10 (overcrowded), day use developed sites were rated 4.7, overnight use developed sites averaged 4.3, and undeveloped areas rated the lowest at 3.9. In 2001, 67 percent of visitors at developed day use sites, 84 percent at overnight use sites, and 90 percent in general forest areas gave crowding ratings of 5 or less (USDA, 2004c). Other use studies (Poe, Gimblett, & Itami, 2010; Smith M. A., 2010;

USDA, 2010d) support the finding that crowding is not often perceived as a problem and is not displacing current users.

Another indication that the Chugach National Forest is meeting demand is a comparison of allocated commercial days to actual used days. Outfitters and guides are allocated days based on their request for days within a defined recreation capacity for an area, which is directly linked to the type of recreation setting. Frequently, guides have not used all of their allocated days. For example, from 2008 through 2012, the Forest Service special uses database showed that outfitters and guides only used 32 percent of their total allocated days on a series of trail systems on the Seward Ranger District. Nonetheless, the Forest Service continues to receive new requests for special use permits for guided activities, and under the 2002 Forest Plan, there is still capacity available for more commercially-guided use across the national forest. The Forest Service is working towards offering new guided opportunities as part of the Whistle Stop project and elsewhere across the national forest. At developed recreation sites, the Chugach National Forest is meeting demand overall, but may not be meeting demand for cabins during the summer on the Kenai Peninsula and in western Prince William Sound, and for campgrounds during the peak summer days (weekends and holidays) and during salmon runs. Cabins in these areas are extremely difficult to reserve; it is common for people to try to book these months in advance and find there are no nights available. Use reports for the past decade show that campgrounds near the Russian River often had overflows in camping during salmon runs. Despite similar facilities in communities and other lands adjacent to the Chugach National Forest, demand for these facilities has remained high. There also continues to be demand for greater access to the national forest for both winter and summer recreational activities.

Sustainability of Recreation Opportunities and Scenic Character

Trends between 2002 and 2012 described in this chapter indicate recreation opportunities and scenic character have been sustained within the Chugach National Forest; scenic integrity continues to be high and there continues to be a wide range of opportunities in natural landscapes. During the past 10 years, the Forest Service has been able to develop additional opportunities through large scale projects like the INHT and Whistle Stop and to expand and to diversify ways of connecting people with nature. Investments in cabins and campground reconstruction have maintained the capacity of developed sites across the national forest. Use has increased at some sites and decreased at others, though not to the point where opportunities and settings have changed or been eliminated. With limited recreation facilities, trails, and roads, remote backcountry opportunities in natural settings abound.

The biggest challenge in sustaining recreation opportunities in the future, however, will be maintaining existing recreation infrastructure and access throughout the national forest while demand for recreation opportunities increases and diversifies. Many new types of activities may compete for use of the same areas, leading to potential user conflicts. It will also be a challenge to meet the needs of different user groups if new facilities are needed to accommodate that use.

As facilities of all kinds, as well as trail and road bridges, get older or get damaged, it will be a challenge to reconstruct or replace them in a timely fashion. The cost of replacing cabins and reconstructing campgrounds is increasing, while maintenance and capital funds have generally decreased. Broadly speaking, these facilities, roads, and trails are currently in good condition, but deferred maintenance continues to rise. If trends continue, some trails, roads and facilities may need to be decommissioned. The Forest Service, through several planning processes, has worked to prioritize recreation facilities, trails, and roads to operate and maintain across the national forest. The Recreation Facility Analysis (RFA) process, completed in 2006, identified cabin rate increases, volunteers, and partnerships as ways to extend the capacity to cover operations and maintenance costs. The Forest Service is updating the RFA in 2015 to ensure that funds are being used to maintain the most important recreation facilities and may do a similar analysis for prioritizing the trails and roads systems. A regional approach to administering the roads program is being explored to see how much cost savings could be realized. Other Federal funding grants and programs are being pursued.

This assessment shows little if any change in scenic character within the national forest. Spruce beetle killed trees from the 1990s had a major visual effect on national forest scenic integrity, but vegetation management projects and decay have removed many of these dead trees. They are now part of the natural succession and give the canopy of many areas of the Chugach National Forest a diversified look. The trend of continuing development in privately owned parcels along the travel corridors continues. This development does not change the scenic integrity of the national forest as a whole, but can alter the foreground of the viewshed for people traveling the highways within the Chugach National Forest. There are some activities that cause concerns for maintaining the high and very high scenic integrity within the Chugach National Forest.

Highways traversing the national forest are under-designed for today's traffic loads. Alaska Department of Transportation has plans to upgrade and reroute highways within the Chugach National Forest, which could negatively impact scenic integrity. The most notable project being planned is a reroute of the Sterling Highway. One alternative being analyzed shows the highway would be constructed near Juneau Falls, altering the scenery and experience of hikers on the southern three to four miles of the Resurrection Pass Trail.

Debris from the large earthquake and tsunami in Japan in 2012 is washing ashore in many areas of Prince William Sound, with potentially large accumulation on Kayak, Hinchinbrook, and Montague Islands. Large items and large quantities of debris could have a negative impact on Prince William Sound scenic beauty.

Contribution to Social, Economic, and Ecological Sustainability

Based on the NVUM estimates from 2008, the estimated 498,345 annual visits to the Chugach National Forest generated 85 million dollars in visitor spending that supports an estimated 976 full and part time jobs (direct and secondary) each year in the local economy (see the Social and Economic Conditions section for more information) (White & Stynes, 2010). The AVSP (McDowell Group, 2011) reports that Alaska visitors spend an average of 941 dollars per person on their trip excluding transportation to and from the state, with air travel visitors spending the most, at 1,455 dollars per person. More than 150 outfitters and guides operate within the Chugach National Forest for part or all of their business, and most of them live in communities within or near the national forest. Revenue from recreation contributes directly, at around 200,000 dollars annually, to the sustainability of the recreation resource itself through cabin rentals and visitor center visitation.

The value to visitors and local residents from the recreation resource goes beyond economic generation. Literature on sense of place describes how public lands recreation creates meaning for local residents and visitors alike, both on an individual and community level (Farnum, Hall, & Kruger, 2005). As the 2009 SCORP survey showed, a vast majority of Alaskans, especially in rural and small town settings, rate outdoor recreation opportunities as important to them. As a more specific and detailed example, Amsden et al. (2011) showed how complex interactions with other community members, visitors, and natural settings all helped form a sense of place for residents of Seward. Reed and Brown (2003) identified the importance of public land environmental attributes to the quality of life in 12 communities in and around the Chugach National Forest, including scenic quality and providing opportunities for wildlife viewing and outdoor recreation. Lastly, during the public meetings described in chapter 1, comments about changing or maintaining recreation opportunities outnumbered all other comments combined.

Along with providing value to local residents and visitors, outdoor recreation opportunities also help people understand the value of land for conservation and build a sense of shared stewardship of these public land resources. Community events like the Shorebird and Salmon Festivals in Cordova highlight how natural places and wildlife are intertwined with towns. Since the early 1900s, hunting and fishing enthusiasts have led or participated in fish and wildlife conservation efforts. The recognition of the value of wildlife, however, has continued to evolve as participation in wildlife viewing, in Alaska and elsewhere, continues to increase (Mockrin, Aiken, & Flather, 2012). Recreation has also been a forum to build a personal health and land conservation ethic in the next generation through expeditions across the national forest.

Information Needs

Forestwide use patterns in the backcountry and trail system

Recreation use data for the Chugach National Forest are usually gathered on an as-needed, project-by-project basis. This means that data is often gathered through different methods and only provides a snapshot in time at a specific location or several locations. Occupancy data at cabins, campgrounds, and the BBVC generally provide consistent annual data, and NVUM provides a forestwide picture of visitor use, but use at non-fee sites where registration is not required can only be estimated. These uses, to name a few, include kayaking in Prince William Sound, winter recreation, backcountry camping, and trail use. Monitoring at some backcountry overnight sites, including the Lost Lake area and western Prince William Sound, indicates increased use and thus the potential for resource damage in some areas. The Forest Service could develop a cyclical monitoring system using trail counters to better understand, at a minimum, use patterns on the trail system where visitors are accessing the backcountry. Parking lot counts could also be taken periodically to develop trends in use at certain locations and seasons. The information would give managers a more complete idea of the amount, timing, and types of use occurring within the national forest.

Trends in outfitted and guided opportunities and use

Outfitters and guides are allocated a certain number of user days each year and are required to report their actual use annually. The Forest Service should be able to show trends in number of guides and location and amount of use in a concise manner. Consolidated data on outfitter and guide use, however, is currently only available for 2011 and 2012. Allocation and use data is available in records filed for the national forest but needs to be consolidated into a single database. Amount and location of use could also be mapped to show where guided use is more and less common.

Climate change impacts on recreation facilities, access, and use

Literature on climate change impacts to tourism and recreation continues to grow (Hamilton & Tol, 2004; Richardson & Loomis, 2004; Shaw & Loomis, 2008), providing a foundation to assess this topic at a smaller, local setting. A more detailed analysis of climate change impacts to recreation within the Chugach National Forest potentially would be valuable to inform future recreation planning, particularly for a national forest that offers a variety of snow-based recreational opportunities. A study could analyze potential impacts of climate change on recreation to assess the resilience of current opportunities, access, and facilities to dynamic land and seascapes.

Social and Economic Conditions

This section identifies and evaluates available information relevant to the plan area for social and economic conditions. Please note that subsections refer to the Municipality of Anchorage, Kenai Peninsula Borough, and Valdez-Cordova census areas and are not the same as the Copper River Delta, Kenai Peninsula, and Prince William Sound geographic areas.

Relevant Information

- Populations are changing, creating new demands for amenities and services. Key demographic trends include growing ethnic diversity (especially among younger populations) in the region and an aging population. The magnitude and type of amenities, goods, and services to support those shifting demographics could be considered for change.
- The travel and tourism industry accounts for 17 percent of employment in southcentral Alaska and is projected to grow by 12.5 percent for Alaska as a whole by 2020. The Chugach National Forest is a major attraction for regional tourism activities.
- Approximately 500,000 recreational visits to the Chugach National Forest (2008), including sport fishing, are estimated to support 1,062 jobs of which 84 percent (894 jobs) are from non-local visitor spending (i.e., new dollars).
- Commercial fishing is the largest forest resource-related sector in southcentral Alaska. Fish habitat within the Chugach National Forest plays a vital role in sustaining fisheries that support commercial fishing, sport fishing, and processing industries that account for large percentages of economic output in the study area.
- Secure Rural School (SRS) payments and Chugach National Forest Federal spending together support approximately 440 jobs per year (71 and 367 jobs per year respectively).
- The impacts of the 2007-2008 recession, as well as projected recovery rates and optimism among businesses, differ across communities.
- Job growth is greater for the Kenai Peninsula and Anchorage, where economic diversity and resilience is higher, compared to slower growth in the Valdez-Cordova census area.
- Growing employment and economic opportunities are occurring in healthcare and retirement, tourism, and other services in the study area.

Regional and Community Overview: Identifying the Study Area

This subsection describes the social, cultural, and economic conditions for the study area and communities surrounding the Chugach National Forest. Data assessed generally includes the past 10 years, but periods of time may differ depending on available information sources.

The study area adopted for the social and economic assessment is southcentral Alaska and consists of the Municipality of Anchorage, which includes Girdwood; the Kenai Peninsula Borough; and the Valdez-Cordova census area. These areas include the communities of Anchorage; Chenega Bay; Cooper Landing; Cordova, which includes Eyak; Hope, which includes Sunrise; Kenai; Moose Pass; Seward; Soldotna; Sterling; Tatitlek; Valdez; and Whittier.

The social and economic influence of the Chugach National Forest extends beyond the Chugach National Forest boundary. Physically, Anchorage overlaps with small portions of the Kenai Peninsula and Prince William Sound geographic areas. The Kenai Peninsula Borough overlaps with the Kenai Peninsula geographic area and the western edge of the Prince William Sound geographic area, while the Valdez-Cordova census area overlaps with the Copper River Delta and Prince William Sound geographic areas (see table 56). Resource conditions and management decisions in each of the geographic areas may have a direct or indirect effect on social and economic conditions in different parts of the study area, as well as outside the study area. Refer to the Subsistence, Cultural Resources and Uses, and Ecosystem Services sections for cultural conditions.

Table 56. Overlap between towns or areas and Chugach National Forest geographic areas

Place	Geographic Area Overlap
Anchorage Municipality	Small parts of the Kenai Peninsula and Prince William Sound
Kenai Peninsula Borough	Kenai Peninsula and western edge of Prince William Sound
Cooper Landing	Kenai Peninsula
Hope	Kenai Peninsula
Moose Pass	Kenai Peninsula
Kenai	Kenai Peninsula
Seward	Kenai Peninsula
Soldotna	Kenai Peninsula
Sterling	Kenai Peninsula
Valdez-Cordova census area	Prince William Sound and Copper River Delta
Chenaga Bay	Prince William Sound
Tatitlek	Prince William Sound
Whittier	Prince William Sound
Cordova	Copper River Delta
Valdez	Prince William Sound

Similar to the State of Alaska as a whole, the subregions and communities within the study area have been subjected to a number of boom and bust cycles linked to the development and use of a variety of resources since the late 1800s. These fluctuations and cycles and the corresponding uncertainty have had dramatic impacts on social and economic conditions and trends. Details about conditions and trends and potential links to the Chugach National Forest are discussed in the following sections.

Conditions and Trends

Demographics

Alaska is the Nation’s largest state with 16 percent of the country’s land base. Although it is geographically large, Alaska has the third smallest population and the lowest population density in the country.

The Municipality of Anchorage, with slightly less than half of the state’s total population, is the largest population center in Alaska. It is characterized by an urban economy and lifestyle, which is quite different from the smaller, rural communities in the Kenai Peninsula Borough and the Valdez-Cordova census area.

The Municipality of Anchorage has a majority of the population and businesses in the study area, a number of which may be affected by the Chugach National Forest. However, the potential impacts of the national forest on people in smaller communities within the study area may be more profound. For this reason, it is important to examine conditions and identify trends for the three areas individually.

The study area population is approximately 352,000 as of 2011, with a majority in the Municipality of Anchorage (287,000) followed by the Kenai Peninsula Borough (55,000) and Valdez-Cordova census area

(9,600) (see table 57). The population of the Municipality of Anchorage has more than tripled since statehood in 1959. Figure 15 displays population trends from 1990 to 2011 for the United States, Alaska, and the three study areas. The Municipality of Anchorage's population has increased by 27 percent (approximately 61,000 residents), similar to the population growth for Alaska, and slightly less than for the United States. In contrast, populations grew by 35 percent (14,000 residents) for the Kenai Peninsula Borough and decreased by 4 percent (356 residents) in the Valdez-Cordova census area.

The percentage of the population described as white has decreased across all regions since 1998 (ADLWD, 2010a). The black/African-American percentage in these regions has also decreased, but to a smaller degree. Table 57 shows that the percentage of study area populations characterized as white and as black/African-American are lower than the United States. The percentage of the study area population characterized as Native Americans, including Alaska Natives, (7 percent) is lower than the state of Alaska (14 percent), but is still substantially greater than the United States (0.8 percent). The Valdez-Cordova census area contains a high percentage of Native Americans, of which Alaska Natives make up a vast majority (88 percent). The percent of population described as Native American in 2000 and 2010 ranges from 8 to 9 percent for Anchorage and the Kenai Peninsula Borough, and 15 to 16 percent for the Valdez-Cordova census area based on Alaska Department of Labor and Workforce Development reports (ADLWD, 2013a).

The percent of Asians has increased in Anchorage and the Kenai Peninsula Borough since the 2002 Forest Plan was approved. Data evaluated indicate that the percentage of Native Hawaiian and other Pacific Islanders has remained relatively constant. However, changes in how demographic data are reported since 1998 has resulted in data inconsistencies and uncertainty about the significance of small percentage changes in population characteristics. State reports indicate that Anchorage became more racially diverse from 1980 (15 percent non-white) to 2010 (34 percent non-white), with Asians, Pacific Islanders, and Alaska Natives increasing in percentage of total Anchorage population (ADLWD, 2013d). The fast-growing component of the Anchorage population is younger and more diverse (Goldsmith, Howe, & Leask, 2005). Alaska's Hispanic population grew 52 percent between 2000 and 2010, with an average age of 24 in 2010; Anchorage is home to 56 percent of the Hispanic population in Alaska (ADLWD, 2013c).

Table 57. Population characteristics for the United States, Alaska, and southcentral Alaska from 2007 to 2011[1] (US Census Bureau, 2013)

Population Segment	Alaska	Municipality of Anchorage	Kenai Peninsula Borough	Valdez-Cordova Census Area	Study Area	United States
White alone	472,504	193,404	46,520	6,884	246,808	227,167,013
Black or African American alone	23,426	15,844	305	52	16,201	38,395,857
Native American*	97,628	18,720	4,008	1,568	24,296	2,502,653
Asian alone	35,912	22,013	773	336	23,122	14,497,185
Native Hawaiian and Other Pacific Is. alone	6,848	5,520	93	27	5,640	500,592
Some other race alone	8,981	5,147	275	107	5,529	15,723,818
Two or more races	55,404	26,742	2,744	622	30,108	7,816,654
Total Population	**700,703**	**287,390**	**54,718**	**9,596**	**351,704**	**306,603,772**
			Percent of Total			
White alone	67.4%	67.3%	85.0%	71.7%	70.2%	74.1%
Black or African American alone	3.3%	5.5%	0.6%	0.5%	4.6%	12.5%
Native American*	13.9%	6.5%	7.3%	16.3%	6.9%	0.8%
Asian alone	5.1%	7.7%	1.4%	3.5%	6.6%	4.7%
Native Hawaiian and Other Pacific Is. Alone	1.0%	1.9%	0.2%	0.3%	1.6%	0.2%
Some other race alone	1.3%	1.8%	0.5%	1.1%	1.6%	5.1%
Two or more races	7.9%	9.3%	5.0%	6.5%	8.6%	2.5%

[1]Data represent averages for the period 2007 to 2011 as per American Community Survey methods.
*Native American includes American Indian, Alaska Native, and Non-specified tribes.

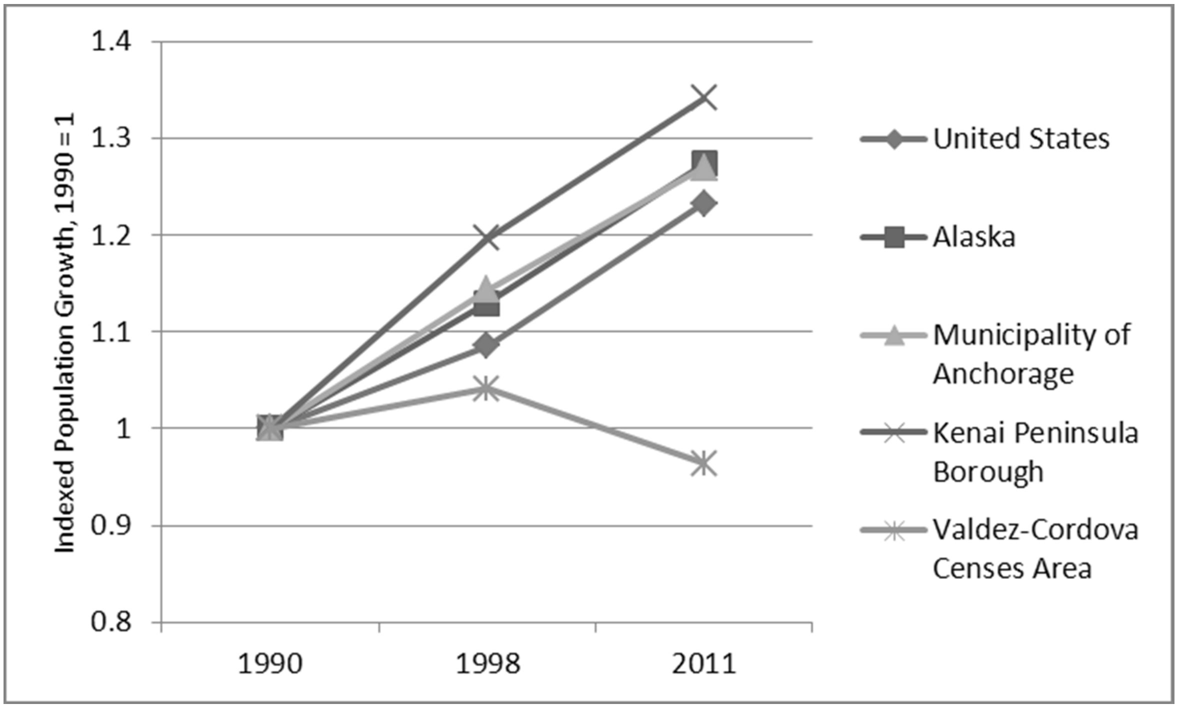


Figure 15. Population growth from 1990-2011 for the United States, Alaska, the Municipality of Anchorage, the Kenai Peninsula Borough, and the Valdez-Cordova Census Area (standardized for comparison) (US Census Bureau, 2013).

Table 58 displays the change in age distribution from 2000 to 2011 with age categories separated into five age groups for the study area. Though the population of Alaska continues to be one of the youngest in the nation, the population is aging as baby boomers grow older. Youth populations (i.e., under 18) have decreased by 3.6 percent in the study area, while age groups under 44 in aggregate have decreased. Age groups 45 and above have increased by 7.1 percent. The same trend in aging population occurs for the three separate subareas, with the results being somewhat more pronounced within the Kenai Peninsula Borough and the Valdez-Cordova census area (i.e., approximately 10 to 11 percent increase in age groups 45 and above).

The 45-64 age group represents the highest percentage of men and women in the study area. From 2000 to 2011, the age category with the largest estimated increase was 45 to 64 (25,140), and the age category with the largest estimated decrease was 35 to 44 (-11,579). Men slightly outnumber women in all age groups, except for the group of 65 and older.

Population growth in the study area, with the exception of the Valdez-Cordova census area and demographic shifts, including aging populations and potentially growing numbers of Chugach National Forest users, suggest changes in the magnitude and types of demands for different Chugach National Forest amenities, goods, and services, as well as the manner in which the national forest contributes to social and economic sustainability. The desires and needs of an aging population are likely to differ from younger age groups, with consequences for local employment and economic development. Greater population diversity in the Municipality of Anchorage, including increasing Alaska Natives, Hispanics, Asians, and Pacific Islanders, as well as younger age groups and families within those minority groups, may also create new demands for Chugach National Forest amenities.

Table 58. Change in age distribution from 2000-11 for the study area*

Age	Kenai Peninsula Borough		Municipality of Anchorage		Valdez-Cordova Census Area		Study Area	
	2000	2011	2000	2011	2000	2011	2000	2011
Under 18	14,859	13,149	75,871	74,716	3,019	2,366	93,749	90,231
18-34	9,071	10,518	64,999	76,199	1,883	1,860	75,953	88,577
35-44	9,074	6,886	48,210	39,512	1,979	1,286	59,269	47,684
45-64	13,038	18,310	56,961	76,217	2,700	3,312	72,699	97,839
65 and over	3,649	5,855	14,242	20,746	614	772	18,505	27,373
Total Population	**49,691**	**54,718**	**260,283**	**287,390**	**10,195**	**9,596**	**320,169**	**351,704**
Percent of Total								
Under 18	29.9%	24.0%	29.1%	26.0%	29.6%	24.7%	29.3%	25.7%
18-34	18.3%	19.2%	25.0%	26.5%	18.5%	19.4%	23.7%	25.2%
35-44	18.3%	12.6%	18.5%	13.7%	19.4%	13.4%	18.5%	13.6%
45-64	26.2%	33.5%	21.9%	26.5%	26.5%	34.5%	22.7%	27.8%
65 and over	7.3%	10.7%	5.5%	7.2%	6.0%	8.0%	5.8%	7.8%

*The data in this table are calculated by ACS using annual surveys conducted from 2007 through 2011 and are representative of average characteristics during this period (US Census Bureau, 2013).

Employment and income

Long-term trends

Long-term trends in levels and types of employment in the study area reflect boom and bust cycles in a number of economic sectors and mirrors trends in Alaska as a whole (though the timing of growth cycles may vary). The Municipality of Anchorage economy originally grew in response to military buildup during World War II, with oil development triggering a new wave of growth in the 1970s, followed closely by increases in trade and service jobs (Goldsmith, Howe, & Leask, 2005). Expanding tourism fueled subsequent economic growth and diversity in Anchorage. In the 1990s, growth was slow yet steady, and oil production declined. Since 2000, increases in Federal spending have boosted employment. Anchorage and other areas of Alaska are subject to the fluctuating nature of energy markets/supplies, Federal spending, and tourism, resulting in a workforce that is more transient compared to other areas of the country.

The economies of other areas and communities within the study area are also subject to boom and bust cycles. Tourism has been one of the fastest growing sectors on the Kenai Peninsula Borough during the past 20 years, but has also been one of the hardest hit by the recession. Economic development in the central part of the Kenai Peninsula, including Kenai, Soldotna, and Sterling, was originally driven by homesteading and fishing. Oil discoveries triggered population growth in the 1950s (KPEDD, 2010). The central Kenai Peninsula economy has since diversified to include retail and services. More recently, oil production has decreased, and commercial fishing earnings have fluctuated.

Beginning in the late 1800s, mining (gold, silver, and copper) and transportation (supply hub) were key drivers in the establishment of Valdez in Prince William Sound (ADLWD, 2009). Mining declined after World War I and commercial fishing took its place until fish stocks crashed in the 1950s. Federal spending supported job growth during World War II, and the Trans-Alaska pipeline resulted in a growth explosion in the 1970s. Oil transport continues to be important, but commercial fishing and fish processing have re-emerged as key industry sectors in Valdez.

The Chugach National Forest is capable of contributing to the viability and stability of some production opportunities and job sectors (e.g., fishing and tourism) but has little influence over other sectors (e.g., oil and gas). The Chugach National Forest is also capable of providing amenities and services that affect the lifestyles and desire of some people to live in the region (e.g., retirees) that could influence spending in other job sectors (e.g., services and healthcare). Projecting long-term cycles or fluctuations in market conditions, government spending, and demographic trends that are all subject to uncertain environmental and social conditions is difficult. Improved understanding of future fluctuations, cycles, and shifts may help inform decisions about Chugach National Forest resource allocation and management that supports specific uses and opportunities, thereby contributing to social and economic sustainability. Alternatively, in absence of better understanding, management decisions supporting a diverse suite of opportunities over time may help mitigate risks to social and economic sustainability.

Employment in Alaska, the Municipality of Anchorage, and the Kenai Peninsula Borough follow similar growth trends with growth of approximately 40 percent between 1990 and 2010 (in contrast to growth of 20 percent in the United States as a whole) (see figure 16). Employment in the Valdez-Cordova census area has been more variable with little overall growth during that time. Based on the same data, employment growth from 2000 to 2010 was 15 percent for the State of Alaska, 10 percent for the Kenai Peninsula Borough and 14 percent for Anchorage. Employment for the Valdez-Cordova census area grew by 1 percent during this time, in comparison to a growth of 2 percent for the United States. Total employment growth for 2010 to 2020 is projected to be 12 percent for the State of Alaska (ADLWD, 2012).

The 2011 unemployment rate for the study area (6.7 percent) was lower than that of the United States (8.9 percent in 2011) due to low unemployment in Anchorage (6.1 percent). Unemployment was higher in the Kenai Peninsula Borough and Valdez-Cordova census area (9.2 to 9.4 percent). The unemployment rate for the study area has fluctuated from a low of 5.2 percent (1998) to a high of 8.3 percent (1992); unemployment highs also occurred in 2003 and 2009-10 (USDC, 2012a).

These results suggest that the impact and recovery from the 2007-08 recession varies by sub-region within the study area; the Municipality of Anchorage and the Kenai Peninsula Borough are experiencing positive growth (possibly as a result of more diverse and resilient economies), while the Valdez-Cordova census area has been slower to recover.

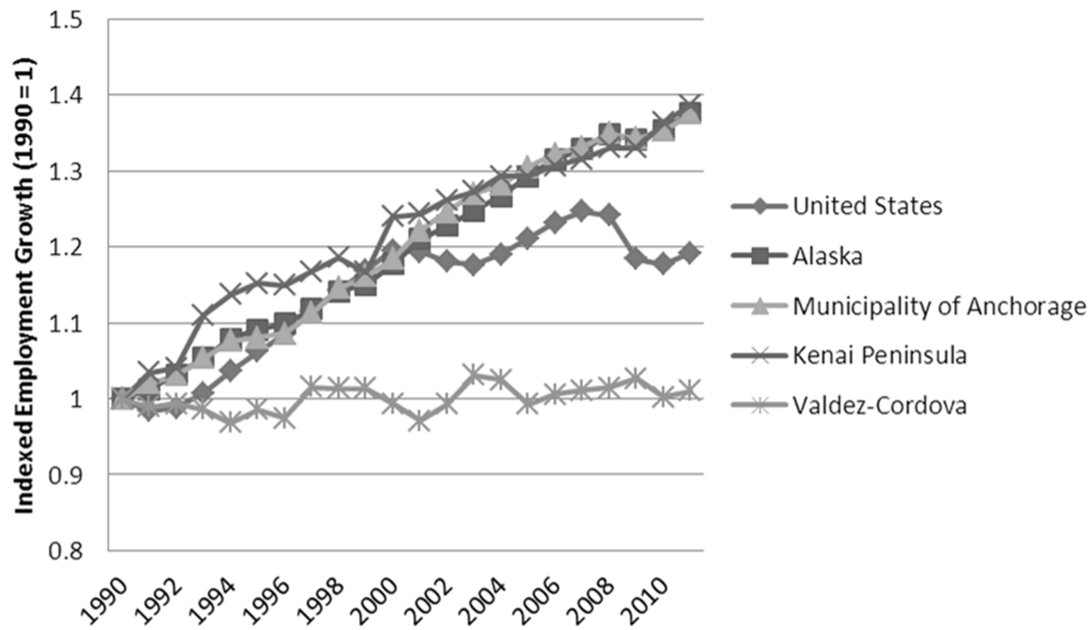


Figure 16. Employment trends of the United States, Alaska, the Municipality of Anchorage, Kenai Peninsula Borough, and Valdez-Cordova census area. The data are standardized for comparison.
Note: All employment estimates used in this portion of the document refer to average annual employment. Here, one employment unit is equivalent to 12 months of full or part-time work.
Source: U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System 2013

While employment statistics help explain overall growth in economic activity, personal income statistics more directly measure the economic benefits residents receive. Similar to the state of Alaska as a whole, the study area regions display similar trends in total personal income growth (see figure 17) generally increasing except for the 2008 to 2009 period. However, income growth for individual study area regions was somewhat lower than that of Alaska, with the Kenai Peninsula Borough being the area with the most growth and Valdez-Cordova census area having the least growth (less than that of the United States).

Personal income can be divided into two main categories; earned income and unearned income (see figure 18). Earned income includes all wage and salary earnings, including wages paid by self-proprietors to themselves. Unearned income includes all non-labor income: government transfer payments to individuals (e.g., social security) and income from property or other investments. Between 1970 and 2011, unearned income increased from 11 to 31 percent of total personal income in the study area as a whole. As components of unearned income, transfer payments, including government payments to retirement, disability, medical, unemployment, etc., increased from 3 to 15 percent and dividends/interest/rents increased from 8 to 16 percent during that time. Unearned income has not changed as much over the last 10 years in the study area, fluctuating between 27 and 32 percent of total personal income; however, age-related transfer payments (e.g., retirement and disability payments and Medicare) rose from 3 to 5 percent of total personal income between 2000 and 2011 (11 to 16 percent of non-labor income), consistent with aging population trends (US Census Bureau, 2013). These results underlie the growing importance of unearned income, reflecting shifts in demographics and aging populations, and potentially affecting local demand for Chugach National Forest services and amenities.

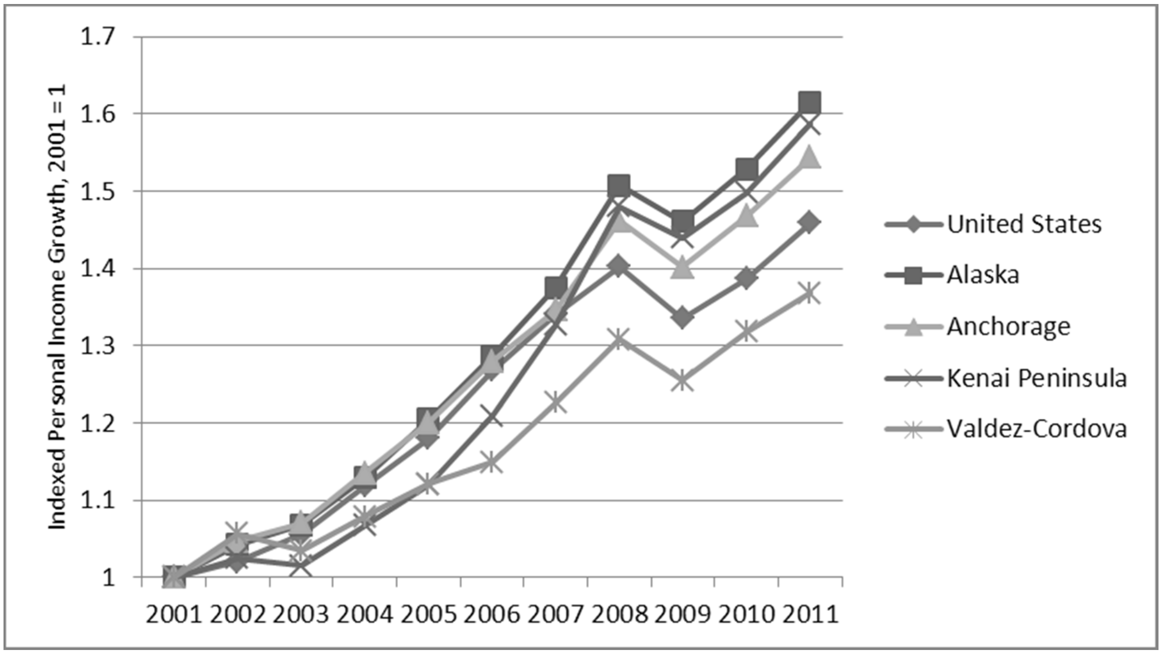


Figure 17. Total personal income trends in the United States, Alaska, Municipality of Anchorage, the Kenai Peninsula Borough, and Valdez-Cordova census area from 2001-2011 (not adjusted for inflation)
Sources: U.S. Department of Commerce. Bureau of Economic Analysis, Regional Economic Information System. 2013.

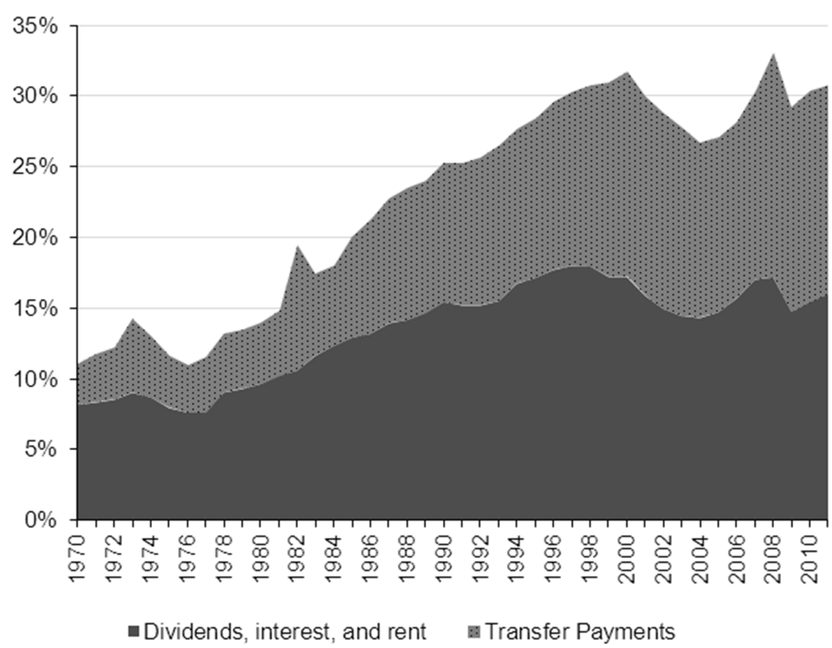


Figure 18. Unearned income, percent of total personal income for the southcentral Alaska study area (US Census Bureau, 2013)

Employment by industry

Table 59 displays data on employment by industry. The four main industries that use forest-related resources in Alaska are commercial salmon fishing and processing, tourism and recreation (including sport fishing), wood products, and minerals (excluding oil and gas). Forest-related resources are included in the "Agriculture, forestry, fishing and hunting, and mining" industry category in table 59. It is important to note that this category in table 59 does not include employment associated with the processing and support services linked to resource harvesting. Production activities associated with these industries occur inside and outside the national forest, and in many cases the Chugach National Forest is not the only source of the resources upon which they rely.

In 2011, 5.2 percent of total employment in Alaska was estimated to be in industries that use forest-related resources (see table 59). For the period from 2010 to 2020, employment in Alaska is projected to grow by 8.3 percent in natural resource and mining-related industries (ADLWD, 2012). The Kenai Peninsula Borough (12.1 percent) and Valdez-Cordova census area (6.5 percent) have higher percentages of employment in forest resource-related industries than the Municipality of Anchorage (3.4 percent) (see table 59).

Table 59. Employment percentage by industry in 2011, listed according to the North American Industry Classification System (NAICS)

Industry	Alaska	Municipality of Anchorage	Kenai Peninsula Borough	Valdez-Cordova Census Area	Study Area	U.S.
Percent of Total						
Agriculture, forestry, fishing and hunting, mining	5.2%	3.4%	12.1%	6.5%	4.8%	1.9%
Construction	8.3%	7.1%	8.6%	8.2%	7.3%	6.8%
Manufacturing	4.0%	1.8%	4.4%	6.4%	2.3%	10.8%
Wholesale trade	2.1%	2.9%	1.9%	4.1%	2.8%	2.9%
Retail trade	11.0%	11.3%	11.2%	7.8%	11.2%	11.5%
Transportation, warehousing, and utilities	7.7%	8.0%	6.2%	9.0%	7.8%	5.1%
Information	2.1%	2.4%	2.4%	5.6%	2.5%	2.3%
Finance and insurance, and real estate	4.5%	5.9%	2.9%	3.0%	5.4%	6.9%
Prof., scientific, mgmt., admin., and waste mgmt.	8.3%	10.7%	5.5%	6.8%	9.9%	10.5%
Education, health care, and social assistance	22.7%	21.7%	22.0%	24.9%	21.8%	22.5%
Arts, entertain., rec., accommodation, and food	8.3%	9.4%	10.3%	7.0%	9.5%	9.0%
Other services, except public administration	4.5%	4.6%	5.1%	4.1%	4.7%	4.9%
Public administration	11.3%	10.7%	7.4%	6.7%	10.1%	4.9%

Note: The agriculture, forestry, fishing and hunting and mining sector does not include processing and support services linked to resource harvesting; manufacturing, trade, warehousing, and other industry sectors include operations associated with seafood processing and other support services.

