

**INVENTORY STUDY PLAN FOR
VASCULAR PLANTS AND VERTEBRATES:
NORTHERN COLORADO PLATEAU NETWORK
NATIONAL PARK SERVICE**

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I. INTRODUCTION AND OBJECTIVES OF BIOLOGICAL INVENTORY

The overall mission of the National Park Service is to conserve unimpaired the natural and cultural resources and values of the national park system for the enjoyment of this and future generations (National Park Service 1988). Actual management of national parks throughout the Service's history has emphasized public use and enjoyment, often to the detriment of natural ecosystems within the parks (National Research Council 1992; Sellars 1997). Funding and support for science and natural resource management has been lacking or severely limited throughout much of the 80+ year history of the Park Service. As a result, basic biological inventories of park ecosystems have not been completed for most parks in the national system (Stohlgren 1995). An understanding of what species occur within a park, as well as information on their current status, distribution and condition is essential to making informed management decisions concerning park natural resources.

The lack of and need for park based biological information has long been recognized (Sellars 1997). In response to this need the National Park Service initiated an Inventory and Monitoring Program in the early 1990's to conduct scientific research and study long-term changes of biological resources in national parks (National Park Service 1992). This program largely emphasized work in 'prototype' parks that served as models for other parks in the system. By the late 1990's most parks still lacked basic biological inventories. In 1998, Congress appropriated servicewide funding for a "program of inventory and monitoring of National Park System resources to establish baseline information and to provide information on the long-term trends in the conditions of National Park System resources" (National Park Service 1999a). As part of this new program 32 networks of parks nationwide have been asked to develop detailed study plans for biological inventory. The study plan which follows is for the Northern Colorado Plateau Network.

The *Northern Colorado Plateau Network* (NCPN) encompasses a total of 16 units managed by the National Park Service in Utah, western Colorado and southwestern Wyoming (Figure 1; Table 1). In addition to individual park offices, the Southeast Utah Group (SEUG) office in Moab is a combined administrative unit for four nearby parks (ARCH, CANY, NABR and HOVE). Within or adjacent to the NCPN are collaborative offices of the U.S. Geological Survey – Biological Resources Division (Table 1). USGS scientists at these locations have been instrumental in helping the NCPN develop this study plan. The new Cooperative Ecosystem Study Unit (CESU) in Flagstaff is also a key collaborator in this effort. A nine-member steering committee comprised of park resource staff has been appointed to oversee development of the inventory and monitoring program for the Northern Colorado Plateau Network. The network has hired a full-time inventory and monitoring program coordinator and two biotechs to assist in program development. This staff will be expanded in the coming year as the NCPN initiates the monitoring phase of the program.

Parks within the network are widely scattered within four western states and range in size from 16 to 136,611 hectares (40 to 337,570 acres) (Table 1). Most parks in the network are adjacent to other federal lands managed by the USDA Forest Service and USDI Bureau of Land Management. Parks within the network have established relationships with these federal agencies, as well as state agencies, academic institutions and other organizations. Since individual parks are typically small islands embedded within larger landscapes it is important that the Park Service collaborate with partners beyond park boundaries, especially in choosing and applying inventory protocols and in data sharing. The NCPN is working closely with the Southern Colorado Plateau Network to ensure that taxonomic group protocols are comparable across parks in the two networks.

Figure 1.

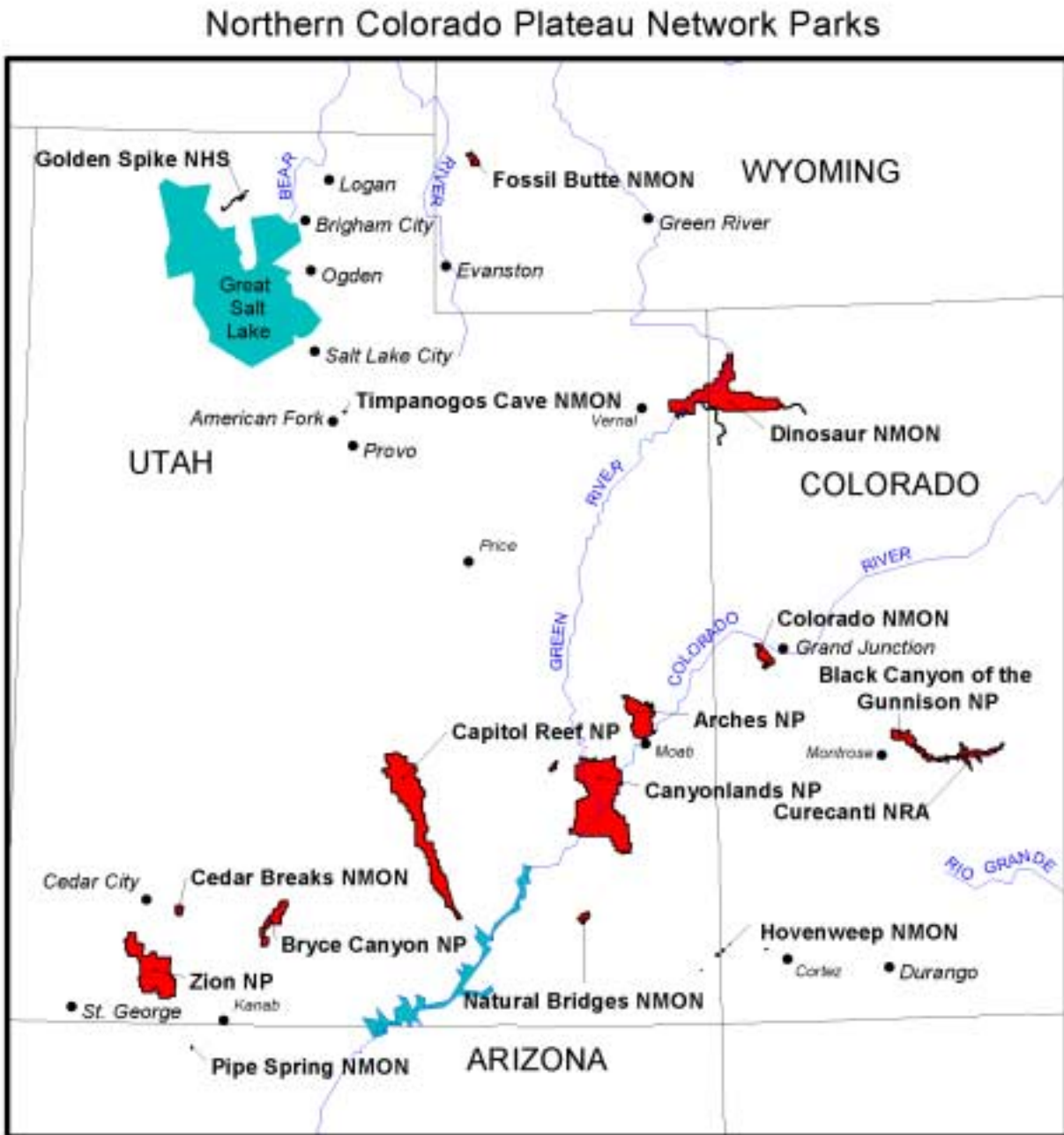


Table 1. National Park Service Units and collaborative offices in the Northern Colorado Plateau Network

Unit	Parkcode	Hectares	Acres
Arches National Park	ARCH	30,979	76,519
Black Canyon of the Gunnison National Park	BLCA	12,660	30,300
Bryce Canyon National Park	BRCA	14,508	35,835
Canyonlands National Park	CANY	136,587	337,570
Capitol Reef National Park	CARE	97,936	241,904
Cedar Breaks National Monument	CEBR	2,491	6,154
Colorado National Monument	COLM	8,280	20,453
Curecanti National Recreation Area	CURE	16,390	40,500
Dinosaur National Monument	DINO	85,361	210,844
Fossil Butte National Monument	FOBU	3,319	8,198
Golden Spike National Historic Site	GOSP	1,107	2,735
Hovenweep National Monument	HOVE	318	785
Natural Bridges National Monument	NABR	3,010	7,626
Pipe Spring National Monument	PISP	16	40
Timpanogos Cave National Monument	TICA	101	250
Zion National Park	ZION	59,947	146,560
Southeast Utah Group Office, National Park Service, Moab	SEUG		
Colorado Plateau Cooperative Ecosystems Study Unit, Flagstaff	CESU		
Canyonlands Field Station, US Geological Survey, Moab			
Colorado Plateau Field Station, US Geological Survey, Flagstaff			
US Geological Survey, Albuquerque			

This project focuses on completing basic inventories of vascular plants and vertebrate animals for parks within the Northern Colorado Plateau Network. A primary goal of the inventory project is to provide park managers in the network with scientifically sound information on the nature and status of selected biological resources in a readily accessible form to assist on-the-ground resource management. Organization of a network based inventory and monitoring program offers several benefits through increased efficiencies in designing and conducting inventory work, and improved opportunities for exchange of ideas and information across parks.

The objectives of this inventory project are as follows:

1. To document through existing, verifiable data and targeted field investigations the occurrence of at least 90 percent of the species of vertebrates and vascular plants currently estimated to occur in the park.
2. To describe the distribution and relative abundance of species of special concern, such as Threatened and Endangered species, exotics and other species of special management interest occurring within park boundaries.
3. To provide the baseline information needed to develop a general monitoring strategy and design that can be implemented by parks once inventories have been completed, tailored to specific park threats and resource issues.
4. To develop a coordinated network data management effort which results in biological resource information being easily accessible to park managers, resource managers, scientists and the public.

II. BIOPHYSICAL OVERVIEW OF NORTHERN COLORADO PLATEAU NETWORK

The network lies predominately within the Colorado Plateau physiographic province (13 of 16 parks), but also includes two parks (FOBU, TICA) within the central Rocky Mountain Province and one park (GOSP) within the Great Basin Province. Following is a general description of the physical setting and vegetation for the Colorado Plateau portion of the network. Descriptions of the biophysical setting for the other parks are located in [Appendix A](#).

Physical Setting. The distinctive Colorado Plateau physiographic province covers approximately 335,000 km² between the Rocky Mountains and the Great Basin in western North America (Hunt 1974). This unique region is characterized by a suite of outstanding physiographic features that strongly influence ecological patterns and processes found in Plateau parks and monuments managed by the National Park Service and the Bureau of Land Management. These features include:

- *Striking structural geology*, with extensive areas of nearly horizontal sedimentary formations consisting of shales, sandstones, and limestones possessing diverse physiochemical characteristics; great upwarps that form dramatic topographic and geomorphic features; and numerous igneous structures, including volcanoes and cinder cones, basalt-capped mesas and plateaus, as well as laccolithic mountains caused by igneous intrusions (Hunt 1974);
- *Great altitude and topographic relief*, with elevations ranging from less than 1100 m to over 3850 m, and the majority of the Plateau over 1500 m;
- *Deeply incised drainage systems*, responsible for steep-walled canyons and abrupt topographic variations in environmental conditions;
- *Aridity*, with riparian corridors and moist, montane islands distributed sparsely within an otherwise dry environment; and
- *Extensive areas of raw, exposed geologic substrates*.

The Plateau is divided roughly into two climatic regions by a broad, northeastward-trending boundary which extends diagonally from northwestern Arizona to north-central Colorado (Mitchell 1976, Peterson 1994). This broad boundary coincides with the mean northwestern extent of summer precipitation associated with monsoonal circulation patterns carrying moisture from the Gulf of Mexico and the Gulf of California. Approximately two-thirds of the Plateau lies southeast of this climatic boundary and is characterized by a bimodal precipitation regime with both winter and summer maxima. The magnitude of the summer precipitation maximum generally weakens from southeast to northwest, and the northwestern one-third of the Plateau is dominated by winter precipitation. Interannual shifts in the monsoon boundary produce considerable variations in levels of summer precipitation across much of the Plateau. Due to aridity and the vast extent of relatively unweathered geologic substrates, dominant soil orders on the Plateau are Entisols and Aridisols (Birkeland 1999).

Climatic and Edaphic Controls. The composition, structure, and distribution of vegetation on the Colorado Plateau are strongly influenced by factors arising from the particular climatic and geologic characteristics of the region (Comstock and Ehleringer 1992). Foremost among these are variables affecting the spatial and temporal availability of water to plants. The amount and seasonality of effective precipitation (as modified by elevation and topographic exposure), in combination with edaphic characteristics including salinity, texture, and soil depth, structure

communities through effects on the hydrologic regime (Caldwell 1985, Comstock and Ehleringer 1992). Though less studied, climatic and edaphic constraints on nutrient relations may be as important for plants in these arid and semiarid environments as the corresponding constraints on water relations (Chapin 1991, Miller 2000).

Although ultimate mechanisms underlying observed plant-soil relationships often are unclear, edaphic control of vegetation remains an important ecological principle on the Colorado Plateau (Welsh 1978, Betancourt 1990). Species distributions tend to be correlated with geology, particularly where relatively unweathered strata remain exposed at the surface (Welsh 1993). Species occurring on raw lithic or unweathered colluvial surfaces tend to be substrate specialists, whereas generalist species tend to occupy alluvial surfaces that have undergone a greater degree of chemical weathering and soil development (Welsh 1993). Consistent with this principle, plant endemism on the Colorado Plateau is highly correlated with the exposure of unweathered colluvium or raw geologic substrates (Welsh 1978, 1993).

The Colorado Plateau is a center of plant speciation and endemism. Although no attempt has been made to determine the size of the flora, there are an estimated 2500-3000 species. About 10% of this flora is endemic (Schultz 1993), consisting mostly of herbaceous dicots in the genera *Astragalus*, *Cryptantha*, *Erigeron*, *Eriogonum*, *Gilia*, *Phacelia*, and *Penstemon*. Many of these species occur in or are adjacent to parks on the Plateau.

Major Vegetation Types. Most contemporary ecologists agree that vegetation composition varies continuously along environmental gradients in space and time (Whittaker 1975, Crawley 1997). Distinct vegetation types are abstractions recognized where environmental gradients are particularly steep or abruptly discontinuous, and where categories are required for convenience of description. This description of major vegetation types found on the Colorado Plateau generally follows treatments of Barbour and Billings (2000); species nomenclature follows Welsh et al. (1993).

Saltbush-Greasewood Shrublands: dominated by perennial shrubs and dwarf-shrubs of the Chenopodiaceae, these communities typically (but not universally) are associated with saline soils of basin bottoms, riparian terraces, and badland substrates on marine shales (West and Young 2000). Common shrub or dwarf-shrub species include *Atriplex canescens*, *A. confertifolia*, *A. corrugata*, *Ceratoides lanata*, *Grayia spinosa*, *Sarcobatus vermiculatus*, and *Suaeda* spp. Typical herbaceous components include grasses *Distichlis* spp., *Sporobolus airoides*, *Elymus cinereus*, and forbs (both exotic) *Halogeton glomeratus* and *Salsola* spp. This type also is referred to as "salt-desert scrub" (West and Young 2000).