Travel and tourism

For the past 20 years, tourism has been a growing industry in the study area, but it has also been one of the hardest hit industries in recent years due primarily to poor or variable national economic conditions. Travel and tourism consist of sectors that provide goods and services to visitors, and the local population, and contribute to the local economy. These sectors include retail trade; passenger transportation; arts, entertainment, and recreation; and accommodation and food.

Information regarding employment in tourism helps demonstrate the importance of that sector of the economy across the different areas in the study area. Travel and tourism accounts for 16 to 17 percent of employment in the study area as well as subregions as of 2010 (see table 60).These percentages are slightly greater than that of the United States (15 percent). Tourism employment is somewhat more concentrated in transportation (e.g., cruise lines) and part-time seasonal jobs compared to the nation as a whole.

In 2011, employment supported by visitors, excluding recreational spending by local residents, was estimated to be 18,900 jobs in the southcentral region of Alaska, representing 7 percent of total employment in the region (ADLWD, 2013b). Visitor-related employment in the southcentral region in 2011 was higher than 2010; reflecting the first increase in annual visits to Alaska in four years, and suggesting continuing recovery from the recession. After steadily increasing between 2002-03 and 2007-08, the Alaska visitor market plateaued, then declined in response to the nationwide economic recession and declining cruise ship traffic. The 2011-12 visitor volume was still 7 percent below the peak volume (1,961,500 visitors) of 2007-08, but 19 percent higher than in 2002 (ADLWD, 2013b). Employment within the leisure and hospitality industry is projected to grow by 12.5 percent for 2010 to 2020 for Alaska, slightly higher than overall employment growth of 12 percent across all industries (ADLWD, 2012), suggesting potential for slight increases in percentages of total jobs associated with recreation and tourism. Additional analysis is needed to identify the proportion of the tourism jobs attributable to expenditures by visitors to the Chugach National Forest (see the Employment Supported by the Chugach National Forest section).

Tourism employment grew from 1998 to 2010 in all sub-regions in the study area. Tourism employment in the Kenai Peninsula Borough and Valdez-Cordova census area fluctuates but still experienced growth from 1998 to 2010. The Municipality of Anchorage experienced more continuous and slightly greater growth at 23 percent during the same period (US Census Bureau, 2013).

Table 60. Percentages of travel and tourism-related employment in 2010 (US Census Bureau, 2013)

Travel and Tourism-related Employment	Alaska	Municipality of Anchorage	Kenai Peninsula Borough	Valdez-Cordova Census Area	Study Area	U.S.
Percent of Total						
Travel and Tourism-related	17.0%	16.4%	17.1%	16.2%	16.5%	15.1%
Retail Trade	2.3%	2.1%	2.2%	2.4%	2.2%	2.8%
Gasoline Stations	0.7%	0.4%	1.0%	0.9%	0.4%	0.8%
Clothing and Accessory Stores	0.9%	1.1%	0.4%	1.1%	1.0%	1.4%
Misc. Store Retailers	0.8%	0.7%	0.8%	0.3%	0.7%	0.6%
Passenger Transportation	2.5%	2.4%	1.3%	2.1%	2.3%	0.4%
Air Transportation	2.3%	2.3%	0.8%	1.6%	2.1%	0.4%
Scenic and Sightseeing Transport	0.2%	0.1%	0.5%	0.4%	0.1%	0.0%
Arts, Entertainment, and Recreation	1.9%	1.8%	1.7%	2.4%	1.8%	1.8%
Performing Arts and Spectator Sports	0.5%	0.6%	0.0%	0.0%	0.5%	0.4%
Museums, Parks, and Historic Sites	0.1%	0.1%	0.2%	0.3%	0.1%	0.1%
Amusement, Gambling, and Rec.	1.3%	1.1%	1.4%	2.1%	1.1%	1.3%
Accommodation and Food	10.3%	10.2%	11.9%	9.3%	10.3%	10.1%
Accommodation	2.5%	2.2%	3.4%	4.5%	2.3%	1.6%
Food Services and Drinking Places	7.8%	8.0%	8.5%	4.8%	8.0%	8.5%
Non-travel and Tourism	83.0%	83.6%	82.9%	83.8%	83.5%	84.9%

Commercial fishing and seafood processing

Commercial fishing was identified as being the largest forest resource-related sector in southcentral Alaska in the FEIS for the 2002 Forest Plan (see Fish section in this chapter for more details about potential economic impacts associated with Chugach National Forest contributions to commercial fisheries).

The three subareas within the economic study area display fluctuating levels of commercial fishing income during the last several decades. Income peaked in the late 1980s at 70 million dollars per year for Kenai Peninsula Borough and 60 million dollars per year for Municipality of Anchorage (1995), accounting for 3.6 percent and 0.2 percent of total annual earned income respectively. Annual income for the Valdez-Cordova census area peaked at approximately 35 million dollars, accounting for 4.8 percent of total earned income. By 1998, commercial fishing income decreased to approximately 25 million dollars for the Kenai Peninsula Borough, 10 million dollars for the Valdez-Cordova census area, and to 12 million dollars for the Municipality of Anchorage. From 2001 to 2011, earnings from commercial fishing in the study area remained the same for the Municipality of Anchorage at 12 million dollars, but rose significantly for both the Kenai Peninsula Borough. Over the longer term, commercial fish harvest values have fluctuated for the Kenai Peninsula Borough with peaks in 1988 and 1992 and lows in 1980, 1984, 1998, and 2001. Commercial fishing earnings have grown between 2002 and 2010 (ADLWD, 2010b). Fish processing income (separate from commercial fishing) was believed to be approximately equal again in magnitude to earnings from the commercial fishing sector at the time. Within the Kenai Peninsula

Borough, fish processing occurs in Kenai, Soldotna, Sterling, Seldova, and Seward, accounting for 52 percent of manufacturing sector jobs in these communities (ADLWD, 2010b).

Today, salmon fisheries are recognized as a major economic driver in the area. A relatively new industry, oyster mariculture, shows promise for future growth for the commercial fishing and seafood industry for the Kenai Peninsula Borough (KPEDD, 2010).

The volatility of commercial fishing income is likely due to various economic and ecological forces beyond the national forest's boundary and control. However, it is recognized that the Chugach National Forest plays a critical role in the health and sustainability of fisheries supporting both commercial and recreational activity (see Fish section in this chapter). Forest Service management has the potential to indirectly affect commercial fishing, but the impact is difficult to predict (USDA, 2002c).

Rivers within the national forest are renowned for salmon fishing, bringing thousands of people to the area. A number of private businesses directly or indirectly support recreational fishing within the Chugach National Forest, and are addressed in the Recreation and Scenic Character section in this assessment. These businesses are affected by the status of salmon runs and administration of the salmon season by ADF&G.

Other economic sectors

The biological or physical attributes maintained by the Chugach National Forest help support a number of other business and community enterprises. Wildlife/landscape artists, trappers, arts and crafts suppliers, tanning operations, and local food markets may rely directly or indirectly on specific botanical, wildlife, or fish resources for use or inspiration. Detailed information was not readily available to describe the economic trends associated with these sectors; however, values are described and recognized in other sections of this assessment (see Wildlife, Subsistence, and Ecosystem Services sections in this chapter).

Timber and wood products

The Alaska Report to the Timber Jobs Task Force reports that the timber industry in southcentral and interior Alaska is largely limited to small mills and cottage manufacturing industries (Alaska Timber Jobs Taskforce, 2012). In contrast to the southeast Alaska, the southcentral and interior regions of the state do not have a history of large volume, heavily commercialized wood product industries. The southcentral and gulf coast regions have experienced significant declines in the quality of timber as both regions suffered from widespread spruce bark beetle infestations. In the Anchorage and Matanuska-Susitna metropolitan areas, the State of Alaska continues to provide commercial timber sales. Decreased housing starts have resulted in less land clearing and increased demand on the state to provide fuelwood sales for both personal and commercial markets. Much of the southcentral industry focuses on value-added product development, including log cabin kits, dimensional lumber, custom beams, and other building materials.

There are an estimated 105 Alaska-owned wood product businesses in areas and communities surrounding the Chugach National Forest, with a majority (63) in the Municipality of Anchorage (Alaska Timber Jobs Taskforce, 2012). Current timber industry activity in the Kenai Peninsula Borough includes the exportation of woodchips from the southern peninsula and one sawmill with value added timber operations. The increase in availability of small timber sales in recent years has enabled small operators to expand their operations.

Timber related employment, including growing, harvesting, mills, and wood products manufacturing, is relatively small in the study area. Employment in this sector in Anchorage was 1.1 percent in 2010 and 0.1 to 0.2 percent in the Kenai Peninsula Borough and Valdez-Cordova census area, respectively (USDC, 2012b).

According to the Forest Plan Review 2002-2012 (USDA, 2012b), demand for timber from the national forest was low in 2002 and was expected to remain low during the life of the 2002 Forest Plan.

See the Timber and Ecosystem Services sections for additional detail about timber, wood for fuel, fiber, and other forest products.

Employment supported by the Chugach National Forest

The primary ways the Chugach National Forest impacts jobs and income that can be modeled quantitatively include:

- Recreational visitor spending in the local area, including wildlife and fish-based recreation (see the Recreation and Scenic Character section for details about visitor use)
- Spending of transfer payments to states/counties (e.g., Secure Rural School payments)
- Spending of salary and non-salary Federal funds by the Forest Service (e.g., expenditures on staff, materials, contracting, etc.)

Other activities related to resource use and extraction, such as timber harvest, gathering of other forest products, and mining, occur within or can be linked to the Chugach National Forest, as discussed in other sections of this chapter. However, in a number of these cases, the magnitude of the activity is relatively small and hard to assess relative to the regional economy as a whole, making it difficult to accurately model economic impacts. See the Renewable and Nonrenewable Energy and Mineral Resources sections in this assessment and the Timber section in this chapter for information about contributions by these respective resource areas to social and economic sustainability.

Method for estimating economic impacts

Economic impact analysis is used to estimate how the Chugach National Forest contributes to regional employment and labor income. Economic impacts analysis evaluates direct, indirect, and induced effects using region-specific multipliers derived from input-output models. Input-output analysis is a means of examining the production and consumption relationships between different industries, services, businesses, government sectors, and consumers (e.g., households) within an economy. Economic impact analysis allows one to examine the effect of a change in one or several economic activities on the economy for a region, all else being held constant.

The IMPLAN modeling system (IMPLAN, 2009) was used to examine the direct, indirect, and induced economic impacts of the Chugach National Forest. IMPLAN multipliers are derived from cross-sectional data regarding employment, output, and expenditures from a single point in time that should be consistent with the period of time for activity data (e.g., IMPLAN multipliers should be based on 2008 data if recreational visit numbers are from 2008 surveys). Data used by IMPLAN to create economic impact models specific for the impact area surrounding the Chugach National Forest are compliant with the Data Quality Act (Section 515 of Public Law 106-554). The impact area is assumed to consist of the Municipality of Anchorage, the Kenai Peninsula Borough, and the Valdez-Cordova census area, consistent with the boundaries of the analysis area defined for assessing social, cultural, and economic conditions. Summaries of economic impact results from recent studies follow.

Recreation

Based on NVUM survey results, the Forest Service estimated that 498,345 visits to the Chugach National Forest occurred in 2008 (USDA, 2008). Supplemental NVUM surveys were completed to improve the reliability of recreational visitor use data for calculating economic impacts (White & Wilson, 2008). Visitor spending is the basis for direct impacts and is assumed to include expenditures on a variety of items and services, such as fuel, food, lodging, and guided opportunities. Using the NVUM visitation numbers from 2008, and the supplemental survey information, it is estimated that 498,345 recreational visits to the Chugach National Forest (from 2008) generated 83 million dollars in visitor spending by both local and non-local visitors. This level of spending is estimated to support 1,062 jobs (804 full and part-time direct jobs plus 259 full and part-time induced and indirect jobs) in the study area during a year. Approximately 84 percent of jobs (894 jobs) are supported by visits from non-Alaskans. Spending by non-local visitors is more likely to introduce new money into the local economy, compared to local residents who are likely to spend their money locally on other goods and services (and still support local employment), even in the absence of Chugach National Forest recreational opportunities. Economic impacts from recreation are therefore often based on non-local spending. Additional details about the types of recreational activities and the nature of recreational visits are described in the Recreation and Scenic Character section in this assessment.

Payments to local governments

Counties receive a portion of the revenues generated on National Forest System lands through the Secure Rural Schools and Community Self Determination Act (2000) and subsequent reauthorizations of this Act. Payments are allocated to counties for use in different types of programs or projects, including schools and roads (Title I); projects to benefit forest lands (Title II); and search, rescue, and Firewise community efforts (Title III). Secure Rural Schools payments generated from the Chugach National Forest are displayed in table 61. Aggregate Secure Rural Schools' payments declined from a high of 6.9 million dollars in 2009 to 4.5 million dollars in 2013.

Counties also receive Payment in Lieu of Taxes to replace tax revenue lost due to the public nature of lands administered by Federal agencies (1976 Payments in Lieu of Taxes Act). The amount is based on the amount of acreage administered by certain Federal agencies, population, a schedule of payments, the Consumer Price Index, other Federal payments made in the prior year, and the level of funding allocated by Congress. Annual Payment in Lieu of Taxes associated with the Chugach National Forest has varied from 4.1 million to 5 million dollars in aggregate for the Municipality of Anchorage (15 to 16 percent of funds), Kenai Peninsula Borough (57 to 63 percent of funds), and Valdez-Cordova census area (22 to 27 percent of funds) for 2009 through 2013, as compiled by Alexander (2013).

Table 61. Chugach National Forest Secure Rural Schools payments (in dollars) 2009 through 2013 (Alexander, 2013)

Type of Payment	2009	2010	2011	2012	2013
Title I: Schools and Roads	5,845,760	5,203,213	4,496,492	4,390,197	3,788,254
Title II: Projects Benefitting National Forest Lands	1,023,396	910,827	787,515	745,912	650,209
Kenai Peninsula Borough	153,522	139,604	113,962	108,450	98,185
Anchorage Borough	23,480	20,569	18,452	17,812	16,576
Cordova	283,258	242,881	213,211	194,957	163,111
Valdez	503,907	455,566	397,112	387,693	336,233
Whittier	13,793	12,233	10,676	10,098	8,726
Chugach REAA	45,436	39,973	34,102	26,902	27,379
Title III: Search and Rescue	0	0	0	23,061	13,297
Totals	**6,869,156**	**6,114,040**	**5,284,007**	**5,159,170**	**4,451,760**

Secure Rural Schools payments may be affected by Forest Service management, but Payment in Lieu of Taxes is less likely to be affected. As such, results from IMPLAN modeling (IMPLAN, 2009) are presented here to demonstrate the potential economic impacts from use of Secure Rural Schools' payments. Assuming 2011 Secure Rural Schools payments levels of 4,496,000 dollars under Title I (50 percent allocated to schools and 50 percent allocated to roads) and 788,000 dollars under Title II (100 percent allocated to national forest projects), Secure Rural Schools payments linked directly to the Chugach National Forest are estimated to support 71 jobs (full or part-time) and approximately 4 million dollars in income (2012 dollars) in a year.

Chugach National Forest spending

Spending by the Forest Service of approximately 25 million dollars (2010 Chugach National Forest budget) is estimated to support 367 full or part-time jobs and 24 million dollars in labor income in the impacted area. This result includes direct, indirect, and induced impacts. The 2010 Chugach National Forest budget was split evenly between salary and non-salary expenditures.

Special use permits

The wide variety of special use permits for the Chugach National Forest illustrates how the Forest Service affects local and regional economies. Numbers and types of special use permits are summarized in the Land Use section of this assessment.

Economic impacts of non-local or tourist spending on commercial operations linked to recreation and tourism are facilitated by special use permits issued by the Forest Service to outfitters and guides. Details about special use permits for guided opportunities are provided in the Recreation and Scenic Character section of this assessment. Quantified economic impacts associated with other types of special uses are not readily available and are therefore not provided in this assessment. However, more details about other types of special uses within the Chugach National Forest are presented in other relevant program sections in this assessment.

Environmental Justice

Poverty data is displayed in table 62. The Census Bureau uses a set of income thresholds that vary by family size and composition to characterize poverty. A family or an unrelated individual that falls below the relevant poverty threshold is classified as being below the poverty level. The percent of people below the poverty level in the region is similar to or slightly below levels for Alaska and below that of the United States for 2011 (8 percent; ranging from 6.7 percent in Valdez-Cordova census area to 9.1 percent in the Kenai Peninsula Borough). Poverty levels may be higher or lower for individual communities within the study area (see table 63).

For public land managers, understanding whether different races and ethnicities are affected by poverty can be important. People with limited income and from different races and ethnicities may have different needs, values, and attitudes as they relate to public lands. In addition, proposed activities on public lands may need to be analyzed in the context of whether minorities and people who are economically disadvantaged could experience disproportionately high and adverse effects. Information compiled does not indicate substantially higher poverty, by race or ethnicity, for individual subareas with the exception of Native Hawaiian and Oceanic populations in the Valdez-Cordova census area.

Table 62. Poverty data for 2011 with categories broken into people, families, people below poverty, and families below poverty (estimates for 2007 through 2011) (USDC, 2012b)

Group	Alaska	Municipality of Anchorage	Kenai Peninsula Borough	Valdez-Cordova Census Area	Study Area	U.S.
People	684,608	281,124	53,327	9,427	343,878	298,787,998
Families	170,948	70,070	14,673	2,524	87,267	76,507,230
People Below Poverty	65,111	22,045	4,860	631	27,536	42,739,924
Families below poverty	11,032	3,804	806	105	4,715	8,000,077
Percent of Total						
People Below Poverty	9.5%	7.8%	9.1%	6.7%	8.0%	14.3%
Families below poverty	6.5%	5.4%	5.5%	4.2%	5.4%	10.5%

Table 63. Percentage of people by race and ethnicity below poverty (averages for 2007 through 2011) (USDC, 2012b)

Race or Ethnicity	Alaska	Municipality of Anchorage	Kenai Peninsula Borough	Valdez-Cordova Census Area	Study Area	U.S.
White alone	6.6%	5.3%	8.4%	3.8%	5.9%	11.6%
Black or African American alone	10.6%	10.5%	12.1%	0.0%	10.4%	25.8%
Native American*	21.0%	16.6%	17.5%	18.0%	16.8%	27.0%
Asian alone	10.1%	11.3%	1.4%	0.0%	10.8%	11.7%
Native Hawaiian and Oceanic alone	17.7%	19.5%	0.0%	74.1%	19.6%	17.6%
Some other race alone	7.5%	6.6%	0.0%	0.0%	6.1%	24.6%
Two or more races alone	12.6%	13.6%	12.1%	11.9%	13.4%	18.7%
Hispanic or Latino alone	10.3%	9.5%	5.8%	4.7%	9.2%	23.2%
Non-Hispanic/ Latino alone	6.5%	5.1%	8.5%	3.8%	5.7%	9.9%

* Native American includes American Indian. Alaska Native, and Non-specified tribes.
Note: Poverty prevalence by race and ethnicity is calculated by dividing the number of people by race in poverty by the total population of that race. The data are calculated by American Community Survey Office (ACS) using annual surveys conducted from 2007 to 2011 and are representative of average characteristics during this period.

Other Social Conditions and Trends

Education and language

Education attainment refers to the level of education completed by people 25 years and older in terms of the highest degree or the highest level of schooling completed. Conditions regarding education and language may have implications for Forest Service activities linked to outreach, interpretive programs, and other student programs. The value of the Chugach National Forest as it relates to education and research is discussed in the Ecosystem Services section.

The percentage of people earning high school (and higher) degrees increased in the study area from 1990 to 1998 according to the FEIS for the 2002 Forest Plan, and that percentage increased again from 1998 to 2011 (USDC, 2012b). Increases ranged from 1 percent in Anchorage to 8 percent for Valdez-Cordova Census Area. High school graduation rates for the study area (92 percent) and subareas were similar to those of the State of Alaska and greater than the rate for the United States (85 percent) in 2011. Attainment of a Bachelor’s degree or higher is greater for the Municipality of Anchorage (32 percent) and lower for the Kenai Peninsula Borough and Valdez-Cordova census area (23 and 24 percent, respectively) when compared to attainment rates for the state and the United States (28 percent). As is the case with poverty, educational attainment may vary for some individual communities within the study area.

Knowing the primary language of the population is important for public land managers who are trying to communicate with citizens of communities adjacent to public lands. It is important to know whether a significant portion of that population can communicate effectively in English. If this is not the case, public outreach, meetings, plans, and implementation may need to be conducted in multiple languages. The percent of the population speaking a language other than English in the study area is similar to or below that of Alaska as a whole as well as the United States for 2007 through 2011, though Asian and Pacific Islander languages are spoken among a greater percentage of people in Anchorage.

Housing

Housing status is an indicator of the housing market and provides information on the stability and quality of housing as a component of overall community and social sustainability, welfare, and lifestyle support for certain areas. The data is used to assess the demand for housing, to identify housing turnover within areas, and to better understand the population within the housing market over time.

Seasonal or recreational homes are often an indicator of the desirability of a place for recreation and tourism. This could also be used as an indicator of recreational and scenic amenities, which can be one of the economic contributions of public lands. Understanding the relative growth rates of housing is relevant for public lands managers in the context of the wildland-urban interface, and as an indicator of overall economic growth. The year the home was built also provides information on the age of the housing stock, which can be used to forecast future demand for services, such as energy consumption and fire protection.

Housing occupancy is high for the Municipality of Anchorage (93 percent) but lower for the Kenai Peninsula Borough (74 percent) and particularly low for the Valdez-Cordova census area (63 percent) when compared to the state (83 percent) on average for 2007 through 2011. This is explained in large part by the relatively high numbers of seasonal or recreational homes in the Kenai Peninsula Borough (19 percent) and the Valdez-Cordova census area (27 percent) versus the Municipality of Anchorage where only 1.4 percent of housing is seasonal. High percentages of seasonal housing are suggestive of demand for scenic, recreational, or other attributes that appeal to the public (not uncommon in areas surrounding National Forest System lands).

Housing availability for the study area (0.7 to 1.0 percent of housing is for sale) is consistent with the rest of Alaska (0.8 percent) but lower than the United States (1.5 percent). Housing for rent in the study area (0.8 to 1.6 percent of housing) is slightly lower than that of the state (1.8 percent) and lower than the United States (2.5 percent), Housing availability in general is therefore somewhat lower for the study area, recognizing that demand for housing may vary substantially for different communities. Based on age of construction, rates of construction have been slower in the Valdez-Cordova census area, somewhat higher in the Municipality of Anchorage, and highest for the Kenai Peninsula Borough.

In terms of housing affordability, housing costs and gross rents as a percent of household income in the Valdez-Cordova census area are less than the rest of the study area, the state of Alaska, and the United States. Housing costs compared to household income for the Municipality of Anchorage and Kenai Peninsula Borough are mostly consistent with the state as a whole, though still somewhat lower than the United States. However, gross rents as a percent of income appear slightly higher for the Municipality of Anchorage (USDC, 2012b).

Disabilities

The Center for Personal Assistance Services (PAS) has compiled state and national data on the prevalence of overall disability and of self-care difficulty (see table 64). The aging of the United States population is expected to bring about large increases in the demand for PAS over the coming decades.

For the Municipality of Anchorage, the percent of the population aged 65 or older with self-care difficulties (10.1 percent) is slightly higher than that of Alaska or the United States (8.8 to 9.1 percent). For the Kenai Peninsula Borough, the percent of the population aged 18 to 64 and 65 and older with self-care difficulties (3.3 percent and 11.8 percent, respectively) is somewhat higher than that of Alaska or the United States (1.8 percent and 8.8 to 9.1 percent, respectively); the percentage of the Kenai Peninsula Borough population aged 18 to 64 with an independent living difficulty (5.5 percent) is also somewhat higher than Alaska or the United States (2.9 percent to 3.4 percent). Persons with self-care difficulty are a subset of those with an independent living difficulty.

Table 64. Estimated number of persons in the Municipality of Anchorage and Kenai Peninsula Borough with self-care difficulty or independent living difficulty by age (with comparable estimates for the state and the nation) (Center for Personal Assistance, 2014)

Area	Ages 18-64			Ages 65 and over		
	Total persons	With a self-care difficulty	With an independent living difficulty	Total persons	With a self-care difficulty	With an independent living difficulty
Municipality of Anchorage	180,365	1.8%	2.9%	20,119	10.1%	14.4%
Kenai Peninsula Borough	34,628	3.3%	5.5%	5,728	11.8%	16.4%
Alaska	438,463	1.8%	2.9%	51,173	9.1%	14.7%
United States	189,239,988	1.8%	3.4%	38,279,866	8.8%	16.4%

Non-Market Benefits and Values

The Chugach National Forest provides a range of resources and amenities (natural, built, and human capital) that contribute to a suite of goods and services valued by people living outside of the study area and beyond the State of Alaska. Many of these benefits are difficult to value in dollars or justify in terms of jobs and income and are therefore categorized as non-market benefits. Beneficiaries range from local residents to the public in general, including individuals and groups outside of Alaska, and even the international community.

To help illustrate potential types of values, a comprehensive survey in 12 communities surrounding the Chugach National Forest was conducted to better understand how the local public values the national forest (Reed & Brown, 2003). The Relevant Information indicated that public land environmental attributes are basic to community quality of life, suggesting that the protection of clean air and water, scenic quality, and open and undeveloped areas, along with providing opportunities for wildlife viewing and outdoor recreation are important. The Relevant Information confirms that the Chugach National Forest has the ability to affect the quality of life of the communities neighboring it (Reed & Brown, 2003). Similar studies of community preferences are summarized in the 2002 FEIS and given consideration in the Ecosystem Services section in this chapter.

A review and assessment of the full spectrum of both market and non-market benefit conditions and trends linked to and affected by the Chugach National Forest is interdisciplinary in scope and expertise. As such, separate sections of this assessment are dedicated to the assessment of those benefits. Refer to the Ecosystem Services and the other program-specific sections in this chapter for details about non-market values and benefits.

Social and Economic Sustainability

Sustainability is, “The capability to meet the needs of the present generation without compromising the ability of future generations to meet their needs.” Furthermore, economic sustainability refers to the capability of society to produce and consume or otherwise benefit from goods and services, while social sustainability is the capability of society to support the network of relationships, traditions, culture, and activities that connect people to the land and to one another and support vibrant communities

The Chugach National Forest is not responsible for deciding what goods, services, networks, traditions, cultures, and activities are most needed or desired; only the public or society can define what they need today and in the future. However, information about social, cultural, and economic conditions and trends provides clues about the needs of present and future generations. When considered in combination with current resource and ecosystem conditions and trends of the Chugach National Forest, this information helps demonstrate how the national forest can provide resources that support the capabilities of society to produce and consume goods and services as well as relationships, culture, and activities that maintain vibrant communities (and therefore contribute to social and economic sustainability).

More specifically, this section and other sections of chapter 3 provide information about public needs and social and economic conditions potentially affected by national forest resources. Chapter 2 of this assessment provides information about resource conditions and trends that help determine if and how the Chugach National Forest contributes to goods and services that satisfy public needs and influences social and economic sustainability, now and into the future. Aggregate consideration of information in chapters 2 and 3, within an interdisciplinary setting, is therefore necessary to inform decisions about how national forest management should guide contributions to social and economic sustainability. Some examples of how the Chugach National Forest might contribute to social and economic sustainability include:

- Providing opportunities to build relationships and facilitate interaction with stakeholders through activities, such as educational outreach through the Chugach Children's Forest program and Classrooms for Climate and through subsistence harvest activities.
- Restoring/maintaining national forest resources and providing opportunities to use resources that directly or indirectly support jobs and income in communities within the study area.
- Offering a variety of unique national forest resource conditions and experiences that are valued by communities and people outside of Alaska (the existence of Chugach National Forest resources and amenities may play a role in the sustainability of social conditions well beyond areas and communities within the social and economic study area).

Information Needs

The following information gaps or needs have been identified; more details in these areas related to social and economic sustainability may help to inform subsequent steps in the plan revision process:

- Recreational visitor trends and projections (local and non-local), by area and gateway community
- Factors affecting (or constraining) recreational visitor days within the Chugach National Forest, including primary factors affecting sport fishing days and experience
- Needs and demands for Chugach National Forest goods and services by minority groups
- Local public perceptions about new or developing types of economic or business opportunities that may benefit from Chugach National Forest resources
- Expectations or projections about long-term fluctuations or cycles in market conditions in the Chugach National Forest study area and Alaska, including specific types of recreational or tourism demand (e.g., cruise ships and the Alaska Railroad Corporation), transportation (e.g., ferries and highway construction), affecting shifts in residential development and visitor traffic, and alternative and renewable energy
- Conditions and trends regarding non-traditional businesses, community programs, and organizations that may directly or indirectly rely on wildlife, plants, or other forest resource conditions or access
- Area and community-specific vulnerability and perceived risks to social and economic sustainability–short and long-term

Ecosystem Services

The Chugach National Forest provides a broad suite of goods and services that are important to the public, help meet community needs and preferences, and sustain livelihoods. These goods and services are the benefits of ecosystems and are referred to as ecosystem services.

Some benefits derived from National Forest System lands are obtained by direct use or consumption of goods or services (e.g., wood products, water, forage, fish, and wildlife, and recreational opportunities). Other services provide benefits indirectly or through non-consumptive means, as they support and regulate ecosystem integrity (e.g., climate regulation, water filtration, pollination, nutrient cycling, flood control, and biodiversity).

Ecosystem services are defined as the benefits people obtain from ecosystems and can be grouped into the following four types:

1. *Provisioning services*
   The products or commodities obtained from forest ecosystems, such as clean air, fresh water, fiber, forage, fuel, minerals, and food
2. *Regulating services*
   The benefits obtained from an ecosystem's ability to impact or influence environmental conditions that affect people's lives, such as carbon sequestration, water filtration and storage, and insect and disease control
3. *Supporting services*
   The category of ecosystem services that are often described as intermediate services that contribute to the production of other ecosystem services and sustainability of integrated ecological, social, and economic systems
4. *Cultural services*
   The nonmaterial benefits people derive from forests, such as educational, aesthetic, spiritual and cultural heritage values; recreational experiences; and tourism opportunities

While the Chugach National Forest provides a broad range of goods and services to the public, this assessment attempts to consider available information about this range of benefits and services and then narrow the list by identifying a *preliminary* set of services that: (1) are thought to be most important to people in the broader landscape and (2) would be most affected by Forest Service management.

The types of information used to help determine if these two conditions are met include:

- *Condition and trend of the service*
  Is it getting worse? Is it stable? Is it not known?
- *Drivers*
  Do people want more or less of the service, or does evidence suggest the public will desire more or less in the future, or is it unknown?
- *Ecosystem characteristics that help to provide the service*
  Are national forest resources or ecosystem functions under threat or in need of maintenance that are critical inputs to the production of the service? Is there uncertainty?
- *Management actions, land uses, or other activities expected to occur*
  During the next 15 years, what is expected to occur that could affect the service (adversely or beneficially)?
- *Outside influences*
  Are actions or changing conditions on lands of other ownership, beyond the authority of the Forest Service, which could be affecting the service?

The identification of key ecosystem services relied on input from the public participation process, a review of available reports and studies, and specialist input. Public comments collected during this phase were reviewed to identify the potential benefits associated with the four ecosystem service categories (see the Public Feedback section in chapter 1). In addition, documents from past planning efforts as well as external publications, including research papers, white papers, dissertations, and survey summaries specific to the region surrounding the Chugach National Forest, were reviewed. This information, along with resource specialist input, was then collated into a matrix describing the types of service benefits the national forest offers.

An evaluation of available information from public input, reports/studies, and resource specialists resulted in the preliminary identification of seven key ecosystem services. The following table displays the seven key ecosystem services grouped by the type of service they provide.

Table 65. Ecosystem services grouped by the service they provide

Type of Ecosystem Service	Key Ecosystem Service
Provisioning	Water quantity and quality Animals and plants as food and resources Wood as a renewable energy and fuel source
Regulating	Carbon sequestration and impacts of climate change
Cultural	Recreational experiences Education and research
Supporting	Sustaining biodiversity, intact ecosystems, and connectivity for global ecological processes

In this section of the assessment, key ecosystem services are organized by category and the supporting evidence for each is summarized. The list will be finalized during the revision phase and may be changed with the receipt of new information. A number of support services associated with ecosystem conditions or processes are considered in greater detail as part of other resource or program sections in this assessment. As such, reference is made, where appropriate, to other sections rather than create duplicative text or redundant service descriptions.

Provisioning Services

Water quantity and quality

Description and geographic scale

Water quality and quantity is important to all living things. As such, the Chugach National Forest plays a critical role in protecting the water resources not only for the people and animals that live within and downstream from the national forest but for those who recreate on or depend on National Forest System lands for their livelihood. The influence of the quantity and quality of water resources is far reaching.

Conditions and trends, drivers, and ecosystem characteristics

The Aquatic Ecosystems–Watersheds section in chapter 2 describes conditions and trends, system drivers and stressors, and ecosystem characteristics for water quality and quantity. These discussions will not be repeated here.

Influence beyond Forest Service authority

The management of water necessitates an interagency approach. The Chugach National Forest provides an example where water links the terrestrial environments from high elevation glaciers through wetland ecosystems to the ocean. In cases where watersheds cross jurisdictional boundaries, adjacent land owners, such as Native Corporations, and local, state, and Federal agencies must work together to manage the quality and quantity of water in the planning area and affected landscapes.

Animals and plants as food and resources

Description and geographic scale

Alaskans and people from around the world use, and in many cases, depend on the fish, wildlife, and plants produced by the Alaskan natural environment (Newton & Moss, 2009). Collection, utilization, and transfer of wild foods are interwoven into the culture of Alaska (Brown & Burch Jr., 1992). Subsistence has been a way of life among Native and rural populations. Fish, wildlife, and plants of the Chugach National Forest provide an essential food source to thousands of people within and outside Alaska. Traditional native proteins in Alaska (i.e., deer, caribou, moose, and fish) are more nutritious to consumers in terms of dense protein, iron, Vitamin B12, polyunsaturated fats, monounsaturated fats and omega-3 fatty acids than equivalent store bought food (Johnson, Nobmann, Asay, & Lanier, 2009). In addition, they are low in saturated fat, added sugar, and salt.

Berries and greens are high in water and macronutrients and have fewer empty calories than processed foods. The act of hunting, fishing and gathering of native foods is energy intensive and further contributes to the health of the participant. The act of hunting, trapping, fishing, and gathering and processing the meat, fur, fish, or berries is socially and culturally important to many Alaskans (Johnson, Nobmann, Asay, & Lanier, 2009). Alaska Natives have collected plants and mushrooms for thousands of years. Objects created by contemporary artists include basketry, beadwork, fur clothing and art, carvings in wood, bone or antlers, artworks created from locally harvested materials, such as porcupine quills and salmon skin, are economically important (Newton & Moss, 2009). Plant fruits and berries, nuts, flowers, leaves, stems, and roots, as well as mushrooms and seaweed are used for food, dye, and art objects. Located within the most developed area of Alaska, the wildland products of the Chugach are easily accessible to residents and visitors and are often incorporated into commercial products.

The culture and tradition of hunting, trapping, gathering, and fishing has complex social and economic implications for forest management. For instance, management of salmon habitat and watershed resources directly links to people's livelihood and survival if the community depends on the harvest of salmon from local waters. Trapping constitutes significant portions of time for participants, who are motivated not only by the collection of furs but also by the wildland experience. Hunting for food or trophies is an inherent social activity in Alaska and throughout the world by those that hunt, driven as much by the experience as by the trophy or meat harvested.

Conditions and trends, drivers, and ecosystem characteristics

The Aquatic Ecosystems–Fish and Terrestrial Ecosystems sections in chapter 2 and the Fish, Wildlife, Plants, and Subsistence sections in chapter 3 provide in depth details about the conditions and trends and system drivers and stressors affecting animals and plants as food resources.

The ecosystem characteristics that maintain animals and plants are described throughout the ecosystem section of this assessment (chapter 2). All elements of ecosystems within the planning area must be considered, including terrestrial and aquatic habitat and the riparian and wetland systems that link them.

These discussions will not be repeated here.

Influence beyond Forest Service authority

The influence of other authorities and administrators of lands of other ownership is significant in managing for the provision of animals and plants as resources utilized by people. Hunting and fishing is mostly regulated by the state of Alaska, unless superseded by the Federal Subsistence Board. Subsistence and personal use of plants and mushrooms does not require a permit, but commercial harvest of special forest products does. To prevent overharvesting within high-use areas and specific watersheds, permits issued for the Kenai Peninsula geographic area are limited (USDA, 2002a).

Because personal (non-commercial) gathering of plants, berries, and mushrooms does not require a permit, little data are available on where people harvest and to what extent. Monitoring plots have been established near Girdwood to address concern over the potential overharvest of fern fiddleheads.

Wood as a renewable energy and fuel source

Description and scale

There is an increased demand for firewood from the national forest. There is increasing competition for firewood, and access is often a challenge. Firewood is very important to local communities within and adjacent to the Chugach National Forest.

Conditions and trends

The assessment of timber resources, including current condition and current harvest and production trends, are addressed in the Timber section. Similarly, biomass conditions and trends are discussed in the Carbon Stocks section.

Drivers

High fuel costs drive demand for fuelwood, in addition to the lifestyle common in Alaska. Access and availability have also become an issue. With inventoried roadless areas making up 99 percent of the Chugach National Forest, the ability to provide access to fuelwood that is more than one-quarter mile from a road is limited.

Ecosystem characteristics

General characteristics of forest vegetation of the Chugach National Forest are summarized in the Terrestrial Ecosystems and Timber sections of this assessment.

Influence beyond Forest Service authority

The influence of non-National Forest System lands is significant in the provisioning of fuelwood. On the Copper River Delta, the Cordova Ranger District coordinates with state agencies, DOT, and the City of Cordova to provide fuelwood to residents. It may be necessary to apply this partnership model in other areas as easily accessible fuelwood becomes uncommon.

Regulating Services

Carbon sequestration and impacts of climate change

Description and geographic scale

Carbon dioxide (CO_2) plays a critical role in climate change. Accounting for carbon sequestration, storage, and flux in forests is becoming a topic of increasing interest for forest land owners.

Conditions and trends, drivers, and ecosystem characteristics

The Carbon Stocks and Climate Change sections in chapter 2 provide details about the conditions and trends and system drivers and stressors affecting carbon sequestration.

The Carbon Stocks section of chapter 2 provides in depth details about ecosystem characteristics.

These discussions will not be repeated here.

Influence beyond Forest Service authority

Carbon sequestration and its climate change implications are difficult to address in national forest planning efforts and to some extent is beyond the control of the Forest Service. Continuing to study projected impacts and then taking into account changes in carbon stocks and impacts of global climate change to adapt planning efforts will be important.