Blackbrush Shrublands: dominated by the shrub *Coleogyne ramosissima*, this type usually is associated with residuum derived from calcareous geologic substrates, soils characterized by a shallow petrocalcic ("caliche") horizon, or with carbonate-stabilized sand dunes. With the exception of occasional *Ephedra* spp., *Gutierrezia* spp., and *Opuntia* spp., other woody plants are uncommon in blackbrush shrublands. Common herbaceous species include the grasses *Hilaria jamesii*, *Stipa hymenoides*, and *Sporobolus* spp. In this community type, relative dominance generally shifts from blackbrush to perennial grasses along a gradient of increasing depth to the petrocalcic horizon or the underlying geologic substrate.

Galleta—Three-awn Shrubsteppes: this type occurs on relatively deep and undeveloped sandy soils, most commonly in the Canyonlands section of the Colorado Plateau province (West and Young 2000). Dominant species include the grasses *Hilaria jamesii* (galleta), *Stipa hymenoides* (Indian ricegrass), and *Aristida* (three-awn) spp. The dwarf-shrub *Gutierrezia* and the chenopod shrubs *Atriplex canescens* and *Ceratoides lanata* also are common.

Great Basin Sagebrush: dominated by *Artemisia tridentata* (sagebrush), this is the major sagebrush community found throughout all but the northern-most portions of the Colorado Plateau (West and Young 2000). Sagebrush typically accounts for greater than 70 percent of the live vascular plant cover in this vegetation type, with *Chrysothamnus* spp. and *Elymus elymoides* as the most common co-occurring shrubs and grasses, respectively. The type typically is found on relatively deep alluvial soils.

Sagebrush Steppe: this sagebrush type also is dominated by *Artemisia tridentata*, but is found at higher latitudes and elevations than Great Basin sagebrush (West and Young 2000). It is the major sagebrush type found at Dinosaur National Monument, at the northern margin of the Colorado Plateau. As suggested by the name, the comparatively mesic sagebrush steppe usually is codominated by perennial grasses such as *Elymus smithii*, *E. spicatus*, *E. lanceolatus*, *Festuca idahoensis*, and *Stipa thurberiana*.

Pinyon-Juniper Woodlands: coniferous woodlands dominated by various species of pinyon and juniper are widespread across the Colorado Plateau (West and Young 2000, McPherson 1997). *Juniperus osteosperma* is the dominant juniper on the Plateau, although it tends to be replaced by *J. monosperma* at the eastern and southern margins. *Pinus edulis* is the dominant pinyon throughout the region. Both juniper and pinyon are substrate generalists capable of establishing in rocky soils derived from a wide range of geologic parent materials (Harper and Davis 1999, West and Young 2000). However, understory components of this community type are strongly affected by substrate characteristics, resulting in considerable compositional variation among assemblages broadly grouped together as pinyon-juniper woodlands (West and Young 2000).

Mountain Mahogany-Oak Shrublands: transitional between pinyon-juniper woodlands and lower montane coniferous forests, these mostly deciduous, montane shrublands typically are dominated by *Cercocarpus ledifolius*, *C. montanus*, and *Quercus gambelii*. Evergreen oaks (e.g., *Q. turbinella*) enter this association at the southern margin of the Plateau. Other shrubs common to this vegetation type include *Amelanchier* spp., *Symphoricarpos* spp., and *Purshia* spp. This type also is referred to as "mountain brush."

Ponderosa Pine Woodlands and Forests: dominated by *Pinus ponderosa*, this is the major vegetation type of the Mogollon Rim region of the southern Colorado Plateau as well as the lower montane zones on mountains elsewhere on the Plateau (Peet 2000). Tree density and understory composition in this type are strongly dependent on disturbance history.

Douglas Fir Forests: dominated by *Pseudotsuga menziesii*, this forest type often replaces *Pinus ponderosa* forests successionaly in the absence of fire, and spatially along a gradient of increasing soil moisture (Peet 2000).

Aspen Forests: dominated by *Populus tremuloides*, these forests often replace those dominated by *Pinus ponderosa* and/or *Pseudotsuga menziesii* following fire and are subsequently replaced again by the conifers following long fire-free periods (Peet 2000). On the Colorado Plateau, clonal aspen populations appear to have dominated some high-elevation shale-derived soils for thousands of years due to edaphic constraints on conifer establishment (Betancourt 1990).

Spruce-Fir Forests: characteristic of the subalpine zones of Colorado Plateau mountains and the Rocky Mountain region generally, these forests typically are dominated by *Picea engelmannii* and *Abies lasiocarpa* (Peet 2000).

Alpine Tundra: this herbaceous vegetation type on the Plateau is restricted to the highest peaks of the San Francisco, La Sal, and La Plata mountains (Barbour and Billings 2000).

Wetlands: herbaceous plant communities dominated by sedges (*Carex* spp.), rushes (*Juncus* spp.), spikerushes (*Eleocharis* spp.), and cattails (*Typha* spp.) are present but uncommon on the Colorado Plateau (West and Young 2000). Because of their comparative rarity and diversity, as well as their association with surface water, these important communities and habitats possess particularly high conservation value.

Riparian and Canyon Woodlands: woody riparian communities dominated by *Populus fremontii* and *Salix exigua* are important at low and intermediate elevations across the Colorado Plateau (MacMahon 1988). In many drainages, these native cottonwoods and willows face considerable competition from exotic *Tamarix* spp. and *Eleagnus angustifolia*. At higher elevations, comparable communities are dominated by *Populus angustifolia*, *Alnus* spp., *Acer negundo*, *Betula occidentalis*, *Shepherdia argentea*, and several *Salix* spp. (Peet 2000).

Hanging Gardens: these unique, insular riparian communities located in rock alcoves and beneath canyon pour-offs are lush and biotically diverse (Welsh and Toft 1981, Fowler 1995). Common species include *Adiantum capillus-veneris*, *Petrophytum caespitosum*, *Epipactis gigantea*, *Carex aurea*, and *Mimulus* spp. Several Colorado Plateau endemics are found almost exclusively in hanging gardens, including *Primulus specuicola* and *Cirsium rydbergii*.

Biological Soil Crusts. In addition to vascular plants, biological soil crusts composed of cyanobacteria, mosses, lichens, liverworts, microfungi, and green algae are ecologically significant components of many ecosystem types on the Colorado Plateau (Harper and Marble 1988, Johansen 1993, Belnap and Gillette 1998, Evans and Johansen 1999, Evans and Belnap 1999). In the absence of soil disturbance, these microphytic soil-surface communities are found in saltbush-greasewood shrublands, blackbrush shrublands, galleta—three-awn shrubsteppes, sagebrush steppes, Great Basin sagebrush shrublands, and pinyon-juniper woodlands. Total cover of biological soil crusts often approaches and even exceeds that of vascular plants in many communities (Kleiner and Harper 1977, Harper and Marble 1988).

III. DESCRIPTION OF PARK BIOLOGICAL RESOURCES AND MANAGEMENT

A detailed overview of park history, biological resources, and management concerns is provided for each of the 16 parks in [Appendix A](#). These park summaries contain the following sections: size, park history and purpose, location, elevation, general description, flora, fauna, unique features and species of special concern, resource management concerns, and references cited. Maps of each park showing topography, hydrography and locators are found in [Appendix B](#).

Several management issues emerge as being of concern to multiple parks in the network including: invasive plants and animals, recreation use impacts, fire, livestock grazing, and management of threatened, endangered, and sensitive plants and animals. At some level *all* parks are concerned the rapid spread of invasive plant species. Several parks list similar habitats of special concern, especially an array of aquatic and riparian habitats including: riverine habitats, seeps, springs, hanging gardens, and wetlands. A few parks identified the lack of basic biological information as a major obstacle to sound resource management.

IV. EXISTING INFORMATION ON VASCULAR PLANTS AND VERTEBRATES

Existing information on vertebrates and vascular plants in network parks is generally not well organized nor easily accessible. This information is scattered throughout a variety of NPS offices, files and databases, as well as located at external institutions. As part of the inventory project we have begun the task of assembling relevant data on vascular plant and vertebrate species occurrences. We reviewed project reports and published papers to determine the approximate completeness of inventories of all major taxonomic groups. A summary of the status of existing inventories by taxonomic group for all 16 parks in the network is located in Appendix C. As the reader will note, many of the existing inventories are several decades old and of questionable quality and in some cases inventories are lacking all together. Due to turnover of park personnel and the resulting lack of specific knowledge of past biological work in the parks, it has been a challenge to assemble a complete picture of past inventory work. It is likely that additional information exists, however, it is not known at this time. We will continue to compile and catalog additional species information throughout the course of this project.

We are using several NPS national databases to organize this information including: NPSpecies, Natural Resource Bibliography (NRBib), and Dataset Catalog. In addition, the ANCS+ and Investigators Annual Report Databases are serving as information sources for species information.

NPSpecies Database. So far most of our data management efforts have centered on assembling species list and occurrence data for NPSpecies. During the months of May and June we compiled existing species list and voucher information for all 16 parks in the network. Much of this data was only available in paper form, which required manually entering species lists into electronic Excel spreadsheet format. These electronic species list files, as well as ANCS+ voucher data for all parks were sent to Mark Wotawa with the I&M office in Ft. Collins for processing. Mark and his crew expedited the data assistance request and processed NPSpecies files were returned to the network during the month of July. Network biotechs worked with park personnel in cleaning up the species lists and adding reference and voucher information. The process of adding voucher information to the NPSpecies database will be ongoing in the early years of the inventory project. We also have obtained voucher information from the Automated National Catalog System (ANCS+) park databases and it has been converted to the NPSpecies format. Several problems exist with the ANCS+ data including the inability to sort on location (eg. Park vs. outside of park), outdated nomenclature and misidentified specimens. An initial draft of the NPSpecies database for NCPN parks is being provided to the National Inventory and Monitoring Program in October 2000.

NRBib Database. We have just started working with the NRBib database in Procite. An extensive NRBib database population effort was completed on the Colorado Plateau in the mid 1990s. Over 4392 records are contained in the database for the network. Data entries include more typical bibliographic references such as reports and publications. In addition, the NRBib database includes reference to manual and electronic datafiles, photos and raw data sheets. The quality of the NRBib data for most network parks is poor. Citations are typically incomplete and often lack key fields including author, date, place of publication, and number of pages. The task of cleaning up the NRBib data for our network is a big one. We anticipate that this will be an ongoing effort throughout the project.

Dataset Catalog. We have recently obtained a beta version of the new Dataset Catalog and we are in the process of familiarizing ourselves with it. This database stores metadata on a variety of datasets. We intend to use this database to compile metadata on inventory and monitoring datasets for the network. There presently appears to be some overlap between the Dataset

Catalog and NRBib – it would be helpful if the national office could clarify the relationship of these two databases.

Maps and GIS Themes. Spatial Data is an extremely important component of the network's inventory and monitoring program. This data will be useful in selecting inventory and monitoring random sampling locations (e.g., stratification). In addition, GIS will be used to organize data on species occurrences, sampling points, survey routes and much more. We have completed an initial assessment of GIS layers currently available to the network parks ([Appendix D](#)). Most parks have basic topographic coverages available, where geological and vegetation information is more limited.

Voucher Specimens & Photographs. So far the network's emphasis on assembling voucher information to document species occurrences in parks has centered on obtaining data from the Automated National Catalog System (ANCS+) for 15 of the 16 parks. In addition, we have obtained mammal, reptile and amphibian voucher data from the Museum of Southwestern Biology in Albuquerque. To date we have not had time to examine what voucher photograph resources may be available for individual parks. We will continue work on assembling voucher specimen and photograph documentation as part of the overall inventory project.

Observation Records. Most parks have utilized Wildlife Observation Cards to document observations of species by park personnel and visitors. In some cases this information has been converted to electronic formats. Observation card data is often of questionable quality and we have generally not included this data in our initial NPSpecies database work. We will assess the potential use of observation data further as the inventory project proceeds.

Inventory Completeness. The first objective of the inventory program is to complete general inventories to document the presence of 90% of all vertebrates and vascular plants within each park. Within the timeframe for completing this study plan we have not had an opportunity to complete a definitive assessment of inventory completeness. As a first step, park resource managers have made a preliminary estimate of inventory completeness ([Table 2](#)). These estimates are being utilized to guide allocation of inventory effort at this time. However, as more data becomes available, we will adjust inventory needs accordingly. Assessing inventory completeness will be ongoing throughout the project period.

Several methods are available for determining whether the inventories have reached the 90% completeness level. The NCPN will use a variety of approaches depending on the type of data available. For most parks and taxonomic groups we anticipate using the 'master species list' approach where range maps and expert opinion are used to generate a list of species which are expected to occur within the park. The total number of species documented as present in a given park are then compared with the total number of species on the 'master list' to determine how complete the inventory is. The NCPN has solicited assistance from subject matter experts in development of the master species lists for birds, mammals, herps, fish and vascular plants.

Where we have suitable data we will use other techniques of estimating species richness including species accumulation curves over time or area. These techniques are preferred to the 'master species list' approach and will be utilized wherever possible.

Table 2. Estimated completeness of biological inventory by taxonomic group for network parks (based on best initial estimates from parks).

PARK CODE	BIRDS	MAMMALS	HERPS	FISH	PLANTS
ARCH	90%	85%	85%	90%	90%
BLCA	80%	65%	70%	80- 90%	60%
BRCA	90%	90%	80%	~	90%
CANY	90%	85%	80%	90%	90%
CARE	94%	65-70%	50%	90%	90% +
CEBR	80%	50%	66%	~	90%
COLM	90%	80%	80%	~	90%
CURE	80%	75%	0%	90%	60%
DINO	70%	90%	80-90%	90%	75%
FOBU	80%	80%	85-90%	~	90%
GOSP	50%	50%	50%	~	90% +
HOVE	90%	75%	70%	~	75%
NABR	90%	85%	85%	~	90%
PISP	98%	20%	40%	~	90%
TICA	50-60%	50-60%	50%	90%	50-60%
ZION	98%	75%	70%	90% +	90%

V. PRIORITIES FOR ADDITIONAL WORK

Biological inventory priorities for parks within the network were determined through a series of meetings and an evaluation of existing inventory information (discussed in previous section; [Appendix C](#)). The Network I&M Steering Committee held a scoping meeting on February 23rd. At this meeting the committee developed a matrix of estimated completeness of presence-absence inventories for each taxonomic group within a park, as well as a list of habitats of special concern and associated stressors. Following this meeting a general evaluation of the status of existing inventories was made and used to refine the estimated inventory completeness matrix (Table 2) and to develop a detailed list of inventory needs for each of the 16 parks within the network.