Supporting Services

Sustaining biodiversity, intact ecosystems, and connectivity for global ecological processes

Description and geographic scale

Biodiversity can be considered the underpinning of an ecosystem service's condition and function. As stated by Mace et al. (2005), "Direct benefits such as food crops, clean water, clean air, and aesthetic pleasures all depend on biodiversity, as does the persistence, stability, and productivity of natural systems." Biodiversity can also be valued for its intrinsic worth, or existence value, and may provide potential future benefits that are yet unknown or unrecognized (Tilman, 1997). Loss of biodiversity impacts well-being unevenly across communities, affecting those who depend most on natural resources, such as those that practice subsistence and the rural poor (Diaz, Fargione, Chaplin III, & Tilman, 2006).

Conditions and trends

Details on the conditions and trends of wildlife, fish, and plants can be found in the Aquatic Ecosystems–Watersheds, Aquatic Ecosystems—Fish, Riparian Areas and Wetlands, and Terrestrial Ecosystem sections.

The Chugach National Forest is relatively new in a geological sense, and the patterns of biodiversity are still developing. A majority of these changes would be expected based on evaluation of the trajectory of the systems as they develop following the last glacial maximum. Successional change occurs as vegetation grows taller and understory vegetation is shaded out by taller trees or shrubs. Natural disturbances, such as flooding, windfall, herbivory, disease pockets, and fire, influence the trajectory of vegetation and habitat. Human management, such as thinning to improve moose browse or selective harvest to improve nesting habitat for marbled murrelets or harlequins, can also alter natural succession.

Climate change is influencing the entire planning area as noted in the various sections of this report; however, the consequences of human-induced climate change are poorly understood for this region (a vulnerability assessment will soon provide more insight). Key ecosystem characteristics of terrestrial vegetation and wildlife are functioning in a way that continues to contribute strongly to ecosystem integrity and sustainability within the plan area.

Drivers

The many ecosystem drivers that influence the biodiversity in the Chugach National Forest are discussed in chapter 2 in the following sections: Aquatic Ecosystems—Watersheds, Drivers and Stressors, Aquatic

Ecosystems—Fish, Riparian Areas and Wetlands, and Terrestrial Ecosystem sections. Drivers of biodiversity within the Chugach National Forest are related to the geographic locale at the interface of marine and terrestrial systems and at the transition from coastal rainforest to boreal forest; varied topography; varied disturbance processes (both at broad and fine scales); and available sources of biota.

Ecosystem characteristics

Ecosystem characteristics that support biodiversity within the Chugach National Forest are described in the Aquatic Ecosystems—Watersheds, Aquatic Ecosystems—Fish, Riparian Areas and Wetlands, and Terrestrial Ecosystem sections of chapter 2.

Influence beyond Forest Service authority

Managing for biodiversity, habitat, and intact ecological processes necessitates an all-lands approach and coordination with other agencies, land owners, and industry. Many of the initiatives the Chugach National Forest is currently involved in require collaboration and coordination with others.

Recreational experiences

Description and geographic scale

Outdoor recreation is an essential part of the culture and economy of Alaska. Alaska's glaciers, mountains, lakes, fish and wildlife, peat bogs, muskegs, spruce/birch forests, intact landscapes, and river systems have a unique mystique to residents, tourists, and people around the world. The lives of Alaskans are intimately interwoven with their natural surroundings. Wildlife, fish, plants, and the recreational opportunities in Alaska are reflected in the lifestyles, businesses, food, art, film, drama, dances, books, advertising, and other products throughout the state and abroad. Local residents as well as non-local or non-Alaskan visitors engage in all types of recreational activities during all seasons within the Chugach National Forest.

Conditions and trends

For information about the conditions and trends of recreational opportunities, activities, and provisions within the Chugach National Forest, see the Recreation and Scenic Character section of this assessment. This information will not be repeated here. Tourism sector businesses, including outfitters and guides, benefit from spending by visitors. Additionally, the Social, Cultural, and Economic Conditions section of this assessment includes a detailed discussion of jobs and income supported by visitors to the Chugach National Forest.

Drivers

There are a number of drivers potentially affecting recreation on the Chugach National Forest. These are described in detail in the Recreation and Scenic Character section.

Ecosystem characteristics

See the Recreation and Scenic Character section in this chapter, as well as other sections within chapter 2 for details about threats to ecosystem components and conditions that could affect the resilience of recreational services.

Influence beyond Forest Service authority

Nearly 25 percent of the lands within the boundary of the Chugach National Forest are owned by other individuals or entities. Ownership of nearly 12,000 acres of land within the Chugach National Forest boundary has changed since 2002, due in part to conveyances authorized by the Alaska Statehood Act and the Alaska Native Claims Settlement Act. These conveyances can impact public access to recreation opportunities, but can also create new opportunities where the lands are managed or developed for recreation purposes.

For more information on recreation opportunities occurring on non-National Forest System lands, please see the Recreation and Scenic Character section of this assessment.

Education and research

Description and geographic scale

Local communities and schools, students, youth crews, and local and non-local visitors all derive cultural, social, and historical benefits from the many opportunities to engage with natural, cultural, and historical resources of the Chugach National Forest through the educational and interpretive programs. Local populations and communities are strengthened by cultural and historical awareness. Non-local visitors transfer and apply their experiences and awareness to their home communities in other areas of the Nation, thereby extending the public benefits beyond the region.

The benefits of education and research include connecting people with nature and culture, increasing place-based-awareness, expanding opportunities for community members to interact in natural settings, spiritual opportunities and experience, increasing and improving the body of scientific knowledge about ecosystem processes, fish and wildlife populations, and social and cultural resources, and reinforcing long-standing traditions and knowledge of resources, including Alaskan Native culture and traditions. Experience with National Forest System lands and resources can be an inspiration for art, literature, and music. Education and outreach efforts clarify the link between underlying supporting services and the more direct human benefits of the national forest that are reflected more commonly in provisioning and cultural services (Asah, Blahna, & Ryan, 2012).

Conditions and trends

The capacity for visitors to benefit from educational and interpretive opportunities, as well as community events and festivals remains good and may be increasing in some cases. In addition to natural environmental and cultural amenities, landscapes, and resources, the Chugach National Forest provides educational programs, visitor centers and information sites, interpretive trails, children's programs, assistance (as partners) with organizing and facilitating community events and festivals, and maintenance/protection of historical and cultural sites.

In May 2013, the Forest Service and the University of Alaska Anchorage co-hosted Classrooms for Climate: A Symposium on the Changing Chugach, Northern Ecosystems, and the Implications for Science and Society. More than 250 participants gathered, bringing together partners in climate inquiry, education, and management. One project that developed from the symposium engages stakeholder communities in a dialogue on their perspectives on the roles and contributions the Chugach National Forest offers in terms of economic, social, and cultural services. The second project evaluates ecosystem services most at risk to changes predicted in the region's climate, relative to the key economic sectors and socio-cultural systems.

The Pacific Northwest Research Station, in collaboration with Loyola, Michigan State, Notre Dame, and Oregon State universities, was recently awarded a two-year National Fish and Wildlife Federation Grant to investigate the effects of climate change on the Copper River Delta. Several other long-term research studies of national and international importance are taking place within the Chugach National Forest, including dusky Canada goose studies for the Copper River Delta and glaciology research at Columbia and Wolverine Glaciers in Prince William Sound. Research station temperature studies are collecting consistent data across the three geographic areas of the Chugach National Forest (Kenai Peninsula, Prince

William Sound, and Copper River Delta); last year temperature sites were expanded to the Yakutat Forelands on the Tongass National Forest. The intent is to also establish temperature sites on the Stikine River Flats. Once all three areas (Copper River Delta, Yakutat Forelands, Stikine River Flats) have temperature sites installed, it will allow for the comparison of habitat conditions and effects of climate change across all three of Alaska's Key Coastal Wetlands. Five RNAs totaling 21,500 acres have been designated within the Chugach National Forest, providing non-manipulative research and monitoring opportunities in a variety of areas (see the Designated Areas section).

Research permits, youth programs, and community events have all either been sustained or are increasing in the plan area.

More detailed information on opportunities for connecting people and nature can be found in the Recreation and Scenic Quality section of this assessment. In addition, information on research natural areas and climate change can be found in the Designated Areas and Climate Change sections of this assessment, respectively.

Drivers

Risks or drivers include concerns about fluctuations in the Chugach National Forest budget that could affect support for programs and events along with changes in demographics (people moving out of the area) and a corresponding decrease or loss in awareness about traditional culture and knowledge. Shifts in education and classroom instruction have been observed.

Ecosystem characteristics

Like recreation opportunities, education and research benefits are supported by the diversity of natural and culture resources within Chugach National Forest. The proximity of Portage Valley to Anchorage makes it a destination for elementary and university students alike to learn more about the natural world. The importance of the Copper River Delta for millions of migratory birds makes it a perfect setting to research and learn about the importance of wetlands to many different species. Climate change and other processes may alter these ecosystems, which may lead to new research opportunities.

National forest management can impact delivery of education and research services through its interpretation and conservation education programs as well as its special use permit process. Both of these programs have evolved over the past decade. The Forest Service has been working with partners to expand educational opportunities through the hands of others and continues to be responsive to research requests.

Influence beyond Forest Service authority

Local businesses and communities also provide support or contribute education and research services.

Subsistence

Subsistence hunting and fishing is both a livelihood and a way of life for many rural residents of Alaska and is protected by the 1980 Alaska National Interest Lands Conservation Act (ANILCA). ANILCA Section 803 defines subsistence uses as "…the customary and traditional uses by rural Alaska residents of wild, renewable resources for direct, personal, or family consumption as food, shelter, fuel, clothing, tools or transportation…" (e.g., harvest of fish, wildlife, berries, firewood, logs, plant materials, etc.). Federal jurisdiction for subsistence hunting and fishing extends to 60 percent of the state's land base, including the Chugach National Forest and the Tongass National Forest in southeast Alaska.

The Alaska Region Subsistence Program represents a unique Forest Service role in wildlife and fisheries management. Normally, the Forest Service role is confined to habitat management, with the State focusing on population management. In Alaska, the Forest Service has a role and workload in developing harvest regulations for subsistence wildlife and fish on Federal lands and waters within the State of Alaska and in enforcing subsistence regulations on National Forest System lands.

Relevant Information

- Subsistence management is a Forest Service program unique to the Alaska Region and is an important part of the Forest Service mission within the region.

Importance of Subsistence

Although not generally thought of in economic terms, subsistence resources play an integral role in the lives of many Alaskans when the replacement value of harvested resources is considered. These resources are also bartered and traded for goods, such as gasoline and boats that are needed to harvest these resources. Additionally, Federal regulations allow limited amounts of harvested resources to be sold.

Wild renewable resources play an important role in ceremonies and long-standing social and religious traditions of Alaska Natives, as well as in the sustenance of rural Alaska residents. Human survival, the economy, and the means of establishing prestige and of maintaining peace have all involved the consumption, transfer, and exchange of fish and game and of products made thereof, since time immemorial (Brown & Burch Jr., 1992).

Hunting and fishing are important activities for Alaska Natives as well as non-natives. Surveys suggest that the continued existence of wildlife and fish and the opportunity to hunt and fish are indispensable to the maintenance of what might be called the pioneer Alaskan lifestyle, particularly in rural communities (Brown & Burch Jr., 1992).

The Chugach National Forest plays several important roles in implementing ANILCA Title VIII Section 804 that mandates "the taking on public lands of fish and wildlife for non-wasteful subsistence uses shall be accorded priority over the taking on such lands of fish and wildlife for other purposes."

The Federal Subsistence Board has determined that for purposes of the Federal Subsistence Program, the only non-rural community within the boundary of the Chugach National Forest is Moose Pass. Therefore, the rural communities on the Chugach National Forest are Cooper Landing, Hope, Whittier, Chenega Bay, Tatitlek, and Cordova. Households in these communities harvest an average of 550 pounds of edible wild renewable resources per year (ADF&G, 2013c), an average of 203 pounds per capita. When compared to the 264 pound average per capita purchase of meat in the United States (FAO, 2013), this indicates a high dependence on natural resources for food by people in these communities.

Alaska National Interest Lands Conservation Act Guidance

Harvest of subsistence resources in compliance with ADF&G sport, personal use, and subsistence regulations plays an important role in the lives of both rural and non-rural Alaska residents. Alaskans living in non-rural communities within the boundary of or near the Chugach National Forest also harvest significant amounts fish and wildlife under state sport or personnel regulations. The populations of Valdez, Seward, Moose Pass, Kenai, Soldotna, Girdwood, and Anchorage fall into this category.

Virtually all of the Chugach National Forest is open to the harvest of subsistence resources except for small areas that are restricted due to safety concerns, such as active mines or developed recreation sites. Additionally, a portion of the Power Creek drainage north of Cordova is closed to motor vehicles, including subsistence activities. The Power Creek area has a low capacity for motor vehicle use for subsistence due to safety and environmental concerns and a determination was made that the closure would not significantly restrict subsistence uses.

Section 810 requires that the effects of land use decisions on subsistence uses will be evaluated. Any projects proposed to take place in the Chugach National Forest are analyzed in terms of their impacts to subsistence uses and resources. Analyses of Chugach National Forest projects related to Section 810 of ANILCA have ensured that no significant impacts to subsistence uses and resources have occurred. In addition, all special use permit applications are evaluated for the potential to impact subsistence uses and resources. Special use permits are frequently modified to mitigate their potential impacts to fish or wildlife resources important to subsistence users on National Forest System lands.

Section 811 of ANILCA states that “rural residents engaged in subsistence uses shall have reasonable access to subsistence resources on the public lands.” This means that most areas in the Chugach National Forest that are closed to motor vehicles remain open to motor vehicle use by rural residents engaged in subsistence activities.

Although lands are open to motor vehicle use for subsistence purposes, it does not mean that vehicle use cannot be restricted due to safety concerns or resource damage. For example, much of the Copper River Delta is accessed by airboats by Cordova residents hunting moose. Airboats are able to traverse wetlands without damaging vegetation whereas wheeled motor vehicles leave long-lasting trenches on these same habitats. For this reason, the use of wheeled motor vehicles on much of the west Copper River Delta has been discouraged.

Wild Renewable Resources

Wild renewable resources used by rural residents for subsistence are varied and include animals, plants, timber, and other special forest products, such as fungi and berries. The most important single resource used for food by rural communities within the Chugach National Forest is salmon. Households in these communities harvest an average of 230 pounds of salmon per year (ADF&G 2013f). Other fish species, both fresh and salt water, mammals, birds, and marine invertebrates (e.g., crabs, clams, and shrimp) are also among the important subsistence resources used as food. Berries constitute an important food resource with households in Chugach National Forest rural communities harvesting at least nine pounds per year (ADF&G, 2013c). With high energy costs in Alaska, for rural communities the most important non-food wild renewable resource is fuelwood.

The Forest Service monitors fish and wildlife with partners to help ensure conservation of populations and subsistence use opportunity. Since 1999, the Forest Service has annually cooperated with ADF&G on Sitka black-tailed deer pellet counts, mountain goat and moose surveys. From 2000 to 2010, the Forest Service funded the Native Village of Eyak to help assess salmon run size in the Copper River. Due to a reduction in appropriations, the Department of the Interior now funds this effort. Knowledge of community uses and needs also contribute to the subsistence management structure. The Forest Service funded projects examining traditional ecological knowledge about the use of black bears and mountain goats in Prince William Sound in 2006 and a study of household subsistence harvest areas in Prince William Sound as part of the Prince William Sound Framework in 2009 (Poe, Gimblett, & Burcham, 2010; Simeone, 2008).

Fish

All Chugach National Forest rural communities reported harvesting fish, with salmon ranking as the most important group of species. Within the Chugach National Forest, much of the harvest of fish for food takes place under various sets of State and Federal regulations. In fresh water, salmon, trout, and char are harvested in accordance with both State sport regulations (all Alaska residents) and Federal subsistence fishing regulations (only rural residents with a customary and traditional use determination). The two most important Federal subsistence fisheries that take place in the Chugach National Forest are the dip net fishery at the Russian River Falls and a freshwater fishery on the Copper River Delta. In 2012, 120 residents of Hope and Cooper Landing harvested 1,339 sockeye salmon on the Russian River fishery. The number of Cordova residents participating in the Federal subsistence salmon fishery in fresh water streams on the Copper River Delta has doubled in recent years to more than 60 permits issued annually. The harvest from this fishery has recently exceeded 500 coho and sockeye salmon.

Currently, fish populations are at levels that fully support available subsistence fisheries. Salmon runs at weirs located on the Copper River Delta, Kenai Peninsula, and Prince William Sound (ADF&G, 2013c) indicate most fish populations, with the exception of chinook salmon in the Kenai River, are within their natural range of variation and harvestable surpluses are more than needed to sustain subsistence fisheries.

Wildlife

Rural communities within the Chugach National Forest reported harvesting large mammals for food but the species of importance varied with locality. All but one community (Tatitlek) reported harvesting moose, with an average of 60 pounds (27.2 kilograms) harvested per household annually (ADF&G, 2013c). Deer were similarly important to the Prince William Sound communities of Cordova, Tatitlek, Chenega Bay, and Whittier, where harvest averaged 58 pounds (26.3 kilograms) per household annually (ADF&G, 2013c). To a lesser degree than deer or moose, caribou are harvested by rural residents of the Kenai Peninsula, and mountain goats are harvested by residents of the Kenai Peninsula and Prince William Sound. Some, but not all of this harvest occurs under Federal subsistence regulations.

Moose rank as one of the most important subsistence foods throughout Alaska, including within the communities near the Chugach National Forest. Moose can be harvested by all State residents under State harvest regulations and by rural residents under Federal subsistence harvest regulations. As of 2014, the communities of Hope, Cooper Landing, Chenega Bay, and Tatitlek have a Federal customary and traditional (CT) use determination for moose in all of Unit 7 (ADF&G refers to these same geographic units as Game Management Units or GMUs) on the Kenai Peninsula. Cordova has a CT use determination for moose in Unit 6C on the Copper River Delta (36 CFR 242.24 and 36 CFR 242.26). The population status of moose in these areas varies considerably.

On the Kenai Peninsula, the Unit 7 moose population increased rapidly during the 1960s after wildland fires in adjacent Unit 15A created large areas of early succession vegetation. Wolf numbers were simultaneously reduced to low levels as a result of predator control efforts. A rapid moose population decline followed in the early 1970s after three severe winters in four years. The moose population has fluctuated at low levels since then as predator populations have stabilized and habitat succession has progressed into later seral stages (Del Frate, 2002). The Unit 7 moose population is considered stable at low densities and is expected to remain at these levels unless significant habitat alteration occurs

(McDonough, Unit 7 Moose Management Report, 2010). As a result, residents of Cooper Landing and Hope, who have had CT use determinations for Unit 7 moose since 2008 and 2010, respectively, have harvested zero to two moose annually under Federal subsistence regulations.

Similarly, in Prince William Sound, the moose population in Kings Bay, a disjointed segment of the Unit 7 moose population, has not been capable of sustaining subsistence needs for the two communities, Tatitlek and Chenega Bay, which have CT use determinations for moose and would be permitted to hunt moose if populations were sufficient (36 CFR 242.26(n)(7)). The amount of moose habitat in the Kings Bay area is very small and consists of narrow riparian areas along the Kings River and Nellie Juan River. Productivity and viability of this small population of moose is marginal. Moose surveys in 1997, 2001, and 2005 counted 20, 9, and 5 moose, respectively (Spraker, 2001; OSM, 2005). As a result of these low numbers, the Federal Subsistence Board kept the moose season closed for conservation concerns as recently as 2012. Due to low moose densities, abundant forested habitats that make surveys difficult, and budgetary constraints, very little moose monitoring has been conducted by ADF&G in Unit 7. Additional survey efforts could improve the management of the small moose population in Kings Bay and help identify management opportunities.

Habitat conditions are currently good for moose on the Copper River Delta. The 1964 earthquake uplifted the tidal wetland and initiated plant succession, which has led to abundant browse for moose. In the western Copper River Delta (Unit 6C), all of the allowable antlerless moose harvest and 75 percent of the bull moose harvest takes place under Federal subsistence regulations. The remainder of the bull moose harvest in Units 6C and the harvest of moose in Units 6A and 6B takes place in compliance with State harvest regulations. The Federal subsistence harvest in Unit 6C is extremely popular among the qualifying Cordova residents with as many as 900 applications submitted annually for the random drawing. The number of permits issued has varied from 26 to 105 between 2007 and 2011, and harvest success is almost 100 percent. Habitat models have predicted a decline in willow browse for moose in the future and the Cordova Ranger District has begun a program to mechanically treat patches of alder and spruce to favor early successional browse species, such as willow.

Sitka black-tailed deer are an important resource to the communities of Prince William Sound. Although residents of Prince William Sound have a positive CT use determination for deer in Unit 6, most harvest has taken place under State regulation. Deer populations remained relatively stable during the last decade until the winter of 2011-12. Near record snows across Prince William Sound reduced the deer population by 50 to 70 percent. As a result, the State season for deer and the Federal season for does closed 3 weeks early in 2012. Deer, especially at the northern end of their range, depend on old growth timber as winter habitat. Most of the deer winter habitat on the islands of Prince William Sound is in good condition with the exception of areas where logging has occurred on private lands on southern Montague Island.

A variety of other species are important to subsistence users in the Chugach National Forest for both food and other values. Caribou, mountain goats, and a variety of small game animals are used as food. Marine invertebrates, such as clams, crabs, and shrimp, are also important foods for many households. The furs and other parts of many species are also important for the making of clothing and handicrafts. Populations of these species are generally considered stable and are managed for sustainable yields.

Plants

Plants are used in a variety of ways by rural and non-rural residents of Alaska. While not the primary source for heating in southcentral Alaska, fuelwood is important to many residents, especially those in areas with high heating fuel costs, such as many of the rural communities within and near the Chugach National Forest (Nicholls, Brackley, & Barber, 2010). Currently, opportunities to harvest fuelwood are available on National Forest System lands and other ownerships on the Kenai Peninsula and on State lands on the Copper River Delta. As mentioned in the Plants resource management section, berries are another plant material heavily used by all rural communities of the Chugach National Forest. They are abundant in the Chugach National Forest but subject to natural variations in production.

Future of Subsistence Uses

Wild, renewable resources produced within the Chugach National Forest will likely remain an indispensable part of the livelihood and lifestyles of both rural and non-rural Alaska residents. The Chugach National Forest will remain integral to providing the opportunity and resources to pursue Federal subsistence and state sport and personal use activities. Changes in use patterns and levels of use, however, will likely occur. Surveys of Prince William Sound households conducted as part of the Chugach National Forest's Prince William Sound Framework (Poe, Gimblett, & Burcham, 2010) identified areas important to subsistence harvest, trends in use of these areas, and reasons for changes in use patterns. These surveys measured the household use of 24 wild resources, and found that households reported they intended to harvest only 6 of these resources at similar levels in the future. Reasons for decreased use of resources included lifestyle changes, lingering effects of the Exxon Valdez oil spill, general changes in resource availability, and competition with others, including recreational users (Poe, Gimblett, & Burcham, 2010). Competition from other users likely affects subsistence users on the Kenai Peninsula as well. These and other factors have the potential to modify subsistence use patterns in the Chugach National Forest over time. Consistent with ANILCA, subsistence will remain a priority for the harvest of wild renewable resources across the national forest.

Fish

The use of fish that originate from the Chugach National Forest is largely associated with commercial and sport fisheries for salmon, trout, and char. Subsistence and personal use fisheries also rely on Chugach National Forest raised fish. Not all fishery use is consumptive. For example, 99 percent of the Dolly Varden char caught in the upper Kenai River recreational fishery are released back into the wild and not kept for food (Begich & Pawluk, 2011). Other popular, non-consumptive public uses of Chugach National Forest fish include fish viewing, science education, photography, and climate change monitoring.

Of the 600 to 635 million salmon estimated to occupy the North Pacific Ocean in an average year, 93 to 100 million of them return to southcentral Alaska waters (Rodgers D. E., 2001; Ruggerone, Peterman, Dorner, & Myers, 2010). Since the Chugach National Forest is the primary salmon production area in southcentral Alaska, this means that up to one-seventh of the salmon in the Pacific Ocean begin life within the Chugach National Forest.

Relevant Information

- Up to one-seventh of the salmon in the Pacific Ocean originate from Chugach National Forest watersheds.
- In Alaska, the largest freshwater fisheries for Chinook salmon, Coho salmon, sockeye salmon, and rainbow trout all occur in Chugach National Forest watersheds.
- More than 70 percent of the estimated 2.5 million days spent by anglers in Alaska occurred in southcentral Alaska, on the Chugach National Forest.
- The annual economic impact of salmon produced within the national forest in commercial fisheries is approximately 232 million dollars per year. This generates an estimated 3,141 jobs. The economic impact of recreational fisheries is more difficult to assess, but it is substantial considering it is estimated to support 1,062 jobs (see discussion in the Social and Economic Conditions section of this chapter).

Species Commonly Enjoyed and Used by the Public

In terms of numbers, economic value, cultural significance, and ecological importance, the five species of Pacific salmon that occur within the Chugach National Forest are the primary resource (see table 66). The Chugach National Forest provides the freshwater habitat for these fish, without which they could not exist. In addition to salmon, several other anadromous species rely on National Forest System lands, including steelhead trout, sea-run cutthroat trout, sea-run Dolly Varden char, and eulachon. Resident fishes are also a key part of the Chugach National Forest. The most commonly used by humans are Dolly Varden char, rainbow trout, and cutthroat trout.

Table 66. Common name, scientific name, and general distribution of fish produced within the Chugach National Forest having high public use and commercial value

Common Name	Scientific Name	Distribution
Chinook (king) salmon	*Oncorhynchus tshawytscha*	Throughout the national forest
Coho (silver) salmon	*Oncorhynchus kisutch*	Throughout the national forest
Sockeye (red) salmon	*Oncorhynchus nerka*	Throughout the national forest
Chum (dog) salmon	*Oncorhynchus keta*	Throughout the national forest
Pink (humpy) salmon	*Oncorhynchus gorbuscha*	Throughout the national forest
Steelhead trout	*Oncorhynchus mykiss*	Copper River Delta and perhaps the Kenai Peninsula
Cutthroat trout	*Oncorhynchus clarki*	Prince William Sound and Copper River Delta
Rainbow trout	*Oncorhynchus mykiss*	Kenai Peninsula and Copper River Delta
Dolly Varden char	*Salvelinus malma*	Throughout the national forest
Eulachon (hooligan)	*Thaleichthys pacificus*	Twentymile River (Kenai Peninsula) and Copper River Delta

Conditions and Trends

The information presented here on the relative condition and trends of selected fish is also discussed in the Aquatic Ecosystems—Fish section of chapter 2. However, the focus of chapter 2 is ecosystems, which makes for a different presentation than the summary provided here. In this section, the focus is the condition and trend of single fish species for each of the three geographic areas.

Copper River Delta

Pink and chum salmon are not common in the Copper River Delta geographic area. The primary species are coho salmon and sockeye salmon. The trend for freshwater catch of coho salmon in this area is upward, while comparable information for sockeye salmon does not show any trend. Information on the other species is limited; however as reported in chapter 2, the trend for Chinook salmon appears downward, while no trend was evident for Dolly Varden char. Catch data for cutthroat trout (Hochhalter et al. 2011) also show a range of variation but no clear indication of a trend.

Kenai Peninsula

Fish produced within the Kenai River watershed dominate fisheries in the Kenai Peninsula. The largest freshwater fisheries in Alaska for Chinook salmon, sockeye salmon, coho salmon, and rainbow trout all occur within the Kenai River watershed (Begich & Pawluk, 2011). It is notable these fisheries are sustained entirely without supplementation from hatchery produced fish. The trends for these species range from noticeably downward for Chinook salmon to upward for other primary species. The increasing trend in catch of rainbow trout and Dolly Varden char has been particularly dramatic. A more detailed discussion of the trends and condition of these species and associated ecosystem is provided in the Aquatic Ecosystem—Fish section in chapter 2.

Sockeye salmon produced from the Kenai River watershed are the most important salmon species in this area for commercial fisheries. The estimated harvest of sockeye in commercial fisheries has ranged from 1.7 million to 13.6 million fish (Shields & Dupuis, 2012).

The singular eulachon fishery on the Kenai Peninsula is located in the Twentymile River and the nearby upper Turnagain Arm. The harvest from 1995 to 2004 averaged 34,460 fish (Bosch, 2010). Harvest decreased to 9,000 fish in 2005. Harvest has been increasing in recent years with approximately 29,000 fish harvested in 2009. The spawning levels of this species are not monitored, and the biology of the species is not well understood. Eulachon are an important food source of the beluga whale, which is currently listed in compliance with the Endangered Species Act (Hobbs, Shelden, Rugh, & Norman, 2008).

Prince William Sound

Pink and chum salmon are the primary species of importance in Prince William Sound. As described in chapter 2, the wild pink salmon population has averaged around 10 million fish since 1960, and the chum salmon population has averaged 1 million fish since 1970. There is no indication that either species is increasing or decreasing. However, a large hatchery program for both species was established in the early 1990s. Hatchery fish from these programs now dominate the catch of salmon in Prince William Sound. Commercial fishery catches have ranged up to 71.7 million fish during the last 20 years (Botz, Sheridan, Weise, Scannell, Brenner, & Moffitt, 2013). Not all hatchery fish are caught or return to hatchery facilities. Stray hatchery fish on spawning grounds also used by wild fish may pose a risk to the continued sustainability of the wild salmon production in certain areas of Prince William Sound.

Only partial information is available for the other primary fish species in this region. As reported in chapter 2, limited information indicates the trend for Prince William Sound Chinook salmon may be upward, neutral for coho salmon, and downward for sockeye salmon and Dolly Varden char. Based on data presented by Hochhalter et al. (2011), the catch of cutthroat trout in the Prince William Sound appears to be neutral.

Contribution to Social and Economic Sustainability

In Alaska, recreational and commercial fishing plays a central economic and cultural role. For example, Southwick Associates, Inc. et al. (2008) estimated that in 2007, resident and non-resident recreational anglers fished 2.5 million days in Alaska, with 72 percent of those days taking place in southcentral Alaska. Bowker (2001) found that Alaskans devoted more trips per capita with fishing as the primary purpose than any other outdoor activity. In addition to the recreational and commercial importance of fishing, the unique existence of subsistence and personal use fisheries in Alaska is evidence that fish play a fundamental cultural and renewable local food supply role for many that live in this state.

In terms of economic impact, fisheries are an extremely important component to Alaska’s economy. The commercial seafood industry has about a 5.8 billion dollar effect on the economy of Alaska (Northern Economics, Inc, 2009). About 25 percent or 1.5 billion dollars of this effect is associated with salmon fishing. The sport fishing industry, which is heavily dependent on salmon, trout, and char, contributes about 1.4 billion dollars to the economy of Alaska (Southwick Associates, Inc, 2008).

In terms of jobs, Southwick Associates et al. (2008) estimates that the Alaskan sport fishing industry contributes 15,879 jobs to the state of Alaska. Of the 78,519 jobs associated with the seafood industry, approximately 25 percent (19,630) are associated with the salmon fisheries (Northern Economics, Inc, 2009).

Converting statewide estimates of use, economic value, and jobs to the portion that is attributable to fish production that occurs or originates within the Chugach National Forest is difficult. From a sport fishery perspective, Southwick and Associates (2008) estimate the total economic output of sport fishing by non-residents for southcentral Alaska was 631 million dollars (supporting 6,365 jobs), demonstrating the economic (and social) significance of sport fishing in the region. Further, assumptions about visitor spending in Southwick and Associates (2008) include expenditures (e.g., boat purchases) that may not be impacted by changes in Chugach National Forest conditions.

The Chugach National Forest is a major production area for salmon, is heavily used by anglers, and therefore accounts for a large percentage (e.g., 50 percent or greater) of total fish pursued by anglers for the southcentral Alaska region. Fish produced within Chugach National Forest watersheds (and corresponding fish populations and catch rates) play a critical role in supporting the economic output and regional employment linked to sport fishing. It is difficult to estimate the percentage of output and employment attributable to the Chugach National Forest because recreational fishing visits and spending are a complex function of many factors. The evidence still demonstrates that Chugach National Forest produced fish account for a substantial portion of economic output and employment associated with sport fishing in the region and the state. See the Social, Economic, and Cultural Conditions section in this chapter for more discussion about economic impacts from recreation.

Estimates for the economic impact of commercial fisheries are based upon ADF&G's annual fishery statistics by region as summarized by R. Medel, Forest Service fish biologist, Tongass National Forest. The average direct value of commercial landings for Prince William Sound fisheries from 1994 to 2012 was 62 million dollars. Although, fish produced within the Chugach National Forest are caught in other fisheries and particularly in Cook Inlet, it is not known what fraction they represent of the total catch. This is not the case with Prince William Sound fisheries, where salmon caught are almost all from Chugach National Forest watersheds. The value of the Prince William Sound commercial fishery was used as a rough approximation for the Chugach National Forest. The direct value of this fishery was expanded to a total economic impact using the ex-vessel value to total economic impact ratio from information presented by Northern Economics, Inc. (2009). They reported a value of 1.55 billion dollars for Alaskan fisheries and a total economic impact of these fisheries of 5.8 billion dollars to the state's economy, a 3.7-fold increase over the ex-vessel value. Based on this ratio, watersheds within the Chugach National Forest produced salmon that contributed to fish harvests and could be valued at 232 million dollars in total output to Alaska's economy. Economic output, as used here, includes direct harvesting and processing impacts, as well as indirect and induced impacts.

Based on information provided by Northern Economics, Inc. (2009), each 73,867 dollars added to the economy could be associated with one job for the industry. Using this relationship, it was estimated that the Chugach National Forest produced salmon help support 3,141 seafood industry-related jobs. This estimation is based on extrapolations from existing state-wide economic impact models, i.e., IMPLAN models derived by Northern Economics, Inc. (2009); estimates may differ and could be higher if models and/or multipliers were derived specific for salmon, the southcentral region of Alaska, and data representing other years of harvest and ex-vessel prices.

Fish habitat and productivity within the Chugach National Forest contributes hundreds of millions of dollars in economic output and thousands of jobs in the commercial and sport fishing industries. Chugach National Forest fish resources play a substantial role to the economic, social, and cultural well-being of Alaska.

Wildlife

Humans use many of the wildlife (and invertebrate) species occurring within the national forest for the meat, eggs, other food, fur, feathers, skins, shells, trophy products, bait, and recreational opportunities they provide. The wildlife species within the national forest have been interwoven into human culture, survival, economic development, and lifestyle since the last ice age. Hunting, trapping, viewing, and subsistence uses remain extremely important to the livelihood of those who live here. Additionally, wildlife species play an important role in local, state, and national economies. In some areas of Alaska, wild game represents nearly all of the non-fish protein consumed by a household. Even in some urban households, moose, caribou, or deer are the primary meat consumed. Titus et al. (2009) noted that in 1991 Alaska ranked highest (93 percent) for the proportion of its population that participated in fish and wildlife related recreation. Selections of the many species that occur within the national forest that are commonly used and valued by people are highlighted in this section.

The following three questions about wildlife resources are addressed:

1. Which species are commonly used by the public for hunting, trapping, and wildlife viewing?
2. What is the status and trend associated with each species used by public for hunting, trapping, and viewing?
3. What is the social and economic importance of these species?

The general status and trend of wildlife species within the national forest, where known, are provided from research and survey information conducted by the USFWS, ADF&G, and others. Skalski et al. (2005) summarize that accurate and precise estimates of wildlife population demographics are crucial to successful conservation and management, but they also highlight the many challenges in gathering this information, including funding (Doak, Gross, & Morris, 2005; Hegel T. M., Cushman, Evans, & Heuttman, 2010; MacKenzie, 2005; Murray & Patterson, 2006; Waits & Paetkau, 2005). Rigorous population estimates of most wildlife species in Alaska are not available.

Alaskan species are described by status in the Wildlife Conservation Strategy (ADF&G, 2006). The strategy focuses on species with the greatest conservation need and includes special status species reports prepared by the Alaskan Natural Heritage Program. It addresses the economic value of game species but also stresses the values of non-game species:

> "*Nongame species are an integral part of every Alaskan ecosystem and many are important for traditional subsistence purposes: Along with plants, nongame species form the foundation of the food chain that produces Alaskans wealth of harvestable resources*."

The Wildlife Conservation Strategy identified the Kenai Peninsula as one of the few areas in Alaska that is experiencing urbanization and development that affect the connectivity of wildlife habitat. It points out that:

> *"…we've barely scratched the surface in terms of recording the diversity, abundance, distribution, and habitat relationships in the state…for the hundreds of species for which information is unknown, we are unable to provide an accurate assessment of populations or their habitats."*

ADF&G manages game species by game management units (GMUs) divided into smaller hunt units (HUs) also known as subunits. These units are used to manage hunting and report hunting statistics. For the location of the game management units located in whole or in part within the national forest, see the GMU map in the map package appendix. The western portion of HU 6A; most of HUs 6B, 6C, and 6D;

and the north half of GMU 7 are within the national forest. GMU 11 and HUs 13D and 14C overlap a much smaller portion of the national forest. Mountain goats and Dall's sheep are managed by even smaller herd/count units within HUs.

The Federal Subsistence Program also manages wildlife on Federal public lands (see the Subsistence section). The Federal program uses the term unit in place of game management unit since game implies sport use and the Federal program is for subsistence only. In this section, state terminology is used while in the subsistence section, Federal terminology is used, but both represent the same geographic units.

Harvest management is a significant driver of hunted and trapped wildlife management on National Forest System lands. Annual regulations of harvest seasons, bag limits, sex ratios, age classes, and harvest thresholds vary by species and administered harvest area (GMU, HU, or herd unit) such that descriptions of trends for each of these would be too extensive for this Assessment. Further, administered hunt areas do not coincide with the national forest boundary. Using population trends from ADF&G or USFWS data could therefore be misleading.

The following section of this assessment focuses on the aspects related to status and trends most influenced by Forest Service management. Hunter numbers and access were averaged for the major game species (summarized from ADF&G management reports) to provide use and access information not readily captured in the NVUM recreational information.

The latest published ADF&G management report (ADF&G, 2014b) provides data up through 2010 or 2011depending on specific data type. The reader is encouraged to view the ADF&G Web site and USFWS migratory bird hunting Web sites for the most current information about the hunting/trapping for their species of interest.

The most influential Forest Service management activities affecting wildlife populations, hunting, trends, and behavior involve access, permits for special uses (including outfitter and guides), vegetation manipulation, resource extraction (e.g., wood, special forest products, and minerals), infrastructure development for Forest Service or requested actions, and disturbances associated with these actions or use of the national forest (see chapter 2).

Hunters, trappers, and wildlife watchers contribute to the economics of the area. Locals may buy goods and services, including planes, boats, OHVs, and fuel and many will use hunted animals for food, skins, trophies, or cultural uses. Non-residents will have higher expenses to access an area and may rent equipment in addition to purchasing lodging, food, and fuel. Non-Alaskans are required to use outfitters or guides for hunting some sheep, goats, and brown bear in Alaska. Non-residents often have their game skinned and mounted by local taxidermy businesses and may pay to process and ship meat out of state.