An experts workshop was held in Moab May 23-25 and brought together 60 subject matter experts and National Park staff to determine inventory priority projects to include in the NCPN study plan. The needs list referenced above was used as a basis for individual taxonomic group discussions and priority setting. The experts workshop was held jointly with the Southern Colorado Plateau Network. Between the two networks 35 individual parks were represented at the workshop. Among the reasons for holding the workshop jointly were to access the same subject matter experts and to select comparable inventory and monitoring protocols across the two networks comprising the Colorado Plateau. Additionally we wanted to explore possibilities for project collaboration across the two networks. Immediately following the workshop the NCPN Steering Committee met to finalize inventory funding priorities for the network.

Three categories of inventory needs have been identified and evaluated: 1) general presence-absence inventories, 2) species of special management concern, and 3) special habitats and communities of concern. Identified inventory needs for NCPN parks far exceeds the amount of funding currently available. Since many parks in the network are lacking basic information on which species are present, the NCPN Steering Committee decided that completing general vascular plant and vertebrate inventories is the highest priority for funding. Inventory of specialized habitats (e.g., riparian areas) will be emphasized in the general inventories since these areas often support high species diversity and species of special concern. We present a listing and description (Appendices E and F) of all identified inventory projects, even though these needs exceed current funding levels.

GENERAL PRESENCE-ABSENCE INVENTORIES

The overall goal of the general taxonomic group inventories is to document the presence of 90% of all vascular plants and vertebrate taxa in a park using scientifically valid techniques. Specific methods for these inventories are presented in Section VI. The estimated priority status of general inventories by taxonomic group are summarized for the NCPN parks in Table 3. These estimates of need and priority are based on currently available information. We view the inventory process as iterative, and we anticipate that as new data becomes available there will be a need to make adjustments to the overall inventory plan. We will place a high priority on maintaining a flexible approach throughout the course of this project.

Table 3. Estimated Status of General Inventory and Priority for Parks within the Northern Colorado Plateau Network.

	BIRDS	MAMMALS	HERPS	FISH	PLANTS
ARCH	X	Medium	Medium	X	X
BLCA	Medium	High	High	X	High
BRCA	X	X	Medium	--	X
CANY	X	Medium	Medium	X	X
CARE	X	High	High	X	X
CEBR	Medium	High	High	--	X
COLM	X	Medium	Medium	--	X
CURE	Medium	Medium	High	X	High
DINO	High	X	Medium	X	High/Medium
FOBU	Medium	Medium	Medium	--	X
GOSP	High	High	High	--	X
HOVE	X	Medium	High	--	Medium
NABR	X	Medium	Medium	--	X
PISP	X	High	High	--	X
TICA	High	High	High	X	High
ZION	X	Medium	High	X	X

Note: An 'X' indicates that the inventory is complete. 'High' priority indicates that inventory completeness for a given park is below 75%. 'Medium' priority indicates that inventory is between 75 and 85% complete. A shaded cell indicates that general taxonomic group inventories will be completed as part of this project.

The Northern Colorado Plateau Network has identified specific general inventory projects in order to meet the goal of 90% complete vascular plant and vertebrate inventories in all parks. Following is a listing of planned projects by taxonomic group. These general surveys are being designed to also obtain distribution and abundance information of species of special concern where applicable. Detailed project statements documenting objectives, methods, implementation schedule and budgets for these biological inventories are located in Appendices E and F. Projects proposed for Inventory funding under this study plan are found in Appendix E. Additional unfunded inventory projects are described in Appendix F. Funding status for the projects listed below is coded as follows: IM= projects covered by inventory and monitoring funding, U = unfunded at this time, and O= funded from other sources.

All Taxonomic Groups. The NCPN intends to fund a combination of permanent and term positions to oversee project coordination, development and data management. Inventory funding will cover a portion of the costs associated with these positions. The remaining funding will come from the monitoring phase of the program which will be initiated in Fiscal Year (FY) 2001.

ALLTAX – 01	All Parks	Inventory Project Coordination and Data Management	IM
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Birds. General bird inventory work is estimated to be complete in nine of the NCPN parks. Field inventory work is needed in 7 of the 16 parks. Also planned are additional searches of museum collections for voucher information.

BIRDS – 01	GOSP, TICA, DINO, FOBU, CEBR	General Bird Inventory	IM
BIRDS – 02	BLCA, CURE	General Bird Inventory	IM

Mammals. Basic mammal field inventory work is needed in all or portions of 14 parks in the NCPN. Searches of museum collections for mammal vouchers will be conducted as part of these inventories.

MAMMALS – 01	BLCA, CURE, CEBR, FOBU, HOVE, GOSP, PISP, TICA	Mammal Baseline Inventories	IM
MAMMALS – 02	ARCH, CANY, CARE, COLO, NABR, ZION	Focused inventories for Mammals	IM

Reptiles and Amphibians (Herps). Amphibian and reptile inventory work is needed in all 16 network parks, many of these being a high priority. Searches of museum collections for voucher information will be completed as part of these inventories.

HERPS – 01	High Priority: BLCA, CARE, CEBR, CURE, GOSP, HOVE, PISP, TICA, ZION Medium Priority: ARCH, BRCA, CANY, COLM, DINO, FOBU, NABR	General Amphibian and Reptile Inventories	IM
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Fish. Fish are known to be present in only eight of the 16 park units in the network and inventories are generally considered complete. No general inventories are planned at this time. There is, however, unverified information on the presence/absence of certain fish at Arches National Park and Hovenweep National Monument. We will investigate this situation further, and if necessary identify inventory needs in outyears.

Vascular Plants. General inventories are thought to be complete for 11 of the 16 parks. Five of the 16 parks are in need of vascular plant field inventory work in all or portions of each park. Existing information on vascular plant distribution will also be compiled as part of the general inventories.

PLANTS – 01	All Parks	National Park and Regional Herbaria Search	IM *
PLANTS – 02	HOVE	Floristic Inventory	IM
PLANTS – 03	TICA	General Floristic Inventory	IM
PLANTS – 04	BLCA/CURE	General Floristic Inventory	IM
PLANTS – 05	DINO	Floristic Inventory of the Green River District	IM

* indicates partial funding from inventory program

Other. Due to special circumstances at Timpanogos Cave NM (TICA) we are planning one inventory that extends beyond the vascular plant and vertebrate species aspect of the project. The primary resource feature at TICA is the cave ecosystem, yet baseline information on cave biota is lacking. Planned is a basic inventory of cave biota.

CAVE – 01	TICA	Cave Biota Study	IM
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SPECIES OF SPECIAL MANAGEMENT CONCERN

Parks within the NCPN are responsible for managing a variety of species of special management concern. These include threatened, endangered and sensitive plant and animal species, invasive exotic plants and animals, and other special situation species (e.g., safety concerns).

Threatened, Endangered and Sensitive Species. A list of threatened, endangered and sensitive plants and animals for each park are found in [Appendix G](#). This list was obtained from a new draft national NPS database of TES species and is in need of review. Inventory work has been completed for most listed threatened and endangered species within the network and parks are well into monitoring many of these species ([Appendix C](#)). In limited situations inventory for listed species is still needed.

Information on distribution and abundance of many sensitive plants and animals is limited for many parks. General inventories will include a focus on obtaining this information for species and habitats of special concern. In some cases inventory needs for special status species will not be met through the planned general inventory work, and we have therefore identified the following projects. As in the previous section, funding status for the project lists below is coded as follows: IM= projects proposed for inventory and monitoring funding, UN= unfunded at this time, and O= funded from other sources.

All Taxonomic Groups. Knowledge of the occurrence and distribution of sensitive species within parks is extremely variable across the network. Standardized lists of sensitive species are lacking for parks within the network. Specific inventory needs and priorities for these taxa will be clarified through this project.

ALLTAX – 02	All Parks	Develop standardized 'sensitive' plant and animal species lists for network parks, and assemble occurrence information.	IM
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Birds. Several species specific inventory projects are proposed for special status birds.

BIRDS – 03	BLCA, CURE, CARE, HOVE, ZION, (MEVE)	Southwestern Willow Flycatcher and Yellow-billed Cuckoo Inventory	IM
BIRDS – 04	ARCH, CURE, CANY	Western Burrowing Owl	U
BIRDS – 05	All Parks	Golden Eagle Inventory	U
BIRDS – 06	CEBR, COLM, DINO	Northern Goshawk Surveys	U
BIRDS - 07	FOBU, GOSP	Sage Grouse Inventory	U

Mammals. Two projects are proposed for special status mammals within the NCPN. These inventory needs will not be met by the planned general inventories.

MAMMALS - 04	ARCH, CANY, DINO	Northern River Otter	U
MAMMALS – 05	DINO, FOBU	Selected Mammal Species of Special Concern Inventory	U

Reptiles and Amphibians (Herps). At this time the network does not have enough information on special status amphibians and reptiles to fully evaluate inventory needs and only one project is

proposed at this time. General inventories for reptiles and amphibians will result in additional distribution and abundance information on special status species.

HERPS – 02	CARE	Chuckwalla	U
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Fish. Three fish inventories for special status fish species have been identified.

FISH - 01	CARE	Field survey for roundtail chub (<i>Gila robusta</i>) along Halls Creek	U
FISH - 02	CURE	Colorado Cutthroat Trout Survey	U
FISH - 03	BLCA	Black Canyon Fish Survey	U

Vascular Plants. For many parks in the network knowledge of plant species of special concern is limited. At this time we do not have enough information to fully assess what inventories are needed for these species. Two parks within the network, Dinosaur NM and Capitol Reef NP are well-known centers of plant endemism. Detailed studies of endemic plant taxa have been completed or are on-going within Dinosaur NM. During the past few years Capitol Reef NP has been actively conducting inventories for numerous endemic plant taxa, including several listed species. So far inventories have been completed for six high priority taxa within high use visitor areas. A three-year parkwide inventory of plant endemics was launched this year (FY2000) using Natural Resources Preservation Program (NRPP) funding. This inventory will contribute significantly to the knowledge of the abundance and distribution of these species. The sensitive plant inventory projects below have been proposed for parks where general plant inventory work is already complete.

PLANTS – 06	ARCH, NABR	Sensitive Plant Inventory for Southeast Utah Group Parks	U
PLANTS – 07	BRCA, CEBR, ZION	Sensitive Plant Inventory for Three Parks	U
PLANTS – 08	FOBU	Sensitive Plant Inventory for Fossil Butte NM	IM
PLANTS - 09	CARE	Parkwide TES Plant Surveys	O

Invasive Exotic Plants and Animals. Most parks in the network identified invasive non-native plants as a significant management concern. Some parks such as DINO and SEUG (ARCH, CANY, NABR and HOVE) have active programs aimed at controlling high priority invasive plants. The Intermountain Region of NPS is about to initiate development of a region-wide strategy for invasive species. A goal of this strategy will be to identify and map all alien species in each park. It will be important to make a connection between the invasive species strategy and network level inventory and monitoring programs. Although we know that there are extensive needs for inventory of invasive exotic species we were not able to conduct a full analysis of this need as part of the current study plan. Distribution and abundance data on invasive plants will be collected as part of the general plant inventory work in the few (5) parks scheduled for this work. Below we have identified a team approach to obtaining distribution and abundance information on important exotics in multiple network parks. This project is currently unfunded, however, the network will aggressively seek funding for this project from other sources.

EXOTIC – 01	All Parks	Multi-park Invasive Plant Inventory Project	U
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Other Species of Management Concern. Park managers may also be concerned with other types of species, for a variety of management reasons. For example, several Colorado Plateau (northern and southern) parks identified mountain lions as being of concern from a human safety

perspective. At the experts workshop it was suggested that a Colorado Plateau wide workshop would be an appropriate starting point for dealing with this issue. This project has been identified as a jointly funded and sponsored effort with the Southern Colorado Plateau Network. At this time the NCPN has not selected this project for immediate funding. We would like to work closely with the Southern Colorado Plateau Network in further developing the concept of this workshop to ensure useful products will follow. We will reconsider funding for this project at that time.

MAMMALS - 06	All Parks	Large Carnivore Workshop	U
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HABITATS AND COMMUNITIES OF SPECIAL CONCERN

Inventory of special habitats of concern is a critical component of the overall inventory effort. Network parks have identified high priority habitats in Table 4 that will be addressed in the general inventory efforts (see Section VI). Most of these habitats are associated with water and include rivers, seeps, springs, hanging gardens, and wet meadows. These specialized habitats often hot spots for biological diversity and support numerous species of special concern. Habitats associated with water may often be threatened by impacts from focused visitor and livestock use (when present).

Table 4. Habitats of special concern with associated stressors for parks in the Northern Colorado Plateau Network.

Park	Habitat Concerns	Stressors
ARCH	Seeps & springs, fir habitat	Exotics, developments
BLCA	Seeps & springs, riparian, hanging gardens	Grazing-cattle, exotics, land use conversion
BRCA	Springs, breaks, & aspen	Exotics, grazing, visitor use, forest succession
CANY	Seeps & springs	Exotics, development
CARE	All wetland areas	Exotics, road maintenance, visitor use, grazing
CEBR	Disappearing spruce, bristlecone pine, wet meadows, springs	Spruce bark beetle, exotics, impending fire
COLM	Riparian, seeps & springs, hanging gardens, relic areas	Visitor use, exotics, external development
CURE	Seeps & springs, riparian, hanging gardens	Grazing-cattle
DINO	Riparian, river, seeps & springs, mountain shrub lands, hanging gardens, crust communities, montane	Grazing, water quality and flow, exotics, past fire, exclusion, toxic spills, habitat fragment, back country, air quality, maintenance
FOBU	Riparian, seeps & springs, mountain shrub, aspen	Exotic plants, over-browsing, fence maintenance
GOSP	Sagebrush, grass distribution	Exotics, adjacent land uses
HOVE	Seeps & springs	Exotics, development
NABR	Seeps & springs	Exotics, development, visitor use
PISP	Springs	Loss of water, exotics
TICA	Cave	Human impacts
ZION	Riparian, springs, aspen, white fir, slot canyons, hanging gardens	Visitation, change in use patterns, adjacent development, exotics, threat of catastrophic fire, water Q&Q, too many mule deer

VI. SAMPLING DESIGN CONSIDERATIONS AND METHODS

DESIGN CONSIDERATIONS

Northern Colorado Plateau Network parks have given thoughtful consideration to the design of this inventory project. We will use a combination of sampling approaches depending on the status of inventory completeness for a given taxonomic group within a park and the size of the park.

Parks with Mostly Complete Inventories. Due to the advanced stage of inventory completeness (>65%) for most parks in the network (Table 2), we have opted to emphasize targeted inventories to fill gaps, as opposed to designing a comprehensive and integrated network inventory program. We realize that there are trade-offs in this decision, and that a stratified random or systematic random sampling design applied more uniformly across entire parks in the network would yield data from which statistical inferences could be made. However, since most parks are between 65 and 90% complete, a parkwide random sampling design would most likely yield information on common and widespread species which are already documented. In addition, inventory funding is not sufficient to implement parkwide integrated inventory for all taxonomic groups in all parks. Given this situation we plan on conducting inventories targeted at specific habitats or geographic areas within the park that are likely to yield data on undocumented species and species of special concern. It is our feeling that this approach will yield the most useful data for resource management in the parks. Managers are in need of specific distribution and abundance information on species of special concern, such as rare plants and invasive exotic plants, and our approach will maximize acquisition of this data.

Target habitats in individual parks will be stratified based on physical and ecological attributes associated with the species and habitats of interest (Table 4; Appendix G) and mapped prior to selecting random sampling locations. Attributes for delineating strata may vary across taxonomic groups and may also be based on what spatial data is available for a given park (Appendix D). For example, plant inventories may be stratified on geologic substrate and bird inventories may be stratified on habitat (e.g., riparian areas). To the degree possible we will attempt to stratify on fixed landscape attributes (e.g., slope, elevation, aspect), however, in some cases it may be necessary to stratify on vegetation or other ecological attributes.

A grid-cell approach of identifying potential sampling locations (Fancy 2000) will be applied to the entire park. The starting point for this base grid will be randomly selected. Stratum of interest will be delineated over the base sampling framework for the park. Once strata have been delineated and mapped using existing GIS datasets, we will sample for the taxonomic group of interest. Within each target stratum, all areas accessible for sampling will have an equal probability of being chosen. Where certain portions of a stratum are inaccessible to sampling, inferences will not be made to these areas. To the degree dictated by need, taxonomic group sampling points may be integrated. Design of inventories for some species of special concern may require departure from a random sampling approach. In these situations data will not be used in model-based estimates of species richness. An example of where such a departure may be warranted is an inventory for a rare plant that is restricted to highly localized outcrops, which would be missed in a random sampling design.

Parks in need of Basic Parkwide Inventories (<50% complete). Six parks (GOSP, TICA, PISP, CARE, CEBR and CURE) in the network have at least one taxonomic group with estimated inventory completeness at 50% or below (Table 2). In the case of GOSP, TICA and PISP, two to four of the taxonomic groups have incomplete inventories (50% or below).

For taxonomic groups at 50% or less inventory completeness we plan on taking a parkwide approach to design of these inventories. For large parks we will use a stratified random approach and for small parks a systematic random design or complete area surveys. Strata will be delineated based on a combination of physical and ecological attributes, depending on need and available spatial data. A grid-cell approach will be utilized to identify all potential sampling locations in the park or within strata. At GOSP and TICA where multiple parkwide basic inventories are needed a focal point approach may be utilized. In this approach focal points will be randomly selected and secondary sampling units for mammals, birds, and herps will be randomly located with respect to the focal point. This approach will allow for integration of taxonomic group data. For inventories of vascular plants in small parks (<121 hectares/300 acres) we will conduct complete systematic inventories of the entire park.

Habitat Variables Common to All Inventories. Consistent descriptions of vegetation types and physical site features will be used to classify all vertebrate sample points. The Northern Colorado Plateau Network will attempt to standardize these variables with the Southern Colorado Plateau Network for consistency. Vegetation types for each sampling location will be classified based on data collected using the releve method from the Colorado Plateau Vegetation Assessment and Classification Manual (Rowlands 1994). More detail on vegetation classification is found in the vascular plant methods section below.

Temporal Aspects of Sampling. In most cases field work for individual projects will be completed over a two year period (not necessarily in consecutive years). Individual taxonomic group inventories will be staggered to ensure seasonal variation in vertebrate occurrences and distributions and phenological variations in plants is captured. Specific timetables for sampling are located in individual project statements ([Appendix E](#)).

Sample Sizes. At this time it is not possible to know how many samples will be needed to achieve our inventory goals. Factors influencing the number of samples needed vary with taxonomic group, season, sampling effort, and variability in species occurrences and year-to-year variations. Assessing inventory completeness will be ongoing throughout the project. We will use these assessments to adjust our sampling intensity accordingly.

Limitations in Selecting Sampling Locations. Significant portions of many parks within the network are inaccessible for sampling. Much of the canyon country is highly dissected and without roads and water. Only areas with reasonable accessibility will be included in the sampling pool. Another challenge in selecting sampling locations will be the high incidence of exposed bedrock in the form of slickrock, and the potential for a high number of random points coinciding with slickrock. Unfortunately the occurrence of slickrock in a park is not easily determined in terms of stratification. Biological soil crusts occur throughout most parks in the network. These crusts are extremely vulnerable to trampling and it will be important to conduct inventories in such ways to minimize impacts.

Relationship of Inventory to Monitoring. Inventories for the Northern Colorado Plateau Network are primarily designed to complete knowledge gaps in basic inventories. Although specific inventory plot locations will be available to future monitoring efforts, we have not emphasized an inventory design that leads to monitoring.

The Northern Colorado Plateau Network will be initiating the monitoring phase of the I&M project during FY01. During this first year we will concentrate on assembling and evaluating existing monitoring data for the parks. In addition, we will begin the process of determining what resource management questions need to be addressed by monitoring and which ecosystem components will be selected for monitoring system integrity. Once monitoring goals and objectives have been

identified for network parks then appropriate indicators and study design can be developed and applied. It is unlikely that we will be able to afford total species monitoring across all habitats in all parks. A more realistic approach is that monitoring will likely focus on portions or components of the ecosystem which are threatened and are of management concern. Data obtained during the inventory phase of this project will be helpful for developing the monitoring phase of the program. For example our emphasis on obtaining better distribution and abundance information on species of special concern will provide a stronger basis for developing monitoring protocols for these species when they are needed.

SURVEY METHODS

Described below are the general methods we will draw from to inventory each major taxonomic group. For each we describe the methods used for general inventories as well as individual species or groups of species which require special approaches. The same methods of field sampling will be used in most inventories and will ensure inter-park comparisons. Please note that not all methods described below will be used in each project. The methods specific to each project are described in individual project statements in [Appendix E](#).

We have attempted to standardize core methods for each taxonomic across the Colorado Plateau. We will continue to work with the Southern Colorado Plateau Network to ensure compatibility of methods and data. Although different investigators may be involved in conducting the inventories, the protocols and type of data collected remain the same. This will provide opportunities to compare and analyze data plateau-wide. In addition, all investigators will be required to complete an Investigators Annual Report (IAR) for each inventory project.

Bird Methods

Estimating Richness, Relative Abundance and Density of Breeding Birds. It is rarely possible to count all of the birds that are actually present in an area, and therefore to estimate abundance or density, sampling methods must be used. *Distance sampling* has been used for more than 30 years to estimate animal abundance and has been found to be a reliable method for estimating relative abundance and population trends for many bird species (Fancy 1997, Nelson and Fancy 1999).

Distance sampling is based on the intuitive knowledge that the distance between an observer and an object will effect the probability of detection; the further away an object, the less likely it is to be detected. Data collected are the horizontal distances from an observer to an object. Using these distance we will calculate a detection function, which is the probability of detecting an object given its distances from the observer. This detection function is used to estimate bird density and allows birds to go undetected during a survey (Buckland et al. 1993).

Distance sampling includes two main approaches; line transects and variable circular plots (VCP).

Line Transect Sampling. An observer walks a transect and measures the perpendicular distance to each bird heard or seen. Another option is to record the sighting angle and sighting distance to each bird and convert these to perpendicular distances. Line transects can be very efficient in open habitat because data are collected continually as an observer walks the transect.

Variable Circular Plot Sampling (VCP). An observer stands at a sampling station and records the radial (horizontal) distance between the observer and the bird. VCP are the preferred approach in patchy or densely vegetated habitats and in rugged or hazardous terrain

The choices between using line transects and VCP, the distances between survey routes, and the placement of routes within strata and habitats will be made after further definition of the sampling frame for each individual park. Each route will be surveyed 3 times from mid-April through July, which will coincide with the greatest number of passerine species exhibiting breeding behaviors. Visits will start at one-half hour after sunrise and be completed by 1000. At each point count station one observer will record all birds seen or heard for 10 minutes. During the last 3 minutes of the count, only new species detected will be recorded. To lessen observer influence on birds, counting will begin 1 minute after arriving at a station. Laser rangefinders will be used to measure distances to birds.

Flyover species will be recorded but with no estimates of distance. Birds flushed while walking between point count stations will be counted and their distance to the nearest point count station will be measured.

Data Analysis. Species richness will be calculated as the number of species detected. Estimates of species richness based on mark-recapture models will provide an estimate of the number of species that are probably present, but have not been detected (Dawson et al. 1995, Boulinier et al. 1998). These species richness estimates will be used to assess the adequacy of sampling technique, by comparing the estimated number of species in an area to the actual number counted during surveys (Swann 1999).

Relative abundance and density of each species with >50 detections will be estimated using program DISTANCE (Thomas et al. 1999). The distance data will be used to model detection functions, from which we can obtain unbiased estimates of abundance for each species (Buckland et al. 1993). The advantages in using Distance Sampling data include 1) multiple surveys can be combined to increase sample sizes. By combining surveys, it is possible to estimate densities of many rare species, even in situations where only 1 or 2 birds are detected while sampling many stations; 2) allows for adjustment of different covariates such as observers, vegetation, and detection distances; and 3) able to use historical count data if the park collected bird data using unadjusted point counts and the park then switches to VCP counts.

Additional Breeding and Non-breeding Surveys. Most bird survey methods provide good information for common species and relatively sparse information for rare or secretive species. This does not mean the survey method is invalid, it is simply a reflection of the difficulty of sampling rare and secretive species using general methods. Therefore, in addition to point-counts using distance sampling, systematic searches of special habitats during breeding and non-breeding periods will be completed to increase the chance of detecting rare and secretive species. These special habitats will be defined on a park by park basis, but might include such areas as cliffs, riparian zones, and historical locations of rare species. Selection of habitats to be searched will be conducted after special habitats have been identified and mapped.

During the non-breeding season (November – February) we will conduct three additional visits. These surveys will be conducted between sunrise and 1000, extra visits will be made in the late afternoon that may reveal presence of vultures, buteos, or any other birds not found in early morning (Robbins 1981). Survey data will include species encountered, habitat, location, dates, and evidence of breeding status (i.e., courtship behavior, nests).

Nocturnal Species. Owls will be surveyed using tape playbacks, in randomly selected habitats that owls may occupy or where historical sightings have been noted (Springer 1978, Forsman 1983). Tape broadcasts will be played for 10 minutes followed by a 5 minute listening period at designated points. Surveys times will occur between 1 hour after sunset and 1 hour before sunrise. We will conduct two surveys during the breeding season and two surveys during the non-

breeding season. Survey data will include species encountered, habitat, location, dates, and evidence of breeding status (i.e. courtship behavior, nests). Caprimulgids (i.e., *Goatsuckers*) are vocal enough that playback recordings are rarely needed during surveys and will likely be encountered during owl surveys.

Species of Concern. These species have been identified by each park because they have either been federally listed as endangered or threatened such as the Southwestern Willow Flycatcher and Mexican Spotted Owl or listed by the state where the park is located as a species of concern (i.e., Burrowing Owl). Species of concern have also been identified by the park because they are suspected to occur at the extreme edges of their ranges in certain parks, or are suspected to be declining. The methods used to survey for species of concern will depend on behavioral traits and habitat.

Tape Playbacks. Broadcasting tape playbacks has been effectively used to survey for endangered species (i.e., Southwestern Willow Flycatcher; Sogge et al. 1997) and marsh-breeding species (Marion et al. 1981). We will include the playback procedure in habitats that target these species, increasing our chance of detecting these targeted species (Verner and Milligan 1971). Broadcasting of taped calls will occur in the habitats that the standard count survey is not being conducted or after the standard count period is completed.

Mammal Methods

Sampling strategies and methods for mammals will vary from park to park, depending upon the specific objectives as specified in detailed study plans, and perhaps upon availability of plots developed for other groups that also can be sampled for mammals. A combination of designs and methods will provide the most complete coverage of mammals for each park. For example, pitfalls are most effective at capturing shrews, mist nets and bat detectors for bats, various sorts of traps for small and medium-sized rodents, larger traps or firearms for some medium-sized species (e.g., rabbits), and a variety of observational and tracking methods for carnivores and ungulates. Data on larger species (furbearers and game species) may be available from park records and state wildlife investigations. Although several investigators have used remote automated photographic stations to advantage, these studies are usually species-specific and we know of no case where such stations have been used in large-scale studies of species richness.

Inventory methods for mammals of the plateau will follow guidelines enumerated in Kunz (1988) and Wilson et al. (1996). Kunz' (1988) book provides details on an array of capture and research techniques for bats. Wilson et al. (1996) provide a comprehensive collection of papers on measuring and monitoring mammalian diversity including several on aspects of design and randomization.

For mammals in general, we envision a seasonal two-year effort for those parks needing partial or complete inventories. Most work will be done in the summer season and a schedule will be developed so that each park is visited at a different time during the two years of visits. It will be possible to work at some parks (e.g., Zion and others) in late spring or early fall. Work at other times of the year will depend on specific needs as outlined in the individual statements of work; capture of data from park records and files would be done off-season. In some cases, work may last three years on selected parks, depending on the vagaries of climate as well as success in confirming species occurrence.

Shrews are vastly undersampled on the plateau and where complete inventories are called for, some effort will be dedicated to pitfall trapping. Although sites for pitfalls can be chosen randomly, aspects of shrew biology should be applied, as most species of *Sorex* have a preference for more

mesic, litter-rich sites. Small plastic cups or buckets, and even bottles, have proven effective as pitfalls for shrews (Jones et al. 1996). The linearity of suitable shrew habitat will influence whether pitfalls are set in grids or lines. In suitable habitat we will install pitfalls at 5-m intervals. Water shrews are most effectively sampled at the edge of small streams with pitfalls spaced at wider intervals (15-20 m). Where possible, drift fences to help “corral” shrews and direct them to the pitfalls will be used. Pitfalls will be unbaited, kept dry, and checked frequently so animals can be released alive.

Pitfalls are also effective for capturing some small heteromyid rodents, such as pocket mice. In suitable habitat, pitfalls for these species will be used. Effort and catch will be quantified for each area based on numbers of nights that a given number of pitfalls are operational (pitfall-nights). It is possible that reptiles and amphibians may be caught in mammal pitfall traps. In this case, mammal investigators will be asked to record and supply data on these herp species.

Small- and medium-sized rodents (including some ground squirrels) are effectively trapped in livetraps such as those made by Sherman or wire traps such as those made by Tomahawk and others; animals can be released unharmed following identification (Jones et al. 1996). For inventory efforts where densities of small mammals are not required, livetraps can be effectively set in lines 150 m in length in appropriate habitat with starting points determined randomly (Jones et al. 1996). Grid designs of traps are more appropriate where densities are needed, as in long-term monitoring, but may miss some species (certain microtine rodents). Two traps will be set per station, and stations will be spaced at 15-m intervals along the line. Additional lines within the same habitat will be spaced at equal intervals. Habitat complexity may require shorter intervals in some cases. Traps will be set for three nights, baited with rolled oats in most cases, checked at least twice per day, and will be closed during daylight hours except for directed efforts on diurnal species. Livetraps will be checked more frequently, up to once per hour, for diurnal species. Where possible, livetraps will be set at habitat features (e.g., logs, trees, burrows) but within 2 m of the station point. Effort and catch will be quantified based on numbers of nights a given number of traps are set (trap-nights).