Relevant Information

- Understanding of Kenai Peninsula brown bear and management of that population has changed significantly since development of the 2002 Forest Plan. An interagency study estimated brown bear population size on the Kenai Peninsula using local field data gathered in 2010 resulting in an estimate of 582 individuals (95 percent CI 469-719). Results indicate there may be twice as many brown bear than estimated when the 2002 Forest Plan was published. Brown bear populations may be more secure than assumed when specific management areas were developed to conserve brown bear (e.g., the Brown Bear Core Area Management Area (USDA, 2002a)). However, high hunter harvest in 2013 and 2014 has resulted in renewed uncertainty regarding brown bear status.
- Black bear harvest in GMU 6 currently exceeds ADF&G's harvest objective by 2 to 3 times.
- Introduced, non-native, and feral animals (including mammals, birds, invertebrates, reptiles, amphibians, and mollusks) have the potential to expose native wildlife to diseases and pathogens for

which they have no resistance. Climate change may increase the chance of contact with infected organisms. Warming temperatures can also increase pathogen development and survival rates, disease transmission, and host susceptibility (Harvell, et al., 2002). Preventing contact may be the best defense.

- Domestic goats and sheep and their close relatives can harbor diseases that severely impact Dall's sheep (Schommer & Woolever, 2008) and mountain goats (Patton, Bildfell, Anderson, Cebra, & Valentine, 2012). ADF&G has restricted the use of domestic goats and sheep during hunting season. The Forest Service could implement similar restrictions for all uses to conserve native wildlife by restricting the use of domestic goats, sheep, llamas, and other related animals as pack animals and by not allowing contact between native sheep and goats with their domestic relatives in any habitat.
- The Forest Service could consider implementing preventative measures to limit the potential exposure of specific animals to pathogens, such as the chytrid fungus (which affects amphibians) and white nose syndrome fungus (which affects bats).
- Human use, including hunting, trapping, motor vehicle and non-motorized recreation, and facilities development within and adjacent to the national forest are increasing in many areas, but no analysis has been done to identify thresholds where such increased use will begin to threaten essential wildlife functions for some species.
- Climate change is expected to alter habitat conditions and change the feeding, sheltering, and migratory patterns of some wildlife.
- The national forest retains the full component of wildlife and ecological process that have been relatively uncompromised by species or habitat loss, development, or road construction. The national forest provides a unique landscape in which to study and evaluate natural processes.
- Recreational users have the potential to impact wildlife habitat, behavior, and sustainability. Landscape level evaluations of crucial wildlife habitat and recreational use, special use permits, and commercial permits may better incorporate mitigations to avoid or reduce impacts to wildlife populations and habitat than project scale evaluations.
- Most of the development, vegetation treatments, mining, special use permits, recreational use, trails, roads, and facilities occur on a narrow band of the national forest adjacent to the ocean or on the flatter, more-accessible vegetated portions. These areas are also the most productive and valuable to wildlife.
- Data on wildlife distribution, occurrence, and habitat associations are poorly known in Alaska, with some exceptions. The lack of this information makes it difficult to accurately assess impacts of projects on wildlife and the ecosystem, to assess species that may be declining, or to identify habitat issues that need management actions to meet Forest Service objectives and policy.

Species commonly enjoyed and used by the public

The species displayed in table 67 identify some of the most valuable wildlife resources to residents and non-residents in terms of numbers, economic value, cultural significance, and ecological contribution that can be influenced by Forest Service management decisions. The national forest provides important habitat for big game species, which are hunted for meat and trophy by residents and non-residents, and furbearers, which provide furs and significant recreational and economic contributions to resident trappers.

Watching, studying, and photographing wildlife is one of the biggest draws to users of the national forest. The viewing of big animals, such as brown bear, wolves, moose, Dall's sheep, and mountain goats, are a particular prize for wildlife watchers who visit and live in Alaska. The rare glimpse of a wolverine, lynx, or river otter are particularly prized because these species are less common in the contiguous 48 states. People from around the world enjoy bird watching from tour boats, ferries, cruise ships, and kayaks. At 30 percent, Alaska is one of the top five states in terms of residents participating in birding (USFWS, 2011a). The overriding trend in outdoor recreation indicates nature-based recreation is growing, particularly viewing and photographing nature (Cordell, 2011). Alaska's Wildlife Conservation Strategy (ADF&G, 2006) also stresses the importance of wildlife viewing to the state. Tourists to Alaska rate viewing wildlife as one of the highest priorities during their visit.

The game and non-game wildlife within the national forest include millions of resident and migratory birds. The national forest provides the primary breeding ground of dusky Canada geese (see At Risk Species—Potential Species of Conservation Concern) and provides thousands of acres of wetlands for nesting waterfowl and shorebirds and a variety of habitats for migratory birds. The national forest also supports waterfowl and upland game birds popular with hunters. One of the most notable contributions from the national forest is the essential migratory bird habitat for millions of western sandpipers, dunlins, and other migratory shorebirds who stop for a few weeks in the Copper River Delta and estuaries of Prince William Sound to double or quadruple their weight during their cross continental migration.

Birds, bees, and other pollinators contribute to the development of flowers and fruits essential to many other species and highly prized by people (see chapter 2). These species are gaining more attention as watchable wildlife. The Forest Service has partnered with international partners to highlight bats, pollinators (National Fish and Wildlife Foundation), and migratory birds (Partners in Flight and many others) for their appreciation as viewable species and also their essential contributions to ecological processes (see chapter 2). Guidebooks are available for native bumblebees, birds of all kinds, and bats. These species are increasing in interest to nature-watchers everywhere, including Alaska. All of these species also contribute to the ecological function of the national forest.

Table 67. Common and scientific names of game species and furbearers that occur within the national forest and have high public use and commercial value

Common Name		**Scientific Name**
Black bear		*Ursus americanus*
Brown bear		*Ursus arctos*
Caribou		*Rangifer tarandus*
Moose		*Alces alces*
Mountain goat		*Oreamnos americanus*
Dall's sheep		*Ovis dalli*
Sitka black-tailed deer		*Odocoileus hemionus sitkensis*
Furbearers	Wolf	*Canis lupus*
	Coyote	*Canis latrans*
	Wolverine	*Gulo gulo*
	Lynx	*Lynx canadensis*
	Marten i.e., sable	*Martes Americana*
	Mink	*Neovison vison*
	River Otter	*Lutra canadensis*
	Beaver	*Castor candadensis*
	Red Fox	*Vulpes vulpes*
	Marmot	*Marmota* spp.
	Weasels	*Mustela* spp.
	Muskrat	*Ondatra zibethicus*
	Red Squirrel	*Tamiasciurus hudsonicus*

Black bear

Black bears are common throughout the forested habitat of the national forest with the exception of Hawkins, Hinchinbrook, Montague, Kayak, and Middleton islands along with other, smaller islands in Prince William Sound. Like brown bears, they have an important cultural link to native people (see Brown bears). Black bears utilize a wide variety of forested habitats, have large home ranges and are a prized specimen for hunting, trophies, and viewing. A good proportion of hunters are non-Alaskans or non-local residents.

Habitat for black bears has not been quantified for the national forest. The forested riparian habitat and succulent vegetation the national forest provides is particularly important to black bears, especially in springtime. Similarly, salmonberry, and other vegetation are essential throughout the summer. Black bears eat vegetation, seeds, and the nearly four dozen types of Alaskan berries, many of which are adapted to sprout after passing through a bird or animal's digestive system. The amount and distribution of blueberries, salmon berries, crow berries and others are partially due to the services of bears. Black bears recycle nutrients, scarify and distribute seeds, and move marine-derived nutrients to terrestrial habitats, fertilizing terrestrial vegetation. Their activities create important microhabitats for other animals and plants. They are important scavengers of dead animals and provide an important component in predator-prey relationships with young ungulates.

Black bear status and trends

There is no rigorous estimate of the black bear population within the national forest or within most ADF&G GMUs. ADF&G estimates population from harvest reports, hunter returns, and population parameters. ADF&G collects data regarding the population status of black bears from sealing certificates, harvest ticket reports, conversations with stakeholders, and opportunistic observations of black bears during other wildlife surveys (Westing, personal communication, 2014). Legally-hunted black bears taken in GMUs 6, 7, and 14 require seals (reports to ADF&G), but those taken in GMUs 11 and 13 do not (ADF&G, 2014a). Hunting over bait is permitted, consistent with ADF&G regulations (ADF&G, 2014a) in all GMUs that occur within the national forest.

Data from reported bear harvest records help ADF&G evaluate if their management objectives are being met. Garshelis and Hristienko (2006) point out the risks of incorrect interpretation of population numbers and trends using harvest data. ADF&G does not report total hunters; only successful legal hunters who have their animals sealed. Information on black bears comes from the most recent published ADF&G Management Report (Harper, 2011) which includes data from 2005 to 2009.

ADF&G black bear management reports (as of July 2014) provide harvest numbers for several years prior to the year of the management report, usually the period from 2005 to 2010. The annual harvest varied by HU and ranged from a low of 5 to 14 bears in HU 6B to 469 to 638 in HU 6D. The annual bear harvest for all of GMU 6 ranged from 569 to 758 bears during that time period (Crowley, 2011a). The annual bear harvest for GMU 7 ranged from 198 to 262 bears (Selinger, 2011a).

The management objective for GMU 6 is to maintain a black bear population that will sustain a 3-year average annual harvest of 200 bears composed of at least 75 percent males with a minimum average skull size of 17 inches (Crowley, 2011a)). According to Crowley (2011a), hunting in HU 6D has "increased substantially during the last half of the 1990s as evidenced by anecdotal reports and increased harvest." Harvest also became more widely dispersed, a statistic that Crowley (2011a) attributes in part to increasing number of transporters, fuel-efficient four-stroke engines, and inexpensive GPS units. Bait stations in HU 6D have more than doubled in the last 20 years. The average skull size of black bears in HU 6C and Prince William Sound (HU 6D) has decreased since the 1960s, suggesting an increased harvest of younger bears (Crowley, 2011a). This may be due to improvements in backcountry access related to the Anton Anderson Memorial Tunnel on the Whittier Road that opened in 2000 and improved boat/snow machine access and technology. ADF&G has increased hunting restrictions in HU 6D, but harvest continued to rise. Reported female harvest climbed until 2007 (Crowley 2011a). A large harvest of females in a low reproductive species (e.g., black bears) may lead to population declines (Schwartz & Franzmann, 1992). Preliminary reports indicate that this trend has continued through 2013 (Westing personal communication, 2014).

Most hunters reported using a plane or boat in GMU 6 or 7 to access their hunting areas. Because of their availability, roads were used more in GMU 7 than 6. OHVs, dogs, and horses were also mentioned as means of access. Access is a factor that is influenced, in part, by Forest Service policy and land use classifications. Out-of-state black bear hunters contract the services of outfitters and guides (see Brown bear). Forest Service policy requires the permitting of commercial outfitters and guides conducting business within the national forest. Outfitters and guides contribute considerable revenues to Alaska's economy. The number of outfitter and guide permits also influences hunting pressure and harvest levels, although the harvest thresholds are set by the Alaska Board of Game (BOG).

ADF&G reports often estimate the unknown and illegal kills, which are thought to approach or exceed 10 percent of the legal harvest. Poaching bears for gall bladders has been a significant issue for all bear species throughout their range, including Alaska (Servheen, 1998). In 2004, seven people were indicted for poaching black bears for their gall bladders on the Kenai Peninsula and in Prince William Sound, the largest bear poaching case in Alaska to that date. The inaccessibility of much of the national forest makes it difficult to accurately quantify the degree of illegal kill of bears or other animals (see Brown bear).

The American black bear is listed as an Appendix II species of the Convention on International Trade in Endangered Species (CITES), not because it is endangered but because its gallbladder cannot be easily distinguished from that of the threatened Asian bear (Garshelis S. L., 2006). CITES Appendix II permits trade if the take is sustainable and legal (see Brown bear).

The Forest Service has partnered with other agencies and communities to reduce the availability of human foods, waste, and other attractants to bears and to reduce problems resulting from food-conditioning and human-habituated bears (see Brown bear).

Brown bear

The national forest is one of a few that supports functional and huntable brown bear populations. Alaska has more than 98 percent of the United States population of brown bears and more than 70 percent of the North American population (ADF&G, 2010). Alaskan brown bears are prized trophy species for resident and non-resident hunters. The United States is the third largest exporter of brown bear trophies to the European Union, only after Canada and Russia (Knapp, 2006), and it is likely most of those trophies came from Alaska, because harvest in the contiguous 48 states is prohibited or highly restricted. Like black bears, they are important in native cultural practices, sought for wildlife viewing, and are one of the more charismatic native wildlife species in art, music, and legend. Alaskan myths abound with stories of bears who behave very much like people, and even bears that can transform into people. Native Alaskan myths portray bears as highly social beings. In stories they are not necessarily savage creatures, even though they are frightening for their great size and strength. The Chugach Alaska Corporation website posts cultural stories, including a historic story: Why brown bears are hostile towards men (CAC, 2014).

Brown bears occur in all three geographic areas of the Chugach National Forest. Brown bears are symbols of functioning ecosystems with a high degree of integrity and are often considered umbrella species because habitat that supports healthy bear populations will also support a diverse set of other species. They eat a protein-rich diet of salmon; ungulates when they can get them, particularly during the spring when moose and caribou are having their young; ground squirrels and other small mammals; insects; and a large quantity of grass and forbs, roots and berries. They play a role in the dynamics of ungulate populations, the spread and planting of fruiting shrubs and plants, and as a nutrient recycler depositing nutrients from nitrogen-rich salmon throughout terrestrial uplands. In localized areas, their digging can create important microhabitats, and some have considered them ecological engineers on the same vein as beavers in terms of influencing habitat. Their propensity to take young moose calves has contributed to development of predator control programs in some areas outside the national forest; conclusions regarding the effectiveness of predator control on bears to enhance ungulate populations vary (Zager & Beecham, 2006). Brown bears, like all bears, have been instrumental in the study of diabetes and kidney function due to their unique winter estivation period and how they are able to use protein without building up toxic byproducts. Brown bears are poached for gallbladders (see Black bear section), and are also a CITES Appendix II species because gallbladders are a significant reason for endangerment of other bears worldwide and Alaskan brown bear gallbladders cannot be easily differentiated from other protected bear species.

Defense of life and property

Like black bears, brown bears are motivated by the need to intake thousands of calories a day to survive. Also like black bears, they are easily attracted to fish and fish waste, gut piles, berries, human foods, garbage, and odiferous attractants. Even non-food items such as scented lotions, soaps and toothpaste, petroleum products and grease can be attractants. Bears that obtain food associated with humans are behaviorally rewarded and can become food-conditioned and habituated to being around humans (see Disturbance section in chapter 2). Bears that lose their natural avoidance of humans or take food from human sources are often killed in defense of life and property (DLP) situations. Enforcing food storage guidelines and education programs to reduce attractants can reduce impacts.

Concerns about high brown bear mortality, primarily related to DLP incidents in the Kenai Peninsula, led to several studies and management guidelines related to brown bears. ADF&G classified the Kenai brown bear as a population of conservation concern from 1998 to 2010. The Forest Service partnered with other agencies and organizations to manage and understand this species and its habitat on the Kenai Peninsula. As a result of population concerns, the 2002 Forest Plan delineated a special management area for brown bears, and identified standards and guidelines for management within those allocated Bear Core Areas (USDA, 2002a).

The 2002 Forest Plan initiated projects to evaluate populations and monitor DLP incidents related to bear habituation and depredation. Criteria for cataloguing and recording DLPs have varied across agencies and the Forest Service generally relies on ADF&G for this information. No DLPs were reported on National Forest System lands in fiscal year 2012, but 13 bear deaths were reported as DLP-related in GMU 7. One female bear was killed at the Russian River for DLP reasons in 2013.

The Forest Service has partnered with other agencies and organizations to teach national forest users and local residents about the importance of keeping human foods, waste, and other attractants away from bears. Precautions include not using bird feeders or compost near bear habitat, use of bear-resistant garbage facilities, not raising chickens in bear habitat or using appropriate electric fences to deter bears, and implementing food storage requirements in campgrounds. These precautions have reduced DLPs on National Forest System lands since the 2002 Forest Plan was approved. The Forest Service has participated in a particularly effective public involvement campaign with the Anchorage Bear Committee and ITREC teachers in Girdwood. The results are improved food storage, safety for humans, and fewer bear incidents in Girdwood. Cordova also collaborates with the Forest Service to educate residents on how to cohabitate safely with bears.

The Forest Service partners with the other land managers of the popular salmon fishing area at Russian River: the Kenai National Wildlife Refuge, Alaska Department of Fish and Game, Cook Inlet Region Inc., the Kenaitze Indian Tribe, and Alaska Department of Natural Resources. The Russian River is a road-accessible intensely-popular fishing destination that has resulted in habituation of brown and black bears. Negligent storage and handling of human-generated attractants, including fish waste, is a primary management concern. The Russian River Interagency Coordination Group recently completed the Managing Human-Bear Conflicts, Kenai-Russian River Area, Five-Year Action Plan, 2013-2017, (USDA, USFWS and ADF&G, 2013). This action plan aims to “minimize human-bear conflicts and related public/employee safety concerns, while continuing to provide recreation opportunities and conserve fish and wildlife resources at the Kenai-Russian River area.” The plan focuses on approaches to reduce availability of fish waste as a potential food source for bears and to reduce access to other human generated food sources and attractants. National forest resources dedicated to addressing bear conflicts related to fishing and recreational use at the Russian River has been growing. The current level of support may be unsustainable under predicted budgets.

Brown bear status and trends

Alaskan-wide brown bear populations were considered stable at 25,000 to 39,100 when the estimation was made using field-based density estimates from several populations to predict state-wide abundance (Miller, 1993). Brown bears are classified as big game and as such may be legally killed by resident, non-resident, and subsistence hunters with the appropriate licenses and tags during specified seasons (Alaska Administrative Code 5AAC 92.990). Knapp (2006) reports that the greatest source of adult brown bear mortality is legal and illegal killing by humans for sport or subsistence harvest and the killing of nuisance bears. Miller and Schoen (1999) identified trophy hunting as the most common source of mortality. Hunting is monitored through mandatory sealing. ADF&G adjusts seasons, harvest limits, and quotas to meet management objectives, which vary by GMU. As of 2006, CITES did not consider intensive management to be a serious threat to brown bear numbers.

Knapp (2006) summarized some recommended annual sustainable harvest levels: McCullough (1981) recommended a maximum sustainable harvest on brown bears in the Yellowstone ecosystem at 5 to 8 percent. Harris (1986) suggested the sustainable human-caused mortality level in Montana should be no more than 5 percent. Brown bears in Europe usually sustain a slightly higher annual mortality rate approaching 10 percent but they are more productive than brown bears in North America (Swenson, 2004). The estimated maximum sustainable harvest for Alaskan brown bears was estimated by Miller (1990) at 5.7 percent of the total population (based on a model that did not include density-dependent effects). British Columbia received scrutiny of its management of brown bears and developed guidelines to keep female harvest to less than 30 percent of harvest annually (Knapp, 2006). Implementing harvest guidelines based on limiting the proportion of the population harvested is constrained by significant challenges to estimate population abundance of brown bears.

Most brown bear studies within the national forest have focused on the Kenai Peninsula. Morton et al. (2013) conducted a rigorous mark-recapture study of brown bears on the Kenai Peninsula in 2010 which resulted in an estimate of approximately 624 brown bears (95 percent CI 504-772). An August 2014 re-evaluation of that data revised the estimate to 582 bears (95 percent CI 469-719) due to the availability of habitat.

The estimate of 582 bears is more than double the assumption used during the development of the 2002 Forest Plan. While there is no direct evidence that brown bears increased (or decreased) during the period from 2002 to the present, the quantitative estimate from 2010 provides a different understanding of brown bear abundance than was available in 2002 before any field-based estimate was made.

A 2013 change in the State of Alaska brown bear hunting regulations for the Kenai Peninsula included an increase in the allowable harvest and authorized hunting brown bears with bait (starting in spring 2014) for the first time. During the calendar year 2014 (January to December), ADF&G is following a mortality cap of less than 70 brown bears of which no more than 17 females can be killed. The harvest cap includes all human-caused mortality: harvest, DLP, road mortality, and agency-related mortality. As of August 11, 2014, there have been 54 reported brown bears killed by any reason in GMUs 7 and 15 on the Kenai Peninsula (Selinger, personal communication, 2014).

Selinger (2011b) reported high female mortality in GMUs 7 and 15 and confirmed female mortality remained high through 2013 (Selinger, personal communication, 2014). Female mortality in 2014 has been considerably lower. There have been five human-caused female mortalities reported for calendar year 2014 to date (Selinger, personal communication, 2014). The literature suggests that high female mortality in species with low reproductive rates contribute to population declines (Miller, 1990).

The high mortality of brown bears in 2013 and 2014 has resulted in renewed uncertainty regarding brown bear status on the Kenai Peninsula. Assuming the population was approximately 582 bears, the deaths of 57 bears through August 11, 2014 is 9.8 percent. That level of harvest is above suggested sustainable harvest rates based on literature (Knapp, 2006; Miller, 1990; Swenson, 2004).

Although harvest rates have increased recently, the 2002 Forest Plan was developed when the bear population on the Kenai Peninsula was estimated to be much lower. As a result, management areas and standards and guidelines designed to conserve brown bears on the Chugach National Forest portion of the Kenai Peninsula, including the Brown Bear Core Areas, could be re-evaluated.

Rigorous brown bear estimates for Prince William Sound and the Copper River Delta have not been completed. Crowley (2011b) estimated the population of brown bears based on den and track surveys on Montague and Hinchinbrook islands. He estimated that there were approximately 100 brown bears on each island and thought the population on Montague might be increasing during the reporting period (2005 to 2010), but warned that these estimates were not based on a rigorous estimation procedure.

The most recent ADF&G brown bear management report is dated 2011 and covers the period from fall 2006 to spring 2010 (Harper, 2011). Annual brown bear mortality in GMU 6 for fall 2006 to spring 2010 from all causes ranged from 59 to 86 bears (Crowley, 2011b). Of these, reported hunter kills ranged from 47 to 70 bears. The remaining were non-hunting kills and estimated illegal kills. Illegal kills were estimated from 9 to 10 bears per year. Female annual mortality during the same period ranged from 11 to 34 bears (of the total hunter kills) and 13 to 35 of the total estimated kills (Crowley, 2011b).

GMUs 7 and 15 brown bear population data are combined (Selinger, 2011b). There was no hunt of brown bears from fall 2005 to spring 2007. Non-hunting mortality occurred, including DLPs, roadkill, illegal, and research-related. Non-hunting human-caused mortality from fall 2005 to spring 2006 was 17 bears (7 were females), and from fall 2006 to spring 2007 was 31 bears (15 were females) (Selinger, 2011b). Annual mortality levels from fall 2007 to spring 2010 ranged from 28 to 40, of which 1 to 6 were hunter kills (2011b). The remaining bears were other human-caused non-hunting mortality. More than half of the total bears killed were females: 16 of 28 bears in 2007-08; 23 of 40 in 2008-09; and 18 of 30 in 2009-10 (Selinger, 2011b).

Access for brown bear hunting was by boat, plane, and roads in patterns similar to those used by black bear hunters. Non-resident hunters made up the majority of brown bear hunters in GMUs 6, 7, and 15. Regulations require non-resident brown bear hunters to use outfitters and guides or a resident relative. Using outfitters and guides contributes to the local economy. The Forest Service requires commercial guides who use National Forest System lands to have permits.

Crowley (2011b) noted logging on state and private lands, primarily in HU 6A, impacts brown bears. Roads reduce habitat quality for bears due to noise, human avoidance, increased access for hunters and poachers, habitat fragmentation, and bear-vehicle collisions (Benn & Herrero, 2002; Clevenger, Chruszcz, & Gunson, 2001; Lewis, et al., 2011; McLellan, 1998; McLellan & Shackleton, 1988; Waller & Servheen, 2005). Forest Service management can influence hunting access and thereby populations through road management, trail management, and designated boat landings in brown bear habitat. Vegetation manipulations that change habitat conditions along roads can moderate (or increase) the effects of roads, depending on how those projects are designed and implemented.

ADF&G biologists track annual number of hunters. From 2005 to 2009, successful hunters ranged from 53 to 93 per year in GMU 6 (Crowley, 2011b).

Caribou

The Kenai Mountains Caribou Herd occurs primarily on National Forest System lands in the Kenai Peninsula geographic area (see chapter 2 Terrestrial Ecosystems—Wildlife). The Chugach National Forest is one of the last national forests in the United States with a viable caribou herd. The Kenai Mountains caribou herd is one of four caribou herds currently occurring on the Kenai Peninsula (ADF&G, USDA, USFWS, 2003). Caribou are prized by people for viewing, food, and fur. Their fur is well adapted to arctic climates, and clothing made from it is used to protect people from harsh winter conditions. ADF&G manages caribou by herds. Caribou movement patterns are not easily predictable. Constraints on herd size are not well known. The Kenai Peninsula caribou herds don't exhibit the large migrations of caribou in some areas of inland Alaska. Caribou range over large areas, particularly when food is limited. They eat a large proportion of lichens in summer as well as in winter, supplemented by grasses, forbs, and deciduous shrubs. Any management activity that would reduce lichens could impact wintering caribou if it occurs in important habitat or over too large an area at a time. Caribou within the national forest calve in early summer, a time when they are particularly sensitive to disturbance.

Caribou were extirpated from the Kenai Peninsula in the early 1900s due to market hunting, predation, and possibly habitat loss from human-caused wildfires (ADF&G, USDA, USFWS, 2003; Bangs, Spraker, Bailey, & Berns, 1982) (see chapter 2 Terrestrial Ecosystems—Wildlife). A series of reintroductions occurred from 1965 through 1986. There is limited data on the historic range of caribou before their extirpation and reintroduction.

Caribou status and trends

Lutz (1959) reported that the last caribou observation on the Kenai Peninsula prior to extirpation was in 1912. They were reintroduced via several transplants from the Nelchina Herd. Forty-four caribou were reintroduced into the Kenai Peninsula in 1965 and 1966. These transplants ultimately established two herds on or near the national forest: the Kenai Mountains herd in GMU 7 and the Kenai Lowlands herd primarily in HU 15A, west of the national forest. The Kenai Mountains herd is primarily within the national forest south of Hope (ADF&G, USDA, USFWS, 2003). A small population was once known to be present near Seward, but the status of this herd is currently unknown. There are two additional herds created with 1985 and 1986 reintroductions: the Fox River herd which is well outside the national forest boundary and the Killey River herd that occurs primarily in the upper drainages of the Funny and Killey rivers in HU 15B, mostly on the Kenai National Wildlife Refuge. There is no rigorous estimate of caribou populations or habitat trends within the national forest. The Forest Service relies on population estimates from ADF&G, which estimates caribou populations by capturing and radioing a sample of each herd and using radio located animals to count herd numbers on fall flights when funding is available. The state's drawing permit hunt and the Federal Subsistence Board's subsistence hunt require mandatory reporting that provides additional information leading to population estimates.

The Kenai Mountains herd initially exhibited excellent production and recruitment, both of which declined sharply during the mid-1970s as the herd appeared to reach carrying capacity. Sport hunting of these caribou was initiated in 1972 to maintain the herd within the estimated carrying capacity of the area. Caribou calf weights were considered an indicator of habitat and were assessed each year from 1996 to 2002. Kenai Mountain caribou had declining calf weights during that period, but causes were unknown.

The 2003 Kenai Peninsula Caribou Management Plan (ADF&G, USDA, USFWS, 2003) stated that the population of the Kenai Mountains herd was increasing or stable. No herd composition counts of the Kenai Mountain herd occurred during that reporting period.

The Kenai Mountain herd was estimated at approximately 300 animals (as of 2009-10). The herd inhabits a limited alpine area of public land (McDonough, 2011a). In 2010, the Federal Subsistence Board determined customary and traditional use of the Kenai Mountain herd and established a Federal season with a quota of five animals. Less than 500 caribou are estimated to occur in the two Kenai Peninsula herds (McDonough, 2011a), and those two herds support approximately 150 hunters a year, with a harvest success rate of 20 to 30 percent. The Kenai Mountain herd, located primarily within the national forest, is the most hunted and is managed to maintain a caribou population of 300 to 400 animals (Selinger, 2009).

Less than half of the average annual 250 Kenai Mountain herd permit holders actually hunted during the 2005 to 2010 reporting period. The success rate for those who hunted was approximately 20 percent per year. Success rate including all permittees was less than 10 percent. Highway vehicles to trailheads were the predominate access reported by hunters for caribou in the Kenai Mountains herd.

Dall’s sheep

Dall’s sheep occur in the Kenai and Chugach mountains, which is the southernmost range of the species. They are a highly-desired for trophy hunting and wildlife viewing. Dall’s sheep are often observed by drivers along the Seward Highway and are occasionally seen in the Kenai Mountains from the Russian River Campground. The national forest is one of the few places where both Dall’s sheep and mountain goats can be observed in close proximity to each other. They are one of the most publicly accessible Dall’s sheep herds. Dall’s sheep are one of two thin-horned sheep species found in North America. They forage predominantly on sedges but will utilize bunch grasses when sedges are depleted and will move along the elevation gradient to find fresh forage as snow melts. Like many animals in winter, they are nutrient deficient, and long winters of deep snow can lead to malnutrition. Exposed vegetation on steep alpine winter ranges blown free of snow is important to provide food and refuge from predators or disturbances.

Dall’s sheep status and trends

There are no reliable estimates of the number of Dall’s sheep within the national forest. The Forest Service relies on ADF&G flights and hunter reports. The only extensive surveys to estimate populations in the Kenai Peninsula were in 1968 and 1992 (McDonough, 2011b). Dall’s sheep surveys in the Kenai Mountains indicated population increases from 1949 to the late 1960s, followed by declines beginning in 1970. The most recent population survey, conducted in 1997, estimated a Kenai Peninsula population of 1,600 animals, down from the 1968 survey which counted more than 2,000 (McDonough, 2011b). Dall’s sheep occur within the national forest in GMUs 7 and 14 and possibly in GMUs 11 and 13. Dall’s sheep and mountain goats are difficult to discern from the air, and consistent, thorough flights have not been conducted for the national forest. McDonough (2011b), using discontinuous and variable survey areas among years, estimated populations in GMUs 7 and 15. He reported population estimates that ranged between 1,000 and 1,700 until 2007. From 2007 to 2009, the estimate ranged from 800 to 1,200.

In 2007, 916 Dall's sheep were harvested Alaska-wide, which is very close to the five-year average. An average of 118 hunters per year on the Kenai Peninsula harvested an average of 12 rams per year from 2008 to 2010 (McDonough, 2011b). The drawing permit units (Round Mountain and Crescent Lake) occur within the national forest. The number of permits authorized in the two permit areas has been low. There have been some years when ADF&G has not issued permits. Hunters who responded reported using a variety of methods for access: boat, highway, airplane, ATV/OHV, and horse. ADF&G 2014 Dall's sheep regulations are restricted to full curl or larger rams (ADF&G, 2014a). There is no Federal Subsistence Board hunting season. ADF&G began capturing and collaring Dall's sheep with VHF radios north of Anchorage, just outside of the national forest in 2009 (Woodford, 2009). From data obtained, preliminary results suggest low pregnancy rates when compared to Dall's sheep in other places and evidence of malnutrition, as shown by bone marrow condition. The reasons for these conditions are unknown to date. Weather and habitat conditions are thought to be factors. Disease was not indicated in preliminary evaluations. It is unknown whether Dall's sheep and habitat within the national forest exhibit similar conditions.

Sheep numbers typically fluctuate irregularly in response to a number of environmental factors, including deep snow, dry summers, and severe winter weather (Whitten, 1997). Sheep populations tend to increase during periods of mild weather. Disease is an important concern with Dall's sheep. Bacteria and viruses cause respiratory illnesses, typically pneumonia, and these illnesses have profoundly affected some populations in the contiguous 48 states. Mountain sheep, in general, are extremely susceptible to disease introduced by domestic livestock. The use of domestic goats or other hooved mammals as pack animals increases the exposure risk. The Forest Service has reviewed disease-related risks among domestic sheep and goats and bighorn sheep (Schommer & Woolever, 2008). Stone sheep are a thin-horned sheep similar to Dall's sheep and disease risks are similar (Schommer & Woolever, 2008). Garde et al. (2005) did a similar evaluation for Dall's sheep.

The Schommer et al. (2008) risk assessment indicated "that contact between domestic sheep or goats and wild Dall's sheep or mountain goats would likely result in significant disease in the wild species with substantial negative and long term effects on population dynamics and sustainability." They strongly advised that domestic goats not be used as pack animals and that domestic sheep and goats not be pastured anywhere in the vicinity of wild sheep population. ADF&G prohibits the use of domestic sheep and goats as pack animals to hunt sheep or mountain goats. ADF&G regulations for hunting apply to National Forest System lands, but the Forest Service currently has no restrictions on the use of pack animals for other reasons, such as recreational hiking/packing. The forest plan revision could address this issue.

Inadvertent hunting of females has been established as a factor in low populations in areas outside of Alaska, and there has been some female harvest from the national forest populations in past years. Habitat for Dall's sheep follow glacial outwash habitats, which are exhibiting successional change to less favorable shrub/tree habitats as glaciers melt. Sheep tend to follow the older ewes in the herd across historic ranges. Losses of older animals from a population can curtail historic migration tendencies. Increasing human population and more human use of alpine areas may affect Dall's sheep. Dall's sheep are sensitive to disturbances, such as low-elevation flights, skiing near habitat, and machinery noise during winter when they are in poor nutritional condition and food and cover are limited. They are particularly vulnerable to predators and other disturbance during the lambing period from mid-May to mid- or late-June (Valdez & Krausman, 1999). Such activities may cause animals to move away from important habitat. They are also susceptible to avalanches and falls.

The 2002 Forest Plan (USDA, 2002a) includes two guidelines intended to minimize human activities near important Dall's sheep wintering and lambing habitat: "Locate concentrated human activities away from important wintering, kidding and lambing habitat…a minimum one mile avoidance distance is recommended." Permitted aerial activities are also restricted near sheep: "Maintain a minimum landing distance of 0.5 mile from observed goats and sheep…and a 1,500 foot vertical distance while flying." The Forest Service requires outfitters and guides to monitor heli-ski activity in mountain goat habitats to evaluate impacts to both sheep and goats within the national forest (mountain goats are a management indicator species (MIS) in the 2002 Forest Plan and serve as an indicator species for alpine ungulates; see Mountain goat subsection). Outfitters and guides have complied with the monitoring but the Forest Service has not yet evaluated if the mitigations have met their intent. Other winter recreational activities may impact Dall's sheep, although these uses are not restricted or monitored. It may be difficult for recreationists to avoid sheep because sheep are notoriously difficult to see against snow. A person could be well within the restricted distance before they are aware of the presence of any sheep.

Snowmobile technology has increased the range, distance, and slopes accessible by snowmachines since 2002. Snowmachines also provide additional access to skiers and snowboarders who use them to access high elevation winter recreation areas. The Forest Service doesn't monitor general recreational use by snowmachines, but public demands for more parking and more winter recreation areas during public meetings indicate use has increased substantially and areas are more crowded since 2002. Identification and buffering of priority sheep habitats may be a more manageable approach to conserving sustainable sheep populations. Further evaluation of sheep and human interactions may trigger a need for change in the 2002 Forest Plan.

Moose

Moose are a highly prized meat and trophy animal, important to many Alaskan residents for subsistence and sport hunting and are a popular viewing species within the national forest. Many non-residents prize moose as a destination guided-hunt species, although guides are not required for moose hunters. Moose have an important ecological role in vegetation development and predator-prey balances in the ecosystem. Many public comments at the assessment phase public meetings indicated the public wanted more moose, a request that may be difficult to meet under current conditions.

Moose are wide-ranging browsers that eat leaves of trees and shrubs. Within the national forest, they prefer willow, sweet gale (in the Copper River Delta) and birch over other woody species, but due to high tannins in their preferred browse species, they need diverse plants over a wide area. Depending on the density, diversity, and condition of shrub and tree species, moose can influence the morphology and production of browse plants and can also increase biomass production through the deposits of their dung and urine (Persson, Pastor, Dannell, & Bergstrom, 2005).

Moose have a strong place in native culture and are highlighted in art, music and legend and are enjoyed by wildlife viewers. Moose antlers and bones are frequently used in local craft and art industries. Moose were identified as an important species during the initial public involvement process for this assessment.

Moose habitat is widespread within the national forest. The availability of habitat for moose in winter is severely curtailed by snow. Moose restrict their movements when snow is more than 30 inches deep, and experience a starvation diet in severe winters. Winter habitat availability is significantly curtailed when snow depths are more than 36 inches. Dussault et al. (2005) modeled moose habitat selection in terms of three limiting factors, limited in priority order: predator avoidance, food availability, and snow. They found that responses followed these general trends, but varied by scale (i.e., home range for an individual versus landscape scale). Females with young also differed in their habitat selection trade-offs. Moose make habitat selections to balance food availability vs. predator avoidance.

The best quality moose habitat in the Kenai Peninsula is located on the Kenai National Wildlife Refuge. National forest habitat is less suitable and productive. Current vegetation maps and imagery on the Kenai Peninsula do not differentiate willow and other moose browse from less-palatable hardwoods, so a complete habitat distribution for the national forest hasn't been completed. Moose habitat on the Copper River Delta occurs primarily in wetlands. Habitat in the wetlands has experienced drying and successional development due to the 1964 earthquake-caused uplift. The Forest Service has partnered with others to model moose habitat within the national forest and has developed habitat improvement projects to enhance early seral species, particularly willow.

Moose have differential tolerances of people. Moose can be deterred from important habitat by recreational use yet alternatively will use the compacted roads and trails to access habitat that would otherwise be unavailable in winter. Access paths created by humans can help provide moose travel routes in winter but, depending on the type, timing, and duration of human activity on the road or snowmobile trail, can also deter moose from important winter habitat (Harris, Nielson, Rinaldi, & Lohuis, 2012). Cows may seek areas close to homes for giving birth and rearing young because these areas are more protected from predators.

Moose status and trends

Moose can be cryptic to observe in forested conditions; ADF&G has developed methods to correct for sightability (Christ, 2011). Moose are easier to survey in the Copper River Delta geographic area than elsewhere within the national forest. Statewide, an estimated 175,000 to 200,000 moose are widely distributed. ADF&G, in partnership with the Chugach National Forest's Federal subsistence program, conducts aerial surveys to obtain moose population estimates and related demographic factors, such as twinning rates, cow/calf and bull/cow ratios, and habitat delineation. Titus et al. 2009 reported that from 1987 to 2007, an annual mean of 29,000 moose hunters harvested 7,260 animals annually in Alaska.

Moose are found in all the GMUs that overlap the national forest: GMUs 6 and 7 and portions of 11, 13, and 14 (see the GMU map in the map package appendix), but the majority of moose are in GMUs 6 and 7. Moose populations normally experience large fluctuations over time driven by habitat, predation, density, weather, and harvest rates. The Subsistence section in chapter 3 provides additional information on moose hunting specific to that program. The majority of moose in GMU 6 originated from transplants. In the 1950s, Cordova residents raised 24 moose calves and released them on the western Copper River Delta. This population grew to a high of about 1,600 in 1988 and declined to about 1,200 as part of a planned reduction. The only moose endemic to the Prince William Sound geographic area are two small populations in the Lowe River Drainage and Kings Bay. Recent surveys indicate the population is stable in most of GMU 6 and is increasing in HU 6C near Cordova. The total moose population was estimated at 1,250 in the GMU, determined by combining survey counts from each of the GMU HUs (Crowley, 2010a). A recent survey in Kings Bay (DelFrate, personal communication, 2014) resulted in no moose seen.

Moose density in GMU 7 on the Kenai Peninsula is consistently low. Less than 10 percent of the moose harvest on the Kenai Peninsula has come from GMU 7 during the last 20 years (McDonough, 2010). Habitat within the national forest is limited when compared to other areas of the Kenai Peninsula. Severe winters with deep snow contribute to high mortality rates. Human-caused wildfires in the 1950s and 1960s on the Kenai Peninsula caused moose populations to increase. Extensive predator control during that time also facilitated artificially high population numbers, and vegetative damage and die-offs occurred. The historic human-caused wildfires in Kenai Peninsula that supported the high moose populations may not be currently feasible due to safety, increased human residents and developments, summer smoke concerns, and economics.

Populations of moose in GMU 13 have fluctuated widely in the past 5 to 7 years but have been generally increasing since 2001. Only a small portion of the southern end of GMU 13 occurs within the national forest and supports a low density of moose. The ADF&G goal for GMU 13 is to increase the moose population to about 25,000 moose GMU-wide; in GMU 13 ADF&G has implemented wolf-control regulations under intensive management protocols (ADF&G, 2011).

Moose can cause safety and property concerns for motorists and homeowners. Moose-vehicle collisions have led to moose mortality and human injury along the Seward and Sterling highways. The Kenai Wildlife Refuge reported that an average of 225 moose were killed annually during the last decade by vehicles on the Kenai Peninsula (USFWS, 2014b). Moose can also be aggressive if encountered too closely, especially when accompanied by calves. More people in Alaska are injured by moose than bears, partially an artifact of their numbers (Conger, 2008).

Moose are susceptible to several diseases and parasites. Interspecies transfers of parasites, particularly species that haven't evolved together, can cause increased mortality to the native host. Transplants of off-site animals and changing climate could increase the chance of parasites.

Habitat treatments, such as thinning on the Kenai Peninsula, have been of too small a scale to be effective in terms of increasing moose numbers. Hydroax treatments on the Copper River Delta to reverse succession in an effort to create more moose browse (primarily willow) have focused on those areas with alder and spruce encroachment in the core winter range. Ongoing monitoring in these areas is currently in analysis. Small scale treatments can improve the availability of winter range for moose if principles of scale and landscape trade-offs are implemented (Dussault et al. 2005). The Forest Service may not be able to treat enough habitat to support the public demands for more huntable moose within the national forest.

Mountain goat

Mountain goats are endemic to all three geographic areas of the national forest and are highly valued by wildlife viewers and hunters. They are endemic but were extirpated on Bainbridge, Culross, and Knight islands (Crowley, 2010b). The mountain goat population in the Heney Range south of Cordova is depleted (Burcham, personal communication, 2014). Most mountain goats harvested in Alaska are mounted for trophies. Southcentral Alaska is one of the few areas where mountain goats and thin-horned sheep (see Dall's sheep) coexist in similar habitat. The Chugach Mountains are the northernmost limit of mountain goat range.

Mountain goats utilize steep, rocky, inaccessible habitat to avoid predators and disturbance. Mountain goats utilize forested habitat for cover and wind-swept snow-free areas above the tree line during winter. Even minor impacts to the availability of their winter habitat can be consequential because snow-free protected winter range is very limited (Fox, Smith, & Schoen, 1989).

Salt is often limited in alpine habitats and goats will travel long distances to reach mineral licks; mineral licks influence habitat range and distribution. Animals can concentrate at limited mineral licks with a corresponding increase in aggressive intraspecific encounters (Cote & Festa-Bianchet, 2003).

They are most susceptible to disturbance when activities occur during their resting periods where they are conserving energy. They are most active in early morning and late afternoon. They are particularly vulnerable to predators and other disturbance (including recreational activity) during the primary kidding period from mid-May to early June, during the winter when quality food is inaccessible, and around concentration areas (such as mineral licks). Starvation is a high risk in late winter and spring.

Mountain goat status and trends

The Forest Service relies on ADF&G flights and population estimates of mountain goats within the national forest. The Forest Service subsistence program helps support surveys in GMU 6, and flights are more regular as a result of that financial support. Mountain goats are a management indicator species in the 2002 Forest Plan for alpine habitats. Habitat and accurate mountain goat kidding/wintering areas are not well defined. The Forest Service partnered with ADF&G to develop a habitat model with the University of Mexico using data collected on a subset of radioed mountain goats in the Kenai Peninsula (Bohara, Thacher, & Nepal, 2011). The majority of the collars deployed for this effort failed, and only five adult females were used to develop a model (Herreman, 2014) that prioritizes some of the occupied mountain goat habitat, although they are known to occur within other areas of the national forest (Bohara, Thacher, & Nepal, 2011).

In 1952, 4,350 mountain goats were documented in an area that makes up most of GMU 6 (Crowley, 2010b). Since then the population in GMU 6 is thought to have decreased and is now estimated at near 4,000 animals. Survey coverage and survey years have been inconsistent and hampered by poor survey conditions (i.e., weather). HU 6D had the highest number of goats within GMU 6. ADF&G established a minimum population goal of 2,400 goats in GMU 6, and the population was thought to be stable for the reporting period (2006 to 2010) (Crowley, 2010b).

In GMU 7, where goats coexist with Dall's sheep, goats are thought to have decreased 30 percent since the early 1990s (McDonough, 2012). GMUs 7 and 15 are combined by ADF&G into the Kenai Peninsula mountain goat range, excluding Kenai Fjords National Park. GMUs 7 and 15 are managed as 28 hunt areas that have had hunts at some point from 2007 to 2011. Populations are monitored by aerial survey. ADF&G tries to survey each hunt area every 3 years, but surveys have been inconsistent and many years have been missed. The trend counts indicate a 30 to 50 percent decrease from the 1990s to 2006, and harvest led ADF&G to close hunts or reduce permits. Not all hunt areas indicate declines; some show stable or increasing trends (McDonough, 2012). A major factor in goat populations is the risk of overharvest and a low billy to nanny ratio (Cote & Festa-Bianchet, 2003; Hamel, Cote, Smith, & Festa-Bianchet, 2006). Harvest recommendations suggest acceptable harvest may be as low as 1 to 4 percent of a native population with a minimum size of 50 animals (Hamel, Cote, Smith, & Festa-Bianchet, 2006). Such parameters may be quite different in larger populations as are found within the national forest. A mountain goat population can maintain population levels better if females are not (or rarely) harvested. Rice and Gay (2010) developed a model for a small mountain goat population in Washington that supported results from Hamel et al. (2006).

There has been consistent harvest of females in both GMU 6 and the combined GMUs 7 and 15 hunt areas. Female harvest in GMU 6 met the ADF&G less than 30 percent harvest stipulation. Female harvest in GMUs 7 and 15 often exceeded 30 percent during the 2007 to 2011 reporting period and may be a concern. The management objective for GMUs 7 and 15 does not provide numerical goals, but states, "…maintain a low proportion of nannies in the harvest, and restrict or liberalize hunting permits and allowable harvest based on conservative assessments of minimum population trends" (McDonough, 2012).

ADF&G has recognized the sensitivity of mountain goat populations and has developed educational information for hunters to properly identify the sex of mountain goats. ADF&G imposed a point system that helps regulate the number of females harvested each year. Mountain goats can also be vulnerable to disturbance from aircraft, snowmachines, and human winter recreational activities similar to Dall's sheep (Cadsand, 2005). The nannies and kids are particularly vulnerable to predators and disturbance during the kidding season from mid-May through mid-June. After mid-June the kids are more mobile and food is more abundant, so they are not as constrained. Mountain goats are nutritionally-deprived in winter like many ungulates in the northern hemisphere. They must build up adequate fat storage during the summer.

A particular concern is winter recreation when it occurs in or near limited winter habitat or near sensitive kidding grounds when kids are very small and unable to move far. Disturbance can cause displacement from important habitat, startled fleeing (causing accidents or misstep), but can also result in less obvious responses, such as elevated heart rate, disrupted feeding and rumination, increased stress hormones and increased utilization of nutritional reserves. Short bursts of elevated stress hormones are normal in prey animals when they run from predators, but long term elevated stress levels or repeated stress can lead to physiological breakdown and reduced fitness, lowered reproductive rate, or less resistance to disease or low nutrition.

Goldstein et al. (2005) observed the visible response of mountain goat groups to helicopter flights in 2001 and 2002 and noted that 25.1 percent of goats displayed overt behavioral changes to helicopters with 66 percent of those responsive goats displaying alert or vigilant behavior and 34 percent fleeing. Cote´ (1996) in Alberta and Foster and Rahs (1983) in British Columbia noted fleeing or hiding responses at helicopter to goat distances less than 500 meters; maintenance behavior was altered at 500 to 1,500 meters and altered head tilts occurred at distances greater than 1,500 meters. Goldstein et al. (2005) reported that Alaskan goats displayed more muted behavior. Habituation, topography, and other habitat differences were offered as potential explanations for the difference between the Alaskan study and those in Canada.

The 2002 Forest Plan (USDA, 2002a) includes two guidelines intended to minimize human activities near important mountain goat wintering and kidding habitat. "Locate concentrated human activities away from important wintering, kidding and lambing habitat…a minimum one mile avoidance distance is recommended," and "Maintain a minimum landing distance of 0.5 mile from observed goats and sheep…and a 1,500 foot vertical distance while flying." The Forest Service began monitoring commercial heli-ski activity in mountain goat habitat in 1997 to evaluate impacts to both sheep and goats within the national forest (Goldstein, Poe, Cooper, Youkey, Brown, & McDonald, 2005). Permittees have complied with the terms of their permit, but the data hasn't been analyzed in depth for effectiveness in avoiding impacts to mountain goats. The permittees are required to avoid areas where goats are observed, but goats are notoriously difficult to see from the air and may flee to avoid aircraft or other disturbance. The Forest Service has flown and mapped alpine winter goat habitat in all of the heli-ski areas (Burcham, personal communication, 2014). Those areas are delineated on maps and permit requirements do not allow skiing or close aerial approach in those areas.

The 2002 Forest Plan (USDA, 2002a) has no standard or guideline restrictions to protect wildlife for the non-commercial national forest users (including private snowmachines, boat, and aircraft operators). Snowmachines have become more powerful than those evaluated by Goldstein et al. (2005) and are now able to access more goat habitat throughout the winter. The more powerful snowmachines also provide access for winter skiers and snowboarders who may alter goat use of preferred habitat or cause excessive energetic demands.

Sitka black-tailed deer

The Cordova Chamber of Commerce introduced Sitka black-tailed deer to Hawkins and Hinchinbrook islands between 1916 and 1923 (Crowley, 2011c). Since then, Sitka black-tailed deer have been seen occasionally in all three geographic areas of the national forest. They are found primarily in HU 6D, but deer have been observed on the Kenai Peninsula and as far west as Anchorage. They swim well and are expanding in forested areas, moving inland from the coast. They are an important sport hunting, meat, and subsistence species (see Subsistence section) in the Prince William Sound geographic area.

Sitka black-tailed deer status and trends

The ADF&G population objective under the Intensive Management Law (AS 16.05.255) for Sitka deer in GMU 6 (for 2010) was 24,000 to 28,000 deer, which is capable of a sustainable annual harvest of 2,200 to 3,000 deer. ADF&G estimated harvest in GMU 6 at 1,900 deer in 2008-09 and 1,600 deer in 2010 (Crowley, 2011c). The highest deer densities in HU 6D occurred on Hinchinbrook, Hawkins, and Montague islands. Lower densities occurred on the smaller islands and mainland areas around Prince William Sound.

ADF&G collected harvest information for Sitka deer via hunter surveys through 2010. More recent data is being collected similar to other game species with harvest reports. The Forest Service subsistence program assists ADF&G with annual deer pellet group surveys in HU 6D to provide an index of pellet density in sample areas from year to year but does not provide population estimates. No estimates have been made in the other GMUs within the national forest. Hunting for Sitka deer in GMU 7 is currently prohibited.

Snow depth and duration are the primary limiting factors in Sitka black-tailed deer populations within the national forest. Sitka deer were introduced to the Queen Charlotte Islands of British Columbia more than 50 years ago. Those islands lacked predators. Sitka deer were found to significantly simplify vegetation patterns in the Queen Charlotte Islands to the detriment of the plants and fauna dependent upon lower-canopy vegetation (Stockton, Allombert, Gaston, & Martin, 2005). Martin et al. (2011) evaluated 18 NW Archipelago islands inhabited by deer and found that "…deer regulate both the cover and architecture of understory vegetation which in turn profoundly affects island bird assemblages." There has been no equivalent evaluation of impacts of introduced Sitka deer on island vegetation within the national forest. Sitka deer populations within the national forest may be controlled by hunting and deep winter snow before they have similar impacts on biodiversity. Deer populations remained relatively stable in GMU 6 during the last decade until the winter of 2011-12, when near record snows across Prince William Sound reduced the population by 50 to 70 percent (see Subsistence section).

Furbearers

All of the important furbearers identified by trappers in Alaska occur within all three geographic regions of the national forest (see table 67). Furbearers are an important resource for trappers. The average trapper in southcentral Alaska spends more than 9 weeks trapping per year. Nearly 40 percent of trappers are accompanied by a young person (ADF&G, 2013b). Selling furs can make a significant contribution to a trapper's income. The average marten pelt in 2012-13 sold for 143 dollars; the average otter for 100 dollars (ADF&G, 2013b).

Wolves, wolverine, and lynx, in particular, are rarely seen within the national forest but are highly prized by wildlife viewers. Many of these species have been extirpated across large portions of their range, are listed as threatened or endangered, or are otherwise severely depleted or out-of-balance in the contiguous 48 states. In the contiguous 48 states, the loss of segments of the furbearer population (such as wolves) has led to increases in other species, such as coyotes. The national forest provides a unique opportunity to evaluate ecological communities where native communities remain intact.

Wolverines are a management indicator species in the 2002 Forest Plan. They are wilderness creatures that utilize areas with persistent winter snow, often mountainous areas that are also favored by heli-skiers and winter sports enthusiasts. Much of their diet is scavenging ungulates, although they have been documented to kill their prey in certain circumstances. Both male and female ranges correspond with moose and caribou habitat and some with mountain goats and sheep (Krebs, Lofroth, & Parfitt, 2007). Krebs et al. 2007 noted that both male and female wolverines were negatively associated with heli-skiing and back country skiing in British Columbia. Females, in particular, used remote high elevation habitats while giving birth and raising young to avoid predatory wolves. Both sexes were negatively associated with human activities in the winter (Krebs, Lofroth, & Parfitt, 2007). Wolverines have low reproductive rates and require large areas of undeveloped habitat. If their habitat is unavailable due to human activity, it could affect population parameters and sustainability. The Forest Service has partnered with ADF&G to conduct inventories on wolverines within and near the national forest. They are not easy animals to count. ADF&G uses a sample unit probability estimator (SUPE) technique (Becker, Golden, & Gardner, 2004). Monitoring is ongoing and results will be evaluated in terms of Forest Service management, although preliminary data indicates national forest wolverines fit the published models and results of other areas and continued restrictions of human use in their winter habitat is warranted.

Each furbearer also provides important ecological contributions to sustainability to ecosystems and other populations. For example, wolves influence big game populations and help maintain habitat from over-grazing/browsing. Beavers build dams and create ponds important for fish rearing, help slow water to help protect riparian areas and reduce downstream flooding, and cut trees to add diversity to riparian vegetation.

Furbearer status and trends

There are no population estimates for furbearers within the national forest. The Forest Service relies on information from ADF&G. Eight thousand trapping permits for furbearers are sold each year statewide. ADF&G depends on trapper survey results and reported harvest of furbearer seals for population trend data for many furbearers. Only lynx, river otter, wolf, and wolverine are required to be sealed across their range. Furbearers can be cyclic depending on their prey levels. Lynx, for instance, experience periodic boom/bust cycles when snowshoe hares, their primary prey, vary. Marten and beaver also require seals in most of the national forest GMUs. Population trends are described for furbearers in periodic furbearer reports by ADF&G and vary by species and by GMU. Annual trapper reports are posted on the ADF&G Web site. The most recent trapper questionnaire is the 2013 report, covering July 2012 to June 2013 (ADF&G, 2013b). The most recent ADF&G furbearer report is 2010, reporting on 2006 to 2009.

Russian explorers and early settlers established fox farms and introduced a wide variety of non-native fur bearers across Alaska. From the late 1800s through the early 1900s, native and non-native furs were the second largest economic driver in Alaska. Many Russian foxes and other fur bearers were dropped on islands to be harvested the next season. Occasionally prey species, such as rabbits, were also introduced to provide food for the introduced fur bearers. Most of the introduced furbearers died off from disease or starvation. The last fur farm within the national forest was permitted in the 1930s. Impacts from the oversaturation of introduced predators probably still remain on some islands. The current impacts of non-native furbearers on native furbearers are not known, but rabies and disease was a factor during the fur farm era (Isto, 2012). An Exxon Valdez oil spill Trustee Council funded project was initiated in 2014 by USFWS to reduce the number of Naked Island mink in order to accelerate the restoration of pigeon guillemots and other island-nesting shorebirds susceptible to fur bearer predation. DNA analysis of mink on Naked Island in Prince William Sound indicates the mink there have mixed genetics showing they developed from a variety of source populations.

Birds

The national forest provides millions of acres of bird habitat used by people for hunting, bird watching, and subsistence. The national forest provides extensive acres of undeveloped shoreline habitats and islands important to nesting birds and upland areas provide millions of acres of songbird habitat. The Copper River Delta is one of the world's largest staging areas for migratory shorebirds (Myers, 1983). Bird meat and eggs have been important protein sources for native peoples for generations and eggs are still collected by some subsistence users. Bird feathers and bones are also used for clothing, crafts, cultural practices, and tools. Nearly all activities within the national forest (by management and users) have the potential to affect one or more bird species or their habitat.

Management designations

The many islands and shorelines in Prince William Sound are also recognized worldwide for their shorebird and seabird habitats (Suring & Poe, 2010). Prince William Sound cliffs provide habitat for kittiwakes and puffins, and Prince William Sound beaches provide cryptic nesting habitat for black oystercatchers. Much of Prince William Sound was within the impact zone of the Exxon Valdez oil spill and several species of birds were impacted, and some species have not yet recovered (see table 35) (EVOS Trustee Council, 2010).

The Copper River Delta is the largest shorebird staging area known in North America (Isleib P. , 1979; Senner, 1979). The Copper River Delta contains 700,000 acres of wetlands plus associated uplands. The entire land base encompasses a 2 million-acre management area. Federal recognition was formalized for a portion of this important resource through ANILCA when Congress specified management direction for the Copper River Delta, stating that the area would be managed for the conservation of fish and wildlife resources and their habitats. It is a site in the Western Hemisphere Shorebird Reserve Network, is a State of Alaska Critical Habitat Area, and is an emphasis area in the North American Waterfowl Management Plan. Other special management actions include the Copper River Delta: the Key Coastal Wetland plan and the Copper River International Migratory Bird Initiative (CRIMBI).

Many of the birds within the national forest are identified on various status lists maintained by ADF&G, AKNHP, Audubon, Partners in Flight, and Pacific Joint Venture as species of concern. Since many of these birds are migrants, descriptions of their status and trends are too extensive and dynamic to summarize for this Assessment. The Forest Service partners with other agencies to contribute to data on bird populations and trends and to work on ways to sustain them across all of their range, not just Alaska. The Forest Service complies with the memorandum of understanding with USFWS and others (Forest Service Agreement 08-MU-1113-2400-264, 2008) regarding implementation of the Migratory Bird Treaty Act, Bald and Golden Eagle Protection Act, and other bird regulations.

Of particular mention to the national forest, black oystercatchers are a in the 2002 Forest Plan. Dusky Canada geese are also a current management indicator species and have been evaluated as a potential species of conservation concern. During a 2012 status review, Kittlitz's murrelets were delisted from candidate species status by USFWS (77 FR 69993 70060). Many other species have special designations due to their status or ecological importance.

Hunting

The national forest provides nesting and migratory habitat for dozens of waterfowl species hunted in Alaska and elsewhere. The USFWS manages migratory waterfowl hunting in North America. Alaska supports 20 percent of the nesting habitat for America's waterfowl. Alaska supports at least 36 species of waterfowl, many of which breed within or migrate through the national forest and are hunted in Canada and the western United States along the Pacific flyway. The status of waterfowl vary by species and population estimates are difficult to obtain, particularly for migratory sea ducks and geese (Sea Duck Joint Venture Management Board, 2008), and are difficult to obtain for waterfowl/shorebirds that nest in crevices, inland forests, or cavities (Piatt & Ford, 1993). The USFWS also analyzes hunter information through the Harvest Information Program and joins with Canada to conduct surveys, analyze bird band returns, and do winter bird counts on winter habitat. Alaska/Yukon-wide waterfowl surveys are conducted annually (USFWS, 2012b) and species results vary widely. The USFWS (2012) publishes a detailed waterfowl population status report periodically. Alaska is combined with the Yukon Territory and Old Crow Flats, so determining the national forest's contribution is difficult, with the exception of dusky

Canada goose and trumpeter swan surveys on the Copper River Delta. The 2012 dusky Canada goose survey indicated the total population was the highest recorded since 2005 (see also At Risk Species—Potential Species of Conservation Concern).

ADF&G administers harvest of upland game birds. ADF&G has limited data on game birds. Merizon (2013) summarized information on grouse and ptarmigan based on road surveys and hunter wing returns. Ruffed grouse are native to parts of southcentral Alaska and were translocated to the Kenai Peninsula in the mid-1990s. Population densities in the Kenai Peninsula are considered low for ruffed grouse, an introduced species, and moderate for spruce grouse.

Viewing and cultural significance

The national forest does not have a large diversity of land bird species as compared to other national forests in the United States, but many of the species that do occur here have special significance to bird watchers. Bald eagles are extremely common and provide a thrill to visitors to Alaska. A bald eagle sighting is usually announced on ferries, cruise ships, and tour buses. Several national forest species are do not occur in the contiguous 48 states and help birders add new species to their life list. A view of the Arctic tern is particularly prized by birders, partially because their migration can exceed 25,000 miles each spring and fall, or 50,000 miles annually. Alaska supports the majority of breeding habitat for the trumpeter swan and sandhill cranes, some migrating from Siberia. Ptarmigan, which do not migrate and turn white during the nonbreeding season, hold particular fascination to bird watchers in winter.

Spruce grouse, ptarmigan, and ruffed grouse provide cultural contributions to native peoples, food for humans and wildlife, and sport hunting and bird watching opportunities. The common raven is a year-long Alaska resident and is common throughout the national forest. The spiritual importance of the raven to Alaska's Native people is still recognized. The Tlingit, Haida, Tsimshian, Bella Bella, and Kwakiutl all view the raven as the creator of the world and bringer of daylight. The raven is also important in the creation of myths by the Eskimo. The myths of the raven remain a significant social and religious component of Alaska culture. This very intelligent bird can provide hours of entertainment to the discerning observer, and its distinctive calls are one of the most commonly heard sounds during winter.

Since 1990, The Forest Service has partnered with the Cordova Chamber of Commerce to host the annual Copper River Delta Shorebird Festival. The event attracts people from around the world to experience the spectacular migratory shorebird concentrations.

Hunting status and trends

Most population and trend data on seabirds and shorebirds were conducted following the Exxon Valdez oil spill. Populations of one species of seabird, the pigeon guillemot, have not yet recovered (EVOS Trustee Council, 2010). Irons et al. (2013) looked at 29 populations (15 taxa in winter and 14 taxa in summer) and found that Alaska supports nearly 50 percent of pigeon guillemot's nests. Populations in Prince William Sound were estimated at 2,300 (USFWS, 2006b) and their populations are experiencing 6.7 percent declines (from 1972 to 2006), attributed to gill net bycatch, oil pollution, and predation. Incidental subsistence collection is authorized. In 2013, the Exxon Valdez Oil Spill Trustee Council funded a project to help restore pigeon guillemots at the Naked Islands group within the national forest by reducing mink (see Furbearers subsection).

Other Exxon Valdez oil spill impacted species that have not fully recovered and which have habitats on or adjacent to National Forest System lands include: marbled murrelets, Kittlitz's murrelets (both status unknown); and Barrow's goldeneye, harlequin ducks, and black oystercatchers (status recovering) (EVOS Trustee Council, 2010). The Forest Service is designing projects to restore habitat for harlequin ducks and marbled murrelets on lands and easements acquired under the Exxon Valdez oil spill settlement.

Seabird populations often fluctuate in response to habitat quality (i.e., fish), and ocean conditions (Suryan & Irons, 2001). Surveys of Arctic terns in Prince William Sound indicate large recent declines of more than 90 percent, including the complete disappearance of 14 historical colonies on Kodiak Island (Agler, Kendall, Irons, & Klosiewski, 1999; Lance, Irons, Kendall, & McDonald, 2001; Stephensen, Irons, Kendall, Lance, & McDonald, 2001; Stephensen, Zwiefelhofer, & Howard, 2002; Stephensen, Zwiefelhofer, & Slater, 2003). Reasons are unknown, but food, ocean conditions and disturbance to nesting areas could contribute. People encountering Arctic terns have caused terns to abandon nests if those birds are not habituated to human activity. Humans with dogs are a particular concern. They also have the ability to adapt to disturbance in areas of regular high human use. They are listed as a species of High Conservation Concern in Alaska (Hatch, 2002; USFWS, 2006b) and are protected under the federal Migratory Bird Treaty Act (MBTA 1918). In Alaska, reported subsistence harvest was estimated at 80 adults and 2,500 eggs per year between 1995 and 2000 (AMBCC, 2007).

In Prince William Sound, marine bird surveys indicated that there was an 84 percent decline in Kittlitz's murrelets from approximately 6,400 birds in 1989 to 1,000 birds in 2000. Seventy-eight percent of the population occurred in two Fjords in the northwest corner, and 20 percent in three other Fjords. Recreational activity on newly exposed rock below glaciers may be a factor in Kittlitz's murrelet nesting success, but this has not been tested.

Kittiwake populations increased in north Prince William Sound and those in south Prince William Sound declined from 1985 to 1997, such that 70 percent of the kittiwake population nested in the north during the latter years of the study (Lance, Irons, Kendall, & McDonald, 2001). The mid-1980s population was distributed equally between north and south. The trend was reversed in 1972 when most of the kittiwake population (70 percent) occurred in the southern Prince William Sound.

The Boreal Partners in Flight report (2004) evaluated and prioritized international and statewide population trends for Alaskan landbirds in 2004. Two of the four priority groups occur in the national forest and have the potential to be influenced by Forest Service management activities: landbirds sensitive to forest management; and landbirds with long-term declines in population size. The olive-sided flycatcher, blackpoll warbler, and rusty blackbird were noteworthy species within the declining group. Olive-sided flycatchers have experienced a 70 percent decline in the last 40 years, possibly related to food (bees, dragonflies, and yellow jackets) (see Information Needs).

Bird declines have been correlated with changes in habitat and food availability. Climate change may also affect competition and predation, factors that may be irreversible. Forest Service activities that influence the type and number of fish and invertebrates, introduced species, or nutrients transfer may contribute to these changes.

Causes of migratory bird declines or changes are difficult to determine. Changes can benefit some species at the detriment of others. The loss or change of breeding habitat, climate change, impacts to the seeds or insects, disturbance, successional change, disease, invasive species, loss of important migratory habitat here or in the southern hemisphere, and activities that upset the natural balance of predators and competitors all can be factors, and can interact with each other in unpredictable ways. Impacts can differ between the short and long terms.

Management impacts

Activities within the national forest can impact birds and habitats in many ways. Habitat change and disturbance from activities, including recreation, can impact bird populations. Habitat losses can be reduced by maintaining important habitat components during activities and permitted projects. Habitat improvements can be significant and effective at maintaining or increasing bird populations with little impact to other programs if wildlife considerations are designed into the project. The designation of important birding areas of the national forest as special management areas has been important in maintaining healthy bird habitats. The Forest Service has instituted habitat enhancements for dusky Canada geese (see At Risk Species—Potential Species of Conservation Concern) and incorporated actions during project planning to enhance bird habitat when possible or to mitigate impacts when actions cannot be totally positive. Recommended mitigations include seasonal protections during the nesting season and capping open pipes that can entrap curious cavity nesting species. Actions that reduce garbage, fish waste, and other and human-associated food sources can reduce the unnaturally high concentrations of gulls, eagles, and corvids that prey on other birds. All animals, including birds, are particularly sensitive to plastic and chemical pollution. The Forest Service has initiated and partnered with others to reduce marine and Tsunami debris that harm birds and other wildlife (see marine pollution). Regulations to discourage pollution or abandoned materials, such as fish line or plastics, and projects that clean up debris can be effective at reducing wildlife mortality associated with these materials.

Nearly all birds are susceptible to introduced mammalian predators such as Norway rats, and feral cats, and dogs. They are susceptible to parasites and diseases from other areas, a problem that is increasing with global warming. Maintaining and protecting winter habitat for migrating birds in South and Central America is essential for birds that nest in or migrate through the national forest. Forest Service programs, such as the Key Coastal Wetlands, and CRIMBI, and participation in national/international programs, such as Partners in Flight, can help reduce habitat losses in other places.

Recent Forest Service activities do not cause large scale vegetation changes within the national forest, but small changes occur resulting from access, firewood harvest, berry picking, the presence of dogs in sensitive areas, human recreational disturbance to nesting locations, developed sites in riparian areas, activities that change the abundance or timing of insects or seeds, or the introduction of non-native species could cumulatively influence landbird populations and trends. The predominant habitat changes within the national forest are tied to climate change and successional development of forest/shrub habitat. The national forest is geologically young, glaciers are melting, and succession is progressing. Baseline distribution, occurrence, and habitat relationship data for Alaska is incomplete. Determining ideal habitat successional patterns, distributions, and patch sizes cannot be tied to historic patterns, which is the goal of much bird management in more developed areas in the contiguous 48 states.

Contribution to Social and Economic Sustainability

The uses of the species summarized here contribute significantly to Alaskan economy. Non-commercial fish and wildlife license revenues brought in 24.6 million dollars to Alaska in 2012 (ADF&G, 2013c). Big game tags contributed 3.9 million dollars to Alaska in 2012 (ADF&G, 2013c). Commercial licenses, including fishing licenses, produced 24.6 million dollars of revenue statewide (ADF&G, 2013c). Additional economic value is multiplied many times over when transportation, lodging, GPS, cameras, scopes, supplies and ammunition, guide fees, meat packaging, fur/trophy processing, and shipping are included.

Nonresidents of Alaska must be personally accompanied by a licensed guide or a qualified resident relative over 19 years of age to hunt brown bears, Dall's sheep, and mountain goats. ADF&G (2013c) states that hunters can expect to pay 6,000 to 15,000 dollars for a brown/grizzly bear hunt, 4,000 to 6,000 dollars for a Dall's sheep hunt, and 1,500 to 4,000 dollars for a goat hunt. Reported fur exports from Alaska were worth nearly 2.3 million dollars/year. Trappers reportedly sold/exported about 50 percent of the animals they harvested (ADF&G, 2013c).

The economic value of wildlife viewing is also a major financial contributor to Alaska and the nation. Nationally, fish and wildlife-related recreation is an important leisure and economic activity. Nationwide, hunters, anglers, and wildlife watchers spend 145 billion dollars/year on wildlife related recreation (USFWS, 2011a). Wildlife viewing is one of the significant reasons tourists visit Alaska, but since viewing is incorporated into other activities, calculations specific to wildlife viewing in Alaska are harder to make. Alaskan wildlife is rated as one of the reasons visitors and residents appreciate Alaska (ADF&G, 2006). Wildlife enriches the experience of local Alaskan hikers, boaters, and recreationists. There is also the intrinsic value that many people around the world assign to an area that still has free-ranging brown bears, wolves, and millions of birds—even if they may never visit.

Information Needs

Detailed information on numbers, trends, distributions, range, age class, and habitat use of many species within the national forest is either lacking or dated. Baseline wildlife population and habitat data is a challenge to all wildlife and land managers in Alaska.

Humans influence wildlife distribution, productivity, and survival. The impact of that influence on wildlife is determined by the location, intensity, season, and duration of human activities and the location, breeding status, vulnerability, and extent of wildlife exposed. Good population numbers or distributions of wildlife within the national forest are currently lacking. Essential breeding, feeding, and wintering habitats for most of these species have not been determined to an adequate degree to fully evaluate the effects of human activities within the national forest.

Habitat associations identify which characteristics of habitat are important to wildlife for necessary life functions. These associations require information that describes the important characteristics, patterns, and extent of habitat for each species. Information on habitat associations and habitat quality, quantity and extent within the national forest is often lacking the detail necessary to meaningfully evaluate project level effects on a species. Other factors, such as invasive species; roads and railroad barriers; mortality sinks; and garbage, pollution, and marine debris, have not been quantitatively evaluated to determine if they have significant effects on national forest wildlife.

Wildlife habitat associations, i.e., the description of the mix of vegetative, topographic, biological, and landscape conditions that support the needs of a species or population of wildlife, have been well-studied for many species in the contiguous 48 states, but studies of some species suggest that patterns of habitat use in Alaska may differ from what is observed in these studies. The differences are due in part to higher latitude, shorter seasons, more predators, more recent geological development, and the different community ecosystems in Alaska (Duffy, Boggs, Hagenstein, Lipkin, & Michaelson, 1999).

Less than one percent of Alaska has been permanently altered by human activity (Duffy, Boggs, Hagenstein, Lipkin, & Michaelson, 1999). Baseline data, habitat relationships, distributions, and population parameters are poorly known for Alaskan wildlife (ADF&G, 2006). The lack of this information makes it difficult to accurately assess impacts of projects on wildlife and the ecosystem, to assess species that may be declining, or identify habitat issues that need management actions to meet Forest Service objectives and policy. Most species in Alaska still appear to have intact ecological communities and functional habitat and can provide a relatively undisturbed study canvas to evaluate the function and patterns of intact ecosystems. These intact functional systems are difficult to find in the contiguous 48 states.

Plants

Chugach National Forest plant species commonly enjoyed and used by the public for gathering, observing, or sustenance are summarized, and the conditions and trends for these species along with the contribution of these species to social and economic sustainability are discussed.

Relevant Information

- In general, the condition of Chugach National Forest plant populations enjoyed and used by the public is good.
- Harvesting fern fiddleheads and mushrooms from within the national forest appears to be increasing. There is a need to evaluate special forest products management to ensure sustainability.
- The spread of non-native and invasive plant species does pose some risk in specific areas of high human use (e.g., trails and roads).

Species Commonly Enjoyed and Used by the Public

Native people of southcentral Alaska have used a variety of plants for thousands of years for food, shelter, fuel, medicine, crafts, and spiritual purposes (Russell, 2011). Some present day uses of these plants include Christmas trees, transplants (for landscaping), cuttings (for restoration), burls, boughs, and medicines along with edible leaves, berries, fruits, stems, and roots. Some trees found within the national forest are used for wood products, such as house logs or fuelwood.

More than 560 vascular plant species have been recorded within the Chugach National Forest, equating to about one-third of the total flora of Alaska (DeVelice, et al., 1999). Of these, the 284 most common are described in DeVelice et al. (2001). All of these species contribute to the aesthetic character of the national forest landscape. A selection of plants found within the national forest and their known uses by people is listed in table 68.