In selected areas and for selected species, “snap” traps that kill rodents may be used. To the extent possible, kill traps (e.g., Museum Specials, Victor rat traps) will be set in a fashion consistent with livetraps as described above. Kill traps are effective for species that are reluctant to enter box (Sherman-style) traps and are useful and effective in logistically-difficult areas (e.g., cliffs) where a sufficient number of box traps may be difficult to carry or set. A snap trap costs less than half the recommended Sherman trap (LFADTG; ca. \$15.00 each) and life spans under normal usage are equivalent. All rodent sampling will be consistent with published guidelines for reducing exposure of trapping personnel to hantavirus and other infectious diseases.

Bats will be sampled in several ways, depending on park size, availability of known or suspected roosts, and presence of water sources. Where roosting sites are known or suspected the sites will be observed without disturbing the bats as the great likelihood is that such aggregations will be maternity colonies (females with young). Such roosts can be selectively and carefully netted from the outside to determine species identification. Detection of roost sites using radiotransmitters affixed to bats will not be emphasized for inventory since this is more of a research question. Bats roosting in small numbers can be hand-captured, identified, and released but such attempts should be used cautiously in maternity colonies. For parks where bats are not readily captured, walking transects will be used to search for bat presence based on observations of guano and insect remains.

All water sources larger than 1 m² (arbitrarily) should be identified as a “sampling pool” for bats. Most pools at hanging garden sites are not suitable for drinking by most bats, and are typically difficult to

net. In addition, netting may damage fragile plants and substrates in these locations. Suitable sites (streams, creeks, stock ponds, etc.) should be netted two to three times per summer season no more often than every four to five days, depending on past success. Where inclement weather results in low capture success the site will be revisited sooner. Effort with mist nets will be quantified based on size and numbers of nets set each night (net-nights). At most water sources on the plateau, 6- and 10 m nets are sufficient although longer nets (14- and 20 m) may be needed at times. Bats will be carefully removed from nets to determine sex, reproductive status, age, and species recorded, and released unharmed. In some cases it may be useful to take selected measurements (mm) or body masses (g). Where there are no water sources over which mist nets can be deployed it may be possible to net areas that intuitively appear to experienced investigators as flyways through which bats might travel. Personnel handling bats will be vaccinated against rabies using the rabies pre-exposure regimen with subsequent testing of rabies antibody titers.

In selected parks or areas, especially those with limited roosts and water sources, it may be necessary to use a bat detector to determine the presence of bats. Sample points or transects can be randomly selected and both species diversity and relative activity levels can be determined at a pre-determined number of points along the line. Most North American investigators use the Australian bat detector Anabat, made by Titley. Typically, calls are recorded on the hard drives of laptop recorders and saved for subsequent analysis. Calls also can be saved on high-quality tape recorders or compact disk devices for analysis. Although randomly chosen bat detector transects may be very useful in long-term monitoring as well, a variety of caveats have been raised about their use in this fashion (O'Shea and Bogan 1999). It is recommended that for parks on the NCP, efforts with Anabat be restricted to identification and confirmation of bat species occurring within the park. This should provide a more cost-effective effort, in conjunction with roost observations, searches, and netting. Also, some species of bats have audible echolocation cries and experienced personnel can recognize those calls to help document presence of some species.

To confirm the presence of some medium-sized terrestrial mammals and all large mammals, especially carnivores, a combination of methods will be used. These will include: review of historic and recent museum records, park staff and visitor files (with caution), field observations (for tracks, scat, sign) by those conducting mammal surveys, photographs, and relevant information from state fish and game agencies. Most small parks will be too small to have any resident carnivores, rather the carnivore's home range may encompass the park or at least the appropriate habitat components that occur on the park. Likewise, for some larger parks and some wide-ranging species of carnivores much of the range of some species will be off the park. Rather than mount an expensive and time-consuming effort to trap such species we recommend that other information sources be used. We believe that this will provide a landscape-level overview of carnivore presence that should be more useful to parks in helping to understand the importance of the park to medium- and large-sized mammals within a regional context. Larger parks will certainly have resident medium and large mammals but we recommend the same methods be used, except in the case of questions about occurrence of selected species on some parks or where identified needs exist.

Finally, there is a suite of perhaps 20 or so medium-sized mammals, many diurnal, that are scansorial, arboreal, fossorial or semi-fossorial, and aquatic. Traps (e.g., for gophers) and trapping methods are available for most of these species but some of these species are difficult to trap and some require sedation for handling. For many of these species the most cost-effective way to document presence for initial inventory is probably by observations documented with photographs by knowledgeable personnel and by specimens taken with a firearm. Park records may help confirm presence of some of these species as well.

Reptile and Amphibian (Herp) Methods

A combination of methods will be used to complete reptile and amphibian inventories, as outlined below.

Gathering of existing information. During the fall and winter of the first year, we will conduct searches of existing databases and museums in parks and other institutions for documentation of occurrences of reptile and amphibian species in each park. We will also interview herpetologists that have worked on the Colorado Plateau to gain their insights into where and how to best survey for particular species, as well as to obtain their records of species' occurrences.

Visual Encounter Surveys. Time/area constrained searches (TACS) will be the primary method used for general reptile and amphibian surveys. This technique requires that an area of known size be searched using a variety of techniques, including scanning with binoculars, using mirrors to shine into cracks in search of hidden reptiles and amphibians, and looking underneath cover (Crump and Scott 1994). It is more difficult to replicate surveys if only time spent searching is constrained, plus there are significant issues concerning whether all appropriate "mesohabitats" within a plot are adequately surveyed. Surveys will cover 1 hectare, and encompass a total of 4 person-hours. Ideally, at least 2 herpetologists will conduct each search. Time spent searching will not be counted during processing of any reptile or amphibian encountered, thus actual time taken to search an area by 2 people may take significantly more than 2 hours. There will likely be a number of different "mesohabitats" within a hectare plot (e.g., boulder piles, open shrub or grassland, exposed bedrock, etc.). It is important that each of these receive search effort commensurate with the proportion of the total plot each represents. In situations where the sampling stratum does not contain at least one hectare, the time spent searching should be reduced proportionally to the reduction in area. Thus, if there is 0.5 ha of habitat, 2 person-hours should be spent searching.

While very difficult to conduct in many habitats, there is value in conducting nocturnal TACSs. There will be little opportunity to detect nocturnal species in other ways for many habitats in parks. Night-driving is effective when paved roads are available, but there are few roads in the parks on the Colorado Plateau, and of those roads that do exist, very few are paved. The dark pavement is what generates a warmer surface than surrounding rock or soil that attracts reptiles. There are also many habitats that are not traversed by roads at all, and thus would not be surveyed by night driving.

Nocturnal TACSs will be conducted in the same plots searched by day, during the evening following the daytime searches. Nocturnal searches will encompass 2 person-hours. At least 2 herpetologists will be used for these searches; however, unlike diurnal TACSs where each person can search independently, for safety reasons, technicians will work in 2-person teams to conduct a nocturnal TACS. Each team will be considered a single person for measuring time spent searching. Thus a single team would work for 2 hours to achieve a 2 person-hour search, 2 teams would each search 1 hour.

Night Road Driving. Driving slowly on roads at night is recognized as an excellent method for surveying some groups of amphibians and reptiles, particularly snakes (e.g., Bernardino and Dalrymple 1992, Dodd et al. 1989, Klauber 1939, Mendelson and Jennings 1992, Rosen and Lowe 1994, Sullivan 1981). This method is also effective for surveying amphibians (Shafer and Juterbock 1994), particularly in the arid southwest where many anuran species are seldom active during daytime, but can often be found crossing roads on warm, rainy nights. Night driving was determined to be the best survey method for amphibians in two arid Colorado Plateau National

Park areas during recent inventories at Petrified Forest National Park (Drost et al. 2000 unpubl.) and at Wupatki National Monument (Persons, in progress).

Time and distance covered during a road-driving session should be standardized by driving at a constant speed for a variable time, depending on availability of road to drive. Road-driving should be done with 2 people, driving at 20 mph; to avoid fatigue, no more than 2 hours of night-driving should be done on a given night, especially if crews have been surveying during the day as well. For most parks, all paved road should be driven, for some, there may be more road than can be covered on a single night in 2 hours of driving. In these parks, night-driving should be done on consecutive nights until all roads have been driven. For all driving surveys, it will be necessary to drive the route during the day, either before (preferred since this allows surveyors to become more familiar with the routes) or after the night survey. The daytime drive will be used to record which habitats are traversed, and length of the transect through each habitat.

Identify all amphibians and reptiles encountered to species, record either alive on the road (AOR) or dead on the road (DOR), sex and age all individuals, as possible. Record locations will to the nearest 0.01 mile using calibrated vehicle odometers, and later convert these positions to GIS point locations. Collect animals found DOR and in good condition and preserve as voucher specimens. Occasionally live animals should be collected for voucher specimens, as needed (see "Voucher Specimen Collection" below for details).

In addition to night driving surveys, reptile and amphibian experts should opportunistically record amphibians and reptiles seen on roads during daytime, during the course of travel within the parks. Although less effective and less quantifiable than night driving, due to faster driving speeds and the presence of other vehicles on the road, this is still an effective method for detecting the presence of some diurnal reptiles, such as whipsnakes (*Masticophis*), patch-nosed snakes (*Salvadora*), and horned lizards (*Phrynosoma*).

Amphibian-Specific Methods. Different habitats may need to be surveyed with different methods. Methods described in the Amphibian Research and Monitoring Initiative (ARMI), which is a national effort funded by Congress starting with the FY2000 Department of the Interior (DOI) Budget will be used where applicable. Many of these techniques have been tested in other parts of western North America, but will need some evaluation for effectiveness on the Colorado Plateau.

Visual Encounter Surveys (VES) or similar systems that have proven reliable to detect pond amphibians (Fellers and Freel 1995, Corn et al. 1997, Bury and Major 1997, Olson et al. 1997, Adams 1999) will be used to survey for amphibians at ponds, tinajas, and other lentic habitats. VES have been used at over 150 ponds and wetlands in Olympic Natl. Park, the Willamette Valley of western Oregon, and elsewhere over the last five years. These studies suggest that two VES per season are needed for detectability of species presence and include a spring search (best for locating egg masses) and one later in the summer (time to locate tadpoles and larvae). VES is comparable to techniques used in adjacent montane regions: Rocky Mountains (Corn et al. 1997) and Sierra Nevada (Fellers and Freel 1995). Standard and field proven data forms are available to record basic habitat variables (e.g., pond size, substrate type, vegetation, etc.), but have not been tested in arid and semi-arid environments. As part of the ARMI effort, VES techniques will be evaluated in ponds and tinajas (e.g., plunge pools in rocky canyons) at Canyonlands National Park and vicinity. These aridland efforts will be directed by Dr. Tim Graham, FRESC Canyonlands Field Station, Moab, UT.

In 1996-98, a walking transect (500-m long mapped at 10 m intervals) was developed by scientists at the USGS Forest and Rangeland Ecosystems Science Center, Corvallis, OR, which was useful to survey visually for adult and larval amphibians along 3rd order and larger streams in western

Oregon (Bury et al., in prep.). These long transects were more effective to observe and record amphibians than time- and area-constrained searches (using amount of time invested in each method). Pilot surveys at three stream/riparian zones in Canyonlands Natl. Park and vicinity will be conducted in conjunction with ARMI to test their utility in different ecosystems. If this method is promising, it will be incorporated into the inventory of NCP parks.

Calling surveys, in the form of audio strip transects (Zimmerman 1994) will be conducted during the spring breeding season, and if males are calling during the monsoon season in July and August, these surveys will be repeated. Audio strip transects will be run along the shores of permanent and intermittent stream channels for up to 500 m, depending on available habitat. Calling surveys will also be conducted at lentic habitats (e.g., ponds, tinajas, potholes, and isolated pools in washes following spring rains and flash floods).

Egg mass and tadpole surveys will also be conducted in the same habitats as the calling surveys. Detection of eggs or tadpoles will be used both to directly identify species' presence where this can be determined from egg mass or tadpole characteristics and to identify locations to be targeted in subsequent surveys when metamorphs are available for identification. Both egg mass and tadpole surveys can provide assessments of reproductive effort, and coupled with later counts of metamorphs can yield estimates of survival rates in selected habitats, which could be incorporated into a monitoring program.

Sound-activated recording devices will be used experimentally in a few areas to determine whether these can be used to detect species presence during breeding calling periods in a number of sites, since it is very difficult to mobilize adequate numbers of personnel to visit large numbers of widespread potential breeding sites within a day of an appropriate precipitation event (e.g., heavy thunderstorms), the areal extent of which is uncertain, thus it may not be clear, even if mobilized successfully, where technicians should be sent.

Timing of surveys. Three to four visits per year per park would be ideal, this would allow surveys that coincide with seasonal shifts in activity patterns (e.g., from diurnal to nocturnal), and to accommodate differences in overall active periods of different species. Spring and fall surveys may be expected to have greater success rates for night road-driving, since the contrast between road and surrounding substrate temperatures will be greatest during these seasons; likewise nocturnal TACS on bedrock, especially if dark, may be more profitable in these seasons. Spring and dry summer are the best times to document amphibians that breed in spring--metamorphs are abundant and identifiable, and have not yet dispersed very far from breeding pools for up to 12 weeks after egg-laying. Summer is the period of greatest activity for many reptiles, and in monsoon climates is a secondary breeding period for some amphibians. Fall surveys may detect migration to dens, leading to concentrations of reptiles that can be inventoried in small areas.

Given the funding limitations of this program, and the goal of documenting at least 90% of species suspected to be in each park, we will concentrate efforts in groups of parks each year, surveying at different seasons to maximize the chances of finding species. When deemed necessary, additional, intensive surveys may be conducted to try to detect particular species strongly suspected to occur, but that have not been detected in previous efforts. Surveys will be conducted by teams of qualified herpetologists and will follow the progression of seasons, from southern to northern parks, and from low elevations to higher elevations.

Fish Methods

General inventories for fish are not being proposed as part of this project, therefore we are not detailing methods here. However, three unfunded special fish inventory projects have been identified and are described in Appendix F.

Vascular Plant Methods

Vegetation Classification. An important step in all taxonomic group studies will be to classify and describe the vegetation and site features of the sampling locations. Overall future data comparisons and interpretation will be facilitated by a consistent approach. The following section provides an overview of our approach to classifying vegetation types associated with this inventory project.