Table 68. A selection of plant species found within the Chugach National Forest that are known to be used by people (based in part on Russell 2011)

Scientific Name	Common Name	Known Uses	Geographic Area
Trees			
Betula kenaica	Kenai paper birch	E T U W	Kenai Peninsula
Picea glauca	white spruce	O U T W X	Kenai Peninsula
Picea X lutzii	Lutz spruce	O U T W X	Kenai Peninsula
Picea mariana	black spruce	U	Kenai Peninsula
Picea sitchensis	Sitka spruce	E M O T U W X	Forestwide
Populus balsamifera ssp. *trichocarpa*	black cottonwood	U W	Kenai Peninsula and Copper River Delta
Populus tremuloides	quaking aspen	T U W	Kenai Peninsula
Salix scouleriana	Scouler willow	C	Kenai Peninsula
Tsuga heterophylla	western hemlock	U W	Prince William Sound and Copper River Delta
Tsuga mertensiana	mountain hemlock	U and W	Forestwide
Tall Shrubs			
Alnus incana ssp. *tenuifolia*	thinleaf alder	T	Kenai Peninsula
Alnus viridis ssp. *sinuata*	Sitka alder	T	Forestwide
Amelanchier spp.	serviceberry	B	Kenai Peninsula
Dasiphora fruticosa ssp. *floribunda*	shrubby cinquefoil	M and T	Kenai Peninsula

Scientific Name	Common Name	Known Uses	Geographic Area
Tall Shrubs (continued)			
Malus fusca	Oregon crab apple	B	Prince William Sound
Myrica gale	sweetgale	M	Forestwide
Oplopanax horridus	devil's club	M and T	Forestwide
Ribes hudsonianum	northern black currant	B	Kenai Peninsula
Ribes lacustre	bristly black currant	B	Kenai Peninsula
Ribes laxiflorum	trailing black currant	B	Kenai Peninsula and Prince William Sound
Ribes triste	northern red currant	B	Kenai Peninsula
Rosa acicularis	prickly rose	B and M	Kenai Peninsula
Rubus idaeus	raspberry	B	Kenai Peninsula
Rubus spectabilis	salmonberry	B	Forestwide
Salix sp.	willow	C	Forestwide
Salix alaxensis	feltleaf willow	C	Forestwide
Salix barclayi	Barclay willow	C	Forestwide
Salix commutata	undergreen willow	C	Forestwide
Salix hookeriana	Hooker willow	C	Copper River Delta
Salix pulchra	diamond-leaf willow	C	Kenai Peninsula
Salix sitchensis	Sitka willow	C	Forestwide
Sambucus racemosa	elderberry	M	Forestwide
Sorbus scopulina	western mountain-ash	M	Kenai Peninsula and Prince William Sound
Sorbus sitchensis	Sitka mountain-ash	M	Forestwide
Vaccinium ovalifolium	early blueberry	B and T	Forestwide
Viburnum edule	highbush cranberry	B and M	Forestwide
Low and Dwarf Shrubs			
Arctostaphylos alpina	alpine bearberry	B	Kenai Peninsula
Arctostaphylos uva–ursi	kinnikinnick	B	Kenai Peninsula
Empetrum nigrum	crowberry	B	Forestwide
Ledum palustre ssp. *decumbens*	narrow-leaf Labrador-tea	E	Forestwide
Ledum palustre ssp. *groenlandicum*	Greenland Labrador-tea	E	Kenai Peninsula
Linnaea borealis	twinflower	T	Kenai Peninsula
Oxycoccus microcarpus	bog cranberry	B	Forestwide
Spiraea beauverdiana	Beauverd spiraea	T	Kenai Peninsula and Prince William Sound
Vaccinium caespitosum	dwarf blueberry	B	Kenai Peninsula and Prince William Sound
Vaccinium uliginosum	bog blueberry	B and T	Forestwide
Vaccinium vitis-idaea	lowbush cranberry	B	Forestwide
Herbs			
Achillea borealis	yarrow	M	Forestwide
Aconitum delphinifolium	monkshood	T	Kenai Peninsula and Prince William Sound
Aquilegia Formosa	western columbine	T	Kenai Peninsula and Prince William Sound
Arnica latifolia	broadleaf arnica	M	Kenai Peninsula and Prince William Sound

Scientific Name	Common Name	Known Uses	Geographic Area
Herbs (continued)			
Artemisia tilesii	*Aleutian mugwort*	*M*	*Forestwide*
Aruncus Sylvester	goatsbeard	T	Forestwide
Boschniakia rossica	ground-cone	M	Forestwide
Chamerion angustifolium	tall fireweed	M and T	Forestwide
Chamerion latifolium	dwarf fireweed	T	Forestwide
Conioselinum chinense	western hemlock-parsley	E and M	Forestwide
Cornus Canadensis	bunchberry	B	Forestwide
Dodecatheon pulchellum	pretty shooting star	T	Forestwide
Erigeron peregrinus	subalpine fleabane	M and T	Forestwide
Fragaria chiloensis	beach strawberry	B and T	Copper River Delta
Fritillaria camschatcensis	chocolate lily	E and T	Forestwide
Geranium erianthum	northern geranium	M and T	Kenai Peninsula and Prince William Sound
Heracleum maximum	cow parsnip	E and M	Forestwide
Honckenya peploides	seaside sandplant	E	Prince William Sound and Copper River Delta
Iris setosa	wild iris	T	Forestwide
Lathyrus maritimus	beach pea	E	Forestwide
Leymus mollis	beach rye	C	Forestwide
Ligusticum scoticum	beach lovage	E and M	Prince William Sound and Copper River Delta
Lupinus nootkatensis	Nootka lupine	E and T	Forestwide
Moneses uniflora	single delight	M	Forestwide
Myosotis alpestris	forget-me-not	T	Kenai Peninsula
Petasites hyperboreus	arctic sweet coltsfoot	M	Kenai Peninsula and Prince William Sound
Polygonum viviparum	alpine bistort	M	Forestwide
Prenanthes alata	rattlesnake root	M	Forestwide
Rubus arcticus	nagoonberry	B	Forestwide
Rubus chamaemorus	cloudberry	B	Kenai Peninsula and Prince William Sound
Rubus pedatus	fiveleaf bramble	B	Forestwide
Rumex fenestratus	western dock	E	Prince William Sound and Copper River Delta
Sedum rosea	roseroot stonecrop	T	Kenai Peninsula
Solidago multiradiata	northern goldenrod	T	Kenai Peninsula
Streptopus amplexifolius	twistedstalk	B	Forestwide
Thalictrum sparsiflorum	fewflower meadowrue	M	Kenai Peninsula and Prince William Sound
Ferns			
Athyrium filix-femina	lady fern	E and T	Forestwide
Dryopteris expansa	wood fern	E and T	Forestwide
Equisetum arvense	common horsetail	E and M	Forestwide

Note: Codes for known uses are B: berries/fruits, C: cuttings, E: edible (leaves, stems, or roots), M: medicinal, O: boughs, T: transplants, U: burls, W: wood products, and X: Christmas trees

Although not technically plants, mushrooms are discussed in this section. Mushrooms are a highly sought after special forest product within the Chugach National Forest as a source of food, pigments for dyes, and for aesthetic enjoyment. There are more than 300 species of mushroom producing fungi documented within the Chugach National Forest and many more species are likely to occur. Mohatt et al. (2013) provides descriptions of 51 common and interesting species of southern Alaska, 50 of which occur within the Chugach National Forest. The species most often collected for consumption include: angel wings (*Pleurocybella porrigens*), gypsy (*Cortinarius caperatus*), shaggy mane (*Coprinus comatus*), winter chanterelle or yellow foot (*Craterellus tubaeformis*), blue or black chanterelle (*Polyozellus multiplex,* rare), king bolete (*Boletus edulis*), sulfur shelf or chicke of the woods (*Laetiporus conifericola*), hedgehog or sweet tooth (*Hydnum repandum*), bear's head (*Hericium coralliodes*), gray fire morel (*Morchella tomentosa*) and other morels (*Morcella* spp.). The most common commercially harvested species are king bolete and hedgehog.

Conditions and Trends

National Forest System lands are available for the personal use gathering of special forest products, such as berries, mushrooms, greenery, and Christmas trees. No permits are required for these activities and no data are available to evaluate this use. Permits are required for commercial harvest of special forest products (USDA, 2000). People collecting special forest products are expected to exercise reasonable care to protect resources from damage. In addition, a special forest products decision memo specifies limits on permits by watershed on the Kenai Peninsula to prevent overharvesting within heavily used areas, highly public areas, and within specific watersheds (USDA, 2002a).

The demand for some special forest products is increasing; this is evidenced by overharvest of fern fiddleheads and mushrooms. Based on public reports and Forest Service site visits, lady fern (*Athyrum filix-femina*) is being overharvested in the Girdwood area. Monitoring plots have been established to quantify harvesting effects on the fern population. Results of this monitoring are not yet available.

The demand for edible mushrooms/fungi appears to be increasing based on public interest in informational presentations. The Girdwood Fungus Fair has consistently drawn more than 1,000 people each of the last 6 years. There has not been an increase in requests for commercial harvest of species, yet several restaurants and shops sell or serve locally harvested species. Complaints have been made about commercial harvests occurring on National Forest System lands (Mohatt, personal communication, 2013). There is a need to review special forest product management for the Chugach National Forest.

In general, the condition of Chugach National Forest plant populations enjoyed and used by the public is good. This is primarily due to the generally low level of intensive human-caused disturbance across the largely unroaded national forest. The spread of non-native and invasive plant species does pose some risk in specific areas of high human use (e.g., trails and roads).

Contribution to Social and Economic Sustainability

The Forest Plan Review 2002-2012 (USDA, 2012b) noted that demand for commercial special forest products from the national forest was low in 2002 and has remained low. Twelve special forest products permits have been issued since 2002, all on the Kenai Peninsula. These permits allowed collection of 100 pounds of mushrooms, more than 350 spruce transplant trees, 200 alder transplants, 5,800 hardwood transplant trees, burls, willow cuttings, spruce boughs, blueberry transplants, and miscellaneous landscaping plants. In addition, an average of two permits are issued each year to collect botanical specimens for scientific research (not directed toward development of a commercial product).

Personal use gathering of special forest products, such as berries, mushrooms, and Christmas trees, is a popular activity within the national forest. A 1997 survey found berry picking to be among the most popular activities among Alaska adults (61 percent participation), and that participation is expected to grow (Bowker, 2001). Additionally, interest among agencies, tribal governments, traditional users, landholders, businesses, and scientists in sustainable special forest products in Alaska is documented by the Alaska Boreal Forest Council. Nature enthusiasts using the national forest often include plants as subjects of interest in photography and observation.

Timber

This section is a summary of information on timber resources within the Chugach National Forest, including the current level of timber harvest and production; the ability of timber harvest to affect forest resistance and resilience to stressors; the ability of timber harvest to maintain or restore key ecosystem characteristics; the current capacity and trend of logging and restoration services; key trends that drive the supply and demand for timber; and the contribution of timber harvest and production to ecological, social, and economic sustainability. General characteristics of forest vegetation of the Chugach National Forest are summarized in the Terrestrial Ecosystems section in chapter 2.

Relevant Information

- Less than one percent of the Chugach National Forest is tentatively suitable for timber production.
- Supply and demand for forest products are not in balance. The decrease in supply (especially fuelwood) and increase in demand suggest it may be desirable to identify opportunities for supplying wood products. This could include designated small timber sales and free use fuelwood collection areas.

Suitable Timberland

The 2002 Forest Plan does not include an allowable sale quantity for a sustained output of volume for commercial timber sales. Although the land suitability analysis identified 282,610 acres of tentatively suitable forestland, those lands are allocated for resource uses other than commercial timber production. To meet National Forest Management Act requirements, an analysis of changes in timber suitability was completed in 2012 (DeVelice R. L., 2012b). Based on the 2012 process, 156,380 acres of tentatively suitable timberland were estimated across the national forest (table 69). The main difference between this estimate and the 282,610 acre estimate from 2002 is the exclusion of productive forest acreage in the Nellie Juan-College Fiord WSA and in research natural areas. In 2014, all remaining acreage designated as part of an inventoried roadless area was further excluded since timber production is prohibited. Presently, 3,260 acres of tentatively suitable timberland are estimated for the national forest.

Table 69. Acreage of tentatively suitable timberlands within the Chugach National Forest by geographic area as identified in the 2002 Forest Plan and in a 2012 analysis (DeVelice R. L., 2012b) and at present (with IRAs excluded)

Geographic Area	2002	2012	Present (excluding IRAs)
	acres		
Copper River Delta	88,514	71,280	2,730
Kenai Peninsula	25,397	17,180	0
Prince William Sound	168,699	67,920	530
Totals	282,610	156,380	3,260

Condition and Trend

Current level of timber harvest and production

Although the overall percentage of tentatively suitable timberland is low (less than one percent of the almost 5.4 million acre Chugach National Forest), there is still considerable social and some economic demand for such things as personal use fuelwood, lumber and house logs, commercial fuelwood, and special forest products.

The 2002 Forest Plan FEIS noted that from 1910 to 2000, the average amount of timber harvested from the Chugach National Forest was 3,800 thousand board feet (MBF) per year, and from 1995 to 2000, the average was 1,500 MBF per year. The FEIS also noted personal use permitting ranged from 100 to 500 MBF per year from the late 1980s to 2000.

According to the Forest Plan Review 2002-2012 and annual accomplishment reports, from 2002 to 2006, the average timber volume harvest for personal use was about 410 MBF per year while the average harvest from sales was 70 MBF per year. From 2007 through 2011, the average harvest for personal use was about 350 MBF per year with an additional harvest of 1,110 MBF per year from sales.

From 2006 to 2011, personal use fuelwood harvested from the Kenai Peninsula geographic area of the Chugach National Forest averaged 1,125 cords per year, and 650 cords per year were sold to fuelwood businesses. The Forest Service also coordinates with the state of Alaska to provide personal use fuelwood in the Cordova area.

Ability of timber harvest to affect forest resistance and resilience to stressors

The largest disturbance (stressor) that has affected forest ecosystems in the Chugach National Forest in recent decades has been spruce bark beetle activity. From 1980 to 2003, spruce bark beetle outbreaks occurred on about 2.25 million acres in the broader Kenai Peninsula-Cook Inlet region (Werner, Holsten, Matsuoka, & Burnside, 2006). The spruce tree mortality associated with this outbreak has resulted in extensive hazardous fuels accumulations. In response to the fuels situation on the Kenai Peninsula, an interagency committee of Federal, state, local, and Alaska Native land managers developed an action plan for fire prevention and protection, hazardous fuels reduction, ecosystem restoration, and community assistance (Kenai Peninsula Borough, 2004). As part of this action plan, mechanical and prescribed fire fuel reduction is occurring on about 100,000 acres on the entire Kenai Peninsula (about 875 acres per year within the Chugach National Forest), with a focus on the wildland-urban interface. Much of the beetle-killed spruce reduction work has been completed within the wildland-urban interface and accessible roaded areas. These treatments are expected to reduce the supply of fuelwood in the future. There is potential to use more preventative treatments, such as green tree thinning, to increase resistance to future insect infestations and to meet current demands for timber. The potential influence of climate change on forest vegetation is discussed in the Terrestrial Ecosystems section.

Ability of timber harvest to maintain or restore key ecosystem characteristics

In 2008, an integrated five-year plan for vegetation treatment was developed for the Kenai Peninsula geographic area. The purpose of this plan is to assist with out-year planning and budget development for projects that reduce hazardous fuels, improve wildlife habitat, improve forest vegetation, and provide a reliable supply of wood products to the public. National forest vegetation and wildlife habitat is managed through thinning and patch cuts that favor early seral hardwoods and maintain aspen stands. Dead and down hazardous fuels are removed or piled. The resulting forest stands are potentially more resistant and resilient to wildland fire and future stressors, such as insects and diseases and precipitation changes, which may result from a changing climate.

Current capacity and trend of logging and restoration services

The Forest Service is providing for personal and commercial uses of timber and special forest products but harvest has decreased. This reduction may be due to a depleted supply of easily accessible wood on the Kenai Peninsula.

Key trends that drive the supply and demand for timber

The price of fuelwood has increased from 180 to 200 dollars per cord to 275 to 300 dollars per cord during the past five years, an increase of about 50 percent. This is likely due to increased fuel oil prices and the decline in accessible fuelwood. Much of the beetle-killed spruce that was close to roads has been gathered or is no longer sound enough to use as fuel. The decrease in fuelwood supply and increase in fuelwood (demand) suggest it may be necessary to consider planning for more designated small timber sale and free use fuelwood collection areas in the future.

Contribution of Timber Harvest and Production to Social and Economic Sustainability

The 1,125 cords of personal use fuel wood collected from the Kenai Peninsula geographic area of the national forest is enough to heat 225 households for the year, saving each approximately 1,250 dollars per year in heating costs, not including the cost to collect fuelwood. Fuel wood businesses (commercial collection) generate approximately 163,000 dollars in revenue from 650 cords per year. See the timber and wood products discussion in the Social, Cultural, and Economic Conditions section for additional information.

Fire Management

Owing to the generally cool, moist climate and low incidence of lightning, natural fires are infrequent within the Chugach National Forest, especially in the Prince William Sound and Copper River Delta geographic areas. Low frequency (about 600 year interval) natural fire has been important in the Kenai Peninsula geographic area of the national forest (Potkin, 1997). Charcoal has been reported as present in most soil pits within the Kenai Peninsula forested zone (Davidson, personal communication, 2013) suggesting the occurrence of widespread, yet infrequent, fires in prehistoric times.

While natural fire has been infrequent, human caused fire on the Kenai Peninsula geographic area has been common over the last 100 years. From 1914 to 1997, approximately 1,400 fires burned a total of 75,000 acres within the national forest (Potkin, 1997) (see figure 19), an average of about 17 fires per year. Based on the Chugach National Forest GIS database, about 85 percent of the fires within the national forest were smaller than one-quarter acre, 10 fires were larger than 1,000 acres, and more than 99 percent of all the acres burned were in the Kenai Peninsula geographic area. Humans have caused more than 99 percent of these fires.

The majority of wildland fires within the Chugach National Forest result from human activities and occur near communities, public concentration areas (e.g., campgrounds), along roads, trails, and waterways. With an increasing number of people using the national forest, human-caused fire is expected to increase. Climate change may alter the frequency and intensity of fire by affecting lightning occurrence and fuel moisture.

One 2002 Forest Plan goal is to "protect human life, property and facilities from wildland fire hazards" (USDA, 2002a). Fire and fuels management for the national forest include wildland fire response, hazardous fuels reduction, and wildlife habitat improvement. The focus is on the Kenai Peninsula geographic area where people and communities are in close proximity to hazardous fuels. Management of vegetation near communities, public concentration areas, and transportation routes is used to help reduce the threat of fire to life and property.

Relevant Information

- There are about 119,000 acres of wildland-urban interface in the Kenai Peninsula geographic area.
- Since 1914, approximately 1,400 fires burned a total of 75,000 acres on the Chugach National Forest.
- More than 99 percent of the acres burned were in the Kenai Peninsula geographic area.
- Humans caused more than 99 percent of the fires.
- With an increase in the number of people using the national forest, the likelihood of human-caused fire is expected to increase.
- Effects of climate change on lightning occurrence and fuel moisture may alter the frequency and intensity of fire.
- The 2002 Forest Plan includes direction allowing broadcast burning as a fire management tool. Plan objectives could be included to emphasize using broadcast burning as a fire management tool where reducing hazardous fuels or improving wildlife habitat is part of the desired condition.

Fire Use by Alaska Natives

Alaska Natives have been present in southcentral Alaska for thousands of years. There is no evidence that they used fire as a land management tool (Berg, personal communication, 2013).

Wildland Fire Response

Protection of life and property from the threat of wildland fire is one of the Forest Service's most critical missions (USDA, 2002c). Fire suppression activities within the national forest are prioritized by the four protection levels (critical, full, modified, and limited) defined in the Alaska Interagency Wildland Fire Management Plan (2010).

The distribution of these four protection levels across the national forest and by geographic area is shown in map 11 and the acreage is displayed in table 70. About 14 percent of the Kenai Peninsula geographic area (where wildland fires are most prevalent within the national forest) is classified either Critical or Full protection level. Even though the probability of fire is low in the rain forests of Prince William Sound and the Copper River Delta, populated areas, property, and structures are present that need to be protected in the unlikely event of wildland fire. The intent of the options follows.

Critical protection level

These are the highest priority areas/sites for suppression actions and assignment of available firefighting resources. Lands in the wildland-urban interface and other populated areas where there is an immediate threat to human life, primary residences, inhabited property, community-dependent infrastructure, and structural resources designated as National Historic Landmarks qualify to be considered for this designation.

Full protection level

This option provides for the protection of cultural and paleontological sites, developed recreational facilities, physical developments, administrative sites and cabins, uninhabited structures, high-value natural resources, and other high-value areas that do not involve the protection of human life and inhabited property. Structures on or eligible for inclusion and non-structural sites on the National Register of Historic Places are placed within this category.

Modified protection level

This option provides a protection level between Full and Limited. Unlike Full protection level areas, the intent is not to minimize burned acres, but to balance acres burned with suppression costs and, similar to the Limited protection level, to accomplish land and resource management objectives when conditions are favorable.

Management actions should:

- Under suitable fire and environmental conditions, accomplish fire-related land-use and resource objectives in a cost effective manner while providing appropriate levels of protection to identified sites.
- Maintain the flexibility to respond to fire conditions and tailor the initial action to those conditions.

Limited protection level

The Limited protection level is designed for broad, landscape-scale areas where the low density and wide distribution of values to be protected best allows for fire to function in its ecological role. Sites that warrant higher levels of protection may occur within the boundaries of Limited protection level areas, and actions to protect these sites will be taken when warranted without compromising the intent of this management option. Limited protection level is also assigned to areas where the cost of suppression may exceed the value of the resources to be protected or the environmental impacts of fire suppression activities may have more negative impacts on the resources than the effects of the fire.

Hazardous Fuels Reduction

The hazardous fuels reduction program strives to minimize the potential for large, destructive wildland fires by reducing the volume of hazardous fuel within the national forest. The highest priority is reduction of fuels in the wildland-urban interface. Coordination occurs with state and private land owners to maximize benefits across the landscape (using the Interagency All Lands/All Hands action plan, i.e., Kenai Peninsula Borough 2004). In general, priorities for treatment follow the fire protection levels described previously (i.e., focusing management actions in Critical protection level areas first).

The wildland-urban interface and Community Wildfire Protection Plan (CWPP) areas of the national forest are displayed in map 12. CWPP areas occurring at least in part within the national forest boundary are: Hope/Sunrise/Summit; Moose Pass/Crown Point/Primrose; Cooper Landing; and Bear Creek/Seward/Lowell Point. There are about 119,000 acres of wildland-urban interface in the Kenai Peninsula geographic area of the national forest. Most areas of the high hazard fuels and high fire risk border the Sterling and Seward highways.

As noted in the Forest Plan Review 2002-2012, a spruce bark beetle (Dendroctonus rufipennis) infestation killed a majority of mature spruce trees across at least 40,000 acres of the Chugach National Forest in the Kenai Peninsula geographic area since the 1950s (peaking in the 1990s). The spruce bark beetle infestation has resulted in extensive hazardous fuels accumulation and increased potential for large wildland fires. Reducing these accumulations has been the focus of the hazardous fuels program.

The 2002 Forest Plan proposed completing 400 acres of hazardous fuel reduction annually. About 600 acres of treatment are actually accomplished each year. Treatments consist of removal, thinning, pruning, piling, and burning, especially in the wildland-urban interface, high use areas, and along transportation routes. Since the Kenai Lake Fire of 2001, which was planned for 1,250 acres but burned 3,260 acres, broadcast burning has not been used within the national forest. Reestablishing broadcast burning as a fire management tool would expand treatment options (and possibly reduce costs) for hazardous fuel reduction and wildlife habitat improvement.

Wildlife Habitat Improvement

The 2002 Forest Plan proposes about 2,248 acres of wildlife habitat improvement burns annually. However, since broadcast burns are not currently being used within the national forest, habitat improvement burns are not taking place.

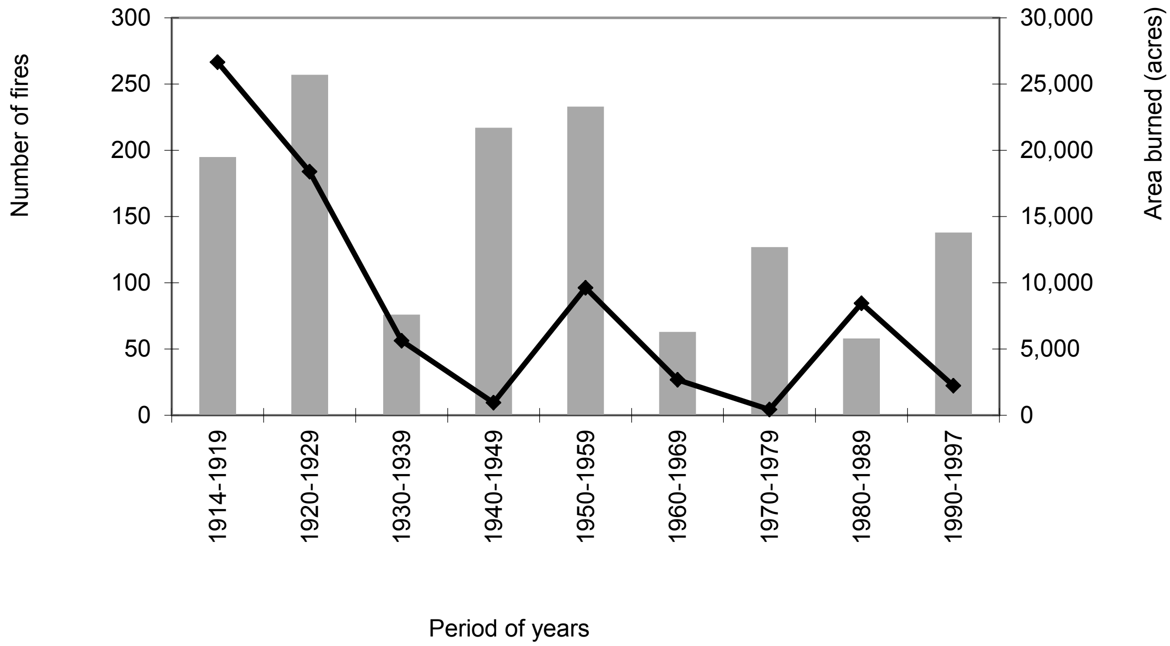
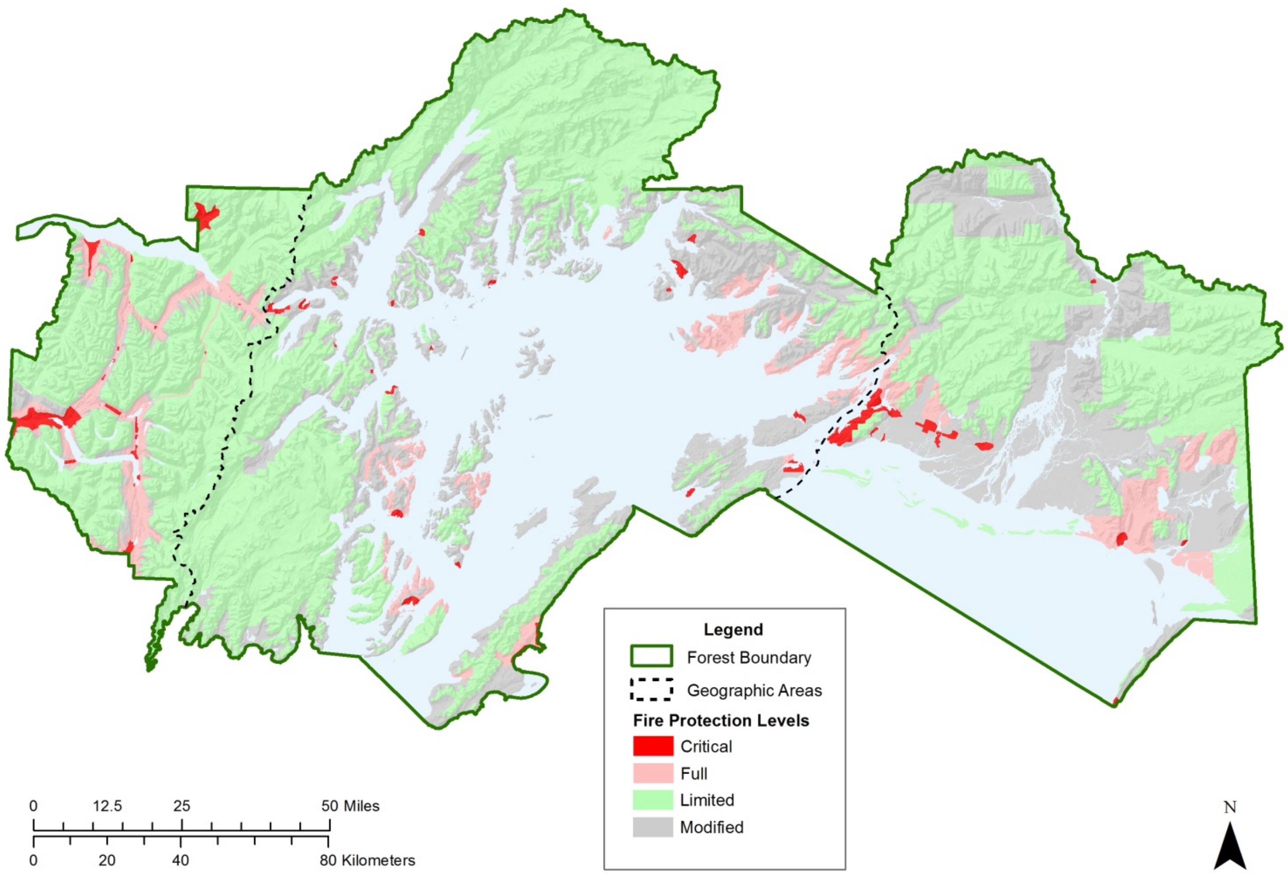


Figure 19. Number of fires (bars) and acres burned (line) by decade in the Kenai Peninsula geographic area from 1914 to 1997 (Potkin 1997 and USFS 2002b)

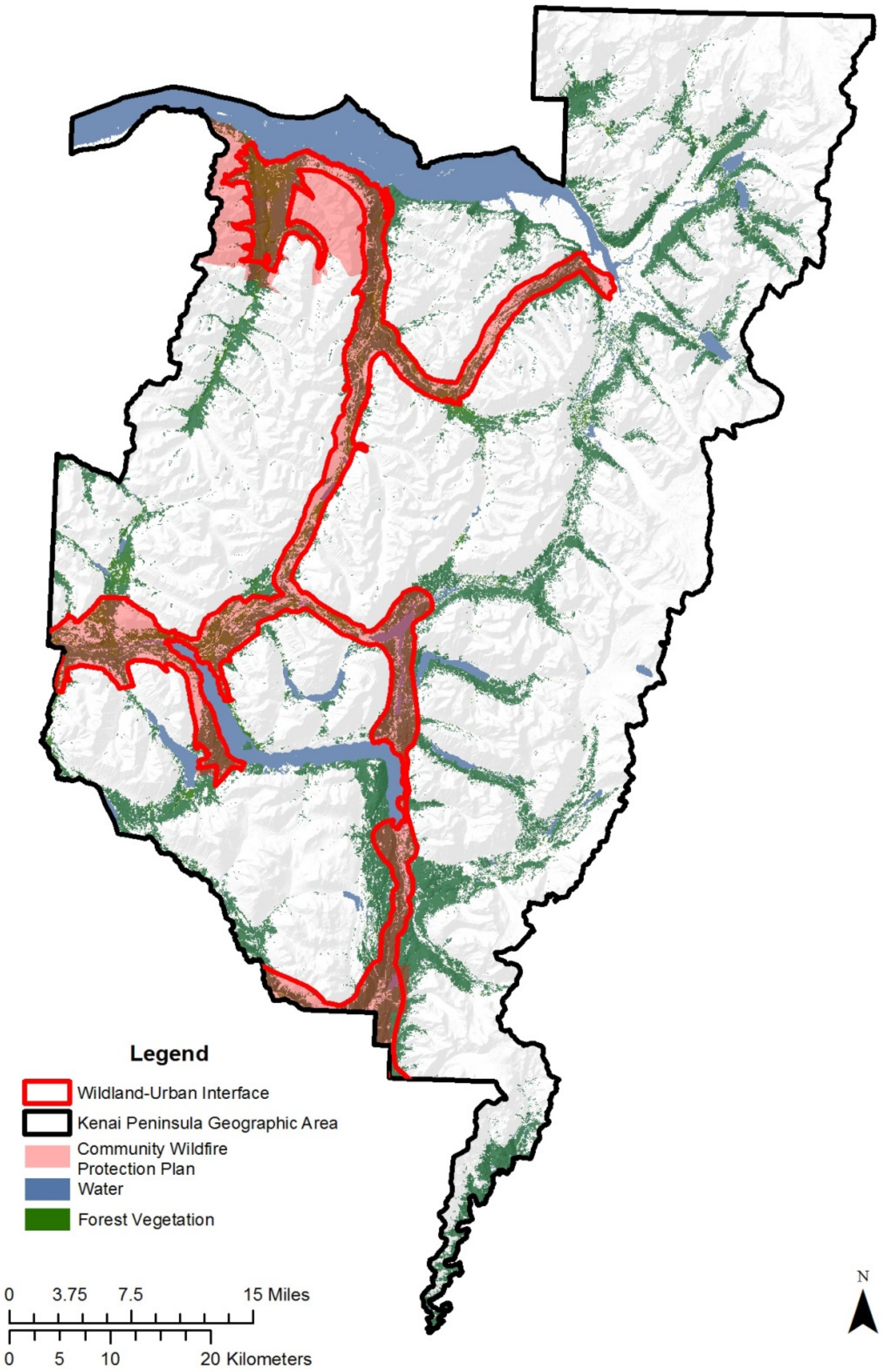
Table 70. Acreage by fire protection level within the outer boundary of the Chugach National Forest (see map 11)

Geographic Area	Protection Level					
	Critical	Full	Modified	Limited	Water	Totals
	acres (percentage)					
Kenai Peninsula	33,152 (2.6)	146,213 (11.6)	74,271 (5.9)	981,689 (77.9)	24,582 (2.0)	1,259,907
Prince William Sound	21,166 (0.7)	161,458 (5.3)	920,456 (30.3)	1,925,382 (63.4)	7,601 (0.3)	3,036,063
Copper River Delta	27,635 (1.4)	139,248 (6.9)	735,205 (36.0)	1,080,091 (53.8)	37,647 (1.9)	2,007,826
Forestwide	81,953 (1.3)	446,920 (7.1)	1,717,932 (27.3)	3,987,162 (63.3)	69,829 (1.1)	6,303,796

Definitions of the four protection levels are provided in the text.



Map 11. Fire protection levels across the Chugach National Forest. The boundaries of the Kenai Peninsula, Prince William Sound, and Copper River Delta geographic areas are also shown (left to right, respectively).
Definitions of the four protection levels are provided in the text.
Source: Chugach National Forest GIS database.



Map 12. Wildland-urban interface (within the red line) and CWPP (in red shading) areas of the Chugach National Forest. The boundary of the Kenai Peninsula geographic area is in black. Areas of forest vegetation are shown in green and open water in blue.
Sources: Kenai Peninsula Borough GIS (wildland-urban interface and CWPP), Chugach National Forest GIS (Kenai Peninsula geographic area boundary), and the National Land Cover Database (http://www.mrlc.gov/).

Watershed and Water Resources

This section represents a rapid evaluation of existing information on the trends and sustainability of the contribution of watersheds and water resources to social, economic, and ecological sustainability. Specific items to be evaluated for the plan area include: water rights and instream flows, consumptive water uses, non-consumptive water uses, condition and trends for water uses in the plan area and broader landscape, and the contribution of watersheds and water resources to social and economic sustainability.

Water resources within the national forest are extremely valuable to the public. These resources are both consumptive and non-consumptive. The main consumptive water uses include drinking water, water use for Forest Service facilities (i.e., campgrounds, maintenance, fire, and management activities), hydropower generation, fish hatcheries, mining operations, highway construction, dust abatement, and special use permits. National Forest System lands provide water for more than 150 public water systems and one designated municipal water source (city of Cordova). Non-consumptive water uses include recreation (i.e., rafting, fishing, boating), wildlife and aquatic habitat, subsistence, and the aesthetic quality of the resource. A substantial part of recreational use within the national forest revolves around water bodies and glaciers.

Relevant Information

- Water uses within the national forest will likely increase in the future with increased demands for hydroelectricity, mining operations, gravel extraction, development, and recreation.
- Nearly 500 water rights exist within the national forest. Seven include instream flow reservations for fish and wildlife habitat. The majority of these are within the Kenai Peninsula geographic area. The Forest Service has not applied for any water rights for in-stream flow reservations within the national forest. With trends for increased demands, filings of water rights, the influence of lands of other ownership, and climate change projections on water resources, the Forest Service could include management direction to pursue applications for securing in-stream flows reservations within priority watersheds.
- Direction could be added to acquire water rights associated with new and existing administrative and recreational facilities.
- Impacts from climate change to non-consumptive national forest water resources include affects to timing, locations, and use of recreational activities, such as whitewater rafting, skiing, fishing, and glacial viewing. Impacts from climate change to consumptive national forest water resources include changes in the timing and amounts of water available for water storage and hydropower generation.

Water Resources Used by the Public

Water rights and instream flows

The 2002 Forest Plan does not use the phrase water rights at all and the phrase instream flows is mentioned only once (USDA, 2002a). Instream flows are identified as a goal for Water, Wetland, and Riparian Areas, specifically: “Provide instream flows to maintain and support aquatic life and habitat, recreation and aesthetics, the natural conveyance of water and sediment, and other resources that depend on such flows on National Forest System lands.” The corresponding objective states: “Establish instream flow requirements or suitable mitigation measures for all water impoundments or diversions” (USDA, 2002a).

Guidance on acquiring water rights and reservation of instream flows is outlined in FSM 2540.

A water right is a legal right to use surface or groundwater. It allows a specific amount of water from a particular water source to be diverted, impounded, or withdrawn for a specific use. Water rights in Alaska are regulated under the Alaska Water Use Act (AS 46.15).

A reservation of water for instream use is a specific type of water right that protects certain instream water uses, such as fish spawning or recreation. It sets aside the water flow necessary for these activities and keeps later water users from appropriating water that may affect instream activity.

Federal reserved water rights are different from state appropriated water rights. Federal reserved rights:

- May apply to both instream and out-of-stream water uses
- May be created without actual diversion or beneficial use
- Are not lost by non-use
- Have priority dates established as the date the land was withdrawn
- Are for the minimum amount of water reasonably necessary to satisfy both existing and foreseeable future uses of water for the primary purposes for which the land is withdrawn

Additionally, Federal subsistence use has a reserved water right in navigable waters within and adjacent to the exterior boundary of the national forest to provide for the harvest of fish (36 CFR 242.3(c)(6)). The reserved water right applies to all waters, within public and private ownership excluding marine waters (see the Subsistence section).

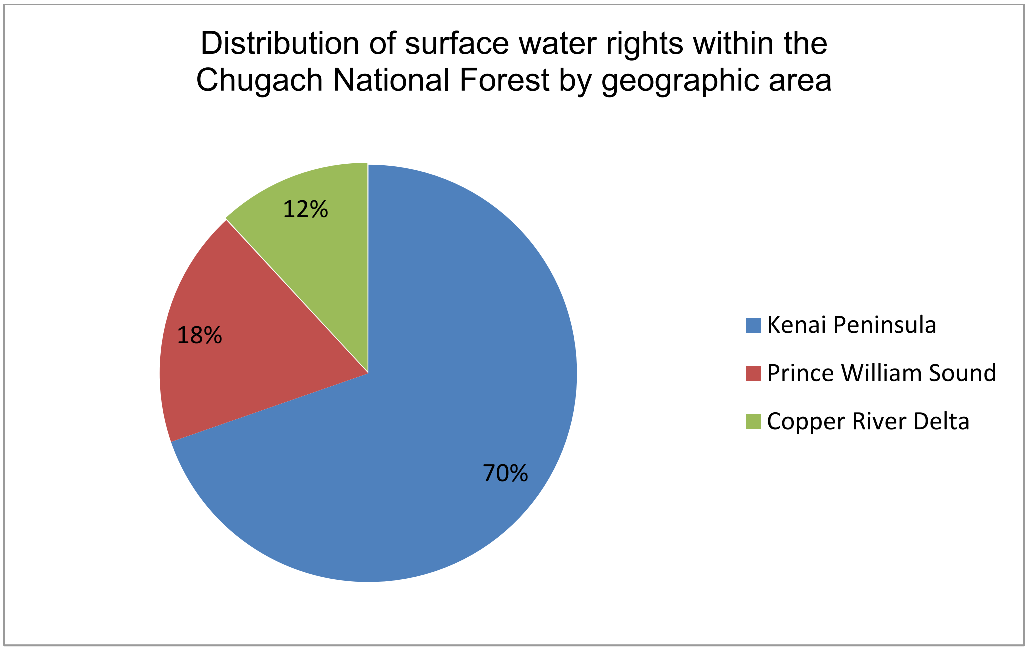
Water rights for all other Federal purposes must be obtained in compliance with AS 46.15.

Water rights within the Chugach National Forest

State-issued water rights are administered and maintained by the Water Resources Program of Alaska DNR Division of Mining, Land, and Water. Table 71 displays the number of surface and subsurface temporary water use permits and state water rights held within any 6th-level HUC watershed that is entirely or partially within the Chugach National Forest. Figure 20 illustrates that the majority of these lie within the Kenai Peninsula geographic area where most of the population resides. The Forest Service holds 15 percent of the surface water rights and 12 percent of the subsurface water rights displayed in these charts.

Table 71. All surface and subsurface temporary water use permits and state water rights permits held within any 6th-level HUC located within the Chugach National Forest boundary; permits listed include all certificates issued, permits issued, certificates pending action, permits pending action, and applications received (ADNR, 2013)

Type	Temporary Water Use Permits (TWUP)	Water Rights	
		Forest Service	Total
Surface	34	36	244
Subsurface (groundwater)	2	28	232



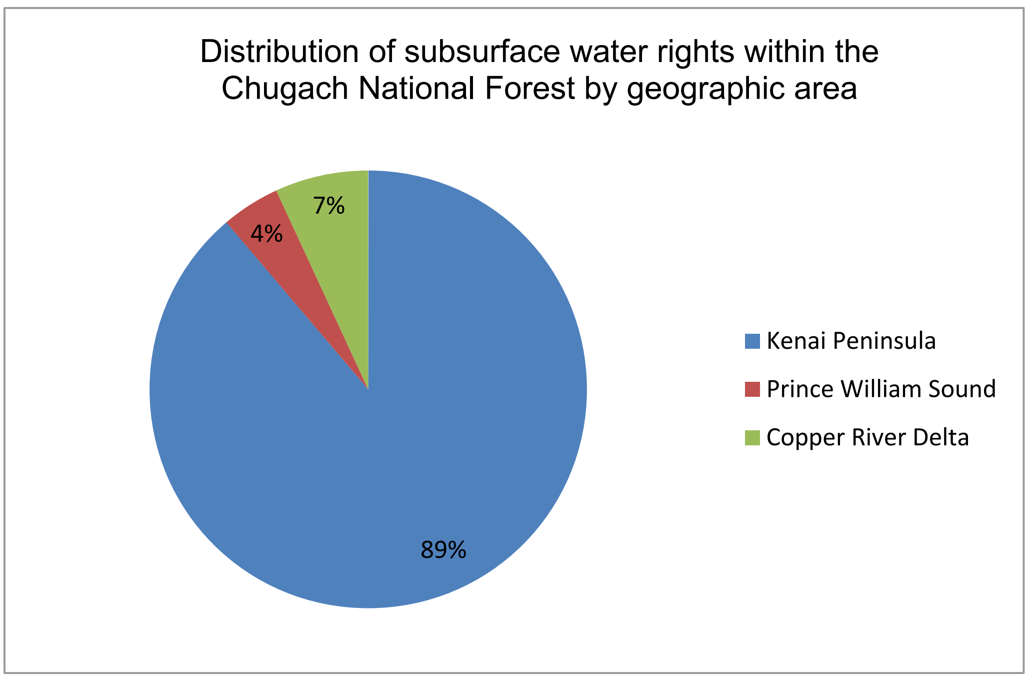


Figure 20. The distribution by geographic zone of surface and subsurface water use permits held within any 6th-level HUC located within the Chugach National Forest boundary. Permits listed include all certificates issued, permits issued, certificates pending action, permits pending action, and applications received (ADNR, 2013).

The Forest Service currently holds no water rights granted by the state of Alaska for in-stream flow reservations. Table 72 contains instream flow reservations by other owners that are on waters within or adjacent to the Chugach National Forest.

Table 72. Instream flow reservations held within or adjacent to the Chugach National Forest (ADNR, 2013)

Instream Flow Reservations			
Stream	**Geographic Area**	**LAS**	**Comments**
Kenai River	Kenai Peninsula	12676	ADF&G certificates issued
Kenai River	Kenai Peninsula	12677	ADF&G certificates issued
Glacier Creek	Kenai Peninsula	20895	ADF&G certificates issued
Copper River	Copper River Delta	22407	ADF&G certificates issued
Copper River	Copper River Delta	22405	ADF&G certificates issued
Grouse Creek	Kenai Peninsula	28418	ADF&G applications received
Twentymile River	Kenai Peninsula	28750	ADF&G certificates issued
Russian River	Kenai Peninsula	28751	ADF&G certificates issued

Contribution of Water Resources: Consumptive Use

Consumptive water use is defined as the amount of water taken from the system during the application of water to a beneficial use that is not returned to the system. The consumptive use of water reduces the overall amount of water in the system, making less water available for environmental purposes or downstream uses. Overall, consumptive water uses are fairly limited within the Chugach National Forest. There are limited water withdrawals and diversions for agricultural, municipal, and commercial uses. The main consumptive water uses include drinking water, water use for Forest Service facilities (i.e., campgrounds, maintenance, firefighting, and management activities), hydropower generation, fish hatcheries, mining operations, highway construction, dust abatement, and special use permits.

Municipal and public water supplies

There currently is one municipal watershed within the national forest. This municipal watershed encompasses Heney Creek, with water diverted into Meals Reservoir, and Murcheson Falls that drains into Eyak Lake and provides the drinking water source for the City of Cordova. Municipal watersheds are managed to protect the municipal water supply of communities adjacent to national forests. Activities on lands managed as municipal watersheds are generally limited to protect and maintain resources in a natural condition. These watersheds meet the provisions of the Safe Drinking Water Act and the State of Alaska Drinking Water Regulations and Water Quality Standards in accordance with Forest Service Manual (FSM 2545 and 36 CFR 251.9).

Municipal Supply Watersheds are defined (FSM 2545.05) as a watershed that serves a public water system as defined in the Safe Drinking Water Act of 1974, as amended, or watersheds that contain Source Water Protection Areas, as defined in Federal or state safe drinking water statutes or regulations. Source Water Protection Areas are delineated by the state for a public water system or include numerous public water systems, whether the source is ground water or surface water or both, as part of the State Water Assessment Program (SWAP) approved by EPA under section 1453 of the Safe Drinking Water Act. Figure 21 displays a list of the number and type of public water systems directly affected by National Forest System lands. These public water systems are entirely within the Chugach National Forest boundary or are adjacent and within a watershed that is partially within the boundary. Eighty-six percent of these public water systems are within the Kenai Peninsula geographic area with 9 percent in Prince William Sound and 5 percent on the Copper River Delta.

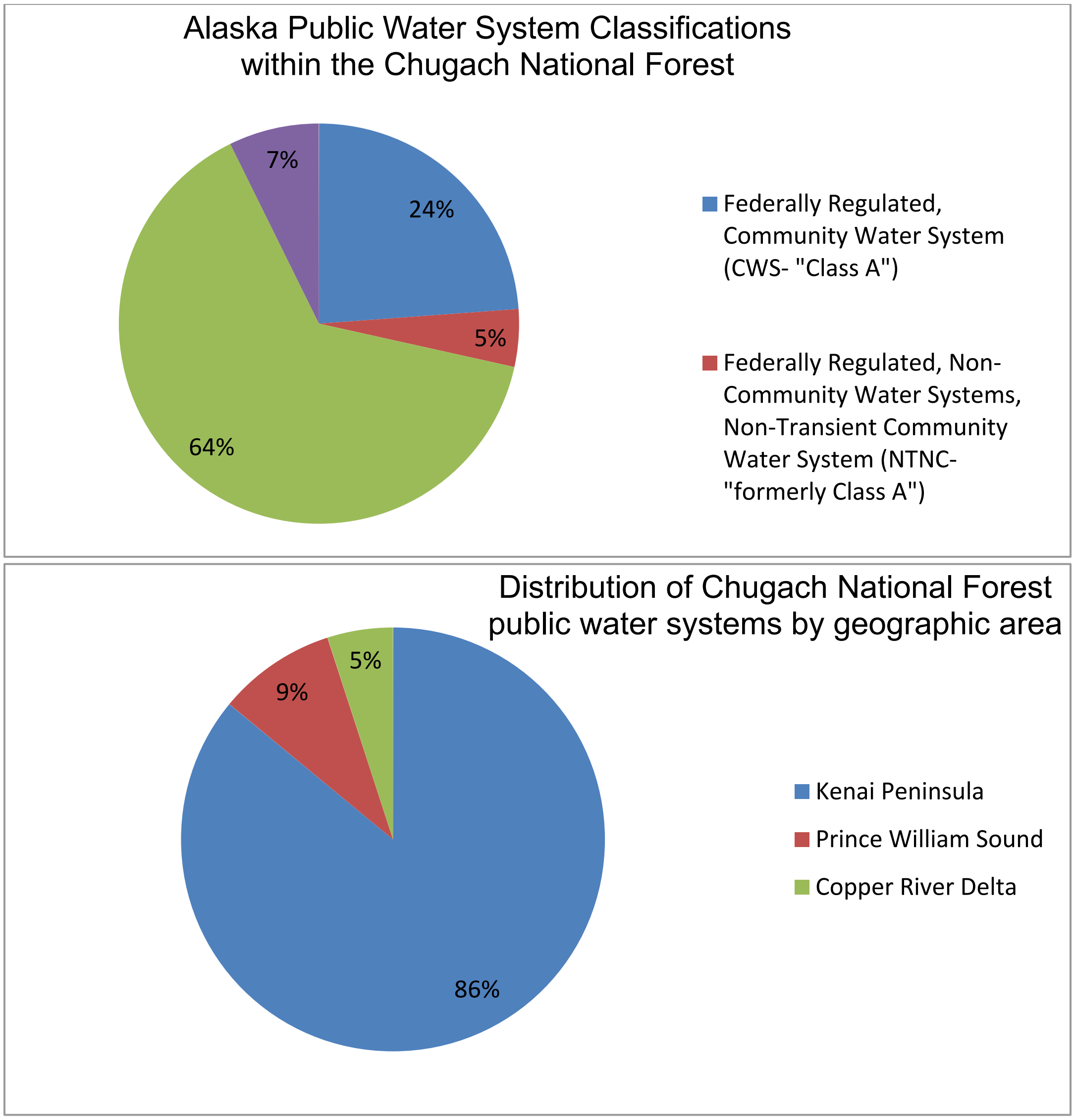


Figure 21. Percentages and types of public water systems within or adjacent to the Chugach National Forest. Data include any public water system that is within a 6th-level HUC that is entirely or partially within the Chugach National Forest. Public water system information has been provided by the Drinking Water Program of the ADEC. The information provided is a data snapshot as of March 12, 2013. There may be errors in source location information as well as other information provided.

A public water system is a system that provides water for human consumption through pipes or other constructed conveyances to one or more multi-family dwellings, two or more duplexes or single-family residences, a factory, office building, restaurant, school, or similar facility. If such a system has a least 15 service connections or regularly serves at least 25 individuals, it must comply with Federal regulations. A public water system is further broken down into classifications as either a community water system; a non-community water system; or Class C water system, which must comply with state regulations. A Community Water System (CWS) is a public water system that, year round, regularly serves 25 people or has 15 service connections. Examples include a municipal water system serving a town or village or a mobile home park. A Non-Community Water System is a public water system that does not serve a permanent resident population. This category is further divided into two types. A Non-Transient Non-Community Water System (NTNC) is a public water system that serves at least 25 of the same people at least 6 months a year, such as a church, school, or office building. A Transient Non-Community Water System (TNC) is a public water system that serves a transient population at least 60 days per year, such as a campground, hotel, or restaurant. A Class C Water System is a public water system that is not a CWS, a NTNC, a TNC, or a private water system. Examples include an assisted living facility or daycare. A Private Water System is a potable water system serving one single-residence or duplex.

Groundwater is of beneficial use both within and outside the national forest in the form of water supply wells. Groundwater provides 92 percent of the public water system water in the geographic area of the national forest (see figure 22). Several communities use wells that are recharged by surface water from National Forest System lands. Most notable are the City of Seward that uses wells recharged by the Resurrection River and the City of Whittier that uses a well recharged by Whittier Creek, which originates within the national forest. The community of Valdez uses groundwater as their public water system as well. The communities of Moose Pass, Hope, and Cooper Landing do not have a city well/water source; however, drinking water for the majority of the households is individual groundwater well sources. Other consumptive use of groundwater within the national forest includes special-use permittees and Forest Service campgrounds and administrative sites with domestic wells. Although located entirely outside the national forest, the Alyeska Ski Area uses water from Glacier Creek for snow making. The Glacier Creek watershed originates on National Forest System lands.

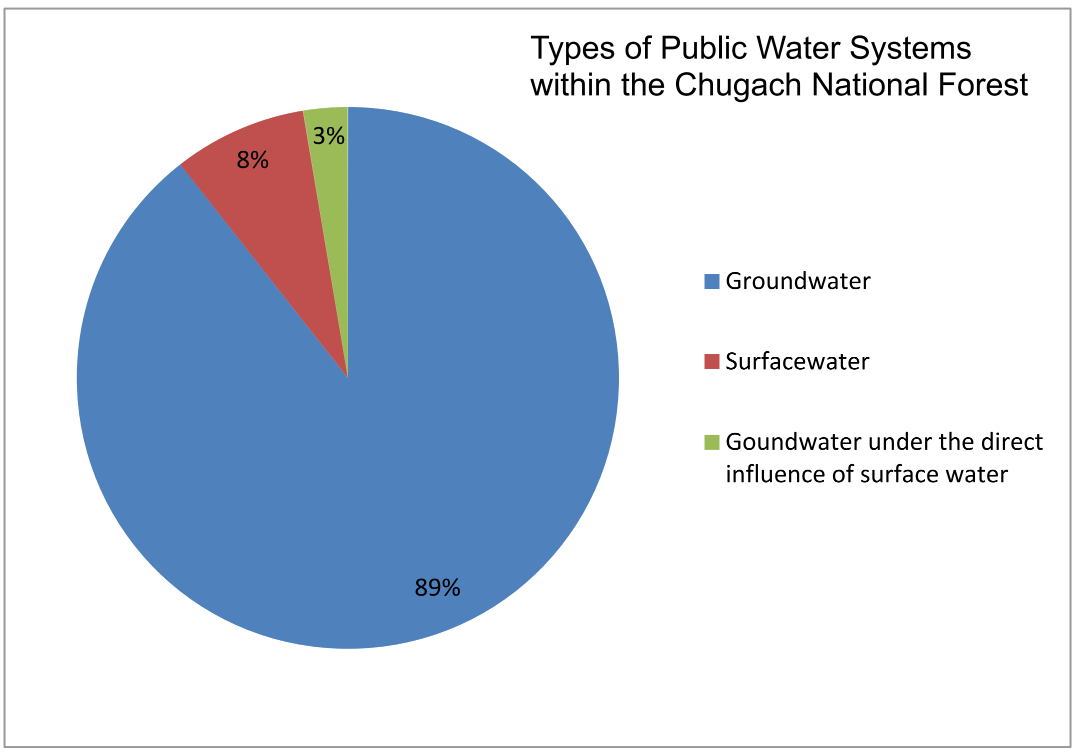


Figure 22. Percentage and type of public water systems within or adjacent to the Chugach National Forest. Data include any public water system that is within a 6th-level HUC that is entirely or partially within the Chugach National Forest. Public water system information has been provided by the Drinking Water Program of the ADEC. The information provided is a data snapshot as of March 12, 2013. There may be errors in source location information as well as other information provided.

Special use permits

The agency's special uses program authorizes uses on National Forest System lands that provide a benefit to the general public and protect public and natural resource values. There are a number of special use permits currently granted by the Forest Service that include water rights or water diversions.

Four hydroelectric power projects draw water from watersheds lying in part on National Forest System lands. These include the Cooper Lake Project near Cooper Landing, Humpback Creek and Power Creek near Cordova, and Salomon Gulch near Valdez. The Cooper Lake project stores inflow from Cooper Lake and diverts it out of the watershed down to Kenai Lake for power production. Currently the Cooper Lake Hydroelectric Project is being modified with the construction of the Stetson Creek diversion. When this project is complete, some flow from Stetson Creek, a tributary to Cooper Creek, will discharge directly into Cooper Lake. The project is slated for completion in fall 2014. The two Cordova projects are run of the river with minimal storage and no water diversion from the watersheds. Solomon Gulch has only a small portion of its upper watershed within the Chugach National Forest. Several additional sites on or adjacent to the national forest are currently being considered for hydropower development. Refer to the Hydroelectric section in this chapter for additional information.

Five fish hatcheries are located within or near the Chugach National Forest and draw water wholly or in part from national forest watersheds. The Main Bay and Cannery Creek hatcheries use watersheds entirely on National Forest System lands. The Main Bay hatchery diverts water from Main Lake and dewaters a stream at the head of the bay while the Cannery Creek Fish Hatchery diverts water from Cannery Lake. The Esther Creek watershed that lies primarily within the Chugach National Forest feeds the Esther hatchery. The San Juan Bay hatchery has a small portion of its watershed (about 40 acres) on National Forest System lands, while the Trail Lakes hatchery uses wells that are recharged by Moose Creek, portions of which are within the national forest.

Several additional permits authorize the diversion of water on National Forest System lands for flood control. The Kenai Peninsula Borough, Seward-Bear Creek Flood Control Area (SBCFSA) maintains a levee on Box Canyon Creek and the Alaska Railroad channels and maintains several dikes on an unnamed intermittent stream at railroad miles 16.6 and 36. Failure of the Box Canyon Creek infrastructure occurred during the September 2012 floods, causing significant damage to private and public property.

Mining

Mining within the national forest includes lode and placer operations, sand and gravel, and rock extraction. The majority of placer mining is small-scale operations with a couple mechanical operations. Processing equipment (suction dredges, washplants, etc.) for gold bearing gravels all require water for gravity separation. Some of these operations are larger (i.e., Hope Mining Company on Resurrection Creek). Lode operations and sand and gravel extraction currently utilize minimal water; however, there is potential for more utilization in the future. See the Locatable Minerals Section for additional information.

Contribution of Water Resources: Non-Consumptive Use

The largest contributions of water resources in the Chugach National Forest are non-consumptive. Non-consumptive water use is defined as water taken for a use that is not consumed or removed from the water system. Non-consumptive water uses include recreation (i.e., rafting, fishing, and boating), wildlife and aquatic habitat, subsistence, and the aesthetic quality of the resource. A substantial part of recreational use within the national forest revolves around water bodies and glaciers. These water bodies provide opportunities for sight-seeing, camping, fishing, motor boating, and non-motorized boating, whitewater activities, skiing, fish and wildlife viewing, hunting, swimming, mountaineering, and educational opportunities (i.e., Kid's Fishing Day and Project Wet). Non-consumptive water storage include weirs and numerous trickle lake dams located on the western part of the national forest that are annually stocked by ADF&G for sport fishing enhancement and fish passes. Prince William Sound has two fish passes, three weirs, and an old dam built by the West Gable Cannery in 1932. The Kenai Peninsula has nine trickle lake dams, two small pond dams, and a weir.

Current Condition and Trends

Watershed and water resources stressors and drivers

The primary system driver to the Chugach National Forest watershed and water resources is climate change with additional limited stressors of spruce bark beetle infestation, spread of aquatic and terrestrial invasive species, and increased human population and/or Forest Service use. Projected impacts to water resources from climate change within the national forest include increased flood frequency and magnitude, glacial recession, changes in the timing of peak and low flows, increased air and stream temperatures, increase in fire potential on the Kenai Peninsula, and conversion of watersheds from glacial and snow-melt dominated to snow-melt dominated and rain dominated. All of these will affect recreational activities, such as whitewater rafting, skiing, fishing, and glacial viewing, as well as water storage and hydropower.

Increases in instream flows and decreased water quality have been associated with changes in vegetation as a result of spruce bark beetle infestations and severe wildland fire (Pugh & Small, 2011; Schnorbus, 2011; Winkler, 2011). These changes could impact both surface water consumptive and non-consumptive water resources, such as recreation.

Impacts to water resources from increased population and/or Forest Service use include increased needs for future water withdrawals, diversions, storage and associated infrastructure, municipal watershed and sole source aquifer needs, increased placer mining, gravel extraction and development, increased recreational use, and the potential for increased introduction of invasive species (both terrestrial and aquatic).

There are several proposed and unconstructed hydroelectric projects within the national forest. These projects affect water quantity by diverting and/or impounding water. Within the last 10 years numerous hydroelectric projects within or near the Chugach National Forest have been proposed. The water resources of the national forest are receiving regional, national, and international attention for potential for producing renewable energy. Within the last seven years, there has been a growth in proposals, and the trend is expected to continue for the foreseeable future. See the Hydroelectric section for more detail. Given this trend, it can be anticipated that water quantity within the national forest has the potential to be negatively affected.

The Forest Service has not applied for any water rights for in-stream flow reservations within the national forest. With trends for increased demands, filings of water rights, the influence of lands of other ownership, and climate change projections on water resources, the Forest Service may want to be proactive in gaining these.

Watershed/water resources resilience

Properly functioning watersheds provide many important ecosystem services. Functioning watersheds generally provide high quality water, recharge of streams and aquifers, moderation of climate variability, and long-term soil productivity. Additionally, healthy watersheds generally create and sustain resilient terrestrial, riparian, aquatic and wetland habitats that support diverse populations of plants and animals capable of rapid recovery from natural and human disturbances.

There is minimal intensive vegetation management activity within the majority of the Chugach National Forest watersheds by the Forest Service. Overall, most of the watersheds are healthy, properly functioning, and generally exhibit strong integrity. Strong integrity enhances resilience to stressors and aids in recovery to the desired conditions when large natural disturbances or land management activities occur. Because more than 90 percent of the Chugach National Forest watersheds are in good condition, it is anticipated that watershed resilience and integrity will continue to remain strong. However, stressors from increased water needs (i.e., hydropower) coupled with climate change and changes in salmon populations contributing to nutrient cycling have the potential to affect watershed resilience. Warming air and stream temperatures, loss of glaciers, reduced snowpack, and changes in magnitude and frequency of flows will affect both consumptive and non-consumptive water uses. Water storage facilities will need to balance storage timing. Recreational opportunities, such as skiing and whitewater rafting, may also have shifts in their seasons. Increased stream temperatures will affect aquatic organism life cycles and change habitats. A number of watershed restoration projects have occurred within the national forest within the last decade. These projects have improved the functions of streams and riparian areas associated with impacts from past or historic land management and current activities. Continuing to conserve complex and diverse habitats and to restore these watersheds will help to maintain and improve integrity and resilience in the face of these stressors.

Influence of lands of other ownership

Upstream water users securing water rights on streams and rivers with headwaters located outside the national forest threaten instream flows within the national forest in the long-term. One of these areas of concern is the Copper River, where water rights to support development in the Copper River basin may reduce instream flows for fish and wildlife and affect geomorphic processes. Private groundwater wells and extraction also located adjacent to National Forest System lands have the ability to affect national forest surface and groundwater resources. Future development and water resource needs may affect water resources within the national forest unless the Forest Service takes an active role in assessing vulnerable areas and needs for requesting future water rights or instream flow reservations.

Contribution to Social, Cultural, and Economic Sustainability

Watersheds and water resources, both consumptive and non-consumptive use, within the Chugach National Forest provide a substantial contribution to social and economic sustainability in southcentral Alaska. Water from the national forest provides drinking water for communities, private residences, businesses and lodges, and visitors at campgrounds. Hydroelectric facilities within the national forest provide electricity to communities throughout southcentral Alaska. Much recreation use within the national forest revolves around water bodies and glaciers, including sight-seeing, camping, fishing, and boating. Most campgrounds within the national forest are located near lakes and streams. The Forest Service issues large numbers of outfitter/guide permits each year to companies that utilize national forest watersheds and water resources. The 2011 Commercial Recreation Monitoring Report showed that water based activities made up a very significant part of guided use across the national forest (Clark, personal communication, 2013). These activities included, but were not limited to, rafting, fishing, motorboat tours, kayak trips, canoeing, fishing, flight seeing and glacial tours, skiing, snow machining, and canoeing. Watersheds and water resources also provide a large local economic off-set for food through fishing and hunting and are culturally important for subsistence. Mining operations within the national forest utilize water resources for wash plants and camp facilities.

Chugach National Forest water resources not only provide a significant contribution to regional social, cultural, and economic sustainability but also to the state, nation, and world. Watersheds within the national forest provide spawning grounds for salmon populations that feed people in the national and global markets. Although it is not anticipated in the short term, Chugach National Forest fresh water resources may be in more demand in the future to meet the long term needs of the rest of the nation.

A number of watershed restoration projects have occurred within the Chugach National Forest (Resurrection Creek, Daves Creek, Ibeck Creek, and numerous smaller scale bank and riparian stabilization projects) in the last decade that have also provided economic income to local contractors. It is anticipated that the trend for watershed use and enjoyment of water resources to social and economic sustainability will continue to remain high and likely increase in the future.

Information Needs

With potential temperature increase due to climate change impacts and as glaciers recede and thin, glacial runoff may gradually decrease. In addition, flow regimes are changing as a result of snowmelt runoff occurring earlier in the year. This can cause increased magnitude of peak flows, lower flows during dry periods, and increased variability in stream flows.

Availability of long term reliable data on stream flow is scarce or lacking. It is difficult to establish instream flow requirements when there are no data available to use in determining historic average and peak stream flows. Since 2007, the number of USGS stream gages within the Chugach National Forest supported by the Forest Service has decreased from 3 to 1. It is difficult to achieve the 2002 Forest Plan objective, “Establish instream flow requirements or suitable mitigation measures for all water impoundments or diversions” without knowledge of stream flows across the national forest.

Forest Service data for well heads in a few of the campgrounds on the Kenai Peninsula do not match the State of Alaska’s water rights data. It appears that a few wells have been constructed that have not been filed for water rights and that there are a few wells no longer in use that remain in the state’s database.

The Forest Service lacks an adequate way to track locations and information on fish passes, diversions, dams, etc. It is recommended these be incorporated into a GIS database as part of the southcentral Alaska National Hydrography Database. Most of the knowledge of these sites is in paper files and acquired by word of mouth from ranger district personnel.

Air

The current conditions and trends of air resources and airshed management in the Chugach National Forest are described in this section. The Chugach National Forest has relatively good air quality overall, but there are some concerns. (Good air quality is defined as satisfactory and air pollution poses little or no risk.) Chugach National Forest air quality related issues are mainly due to dust, woodsmoke, and vehicle and marine vessel emissions.

Airsheds

An airshed is defined as a geographic area that, because of topography, meteorology, and/or climate, is frequently affected by the same air mass. It is difficult to describe airsheds in the planning area. Many of the Forest Service's local airsheds are constrained by topography, especially in some of the fjord and mountainous areas. The mountains channel flow, create winds, cause upslope and downslope flow, initiate drainage winds, produce wind shear and extreme mechanical turbulence. Some areas are also characterized by local inversions and stagnant air flow during parts of the year.

Alaska's Department of Environmental Conservation (ADEC) has divided the state into four Intrastate Air Quality Control Regions (ADEC, 1972). The Chugach National Forest is within two of these regions: Cook Inlet and southcentral Alaska. The Cook Inlet Intrastate Air Quality Control Region comprises all watersheds flowing into Cook Inlet (for the Chugach National Forest, this means anything flowing into the Kenai River or Turnagain and Knik Arms). The rest of the national forest lies within the Southcentral Intrastate Air Quality Control Region.

Class I and Sensitive Air Quality Areas

The Clean Air Act provides the Forest Service with specific responsibilities for protection of air quality in Class I areas. Only wilderness areas designated before August 7, 1977, are classified as Class 1 areas by the Clean Air Act. There are no Class 1 areas within the Chugach National Forest. The Chugach National Forest does have one wilderness study area (WSA). Per 2002 Forest Plan direction, the Nellie Juan-College Fiord WSA is to be managed to maintain the presently existing wilderness character and the potential for inclusion in the National Wilderness Preservation System.

Condition and Trends of Air

There is limited air resource data for the Chugach National Forest. Some recent deposition and haze monitoring have been completed for the national forest. There are also quite a few state air quality monitors in the vicinity, as well as IMPROVE sites for Tuxedni Wilderness Area and Denali National Park.

The 2002 Forest Plan did not include an air quality monitoring question. However, due to the Chief's decision regarding an appeal, the 2002 Forest Plan was amended to include a monitoring question concerning the impact of snow machine use on air quality where winter motor vehicle use is greatest. An air quality monitoring pilot study was conducted for the national forest during the winter of 2006-07 to quantify the levels of air pollutants in areas with high levels of winter motor vehicle use. The carbon monoxide and fine particulate data collected on the eight sample days indicated no violations of the EPA 24 hour standards, though there were some issues identified with the carbon monoxide sampling tool.

While the study was limited in its temporal and spatial scope, it provided an initial look at the potential that these uses are violating EPA air quality standards. It was recommended that this type of sampling be repeated every three to five years to determine trends and to determine whether violations of air quality standards are occurring.

The second round of air quality monitoring was conducted during the winter of 2011-12, using a different carbon monoxide detector rated for extreme cold. Results from 2011-12 monitoring indicate motor vehicle use at Turnagain Pass resulted in increased levels of carbon monoxide and fine particulates at sites measured near the parking lot. However, the carbon monoxide and fine particulate data collected on the sample days indicated no violations of the EPA state air quality standards. The present motor vehicle use trends at Turnagain Pass make the likelihood of exceeding the standards relatively low.

Due to the increase in interest of air quality in this area, one air quality biomonitoring plot was established in a forested area on Turnagain Pass in 2012. It was surveyed for epiphytic lichens and several species were collected for elemental analysis, such as nitrogen and sulphur levels. Elements associated with airborne deposition detected in lichens will be compared to background ranges for forested sites.

Growing air quality concerns in the Nellie Juan-College Fiord WSA point towards diminished visibility and possible ecological impacts from air pollution. Understanding and protecting WSA air quality is a key approach to monitoring and maintaining wilderness character and is used as an indicator in the Chugach National Forest WSA Character Monitoring Protocol.

In 2012, the Forest Service began a pilot project to monitor cruise ship visual emissions in College Fiord. The work responded to a history of questions and complaints from visitors, outfitter, guides, and other tour operators about the impact of cruise ship visual emissions on the area's wilderness character. The public feedback was substantiated by recent research showing that ship emissions reduce visibility in Prince William Sound by up to 30 percent and may have associated ecological impacts on local marine and terrestrial environments (Molders, Porter, Cahill, & Grell, 2010). In spring 2012, the Forest Service partnered with ADEC to become certified in EPA Method Nine Visual Emissions Monitoring Protocol. Between May and September, Forest Service employees used EPA Method Nine to successfully monitor visual emissions from 10 percent of cruise ships visiting College Fiord. Preliminary reports suggest cruise ship visual emissions may have exceeded allowable state standards in College Fiord.

Also in 2012, Chugach National Forest ecology and wilderness specialists revisited lichen biomonitoring plots established in 1993 and 1994 in the Nellie Juan-College Fiord WSA. The work was part of a planned two-year effort to re-survey lichen communities and collect lichens for elemental analysis at 21 existing plots and create up to eight new plots in the WSA. Re-visiting existing plots enables the Forest Service to: (1) determine if baseline air quality conditions have changed; (2) establish thresholds for 27 contaminants in lichens for the Chugach National Forest (Dillman, Geiser, & Brenner, 2007); and (3) track changes in air quality over time indicated by shifts in lichen community composition or contaminant levels. Establishing new plots in specific areas helps the Forest Service address air quality concerns that have arisen since establishing the 1993 and 1994 plots. The community identification element of the work is also a cost-effective way to monitor forest vegetation community changes related to air quality and climate change. Results of this monitoring are included in a multi-regional (Alaska, Oregon, and Washington) lichen monitoring database. These data have been used to suggest critical loads for nutrient nitrogen (N) and to develop better understanding of lichen and forest community dynamics in response to acidifying and fertilizing nitrogen and sulfur-based air pollutants.

Implementation plans for regional haze, non-attainment, or maintenance areas

Haze is caused by particulate matter suspended in the air or atmosphere. Haze can be both naturally occurring and manmade. Some natural sources of particulate matter include windblown dust, wildland fires, bioorganic emissions from trees (i.e., pollen), and coastal emissions from the ocean (i.e., salt spray). Manmade sources include emissions from gas and diesel engines, electric utility and industrial fuel burning, manufacturing operations, prescribed burns, and dust from unpaved roads, construction, and agriculture. Particulate matter can remain suspended in the air for a long period of time and can travel to areas hundreds or even thousands of miles away from the pollution sources.

The Regional Haze Rule, adopted by the EPA in 1999, calls for state and Federal agencies to work together to improve visibility in 156 national parks and wilderness areas. The rule requires the states, in coordination with the EPA, NPS, USFWS, Forest Service, and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment. The Regional Haze Rule establishes specific state implementation plan requirements (SIPs) and strategies to adopt when implementing a plan. States must develop long-term plans for reducing pollutant emissions that contribute to visibility degradation and within the plans establish goals aimed at improving visibility in Class 1 areas. The SIP must address haze caused by all sources of pollutants that impair visibility, including haze caused from smoke, vehicles, electric utility and industrial fuel burning, and other activities that generate pollution. Alaska has four Class 1 areas:

- Denali National Park
- Tuxedni Wilderness Area
- Simeonof Wilderness Area
- Bering Sea Wilderness Area

Denali National Park and the Tuxedni Wilderness Area are the two closest to the Chugach National Forest and could possibly be affected by emissions generated within the national forest. It is not known to what extent the Forest Service emission estimates have been included in the Regional Haze SIPs, though emissions and the risk of emissions from the Chugach National Forest are probably low.

No communities within or directly adjacent to the national forest are classified by the EPA as non-attainment areas or maintenance areas. However, there are multiple rural communities within or adjacent to the Chugach National Forest that have been identified as reporting problems with PM_{10} (dust) and/or $PM_{2.5}$ (woodsmoke). Also, Anchorage is identified as being a maintenance area for carbon monoxide (CO) and Eagle River is classified as a non-attainment area and is currently working to apply for re-designation to a limited-maintenance area for PM_{10} (dust) (ADEC, 2011).

Critical loads

A critical load is defined as “a quantitative estimate of the exposure to one or more pollutants below which significant harmful effects on specific sensitive elements of the environment do not occur according to present knowledge.” A target load is set based on policy and management direction and, depending on whether or not current critical loads values have been exceeded, can be above or below the critical load. In general, the critical load is based on modeled or measured dose-response data, while a target load can be based on political, economic, spatial, or temporal considerations in addition to scientific information. Defining the critical and target loads for areas within the national forest helps resource managers communicate the effects of air pollution on resources to Forest Service decisionmakers as well as to air regulators. At this time there are no known target loads set for this area.

There has been limited data collected for the Chugach National Forest. However, lichen community data from the Tongass National Forest collected by the regional air program and Forest Inventory and Analysis shows that species overlap with western Oregon and Washington (Region 6) is probably sufficient to apply those nutrient N critical loads to Region 10 until region-specific critical loads can be established (Pardo, Robin-Abbot, & Driscoll, 2011). Based on existing literature (Geiser, Jovan, Glavich, & Porter, 2010) and a recent study to calibrate dry weight lichen nitrogen concentrations with nitrogen deposition in Alaska, Oregon, Washington, and California (Root, et al., 2013), a conservative nutrient N critical load for the Chugach National Forest would be between 2.7 and 4 kg per hectare per year.

A recent study by Shirokauer et al. (2013) suggests that acidic deposition from local sources of nitrogen and sulfur oxides is likely to be more important than local or long distance transport of nutrient nitrogen as ammonium nitrates and sulfates. This is especially true in areas with frequent inversions and docking ports where ships are continuously running their generators.

Renewable Energy and Mineral Resources

Renewable energy sources, including biomass, hydroelectric, hydrokinetic, solar, and wind, are discussed in this section. Power site classification withdrawals and utility corridors are also included. Geothermal energy is included under leasable minerals in the Nonrenewable Energy and Mineral Resources section, in addition to coal, oil, and gas. Discussions of locatable minerals, leasable minerals, mineral materials, and mining activities are in the Nonrenewable Energy and Mineral Resources section.

Renewable Energy

Alaska is one of 37 states with renewable portfolio standards or policies that require or encourage increased production and reliance upon renewable energy sources. In 2012, Alaska adopted the goal of generating 50 percent of the state's electricity from renewable sources by 2025 (solar, wind, biomass, hydropower, wave, tidal, and geothermal sources). Alaska is already generating more than 24 percent of its electric power from renewable sources (mostly hydroelectric power). The state legislature and the Alaska Energy Authority (AEA), a state agency, fund a variety of grant and loan programs to incentivize renewable energy production and energy conservation in Alaska.

Relevant Information

- Alaska has adopted the goal of generating 50 percent of the state's electricity from renewable sources by 2025 (solar, wind, biomass, hydropower, wave, tidal, and geothermal sources).
- The Chugach National Forest will continue to have an increase in the number of new energy project proposals, due, in part, to the availability of Federal and state grants, high fossil fuel costs, and tax breaks for renewable energy projects.
- The location of previously-proposed, current, and planned energy projects and potential utility corridors should be considered when making land use allocation decisions so as to not preclude future energy development.

Biomass Energy

Specific items to be evaluated for biomass include: the current type, extent, and general location of biomass energy activity and biomass energy facilities; the potential for biomass energy activity; trends that affect biomass energy activity; and the contribution of biomass energy activity to social, economic, and ecological sustainability.

The 2002 Forest Plan did not directly address biomass energy except by referencing the Energy Security Act of 1980 that authorizes making timber resources available from National Forest System lands for use by biomass energy projects. The 2002 Forest Plan references providing timber for fuelwood for personal and commercial uses.

Relevant Information

- There are currently no biomass energy facilities within the boundary of the Chugach National Forest, but the interest and demand may increase. Parties in Cordova, Valdez, and Seward have expressed interest in biomass projects. Cordova has completed a feasibility study considering state and corporation land.
- The pervading roadless character of the Chugach National Forest limits the capacity for biomass utilization.
- Most of the easily accessible tree biomass within the national forest is in the Kenai Peninsula geographic area.

Biomass energy activities and facilities

In Alaska, 19 non-industrial wood biomass energy plants have been installed from the southeast to the interior, and many others are planned or in development (Parrent, personal communication, 2013). There are currently no biomass energy facilities within the Chugach National Forest, but the interest and demand may increase (see the Timber section). Parties in Cordova, Valdez, and Seward have expressed interest in biomass projects. Cordova has completed a feasibility study considering state and corporation land. The projects in Seward and Valdez and are still in the early stages.

Potential for biomass energy

A report on aboveground carbon in trees across the Chugach National Forest (Barrett T. , 2014) can be used to provide estimates of potential biomass energy opportunity from trees in the plan area. Excluding the WSA, the carbon pool reported by Barrett (2014) is 88.3 thousand pounds per acre of forest vegetation. The pool is split as 84 percent live trees, 6 percent snags, and 10 percent downed logs. Since carbon mass is approximately one-half dry biomass, the biomass estimate is 176.6 thousand pounds per acre (i.e., 88.3 thousand pounds per acre times two). Barrett (2014) estimates that forest vegetation covers approximately 596,000 acres within the Chugach National Forest (excluding the WSA) (see the Carbon Stocks section for belowground and non-tree aboveground biomass estimates).

Interest in biomass energy in Alaska is expanding (Parrent, 2012). Commercial demand to tap biomass supplies within the Chugach National Forest may increase. The roadless character within the national forest limits the capacity for biomass utilization. About 99 percent of the Chugach National Forest is farther than one-quarter mile from existing road network. Most of the easily accessible tree biomass within the national forest is in the Kenai Peninsula geographic area.