In order to be useful in inventory work, a vegetation classification needs to have some form of hierarchical structure. Currently, three vegetation classifications being used on the Colorado Plateau provide this structure, the Standardized National Vegetation Classification (SNVC), the Brown-Lowe-Pase (BLP) classification (Brown 1982), and the SRFR vegetation classification (Spence et al. 1995, Spence 1997a). The SRFR is a modified BLP classification with some differences in hierarchical structure. There is also relatively close correspondence between the SNVC and SRFR systems for some hierarchical levels. The SNVC is to be used by all government agencies in order to facilitate uniform vegetation classifications and communication between agencies. However, it is an extremely complex system that remains incomplete and requires additional plot data on canopy coverage before vegetation can be classified. In particular, the SNVC levels Physiognomic Group and Formation still have some ambiguity in how new vegetation types need to be classified.

We will use the following approach for vegetation classification as part of the inventory process on the Colorado Plateau:

SRFR (field classification) → SNVC (office and report classification)

While sampling in the field, the vegetation type will be determined using the relatively simple and quick SRFR classification. Estimation in the field of woody plant canopy coverage is needed to convert from SRFR to SNVC. This will be accomplished through the use of a CPVAC releve data form (see below under Field Methods). Once the vegetation is determined, the SRFR field type will then be converted into the analogous SNVC type in the office for report preparation. It is recommended that additional data, specified on the CPVAC form (Rowlands 1994), be collected at each sampling point as well, including data on landforms, elevation, soils, geology, and disturbances.

Since both systems are hierarchical, sampling for flora and vertebrates can be done at any level, from the relatively broad formation type, through intermediate levels (e.g., evergreen forest, montane cold-deciduous shrubland, cold-temperate mixed short bunchgrass-sodgrass grassland), to floristic alliances or associations. Examples of the hierarchical levels for both the SRFR and SNVC can be found in [Table 5](#).

Table 5. A comparison of the relationship between the SRFR vegetation classification and the Standardized National Vegetation Classification (SNVC). The example is for a closed canopy *Pinus ponderosa*/*Festuca arizonica* community.

SRFR CLASSIFICATION	EXAMPLE	SNVC CLASSIFICATION	EXAMPLE
Biogeographic Realm	Nearctic	-	-
Floristic Province	Colorado Plateau	-	-
Climate-Elevation Zone	Montane	-	-
-	-	Division	Vegetated
Formation	Forest	Order	Forest
-	-	Physiognomic Class	Closed Canopy
Physiognomic Class	Evergreen	Physiognomic Subclass	Evergreen
-	-	Physiognomic Group	Temperate/Subpolar Needle-leaved
-	-	Subgroup	Natural
-	-	Formation	Rounded Crowns
Alliance	<i>Pinus ponderosa</i>	Alliance	<i>Pinus ponderosa</i>
Association	<i>Pipo/Festuca arizonica</i>	Association	<i>Pipo/Festuca arizonica</i>

Study Area Vegetation. A general description of the vegetation of the parks in the NCPN can be found in section III of this plan. An Excel database has been developed with lists of vegetation types for the 16 network parks ([Appendix H](#)). The basic type is the SRFR and/or SNVC alliance, which is named by the dominant species or group of species. For example, Ponderosa Pine forest, Pinyon-Juniper woodland, etc. These alliances can be grouped into higher level types in order to simplify sampling for vertebrate groups. Currently, 73 alliances are recognized among the parks in the NCPN, organized into forest and woodland, savanna, shrubland, mat shrubland, grassland, marshland, forbland, barren, and unclassified types. This list is not likely to be complete for all 16 parks. Some of the alliances recognized may not actually be represented by on-the-ground vegetation.

The use of a releve to describe the vegetation at each sampling point will allow for direct comparisons between parks for not only floristic data, but vertebrate survey data as well. In addition, the use of a standard releve size means that species-area curves can be calculated for floristic species richness estimates. Because of the value of doing vegetation description, we will require all inventory teams to use some type of releve form for documenting dominant species, such as the CPVAC form, to describe the vegetation at each sampling point. Our suggested approach is to complete an abbreviated releve (for 5-7 dominant species) which will require less time than a full releve. This data will be sent to the plant ecologist at Glen Canyon NRA for analysis and classification using the SRFR and SNVC classifications. One goal of this is to eventually produce a database of vegetation descriptions for all Colorado Plateau parks at the alliance level.

Vegetation Inventory Techniques. Once a sample point is selected, there are many different ways of sampling the flora and vegetation at the point. These can be divided into two basic categories, area searches, or some form of area or plot sampling. Although different methods are detailed below, some of them are included only because they can be used for long-term monitoring. For basic inventory work, a combination of an area search and one or more releve's will be sufficient. If the releve center is permanently located using GPS, then future monitoring can be done by repeated visits for floristic and vegetation information. The more complex transect and modified-

Whittaker plots are much more time-consuming, and are generally not recommended for general floristic inventories, unless the intent is to establish plots for long-term monitoring. We will use a combination of these methods depending on individual park needs.

Area Searches. The area around the sample point can be thoroughly searched for species presence. As part of the fieldwork amount of time expended and the number of searchers should be noted. The search can be limited to a particular community type, or if the sample point is located in a mosaic of types or on an ecotone, all types and the ecotone should be searched. Experienced botanists are required in order for this technique to be useful. Another problem is that to sample the total flora, several visits may be necessary at different seasons. This is primarily because of different groups of annual species that germinate and flower in spring or after the summer monsoons. In drought years, many annuals will not even germinate. This technique, combined with one or more relevés, is the recommended method for completing basic floristic inventories in the parks.

Transects. A method that can be used to collect quantitative data, and that can be used for long-term monitoring, involves establishment of a vegetation transect. A transect is typically either 30 or 100 meters long, and is permanently located. Various kinds of data can be collected along this transect, including cover and frequency data from quadrat frames, line-intercept cover, and height-cover points. Variations on this approach are widely used in monitoring designs, for example Glen Canyon NRA upland vegetation (Spence 1997b) and Channel Islands NP (Halvorson et al. 1988). The transect method is easier and quicker to use than the modified Whittaker plot technique (see below), but cannot easily be used for species-richness estimates by the species-area curve approach.

Plot Sampling. Plot sampling can consist of a randomly placed temporary or permanently positioned plots. Two basic methods in use regionally are suggested below.

The relatively simple CPVAC relevé method can be used if detailed quantitative data is not required. In this technique, a circular plot of specified dimensions is positioned in the community of interest, and species presence is recorded within the area. A standard area is 0.1 hectare (circular plot diameter of 17.84 meters). A ranked scale of abundance from 1-5 is assigned to each species. Estimates of canopy cover and vegetation height by strata, and notes on disturbance can also be collected. The method is detailed in Rowlands (1994). If this relevé is permanently fixed using GPS, then it can be incorporated into future monitoring work. Estimates of amount of time for this technique vary from ca. 20-40 minutes/relevé depending on vegetation complexity and experience of the field crew.

A more detailed and useful method is based on a modified Whittaker plot design. Although much more time-consuming than the other methods, a great deal of useful data can be collected for subsequent analysis, and the plot can also be used as a permanent monitoring location. A modified-Whittaker plot is a rectangle 20 meters by 50 meters (1000 m² or 0.1 hectare). Various smaller plots, ranging from 1 m² to 100 m² are positioned within the macroplot. Within each of these smaller plots species presence, and if necessary canopy cover or density, is determined. When a variety of these macroplots are sampled, species-area curves can be directly constructed using a range of nested plot sizes. Examples of this method can be found in Stohlgren et al. (1995) and Yorks and Dabydeen (1998).

VII. DATA MANAGEMENT AND VOUCHER SPECIMENS

DATA MANAGEMENT

The Northern Colorado Plateau Network views data management as central to the success of a network inventory and monitoring program. The ultimate value of these inventories is in the information that they generate, and it is essential that this information be easily accessible to park managers and others in order to make informed decisions on resource management within the parks. Therefore we are placing a high priority on developing an integrated network data management system to ensure that biological inventory and monitoring data are organized and managed in formats that are most useful to park managers. We will emphasize the use of GIS spatial datasets and tools which offer friendly user interface options (e.g., GIS databrowser; web access).

Another important aspect of data management will be to create an approach that will endure beyond the funding cycle for this initiative. With the frequent turnover in park resource personnel it is imperative that we are successful in developing data management protocols which ensure the long-term integrity and accessibility of these datasets. We cannot afford to continually reinvent the wheel. Our experience this year in assembling existing inventory data has been a strong reminder of the large amount of effort required to obtain and manage data and the importance of going through this exercise only once. Park resource staffs are much more mobile now than in former years and as a result institutional knowledge of park resources is often lacking. A well organized data management system can help fill the void of longer-tenured resource staff and can offer a very useful tool in acquainting new staff with all the previous work conducted within a park.

Network Coordination and Data Management. As detailed in project statement [ALLTAX-01 in Appendix E](#), the network intends to staff a five-person team for overall project coordination and data management. A full-time network program coordinator is already in place. This fall the network will hire a permanent full-time data manager to oversee development of the data management aspects of the I&M program. We will rely on this new person to help us develop a network wide strategy for data management. We envision a data management system which is largely centralized at the network I&M project office in Moab. However, we anticipate that there will also be decentralized components to data management, in that several parks already have existing GIS and data management staff. The network data management plan will address how to most efficiently and effectively accomplish data management goals capitalizing on the resources available. A close partnership will be developed and maintained with the Southern Colorado Plateau Network program to ensure consistency in form and quality of data. We will also work closely with other outside partners where data compatibility and sharing is desired.

Emphasis on Existing Data. The network realizes that a great wealth of park inventory information lies in datasets, reports and other formats which are not readily accessible. We are placing a high priority on the identification of all existing inventory data for each park. Individual project statements in Appendix E address the need for obtaining and assessing existing information. For each inventory dataset we will assess the quality and usefulness of the existing information. All pertinent reports and datasets will be referenced in the Dataset Catalog (metadata) and/or NRBibliography. Metadata standards will meet Federal Geographic Data Committee (FGDC) requirements.

Existing data will come in a variety of tabular and spatial formats. As recommended by the national I&M program we will use Microsoft Access for organizing tabular data and all GIS products

developed will be compatible with ArcView software. We anticipate developing a centralized network Access database and/or data standards for inventory data. A centralized network database can be made available to all parks through web-based developments.

In addition to network-based databases, we will also continue to update data in the suite of national I&M databases including: NPSpecies, NRBib and Dataset Catalog. Section IV of this study plan documents the work we have accomplished so far with these databases. New inventory information will be generated annually through field investigations. We will establish protocols for updating these databases, as well as the network inventory databases regularly.

VOUCHER SPECIMENS AND CURATION

For documenting species occurrences, vouchers represent the most concrete evidence available. Vouchers may be an actual specimen (collected and preserved) or a photograph. All voucher specimens will be georeferenced. The network is actively gathering information, from a variety of sources, on existing specimen vouchers for park species. To date we have not had the opportunity to review voucher photographic resources in each of the parks. This work will be completed as part of conducting the basic inventory work starting in FY01.

As part of the upcoming field inventory effort, we will augment existing voucher material so that almost all vascular plant and vertebrate species within a park (except listed threatened and endangered taxa) are represented by voucher specimens or photographs. Collection of specimens will follow policies outlined in NPS Management Policies, Museum Objects and Library Materials (5:9-11); Security and Protective Measures (5:12-13); Preservation of Data and Collections and Protection of Research Potential (5:3-4) Chapter 5 and NPS 77, the Natural Resource Management Guideline.

In order for collections to be of the greatest utility to the broader scientific community, as well as individual parks, we will consider deposition of specimens in larger accredited regional collections, especially ones that currently serve as major repositories for NCPN park specimens. When the primary depository is a park collection, specimen information is often not readily accessible for broader use. Specimen deposition will be considered on a taxonomic group basis. Voucher photographs will be deposited in individual park archives.

Following are taxonomic group specific guidelines and thoughts on obtaining vouchers. For many parks and many taxonomic groups significant voucher resources already exist. In field investigations, we will emphasize obtaining voucher information for presently unvouchered park species. All voucher data will be cataloged in ANCS+ and NPSpecies databases. Voucher specimens will not be collected for listed threatened and endangered species, unless specifically approved by US Fish and Wildlife Service.

Bird Vouchers. In general, bird specimens for NCPN parks are poorly represented within internal (NPS) and external museum collections. Bird voucher specimens will not be collected as part of this inventory effort, except in cases where animals are found dead and in identifiable condition. Instead, to the degree possible we will ask field investigators to acquire voucher photographs. We realize that photographing birds is often not feasible, and that many birds are identified by sound rather than sight. Bird vouchers may be deposited in park collections or larger institutional museums such as Northern Arizona University, Museum of Northern Arizona, Brigham Young University, or Utah State University.

Mammal Vouchers. Some NCP parks are the beneficiaries of previous surveys in which mammal voucher specimens have been taken and deposited in accredited museum collections. In

particular, the USGS Biological Survey Collection in the Museum of Southwestern Biology, University of New Mexico, Albuquerque, has significant holdings of mammals, and some amphibians and reptiles, from NCPN parks. For parks, which are not scheduled for additional inventory work, we will rely on existing vouchers for documentation (e.g., for NPSpecies) rather than take additional vouchers. There are few significant taxonomic problems for mammals on the plateau that require additional vouchers but these should be taken by principal investigators as approved for research, rather than as part of an inventory or monitoring effort.

However, there should be no mistake that voucher specimens, identified to the extent possible, properly cataloged and accessioned, and deposited in accredited museums are fundamental to an improved understanding of occurrence and distribution of vertebrate species and plants on NCPN parks. All new mammal inventory work on NCPN parks should be properly vouchered. For species where it is not appropriate (e.g., protected species) or feasible (e.g., black bear or pronghorn) to take voucher specimens, documentation should be provided in some other form. We will attempt to document such species with voucher photographs of individuals, their sign, or scat. For parks with little or no previous inventory work, we will retain small numbers of all species for which voucher specimens can be prepared. We will salvage dead animals whenever possible (e.g., road-killed animals) and will work with each park to process material they may have in freezers on-site.

Museums that currently have holdings of mammals from the NCP include University of Colorado Museum, Boulder; University of Wyoming (inactive), Laramie; University of Kansas, Lawrence; Carnegie Museum, Pittsburgh; Utah Museum of Natural History, Salt Lake; and Biological Survey Collection, Museum of Southwestern Biology, Albuquerque. For mammals we recommend deposition in the Museum of Southwestern Biology; variances to this can be resolved as needed.

Reptile and Amphibian Vouchers. At a minimum, presence of reptile and amphibian species at each park should be documented using high-quality photographs (close-up color slides). Animals found dead and in identifiable condition should also be salvaged as voucher specimens (e.g., those found dead on the road). Depending on park needs, live animals may also be collected and preserved as voucher specimens. This is particularly important when species are found at parks that are not expected, and/or range extensions.