Trends that affect biomass energy

A report on woody biomass energy in Alaska (Parrent, 2012) listed the following opportunities:

- *For the forest manager*: biomass utilization can provide opportunities to mitigate the costs associated with pre-commercial thinning, hazardous fuels reduction, forest restoration, and habitat enhancement.
- *For the forest products industry*: biomass markets can mean new, or more profitable, local opportunities to utilize processing by-products, such as sawdust and bark.
- *For communities*: biomass fuels can save facility operators money, create and sustain local jobs, and keep energy dollars in the community.

Contribution of biomass energy to social, economic, and ecological sustainability

See the Timber section.

Hydroelectric Energy

Specific items to be evaluated include the current type, extent, and general location of hydroelectric resources; hydroelectric potential of the plan area; trends that affect hydroelectric activity in the plan area; and the contribution of hydroelectric energy activity to social, economic, and ecological sustainability.

The 2002 Forest Plan provides direction for Federal Energy Regulatory Commission (FERC) hydroelectric projects and includes a management area prescription for major transportation and utility systems (USDA, 2002a). In addition to transportation facilities, this direction is applicable to the following energy-related facilities: hydroelectric dams, reservoirs, power generation sites, powerlines, and pipelines 10 inches or greater in diameter.

Hydroelectric power and Alaska

Hydroelectric power is the generation of electric power from the movement of flowing water to a lower elevation. It supplies about 21 percent of the state's electrical energy in an average year and is the largest renewable energy source in the state, producing more energy than every other renewable resource combined. Hydroelectric projects are found throughout the state but primarily in the Aleutian Islands, southcentral, and southeast Alaska.

The FERC evaluates proposed non-federal (those proposed by other than Federal government) hydropower projects and determines if they should be issued a preliminary permit and perhaps eventually, a FERC license. The Forest Service works closely with FERC and the applicant to ensure that impacts to National Forest System lands and resources are considered and balanced with the need for power.

Hydroelectric resources and facilities

Existing and operating FERC projects located within the Chugach National Forest include:

- Cooper Lake: Chugach Electric Association owns and operates this 19.4 MW facility on Cooper Lake, Cooper Creek, and Kenai Lake near the community of Cooper Landing in the Kenai Peninsula. It was originally licensed in 1960 and was relicensed by FERC in 2007. The project occupies 3,012 acres of land on the Seward Ranger District and is within the Kenai Lake Inventoried Roadless Area (IRA).
- Solomon Gulch: The Solomon Gulch Hydroelectric Project is owned by the Copper Valley Electric Association and supplies power to Valdez. This 12 MW project has been operating since 1982. The project facilities and structures are located off National Forest System lands; however, the upper reaches of the watershed are within National Forest System lands in Prince William Sound.
- Power Creek: The Power Creek hydroelectric plant is located 7 miles east of Cordova and has a total installed generating capacity of 6 MW. It is owned by the Cordova Electric Cooperative and provides about 50 percent of the electrical power to the town of Cordova and surrounding areas. It was licensed in 1997. Project structures are on private land but much of the watershed lies within National Forest System lands in the Copper River Delta.
- Humpback Creek: This is a 1.25 MW run-of-the-river (water is taken directly from the stream) project roughly 7 miles north of the Cordova boat harbor. It is owned and operated by Cordova Electric Cooperative and was licensed by FERC in 1990. The project facilities are located off National Forest System lands; however, much of the Humpback Creek watershed is within National Forest System lands in the Copper River Delta.

There are no operating non-FERC projects within the Chugach National Forest.

Potential of the plan area for hydroelectric energy

Proposed and unconstructed FERC projects (active) within the national forest include:

- Cooper Lake/Stetson Creek Diversion, P-2170: This project is located on Cooper Lake, Cooper Creek, and Kenai Lake, near the community of Cooper Landing in the Kenai Peninsula. The project occupies National Forest System lands within the Kenai Lake IRA. The new 2007 FERC license included a new diversion structure, pipeline and outlet works to divert flows from Stetson Creek into Cooper Lake. The Stetson Creek Diversion, including 2.13 miles of pipeline and access road, will be constructed on National Forest System lands within the IRA. The Forest Service issued the special use permits and approved the final construction plans.
- Grant Lake, P-13212: Kenai Hydro LLC is evaluating this 5 MW project about 26 miles north of Seward. The constructed facilities would be located outside National Forest System lands, but Grant

Lake, most of which is on National Forest System lands, would be used for water storage. The project is within the Kenai Mountains IRA in the Kenai Peninsula.
- Allison Creek, P-13124: The Copper Valley Electrical Association is determining the feasibility of this 4 MW project on Allison Creek near Valdez. The project structures would be located on state land; however, the very upper reaches of the watershed are on National Forest System lands in Prince William Sound. The project is not expected to affect National Forest System lands or resources.

Only one proposed and unconstructed non-FERC project (active) occurs within the Chugach National Forest.

- Chenega Bay: Located on Evans Island and proposed by the Chenega Corporation, this 90 kilowatt (kW) run-of-the river project on Anderson Creek was funded by AEA and is currently in the design phase. The project is on private land and is not expected to affect National Forest System lands or resources.

During the last 10 years, other hydroelectric projects have been proposed that were located within or near the Chugach National Forest. The projects are inactive primarily due to funding issues, significant environmental effects, and unfavorable cost-benefit ratios. While these projects are currently inactive, it is important to note that these projects may become viable in the future. The Forest Service may want to track these projects and consider their location and any associated transmission line corridor needs when making land use allocation decisions. Previously proposed projects include:

- Falls Creek: Kenai Hydro LLC decided to not pursue this 5 MW project about 26 miles north of Seward. The constructed facilities would have been outside National Forest System lands but much of the watershed is on National Forest System lands and within the Kenai Mountains IRA in the Kenai Peninsula. This project was associated with the Grant Lake project (see above).
- Victor Creek: This 5 MW project was proposed by Kenai Hydro, LLC and would be located near Lawing, just south of Moose Pass in the Kenai Peninsula.
- Fourth of July Creek: Proposed by Independence Power, LLC, this 5.4 MW project across Resurrection Bay from Seward was thought to be capable of supplying one-third of Seward's annual electrical needs. AEA funded the feasibility work but chose to not fund the permitting and design phase.
- Colorado Creek: In September 2012, an individual representing the Summit Lake Lodge (in the Kenai Peninsula) contacted the Forest Service to inquire about a potential hydroelectric project on Colorado Creek. He was referred to FERC and also given an application for an investigative studies permit. There has been no further contact.
- Silver Lake: The Copper Valley Electric Association considered this 15 MW project about 15 miles southwest of Valdez. The proposed project would have been located on private lands with a dam and water storage reservoir at Silver Lake. The project would supply power to Valdez and to Tatitlek, a diesel-dependent community. Proposed transmission lines would have likely crossed National Forest System lands in Prince William Sound.
- Whittier Creek Hydroelectric Project: In 2009, the City of Whittier received funding from the AEA to examine the viability of hydropower on Whittier Creek. Proposed structures included a dam, intake, and powerhouse. All structures would have been on land owned by the city of Whittier.
- Snyder Falls Creek: This 3 MW project was near Nelson Bay, about 7.5 miles north of Cordova, and was proposed by the Cordova Electric Cooperative, Inc. The proposed project included a dam, reservoir, and penstock on National Forest System lands in the Copper River Delta. The other constructed facilities would have been on private land. The National Forest System lands portion of the project area would have been within the Fidalgo-Gravina IRA. While this project is considered inactive, and the FERC Preliminary Permit for the project has been relinquished, the Cordova Electric

Cooperative continues to hold a Forest Service special use permit for investigative studies. Recent reports indicate that field studies and data gathering are underway and that the project may be formally re-activated in the future with an application to FERC.

Trends that affect hydroelectric energy

Water is everywhere in Alaska's national forests, originating as rainfall and melting snow and ice. Increasingly, it is this plentiful water that is the focus of communities, utility companies, consultants, and developers. These water resources are receiving local, regional, national, and international attention as potential sources of reliable and relatively inexpensive renewable energy. Within the past seven years, the Chugach National Forest has had growth in the number of new energy project proposals, due in part to the availability of Federal and state grants, high fossil fuel costs, and tax breaks for renewable energy projects. This trend is expected to continue for the foreseeable future. Alaska is thought to have numerous suitable sites that are undeveloped and is estimated to contain 40 percent of the untapped hydropower potential in the United States.

Contribution of hydroelectric energy to social, economic, and ecological sustainability

More than 35 hydroelectric projects, with a total capacity of approximately 423 MW, generate 21 percent of the electricity used throughout Alaska. Several of these projects have been operating for more than 95 years. Hydropower has been proven to be a reliable source of renewable energy in Alaska.

Hydrokinetic Energy

Hydrokinetic energy is considered in this assessment since it is a potentially feasible energy source in much of Alaska. Hydrokinetic projects generate electricity from waves or directly from the flow of water in ocean currents, tides, or inland waterways and rivers.

The 2002 Forest Plan makes no mention of hydrokinetic energy resources or facilities. Hydrokinetic projects are typically located in marine waters or on state tidelands and submerged lands; however, these projects have the potential to affect National Forest System lands and resources due to the need for upland facilities and transmission lines.

Specific items to be evaluated include the current type, extent, and general location of hydrokinetic resources; potential for hydrokinetic resources in the plan area; trends that affect hydrokinetic activity in the plan area; and the contribution of hydrokinetic energy activity to social, economic, and ecological sustainability.

Hydrokinetic energy and Alaska

Hydrokinetic power projects are similar to traditional hydropower projects but rather than storing, controlling, or diverting the flow of water to take advantage of hydraulic head (potential energy), hydrokinetic projects use the density of water and harness kinetic energy from its motion. This motion includes waves, flowing rivers, and tides. The kinetic energy harnessed is dependent upon the kinetic energy available during tide cycles, wave periods, and river flows.

With more than 44,000 miles of shoreline and many miles of rivers, Alaska has vast unrealized potential for hydrokinetic energy development using river in-stream and wave and tidal energy technologies. Alaska is thought to have more than half the nation's potential wave energy.

River in-stream hydrokinetic devices are placed directly in the river current and are powered by the energy of the moving water. The speed of the water current determines the available power. The best river locations provide significant flow year-round with no major flood events, little turbulence and debris, and no lengthy periods of low water.

Tidal energy devices generate power from the ebb and flow of ocean tides. Designs range from the underwater wind turbine-style, to vertical- or horizontal-axis cross-flow turbines.

Wave energy is derived from the motion of ocean waves. Alaska has one of the best wave resources in the world but the best sites are typically far away from population centers where the power is needed. Many different designs that attempt to convert wave energy into electricity are being tested around the world. Designs include oscillating water columns and single buoys riding the waves in the open ocean.

All hydrokinetic projects in Alaska are currently at the pilot project or demonstration level and the available technology is considered to be pre-commercial.

Hydrokinetic energy resources and facilities

Currently, there are no operating utility-scale hydrokinetic generation projects within the plan area or within the entire State of Alaska. In addition, there appear to be no proposed projects within or adjacent to the Chugach National Forest.

Within the last 10 years, several tidal power projects have been proposed within Cook Inlet and elsewhere in southcentral Alaska. FERC has issued preliminary permits for pilot projects in Cook Inlet, Turnagain Arm, and Kachemak Bay. These projects are still undergoing feasibility determinations and environmental analysis and if developed, are not expected to affect National Forest System lands or resources. The project sites are not located adjacent to National Forest System lands.

Several in-river hydrokinetic devices have been and/or are being tested in locations around Alaska, including the Yukon, Tanana, and Kvichak rivers. None of these sites are within or adjacent to the plan area.

Potential of the plan area for hydrokinetic energy

AEA compiled tidal, wave, and in-stream energy information from several reports and inventories and displayed the information in the 2011 Renewable Energy Atlas of Alaska. Three potential sites or areas are within or adjacent to the Chugach National Forest: (1) Bainbridge Passage near Bainbridge Island is identified as having significant tidal power potential; (2) The Million Dollar Bridge site northeast of Cordova is identified as having significant potential for in-river power; and (3), the entire outside shoreline along the Chugach National Forest is identified as having wave power potential.

Trends that affect hydrokinetic energy

Hydrokinetic power generation technologies suitable for use in Alaska are still considered to be pre-commercial and somewhat experimental. However, as these devices are tested in pilot projects and the technology continues to improve, there will likely be a rapid increase in the number of new project proposals statewide, including the greater Anchorage area.

With reportedly the second highest tidal fluctuation in North America and the fourth highest tidal fluctuation in the world, the Cook Inlet area is considered to be one of the premier world sites for hydrokinetic power generation and is receiving interest from both international and domestic developers. To date, none of the permitted and funded projects are likely to affect National Forest System lands or resources, but it is possible that additional projects may be proposed in the area that would require upland facilities or transmission lines within the Chugach National Forest.

Contribution of hydrokinetic energy to social, economic, and ecological sustainability

It is generally agreed that Alaska has great potential for hydrokinetic power development and that this has the potential to displace some fossil fuels used for power generation. However, the current hydrokinetic projects are small-scale pilot or demonstration projects and very few are actually operational and generating power. The various technologies are not fully developed or tested and have received no utility-scale testing in Alaska. It is much too soon to make any conclusions about the contribution of hydrokinetic power to social, economic, and ecological sustainability in Alaska.

Solar Energy

The current type, extent, and general location of solar resources; solar energy potential of the plan area; trends that affect solar activity in the plan area; and the contribution of solar energy activity to social, economic, and ecological sustainability are discussed in this section.

The 2002 Forest Plan makes no mention of solar energy resources or facilities.

Solar energy and Alaska

Solar energy or solar radiation can be captured in specially designed solar panels that concentrate the rays and convert the energy for use. Generally, solar energy projects in Alaska are small-scale solar thermal or solar electric projects for home use. Solar thermal projects involve the use of solar energy to heat a building through the use of heated water and other methods. Solar electric projects convert the energy into electricity to power the building unit or the grid to which it is connected, typically through the use of photovoltaic panels.

While there are numerous examples of both private and public small-scale solar energy projects in Alaska, there are no utility-scale solar generation projects. The use of photovoltaic panels to generate power for Alaskan communities is generally not practicable at this time due to the high cost of solar panels and the low levels of year-round solar radiation received throughout the state.

Solar energy resources and facilities

Currently, there are no utility-scale solar generation projects within the plan area or within the entire State of Alaska. There are numerous private and public solar energy projects that heat or provide power to individual buildings or small developments. An example is the Anchorage Solar Building in downtown Anchorage.

Potential of the plan area for solar energy

The U.S. Department of Energy's National Renewable Energy Laboratory has compiled solar radiation maps for the United States. Within the Chugach National Forest, most areas average less than 3.5 $kWh/m^2/day$ of solar insolation annually. Insolation is a measure of the amount of solar radiation received on a given surface area and represents the amount of solar radiation available to a flat plate collector, such as a solar panel. Insolation is measured in kilowatt-hours per square meter per day $kWh/m^2/day$. A small area on the Kenai Peninsula averages between 3.5 to 4.0 $kWh/m^2/day$ on an annual basis. These figures are very low when compared to the average value for southern Arizona of greater than 7.5 $kWh/m^2/day$. Based on these maps, it appears that there is very low potential for utility-scale solar generation facilities within the Chugach National Forest.

Solar energy was not included as a viable renewable energy source in the Railbelt Integrated Resource Plan, contracted by AEA or in the report from the Chugach Regional Renewable Energy Conference sponsored by AEA, held in Cordova in July 2009.

There have been no solar energy proposals submitted to AEA for 2009 to 2014 funding, and solar energy is not included as a viable utility-scale renewable energy resource in AEA's Energy Pathway.

It appears that the use of solar energy will likely remain small-scale and will continue to be used to heat or provide power to homes, individual buildings, or small developments.

Key trends that affect solar energy

As previously noted, Alaska is one of 37 states with renewable portfolio standards or policies that require or encourage increased production and reliance upon renewable energy sources. Solar energy is an integral component of renewable energy strategies in the southwestern United States, but its use for utility-scale projects in Alaska is limited by the lack of solar radiation and the high cost of the technology. It is unlikely that solar energy generation will become a viable substitute for other types of renewable energy or will displace the use of fossil fuels in Alaska.

Contribution of solar energy to social, economic, and ecological sustainability

It appears impracticable to substitute solar energy for other renewable energy sources or fossil fuels in Alaska on a large scale. Solar energy will continue to be used to heat or provide power to homes, individual buildings, or small developments and will contribute locally or on an individual and family basis to social and economic sustainability.

Wind Energy

The current type, extent, and general location of wind resources; wind energy potential of the plan area; trends that affect wind energy activity in the plan area; and the contribution of wind energy activity to social, economic, and ecological sustainability are discussed in this section.

The 2002 Forest Plan makes no mention of wind energy resources or facilities.

Wind energy and Alaska

Alaska has abundant wind resources and the best resources are generally located in the western and coastal portions of the state. The quality of wind resource is very site specific and the windiest locations are not always suitable. In some areas, turbines may actually need to be sited away from the strongest winds to avoid strong gusts and turbulence.

Wind power technologies currently in use in Alaska include small off-grid systems for homes and remote camps to medium-sized machines displacing diesel fuel in village wind-diesel combination systems, to large industrial turbines generating energy on the railbelt and in towns, such as Kodiak. At least 17 Alaska towns and communities have operating wind generation projects. An additional 7 projects are under construction, 6 are in the design phase, and 30 wind projects are in the feasibility phase.

Wind resources and facilities

There are no operating utility-scale or community wind generation projects within the Chugach National Forest. Numerous small off-grid systems are likely present within the plan area, but the number of these systems is unknown.

The Fire Island Wind Project near Anchorage is the utility-scale or community project closest to the Chugach National Forest. Built by Cook Inlet Region Inc. (CIRI), the project began operating with 11 turbines in September 2012. The project has a 17.6 megawatt generation capacity and is expected to sell more than 50,000 MW-hours to Chugach Electric Association (CEA) annually. The project is expected to supply about four percent of CEA's energy needs (enough to power about 4,000 homes) and offset up to

0.5 billion cubic feet (bcf) of natural gas consumption each year. The project may be expanded in the future. The full project is permitted to include up to 33 turbines with a total generation capacity of 52.8 MW. The project is operated by CIRI and its subsidiary Fire Island Wind, LLC.

Potential of the plan area for wind energy

AEA has developed a high-resolution wind resource map of Alaska in coordination with the National Renewable Energy Laboratory and consultants at AWS Truepower. The map integrates historical weather data at various heights above ground level, vegetation cover, terrain effects, and atmospheric simulation models and can assist in determining the ideal location for a potential project. This map is included in the 2011 Renewable Energy Atlas of Alaska (REAP, 2011). Based on this map, the highest wind potential in the plan area occurs near Katalla in the Copper River Delta, both on the mainland and on several nearby islands in the Gulf of Alaska. These islands are rated as having outstanding wind power potential. The area near Cordova is rated as fair to good.

Four wind energy proposals were submitted to AEA for 2009 to 2014 funding through the Alaska Renewable Energy Fund. Proposed projects included a 60 kW project at Seldovia, a 9 MW wind farm at Nikiski, a 500 kW wind project at Tatitlek, and a wind project at Camp Hill near Cordova. Two of the projects that received funding are located near National Forest System lands within the plan area: Tatitlek and Camp Hill near Cordova.

- Tatitlek High Penetration Wind Project: This 500 kW project is about 30 miles south of Valdez on the eastern side of Tatitlek Narrows in Prince William Sound and is designed to serve the community of Tatitlek. Funding was requested and received in 2009 to conduct initial feasibility studies. If constructed, this project might provide 100 percent of the electrical needs and displace at least 50 percent of the heating fuel used in the community.
- Camp Hill Wind Project: The project is located at Camp Hill near Wireless Point, approximately seven miles south of Cordova in the Copper River Delta and would be designed to provide power to Eyak and Cordova. Funding was requested and received in 2009 to conduct initial feasibility studies. The project, if constructed, might provide approximately 3.4 million kWh per year to displace diesel generation.

In addition, the Forest Service was contacted in 2011 by the University of Alaska School of Engineering regarding a potential wind project in the Portage Valley. There has been no contact since the initial inquiry.

Trends that affect wind energy

Due to the high cost of diesel-generated electricity in rural Alaska, as much as 0.65 to 1.30 dollars per kWh in some locations, the use of wind energy has grown rapidly over the last several years. The number of utilities using wind to generate part of their electricity increased from 7 to 17 between 2008 and 2012. The electricity generated by wind increased 10 times, from about 2 megawatt-hours to more than 20 megawatt-hours. Nevertheless, that was less than 0.5 percent of statewide electricity in 2010.

As noted previously, at least 17 Alaska towns and communities have operating wind generation projects. An additional 7 projects are under construction, 6 are in the design phase, and 30 wind projects are in the feasibility phase. The use of Alaska’s abundant wind resources to generate electricity is a proven and accepted technology that will continue to grow in use, both for small-scale off-grid home use and for utility-scale and community applications.

Contribution of wind energy to social, economic, and ecological sustainability

The increasing use of wind power in Alaska has the potential to displace modest amounts of fossil fuels, reduce carbon emissions, and may reduce the cost of electricity, especially for rural residents. Based on information from the Institute of Social and Economic Research at the University of Alaska, wind power replaced about 12,000 barrels or 500,000 gallons of fossil fuels in Alaska in 2010. Due to wind power and the use of natural gas, carbon dioxide emissions from power generation were about 3 percent lower in 2010. The Fire Island Wind Project is expected to offset up to 0.5 billion cubic feet of natural gas consumption in southcentral Alaska each year. The Kodiak Electric Association has operated the Pillar Mountain Wind Farm at Kodiak since July 2009 and estimates that it has saved an estimated 3,739,078 gallons of diesel through February 2013. While these and other operating wind projects can clearly offset the use of fossil fuels and decrease carbon emissions, data on the effects of these projects on local economies and utility rate payers appear to be unavailable.

Power Sites

Power sites are discussed as renewable energy infrastructure. The 2002 Forest Plan makes no mention of power site classifications and withdrawals. They are identified during this assessment due to potential conflicts with future management direction.

Power site classifications and withdrawals

There are two main categories of water power withdrawals in Alaska:

1. Withdrawals made to set aside and protect lands that have potential water power value until that potential can be realized or developed. In Alaska there are two types in this category:
    a. Power Site Classification (PSC): these are administrative orders that are created under the authority of the Organic Act of 1879. (This is the USGS Organic Act; authority for these withdrawals was/has been given to the BLM.)
    b. Power Site Reserve (PSR): these are administrative orders that were created under the authority of the Pickett Act of 1910.
2. Withdrawals made because water development is actually being planned:
    a. Power Project: these are not created by an administrative order but the lands are withdrawn when an application for a hydroelectric project preliminary permit or license is filed with FERC under the Federal Power Act (FPA) of 1920, as amended.

Although these water power withdrawals are created under different authorities, they are all subject to the provisions of Section 24 of the FPA. This section provides that the lands that fall in these categories are reserved from entry, location, or other disposal under the public land laws until otherwise directed by FERC or by Congress.

The PSC withdrawal in Prince William Sound is the only one still active within the Chugach National Forest:

- Nellie Juan Lake and River, PSC 456. 12,319.5 acres were withdrawn in 1965 by Public Order No. 3665. BLM Case: AK 061270.

All other PSCs within the Chugach National Forest appear to have been revoked and are no longer in effect.

There are no PSRs within the Chugach National Forest.

Two power project withdrawals occur in the national forest, both on the Kenai Peninsula:

1. Cooper Lake, Kenai Lake, Stetson Creek, P-2170, existing power project. In 1956, 2,320 acres were withdrawn for FERC Project P-2170. The withdrawal has been amended several times and the FERC license was renewed in 2007. The current withdrawal consists of 41 acres. BLM Case: AA-39417.
2. Grant Lake/Creek, P-13212. In 2008, 6,460.483 acres were withdrawn for proposed FERC Project P-13212. BLM Case: AA-91091.

Additional power project withdrawals appear in the BLM records but are no longer in effect. These will be removed from the records when FERC issues an updated status plat.

Utility Corridors

The location and condition of utility corridors; the need for additional utility corridors; and the contribution of utility corridors to social, economic, and ecological sustainability are discussed in this section.

The 2002 Forest Plan includes a management area prescription for major transportation and utility systems. In addition to transportation facilities, this direction is applicable to the following energy-related facilities: hydroelectric dams, reservoirs, power generation sites, powerlines, and pipelines 10 inches or greater in diameter.

Location of utility corridors

There are six powerline corridors in the plan area on National Forest System lands.

1. Chugach Electric Association transmission line from the Quartz Creek substation to Anchorage. The entire powerline is 90.4 miles in length. Approximately 70 miles of this are on National Forest System lands in the Kenai Peninsula and are authorized by a Forest Service special use permit. This line transmits power from the Cooper Lake Hydroelectric Project to Anchorage; work is underway to upgrade the powerline from 115-kv to 230-kv.
2. Chugach Electric Association distribution line from the Hope substation on the Seward Highway to Hope (in the Kenai Peninsula). The entire powerline is 19.3 miles in length. About 12.7 miles are on National Forest System lands and are authorized by a Forest Service special use permit. Sections along the Hope Highway will be re-routed in the near future.
3. Chugach Electric Association distribution line from the Portage substation to Whittier. About 4.6 miles of this 11 mile powerline are on National Forest System lands (Kenai Peninsula and Prince William Sound) and are authorized by a Forest Service special use permit.
4. City of Seward distribution line in vicinity of Seward. About 15 miles of this powerline are on National Forest System lands (in the Kenai Peninsula) and are authorized by a Forest Service special use permit.
5. Homer Electric Association distribution line in the vicinity of Homer. Approximately 8.5 miles of this line are on National Forest System lands (in the Kenai Peninsula) and are authorized by a Forest Service special use permit.
6. Cordova Electric Cooperative buried distribution line along the highway from Cordova to past the airport (on the Copper River Delta). This powerline is approximately 12 miles long and is authorized by a Forest Service special use permit.

Need for additional utility corridors

It is unlikely that additional utility corridors would be needed on National Forest System lands for the Grant Lake and Allison Creek hydroelectric projects. The Grant Lake project is next to the Seward Highway and would likely connect to the existing distribution lines. The Allison Creek project is not on National Forest System lands and any powerlines would likely be located on State of Alaska land.

The Cordova Electric Association holds a Forest Service special use permit for investigative studies for a potential hydroelectric project at Snyder Creek Falls. If the project is developed, a utility corridor may be needed for the associated transmission line.

It is also possible that additional utility corridors will be needed in the future to support other types of planned renewable energy development, including wind and hydrokinetic. It is impossible to anticipate the locations at the present time.

Contribution of utility corridors to social, economic, and ecological sustainability

Utility corridors may contribute to social, economic, and ecological sustainability by transmitting power generated from renewable sources, such as hydropower, wind, and hydrokinetic.

Nonrenewable Energy Resources

Leasable Minerals

Leasable mineral authority is under the Secretary of the Interior. Various Acts provide authority for nonrenewable energy leasable minerals as outlined.

- Geothermal: The Geothermal Steam Act of 1970, as amended (84 Stat, 1566; 30 U.S.C. 1001-1025), provides the Secretary of the Interior with the authority to lease public lands, including National Forest System lands, for geothermal exploration and development in an environmentally sound manner.
- Oil and Gas: The Mineral Leasing Act of 1920 gives the BLM responsibility for oil and gas leasing on public lands, including National Forest System lands, and other Federal lands, as well as private lands where mineral rights have been retained by the Federal government.
- Coal: BLM has several primary authorities under which it leases, including the Mineral Leasing Act of 1920, as amended; the Mineral Leasing Act for Acquired Land of 1947; and the Federal Land Policy and Management Act of 1976.

Oil and gas

Oil was first discovered in 1901 at Katalla, and, by 1902, Alaska had its first producing oilfield. More than 150,000 barrels were produced. Production ceased when the onsite refinery burned in 1933. A settlement agreement (1982) gave the Chugach Alaska Corporation (CAC) rights to drill from a private portion of the mineral estate beneath the Chugach National Forest but rights would be extinguished if a producing well was not established by December 31, 2004. A producing well was not established and the rights have expired.

No encumbrances currently exist on the oil and gas estate at Katalla since the rights under the 1982 CNI Settlement Agreement have been extinguished. The process to establish a new oil and gas lease is as follows:

- An oil and gas operator must possess a Federal oil and gas lease in order to explore for and develop federally owned oil and gas. The operator may directionally drill from the adjacent non-Federal surface but still must have a Federal lease. The process to obtain a Federal lease is initiated by submission of a nomination of lands/expression of interest to the BLM State Office.
- Lands may be nominated to the BLM in either a letter identifying the legal description of the lands to be leased or in a completed offer to lease (Form 3100-11).
- BLM would request Forest Service consent to leasing.
- After the completion of a NEPA analysis and associated decision, BLM would offer the lands for competitive leasing. The notice of lease sale would be published a minimum of 45 days in advance of the lease sale date. Leases are issued to the highest bidder.
- The Forest Service would approve surface use based on the lessee submitted surface use plan of operations.

Coal

The Bering River Coal deposit is on privately held lands so Forest Service surface management regulations do not apply and the Forest Service has no authority. There is a road right-of-way to this deposit held by CAC.

Geothermal

There are no known geothermal resources within the Chugach National Forest.

Mineral Resources

This section addresses the current type, extent, and general location of mineral activity; potential of the plan area for mineral activity; mineral activity trends; and the contribution of mineral activity in the plan area to social, economic, and ecological sustainability.

Existing mineral activity

Almost the entire national forest, with the exception of areas that have been appropriated, withdrawn, or segregated, is open to location under the General Mining Law of 1872, as amended. Acquired lands are not open to mineral location but are available under leasable laws.

It is not possible to quantify the number of active mining operations within the national forest since many activities do not require an authorization. The national forest has about 50 surface disturbing mining operations that are authorized under an approved plan of operations and most have a performance-reclamation bond.

There are four frequently used sand and gravel community sites within the national forest. At least eight additional sites are used, but less frequently.

Hundreds of mining claims are located within the national forest. Mining claims are dynamic and are routinely staked, filed, and dropped. The Forest Service does not administer mining claims. All mining claims on public lands are administered by the BLM. The Forest Service only administers surface mining operations.

Locatable minerals

Locatable minerals are those minerals that may be located and removed from Federal lands under the authority of the General Mining Law of 1872, as amended. In general, locatable minerals are those hard rock minerals that are mined and processed for the recovery of metals. They may also include certain nonmetallic minerals and uncommon varieties of materials that possess valuable and distinctive properties, such as some deposits of limestone or silica. Lands open to mineral entry are in the public domain and have not been appropriated, withdrawn, or segregated from location and entry.

Placer gold deposits/operations

In the late 1840s when Alaska was still owned by Russia, placer gold was first discovered in Kenai Peninsula drainages, which would later become part of the Chugach National Forest. Thousands of ounces of placer gold have been mined from many of the creeks, primarily on the roaded portions of the Kenai Peninsula. Placer gold producing drainages include: Crow Creek, Canyon Creek, Resurrection/Palmer creeks, Lynx Creek, Bear Creek, Mills Creek, Gulch Creek, Sixmile Creek, Cooper/Stetson Creeks, and Quartz Creek. As of 2012, active plans of operations exist for small-scale operations on all but one of the above streams (most of Sixmile Creek is withdrawn from mineral entry). Mid-sized mechanical operations (Hope Mining Company) have been active on Resurrection Creek for the past 4 to 5 years.

Lode deposits/operations

The rigorous permitting requirement to establish a lode mine, the limited size of lode deposits in the area, and the small-scale miners that dominate mining within the national forest all serve to limit development of lode mines. Two or three lode operations do exist within the national forest but production is very limited. Operators work seasonally and use rudimentary hand tools.

Larger gold lode deposits exist in northern Prince William Sound. Both the Cliff and Granite mines have had significant historic gold production. Historic base metals, primarily copper, have also been produced from lode mines in Prince William Sound: Latouche and Knight islands, and Ellamar; however, the more significant identified deposits have been selected and conveyed to the Chugach Alaska Corporation, an Alaska Native regional corporation under Alaska Native Claims Settlement Act (ANCSA).

Leasable minerals

Leasable mineral administration is under the authority of the Secretary of Interior. Various Acts provide authority for leasable minerals as outlined below.

- Solid leasables: The BLM leases certain solid minerals, like phosphate, sodium, and potassium, on public and other Federal lands, including areas managed by the Forest Service.
- Hardrock leasables: Where the Federal government has acquired the land, the BLM leases hardrock minerals under leasable regulations.

Hardrock leasable: Copper River addition

Hardrock minerals, such as gold and other metals, are generally conveyed by discovery and location. However, when mineral lands are acquired by the Federal government, those minerals are only available under the laws and regulations for leasable minerals. The Copper River Addition was appended to the Chugach National Forest under provisions of ANILCA in 1980. Hardrock minerals within this addition are not available for mineral entry because the lands are acquired but may be made available under leasing laws.

Salable minerals (mineral materials)

Salable minerals are common variety minerals disposed under free use permit or sale contract as authorized under the Materials Act of 1947 and the Surface Resources Act of 1955. They include the following categories: agricultural supplies; building materials; abrasive materials; construction materials; and landscape materials. The regulations for salable minerals may be found at 36 CFR 228C.

Sand and gravel

Extensive deposits of sand and gravel occur as alluvial, bench, and glacial deposits and are ubiquitous to nearly every valley within the national forest. Suitability of sand and gravel deposits for construction purposes varies based on factors, such as particle hardness, durability, and silt content. Road or rail accessibility is necessary for development.

The most significant sand and gravel deposit is located along the Spencer Glacier outwash plain. A second important sand and gravel resource is the deposits in Portage Valley, which have supported infrastructure projects for many decades.

Quarry rock: shot rock, rip-rap, and armor stone

Quarry rock suitable for construction purposes is in short supply within the Chugach National Forest, especially near roaded areas where the demand is greatest for road and other construction projects. Extensive portions of the Valdez Group are the underlying rocks on the roaded corridor and are commonly low grade slates and other non-competent or highly fractured rock that is unsuitable for construction use. Rock that fractures either naturally or by controlled blasting into large blocks is even less common and in demand for many infrastructure projects. A rock knob along the north edge of Spencer Lake is one of the few sources armor stone in the state certified for use in COE (U.S. Army Corps of Engineers) projects. The blasted rock fractures in large blocks, is durable, has rail accessibility, and is a proven commodity.

Decorative stone

A small tonnage of stone is produced from the national forest each year for use as decorative stone. Slate is produced from two locations along the Hope Highway.

Salable agricultural minerals

Travertine deposits occur infrequently within the Chugach National Forest and potentially may be suitable for use as an agricultural soil conditioner or amendment and are disposed under salable mineral materials regulations at 36 CFR 228C. One or more deposits occur along the Russian River but are precluded from development due to provisions of the Roadless Area Conservation Rule.

Mineral potential

The mineral potential for locatable minerals varies across the national forest, but activity is heaviest in areas with ready road access. The most comprehensive report delineating the mineral potential of most lands of the national forest was provided by Nelson and Miller (2000). Nelson and Miller delineated 21 mineral tracts and classified tracts into one of four categories as follows:

1. Tracts containing identified mineral resources (mines and prospects) and considered highly favorable for future mineral development and production
2. Tracts containing identified mineral resources and considered moderately favorable for future mineral development and production
3. Tracts without identified resources but considered highly favorable for containing undiscovered mineral resources
4. Tracts considered under-evaluated as to their mineral resource potential because geologic data is lacking due to rugged topography and (or) glacial cover

Leasable mineral potential is low for the Chugach National Forest.

Salable mineral potential is high. Sand and gravel demand is moderate to high along roaded areas of the national forest. Larger deposits exist in valley floors and as bench deposits.

Trends affecting mineral activity

Mineral activity within the Chugach National Forest is often related to the market for specific mineral resources. The price of gold was about 300 dollars per ounce when the 2002 Forest Plan was implemented. Since then, the price of gold has exceeded 1,800 dollars per ounce, an increase of more than 500 percent. The huge increase in the price of gold has resurrected interest in gold prospecting and mining and by persons seeking recreational opportunities for gold recovery. The Forest Service can gauge interest in locatable minerals by anecdotal indicators, such as observed activity, mining claim filings with BLM, number and topics of phone calls from the public, and submitted plans of operations. There is no requirement that operators provide information to any agency on their mineral recovery, except for the state mining license tax to the Alaska Department of Revenue, and that information is considered confidential. Mineral materials demand is driven by immediate area construction projects.

Split estate

Certain acquired National Forest System lands, including lands purchased by the United States following the Exxon Valdez oil spill, have a split estate: the surface ownership is held by the Federal government but the subsurface estate remains the possession of CAC. In the event that CAC identifies a mineral deposit, they may choose to develop that deposit.

Wilderness areas, recommended wilderness areas, and wilderness study areas

A wilderness area is a congressionally designated area that is withdrawn from mineral entry by an act of Congress. Mining development may occur in a wilderness area if a pre-existing mining claim has been determined to possess valid existing rights. Recommended wilderness areas within the Chugach National Forest are not congressionally designated areas. All recommended wilderness areas within the Chugach National Forest are in the Nellie Juan-College Fiord WSA. Recommended wilderness areas and the WSA are not withdrawn from mineral entry and are open to location and mineral entry in compliance with U.S. Mining Laws, therefore mineral development may occur. Several areas of moderate and high mineral potential (Nelson & Miller, 2000) exist in recommended wilderness areas and the WSA. Management to retain wilderness character discourages locatable mineral exploration and development.

Recreational mineral recovery

Recreationists may remove mineral specimens from National Forest System lands, including withdrawn lands, using small hand tools and four inch or less suction dredges. Recreational users are afforded no rights under U.S. Mining Laws and the activity is not covered under 36 CFR 228A. The process of recreational mineral recovery does not consider the mineral recovery an economically gainful endeavor. Only one area within the national forest (Resurrection Creek restoration area) has a closure order as of 2012 to preclude the use of gold pans and other hand tools for recreational mineral recovery.

Social and economic contribution of mineral activity

Mining laws do not consider any social aspects beyond the economic production of minerals in support of the national economy and personal capitalistic principles. A large social contribution exists for salable minerals, which supports infrastructure and construction projects, safety (road traction sand and flood control), and personal use needs for area residents.

Anecdotal evidence suggests that economic considerations are not considered by the individuals that seek out placer gold and other locatable minerals within the national forest. Economic contributions, however, do exist through purchase of goods and service, including fuel, heavy equipment, suction dredges, gold pans, hand tools, diving gear, and ATVs.

Abandoned mine lands

Abandoned mine sites were inventoried in the mid-1990s and rated on criteria, including physical and chemical hazards (site reports are on file in the Chugach National Forest minerals library). Explosives and immediate chemical hazards have been addressed at abandoned mine land sites. Mitigation of physical hazards at abandoned mines continues to be addressed and often includes sealing mine adits, shafts, and other workings from entry by humans. Some sites were designated as superfund sites under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and pose longer term chemical risks due to contamination of soil and/or ground water.

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