A potential negative side effect of any wildlife research project is injuring or stressing captured animals. Researchers may minimize stress by releasing animals as quickly as possible after capture. There is no reason to mark animals as part of the initial inventory work, but marking is more critical to the success of the future monitoring phase of the I&M projects. All animals captured during monitoring should be marked to assist with detection of long-term population trends, and to assess relative abundance and distribution of local reptiles and amphibians. Lizards may be toe-clipped (Ferner 1979); snakes may be scale-clipped (Ferner 1979); and amphibians may be freeze-branded (Donnelly et al. 1994). All of these methods will produce a mark that will be identifiable over at least several years, and none are thought to cause severe pain or long-term suffering to the animals. All procedures for handling the animals will be reviewed and approved by a University Institutional Animal Care and Use Committee (IACUC), and by each state's Game and Fish Department.

Vascular Plant Vouchers. *Voucher specimens will be collected for all new vascular plant species (except listed threatened and endangered) encountered during surveys. At least one specimen of each species collected will be deposited in each park that has a herbarium. Duplicate specimens and specimens for parks that lack a herbarium will be deposited in a major regional herbarium, such as one of those at Utah State University, Brigham Young University, University of Colorado or University of Wyoming.*

VIII. BUDGET AND SCHEDULE

The NCPN has developed the following budget and schedule to accomplish inventory work under the present funding initiative. A total of \$1,037,439 has been identified for the inventory phase of the NCPN I&M program. We received \$123,000 of this funding in FY 2000 to develop this study plan and initiate inventory work. Through this study plan we are requesting the remaining funding of \$914,439, to be distributed to inventory work in the network over a four-year period.

Work conducted in FY 2001. The NCPN received \$123,000 to complete work described in the network pre-proposal (NPS 1999b). Specifically the NCPN hired a full-time project manager and seasonal biotechs to develop the study plan and conduct the NPSpecies and other database work. Funding was also utilized to host a 3-day experts workshop in late May. Additionally we contracted with subject matter experts for assistance in developing various components of the study plan and for help with compilation of master vertebrate and vascular plant species lists. After these expenditures the NCPN had a residual balance of \$13,000 from FY 2000 funding. Through an interagency agreement with the USGS, these funds have been allocated for mammal inventory work next field season.

Work proposed for completion in FY 2002-2004. Two tables below summarize the budget and time schedule for NPCN inventory work by taxonomic groups and individual inventory projects. A third table summarizes the scheduled field inventories by park. Detailed project budgets and implementation schedules are found in the individual project statements in [Appendix E](#). These statements also describe our approach to project implementation. We anticipate significant involvement of USGS, Biological Resource Division scientists as well as partners of the Colorado Plateau Cooperative Ecosystem Studies Unit (CESU). Interested and qualified investigators will be sought through requests for interest and qualification. In addition, some of the inventory work will be contracted out through other sources.

Since the NCPN has been selected for initiation of a network monitoring program in FY 2001, we have requested a larger proportion of our inventory funding be distributed early on in the project. Our rationale is that we would like to expedite completion of general inventories to provide a stronger foundation for development of the monitoring phase of the program.

We are allocating approximately 20% of overall inventory funding to coordination and data management (see project statement [ALLTAX-01 in Appendix E](#)).

Summary of inventory funding by taxonomic groups.

PROJECT	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	TOTAL
Project Initiation and Study Plan	110,000					110,000
Coord./Data		115,034	50,270	28,076	24,526	217,906
Birds		43,224	60,420	37,172	18,053	158,869
Mammals	13,000	44,000	57,000	43,000	43,000	200,000
Herps		60,619	60,619	40,614	40,614	202,466
Plants		21,266	64,466	49,466		135,198
Cave		6,500	6,500			13,000
	123,000	290,643*	299,275*	198,328*	126,193*	1,037,439

*An estimated 15% of these annual totals will be applied to overhead costs (see individual project statements). Over the next four year period (FY 01-04) overhead costs will amount to approximately \$137,165.

Summary of inventory funding by individual projects.

PROJECT	FY 2000	FY2001	FY2002	FY2003	FY2004	TOTAL
ALLTAX – 01 Project Coordination & Data Mgt.		105,034	50,270	28,076	24,526	207,906
ALLTAX-02 Network Sensitive Species Project		10,000				10,000
CAVE-01 Timpanogos Cave Inventory		6,500	6,500			13,000
BIRDS-01 Small Parks General Bird Inventory		43,224	41,060			84,284
BIRDS-02 BLCA/CURE General Bird Inventory			19,360	18,343		37,703
BIRDS-03 SW Willow Flycatcher/YB Cuckoo				18,829	18,053	36,882
MAMMALS – 01 Baseline Mammal Inventory	13,000	37,000	50,000			100,000
MAMMALS – 02 Focused Mammal Inventory		7,000	7,000	43,000	43,000	100,000
HERPS-01 General Herp Inventory – All Parks		60,619	60,619	40,614	40,614	202,466
PLANTS-01 Herbarium Search		10,000	10,000			20,000
PLANTS-02 Hovenweep Floristic Inventory		4,766	4,466	4,466		13,698
PLANTS-03 Timpanogos Floristic Inventory		5,000	5,000			10,000
PLANTS-04 Black Canyon/Curecanti Plants			20,000	20,000		40,000
PLANTS-05 Plant Inventory Dinosaur NM			25,000	25,000		50,000
PLANTS-08 Fossil Butte Sensitive Plants		1,500				1,500

Total Funding Requested from I&M Program (FY2002-2004)

\$914,439

Schedule of Field Inventories by Park, Taxonomic Group and Fiscal Year

	BIRDS				MAMMALS				HERPS				PLANTS				CAVE			
	01	02	03	04	01	02	03	04	01	02	03	04	01	02	03	04	01	02	03	04
ARCH							X	X		X		X								
BLCA		X	X	X	X	X				X		X		X	X					
BRCA									X		X									
CANY							X	X		X		X								
CARE			X	X	X	X														
CEBR	X	X			X	X			X		X									
COLM							X	X		X		X								
CURE		X	X	X	X	X				X		X		X	X					
DINO	X	X	X	X					X		X			X	X					
FOBU	X	X			X	X				X		X	X							
GOSP	X	X			X	X			X		X									
HOVE			X	X	X	X				X		X	X	X	X					
NABR										X		X								
PISP					X	X			X		X									
TICA	X	X			X	X			X		X		X	X			X	X		
ZION			X	X			X	X	X		X									

IX. PRODUCTS AND DELIVERABLES

Annual reports summarizing progress of inventories will be prepared and provided to network parks, the Regional I&M Coordinator and National Servicewide I&M Coordinator. At appropriate intervals, copies of all products will be also be distributed to these same entities. At the completion of each inventory we will provide:

- a. Description of the protocol
- b. Inventory data in MS Access with appropriate documentation
- c. GIS data
- d. Metadata for new datasets utilizing FGDC standards.
- e. Updates to NPSpecies database.
- f. Updates to NRBib database.

X. COORDINATION AND LOGISTICAL SUPPORT

The nine-member Northern Colorado Plateau Network Steering Committee has overall responsibility for the network inventory and monitoring program. The network I&M program manager and associated staff work to implement the program as directed by the steering committee. Periodic meetings between the steering committee and program staff ensure that all key decisions and program needs are addressed in a timely manner. Regular communication between the program manager and steering committee ensures a smoothly functioning program.

Network parks and I&M project staff will assist with logistical support needed to complete field inventories. [Appendix I](#) provides a summary of individual park resources that may be available to this project, including housing, camping, office space and vehicle use. Unfortunately many parks have little to offer in the way of facilities. The network will support logistical needs of cooperators and project staff as much as possible.

As mentioned elsewhere in this study plan, the network will attempt to coordinate inventory work in close cooperation with the Southern Colorado Plateau Network. Taxonomic group methodologies identified in this plan are proposed for use across both networks. Additionally, we will attempt to identify and employ comparable data management protocols so that data may be shared plateau wide.

XI. ACKNOWLEDGEMENTS

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contributed overview information on plant communities. Chris Florian and Elliott Swarthout assisted with editing various portions of this study plan.

XII. REFERENCES CITED

- Adams, M.J. 1999. Correlated factors in amphibian declines: exotic species and habitat change in western Washington. *Journal of Wildlife Management* 63:1162-171.
- Armstrong, D.M. 1972. Distribution of mammals in Colorado. *Monogr., Univ. Kansas Mus. Nat. Hist.*, 3:1-415.
- Barbour, M. G., and W. D. Billings (eds.). 2000. *North American terrestrial vegetation*. Second edition. Cambridge University Press, Cambridge. 708 p.
- Belnap, J., and D. A. Gillette. 1998. Vulnerability of desert biological crusts to wind erosion: the influences of crust development, soil texture, and disturbance. *Journal of Arid Environments* 39:133-142.
- Bernardino, F.S., Jr. and G.H. Dalrymple. 1992. Seasonal activity and road mortality of the snakes of the Pa-hay-okee wetlands of Everglades National Park, USA. *Biological Conservation* 62:71-75.
- Betancourt, J. L. 1990. Late quaternary biogeography of the Colorado Plateau, p. 259-292. In J. L. Betancourt, T. R. Van Devender, and P. S. Martin (eds.), *Packrat middens: the last 40,000 years of biotic change*. University of Arizona Press, Tucson.
- Birkeland, P. W. 1999. *Soils and geomorphology*. Third edition. Oxford, New York. 430 p.
- Boulinier, T., J.D. Nichols, J.R. Sauer, J.E. Hines, and K.H. Pollock. 1998. Estimating species richness: the importance of heterogeneity in species detectability. *Ecology* 79:1018-1028.
- Brown, D.E. (ed.). 1982. *Biotic communities of the American southwest-United States and Mexico*. *Desert Plants* 4:1-342.
- Buckland, S.T., D.R. Anderson, K.P. Burnham, and J.L. Laake. 1993. *Distance sampling: Estimating abundance of biological populations*. Chapman and Hall, New York. 446 p.
- Bury, R. B., and D.J. Major. 1997. Integrated Sampling for Amphibian Communities in Montane Habitats, p. 75-82. In Olson, D.H., W.P. Leonard, and R.B. Bury (eds.), *Sampling Amphibians in Lentic Habitats: Methods and Approaches for the Pacific Northwest*. *Northwest Fauna* 4. 134 p.
- Caldwell, M. 1985. Cold deserts. Pages 198-212 in B. F. Chabot and H. A. Mooney (eds.), *Physiological ecology of North American plant communities*. Chapman and Hall, New York.
- Chapin, F. S., III. 1991. Effects of multiple environmental stresses on nutrient availability and use, p. 67-88. In H. A. Mooney, W. E. Winner, and E. J. Pell (eds.), *Responses of plants to multiple stresses*. Academic Press, San Diego.
- Comstock, J. P., and J. R. Ehleringer. 1992. Plant adaptation in the Great Basin and Colorado Plateau. *The Great Basin Naturalist* 52:195-215.
- Corn, P.S., M.L. Jennings, and E. Muths. 1997. Survey and assessment of amphibian populations in Rocky Mountain National Park. *Northwestern Natur.* 78:34-55.
- Crawley, M.J. 1997. The structure of plant communities, p. 475-531. In M.J. Crawley (ed.), *Plant ecology*. Second edition. Blackwell Science, Oxford.

- Crump, M.L., and N.J. Scott, Jr. 1994. Visual encounter surveys, p. 84-92. *In* Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Haye and M.S. Foster (eds.), *Measuring and monitoring biological diversity: standard methods for amphibians*. Smithsonian, Washington, D.C.
- Dawson, D.K., J.R. Sauer, P.A. Wood, M. Berlanga, M.H. Wilson, and C.S. Robbins. 1995. Estimating bird species richness from capture and count data. *Journal of Applied Statistics* 22:1063-1068.
- Dodd, C.K., Jr., K.M. Enge, and J.N. Stuart. 1989. Reptiles on highways in north-central Alabama, USA. *J. Herpetology* 23(2):197-200.
- Donnelly, M.A., C. Guyer, J.E. Juterbock, and R.A. Alford. 1994. Techniques for marking amphibians, Appendix 2. *In* M.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster (eds.), *Measuring and Monitoring Biological Diversity: Standard methods for amphibians*. Smithsonian Institution Press, Washington, D.C. 364 p.
- Drost, C.A. 2000. Inventory of threatened, endangered and candidate species at Navajo National Monument. Unpublished final report, USGS Colorado Plateau Field Station, Flagstaff, Arizona.
- Durrant, S.D. 1952. Mammals of Utah: taxonomy and distribution. *Univ. Kansas Publ., Mus. Nat. Hist.*, 6:1-549.
- Evans, R.D., and J. Belnap. 1999. Long-term consequences of disturbance on nitrogen dynamics in an arid ecosystem. *Ecology* 80:150-160.
- Evand, R.D. and J.R. Johansen. 1999. Microbiotic crusts and ecosystem processes. *Critical Reviews in Plant Sciences* 18:183-225.
- Fancy, S.G. 1997. A new approach for analyzing bird densities from variable circular-plot counts. *Pacific Science* 51:107-114.
- Fancy, S.G. 2000a. Guidance for the Design of Sampling Schemes for Inventory and Monitoring of Biological Resources in National Parks. Unpublished report dated March 24, 2000 from the National Park Service Inventory and Monitoring Program. 19p.
- Fancy, S.G. 2000b. Additional guidance on writing biological study plans. Unpublished memo dated June 27th. Inventory and Monitoring Program, National Park Service. 8p.
- Fellers, G.M., and K.L. Freel. 1997. A standardized protocol for surveying aquatic amphibians. National Park Serv., Tech. Report NPS/WRUC/NRTR-95-01. Davis, Calif.
- Ferner, J.W. 1979. A review of marking techniques for reptiles and amphibians. *Herpetological Circular No. 9: Society for the Study of Amphibians and Reptiles*.
- Forsman, E. 1983. Methods and materials for studying Spotted Owls. Pacific Northwest Forest and Range Experiment Station. Gen. Tech. Rpt. PNW-162. 8 p.
- Fowler, J.F. 1995. Biogeography of hanging gardens on the Colorado Plateau. Unpublished Ph.D. dissertation, University of Wyoming, Laramie.
- Hafner, M.S., W.L. Gannon, J. Salazar-Bravo, and S.T. Alvarex-Castandeda. 1997. Mammal collections in the Western Hemisphere: A Survey and Directory of Existing Collections. American Society of Mammalogists, Lawrence, KS.
- Halvorson, W.L., S.D. Veirs, Jr., R.A. Clark, and D.D. Borgais. 1988. Terrestrial vegetation monitoring handbook. Channel Islands National Park, California. NPS Cooperative Park Studies Unit, U. of California, Davis.

- Harper, K. T., and J. R. Marble. 1988. A role for nonvascular plants in management of arid and semiarid rangelands, p. 135-169. In P. T. Tueller (ed.), *Vegetation science applications for rangeland analysis and management*. Kluwer Academic Publishers, Dordrecht.
- Harper, K.T., and J.N. Davis. 1999. Biotic, edaphic, and other factors influencing pinyon-juniper distribution in the Great Basin, p. 51-54. In S. B. Monsen and R. Stevens (eds.), *Proceedings: ecology and management of pinyon-juniper communities within the Interior West; 1997 September 15-18; Provo, UT*. Proc. RMRS-P-9. U.S.D.A. Forest Service Rocky Mountain Research Station, Ogden, UT.
- Hunt, C. B. 1974. *Natural regions of the United States and Canada*. W.H. Freeman, San Francisco. 725 p.
- Johansen, J.R. 1993. Cryptogamic crusts of semiarid and aridlands of North America. *Journal of Phycology* 29:140-147.
- Jones, C., W.J. McShea, M.J. Conroy and T.H. Kunz. 1996. Capturing mammals, p. 115-156. In D.E. Wilson, F.R. Cole, J.D. Nichols, R. Rudran and M.S. Foster (eds.), *Measuring and monitoring biological diversity: standard methods for mammals*. Smithsonian Institution Press, Washington, D.C.
- Klauber, L.M. 1939. Studies of reptile life in the arid southwest, part I: Night collecting on the desert with ecological statistics. *Bulletin of the Zoological Society of San Diego* 14:7-64.
- Kleiner, E. F., and K. T. Harper. 1977. Soil properties in relation to cryptogamic groundcover in Canyonlands National Park. *Journal of Range Management* 30:202-205.
- Kunz, T. H. (ed.) 1988. *Ecological and behavioral methods for the study of bats*. Smithsonian Institution Press, Washington, D.C.
- MacMahon, J.A. 1988. Introduction: vegetation of Utah, p. xiii-xx. In B.J. Albee, L.M. Schulz, and S. Goodrich (eds.), *Atlas of the vascular plants of Utah*. Utah Museum of Natural History Occasional Publication No. 7, Salt Lake City.
- Marion, W.R., T.E. O'meara and D.S. Maehr. 1981. Use of playback recordings in sampling elusive or secretive birds. *Studies in Avian Biology* 6:81-85.
- McPherson, G. R. 1997. *Ecology and management of North American savannas*. University of Arizona Press, Tucson. 208 p.
- Mendelson, J.R., and W.B. Jennings. 1992. Shifts in the relative abundance of snakes in a desert grassland. *J. of Herpetology* 26(1):38-45.
- Miller, M.E. 2000. Effects of resource manipulations and soil characteristics on *Bromus tectorum* L. and *Stipa hymenoides* R. & S. in calcareous soils of Canyonlands National Park, Utah. Unpublished Ph.D. dissertation, University of Colorado, Boulder. 176 p.
- Mitchell, V. L. 1976. The regionalization of climate in the western United States. *Journal of Applied Meteorology* 15:920-927.
- National Park Service. 1988. *National Park Service management policies*. Washington, D.C.
- National Park Service. 1992. *NPS-75: Natural Resources Inventory and Monitoring Guidelines*. U.S. Dept. of Interior, National Park Service, Washington, D.C.
- National Park Service. 1999a. *Guidelines for biological inventories. Inventory and Monitoring Program*, National Park Service. Unpublished. 10p.
- National Park Service. 1999b. *Pre-Proposal for Biological Inventories: Northern Colorado Plateau Network*. December 29, 1999. 20p.

- National Park Service. 2000. A Study Plan to Inventory Vascular Plants and Vertebrates: Sonoran Desert Network, National Park Service. August 2000. 39 p. plus appendices
- National Research Council. 1992. Science and the national parks. National Academy Press, Washington, D.C. 122p.
- Nelson, J.T., and S.G. Fancy. 1999. A test of the variable circular-plot method when exact density of a bird population was known. *Pacific Conservation Biology* 5:139-143.
- Olson, D.H., W.P. Leonard, and R.B. Bury, (eds). 1997. Sampling Amphibians in Lentic Habitats: Methods and Approaches for the Pacific Northwest. *Northwest Fauna* 4. 134 p.
- O'Shea, T.J., and M.A. Bogan. 2000. Workshop on monitoring trends in U.S. bat populations: problems and prospects. Interim report available at: www.mesc.usgs.gov/BRD/ireport.htm.
- Peet, R.K. 2000. Forests and meadows of the Rocky Mountains, p. 75-121. In M. G. Barbour and W. D. Billings (eds.), *North American terrestrial vegetation*. Second edition. Cambridge University Press, Cambridge.
- Persons, T. 1999. Road Mortality of Amphibians and Reptiles at Wupatki National Monument. Investigators Annual Report to Wupatki NM.
- Peterson, K. L. 1994. Modern and pleistocene climatic patterns in the West, p. 27-53. In K. T. Harper, L. L. St. Clair, K. H. Thorne, and W. M. Hess (eds.), *Natural history of the Colorado Plateau and Great Basin*. University Press of Colorado, Niwot, Colorado.
- Robbins, C.S. 1981. Reappraisal of the Winter-Bird-Population Study technique, p. 52-57. In C.J. Ralph and J.M. Scott (eds.), *Estimating the numbers of terrestrial birds*. *Stud. Avian Biol.* 6.
- Rosen, P.C., and C.H. Lowe. 1994. Highway mortality of snakes in the Sonoran desert of southern Arizona. *Biological Conservation* 68:143-148.
- Rowlands, P.G. 1994. Colorado Plateau Vegetation Assessment and Classification Manual. Technical Report NPS/NAUCPRS/NRTR-94/06. National Park Service and Colorado Plateau Research Station. Flagstaff, AZ. 40p.
- Schultz, L.M. 1993. Patterns of endemism in the Utah flora, p. 249-269. In Sivinski, R. and K. Lightfoot (eds.), *Proceedings of the southwestern rare and endangered plant conference*. New Mexico Forestry and Resource Conservation Division Misc. Publ. No. 2
- Sellers, R.W. 1997. *Preserving Nature in the National Parks: A History*. Yale University Press, New Haven, CT. 380 p.
- Shafer, H.B., and J.E. Juterbock. 1994. Night driving, p. 163-166. In W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster (eds.), *Measuring and monitoring biological diversity: Standard methods for amphibians*. Smithsonian Institution Press, USA.
- Sogge, M.K., R.M. Marshall, S.J. Sferra and T.J. Tibbits. 1997. A Southwestern Willow Flycatcher Natural History Summary and Survey Protocol. Technical Report NPS/NAUCPRS/TR-97/12.
- Spence, J.R. 1997a. The SRFR vegetation classification for the Colorado Plateau, Version 2.0. Unpublished report, Resource Management Division, Glen Canyon National Recreation Area. 9 p.
- Spence, J.R. 1997b. Inventory, classification, and monitoring of rangelands in Glen Canyon National Recreation Area. 1996 progress report. Resource Management Division, Glen Canyon National Recreation Area. 25 p.
- Spence, J.R., W.H. Romme, L. Floyd-Hanna, and P.S. Rowlands. 1995. A preliminary vegetation classification for the Colorado Plateau, p. 193-213. In Van Riper III, C. (ed.), *Proceedings of*

- the Second Biennial Conference of Research in Colorado Plateau National Parks. Transactions and Proceedings Series NPS/NRNAU/NRTP-95/11.
- Springer, M.A. 1978. Foot surveys versus owl calling surveys: a comparative study of two Great Horned Owl censusing techniques. *Inland Bird Banding News* 50:83-92.
- Stohlgren, T.J., M.B. Falkner, and L.D. Schell. 1995. A modified-Whittaker nested vegetation sampling method. *Vegetatio* 117:113-121.
- Stohlgren, T.J., J.F. Quinn, M. Ruggiero, and G.S. Waggoner. 1995. Status of biotic inventories in US National Parks. *Biological Conservation* 71:97-106.
- Sullivan, B.K. 1981. Distribution and relative abundance of snakes along a transect in California. *J. of Herpetology* 15(2):247-248.
- Swann, D.E. 1999. Evaluating approaches for monitoring terrestrial vertebrates in U.S. National Parks: an example from Tonto National Monument, Arizona. M.S. Thesis. University of Arizona, Tucson, AZ.
- Thomas, L., J. Laake, and J. Derry. DISTANCE V3.5. Research Unit for Wildlife Population Assessment, University of St. Andrews, Scotland, U.K.
- Verner, J., and M.M. Milligan. 1971. Responses of White-crowned Sparrows to playback of recorded songs. *Condor* 73:56-64.
- Welsh, S. L. 1978. Problems of plant endemism on the Colorado Plateau. *Memoirs Great Basin Naturalist* 2:191-195.
- Welsh, S.L. 1993. Introduction, p. 1-12. In S.L. Welsh, N.D. Atwood, S. Goodrich, and L.C. Higgins (eds.), *A Utah flora*. Second edition, revised. Brigham Young University, Provo, Utah.
- Welsh, S.L., and C.A. Toft. 1981. Biotic communities of hanging gardens in southeastern Utah. *National Geographic Society Research Reports* 13:663-682.
- Welsh, S.L., N.D. Atwood, S. Goodrich, and L.C. Higgins (eds.). 1993. *A Utah flora*. Second edition, revised. Brigham Young University, Provo, Utah. 986 p.
- West, N. E., and J. A. Young. 2000. Intermountain valleys and lower mountain slopes, p. 255-284. In M. G. Barbour and W. D. Billings (eds.), *North American terrestrial vegetation*. Second edition. Cambridge University Press, Cambridge.
- Whittaker, R.H. 1975. *Communities and ecosystems*. Second edition. MacMillan, New York. 385 p.
- Wilson, D.E., F.R. Cole, J.D. Nichols, R. Rudran and M.S. Foster. 1996. *Measuring and monitoring biological diversity: Standard methods for mammals*. Smithsonian Institution Press, Washington, D.C.
- Yorks, T.E., and S. Dabydeen. 1998. Modification of the Whittaker sampling technique to assess plant diversity in forested natural areas. *Natural Areas Journal* 18:185-189.
- Zimmerman, B.L. 1994. Audio strip transects, p. 92-97. *In* Chapter 6, *Inventory and Monitoring*, *In* W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster (eds.), *Measuring and monitoring biological diversity: Standard methods for amphibians*. Smithsonian Institution Press, USA.

APPENDIX A. Northern Colorado Plateau Network Park Overviews

ARCHES NATIONAL PARK (ARCH)

Size: 30,979 hectares (76,519 acres)

Park History and Purpose: Arches National Monument was established by Presidential Proclamation No. 1875 on April 12, 1929. The monument was specifically set aside due to its outstanding and unusual geologic features. The proclamation states that the monument was established "to protect extraordinary examples of wind erosion in the form of gigantic arches, natural bridges, "windows", spires, balanced rocks and other unique wind-worn sand-stone formations, the preservation of which is desirable because of their education and scenic value". Geologic research has since established that water is the primary agent of erosion involved, although wind does play a role.

In 1938 the Monument was enlarged to include a number of historic and prehistoric cultural sites. Later boundary adjustments were made on November 15, 1938; July 26, 1960; January 21, 1969; and November 12, 1971. In 1971 the designation for Arches was changed from a National Monument to a National Park and the acreage was also increased to 29,708 hectares (73,379 acres). In 1999 the Lost Spring section was added to the park, which increased the total area by 1,255 hectares (3,100 acres) to 30.979 hectares (76,519 acres).

Location: Arches National Park is located in southeast Utah along and north of the Colorado River in Grand County. The park is 8 kilometers (5 miles) north of Moab, Utah, 161 kilometers (100 miles) west of Grand Junction, Colorado, and 386 kilometers (240 miles) southeast of Salt Lake City, Utah. The park is readily accessible by major travel routes such as Interstate I-70 located 32 kilometers (20 miles) north of the park headquarters; Utah Highway 191 runs from Interstate I-70 south to Moab and accesses the park entrance road.

The area surrounding the park (Grand County) is sparsely populated with a density of two people per square mile. Tourism is currently the most important economic activity.

Elevation: The elevation within the park ranges from approximately 1,219 meters (4,000 feet) in the canyons to 1585 meters (5,200 feet) on the rims.

General Description: Arches National Park has the largest concentration of natural stone arches in the world. Examples of developing, complete, and collapsed arches are all evident within the 114 square miles of the park. Several arches are particularly noted for their outstanding size and erosional history. Landscape Arch is probably the longest natural stone arch in the world. Delicate Arch, a freestanding arch carved from what was once a freestanding fin, is internationally recognized.

The park is 26 kilometers (16 miles) from north to south and 13 kilometers (8 miles) from east to west. There are a total of 30,979 hectares (76,519 acres) of land within the legislative boundaries of the park. The topography of the area is diverse, ranging from open flats to steep-walled cliffs. The area has been greatly effected by geologic activity associated with the salt intrusions of the Paradox formation and the landscape has been carved by the effects of wind and water and preserved by the arid climate and lack of earthquake activity. This has produced a landscape dominated by red sandstone formations such as arches, fins, balanced rocks, mesas, canyons and spires. Major topographic features of Arches National Park are Courthouse Wash, Courthouse Towers, The Windows Section, Salt Valley, Klondike Bluffs, Devil's Garden and the Fiery Furnace. Some of the more famous geologic structures in the park are Landscape Arch, Delicate Arch, Tower Arch, the Marching Men, Skyline Arch, the Three Gossips, the Three Penguins, the Windows, the Parade of Elephants, Balanced Rock and the Great Wall. There are more than 1800 catalogued arches within the park that have a span greater than one meter (3 feet).

Arches National Park is largely covered by exposed bedrock, weakly developed soils and sand dunes. The park was established because of its unique geologic features, in particular the massive, spectacular natural rock arches formed in the Entrada Sandstone. The geology of Arches National Park is largely determined by the

collapsed salt anticline in Salt Valley and to a lesser extent by the collapsed Moab and Cache Valley anticlines. There are ten major sedimentary formations exposed in the park ranging in age from the Pennsylvanian Paradox formation to the Cretaceous Mancos Shale. In stratigraphic order, formations include Paradox, Honaker Trail, Cutler Group, Moenkopi, Chinle, Wingate Sandstone, Kayenta, Navajo Sandstone, Entrada, Morrison, Cedar Mountain, Dakota Sandstone and Mancos Shale. The Paradox formation of salt and gypsum evaporates is a highly plastic formation which has formed the salt anticlinal structures in the park, which collapsed when ground water eroded the salt. The Navajo and Entrada Sandstones crop out over most of the park's surface, with the Entrada forming the majority of the outstanding geologic features. The cliff-forming Wingate Formation exposed along the Colorado River forms the south boundary of the park. Together with the associated Kayenta, Chinle and Moenkopi formations, it forms impressive eight hundred foot cliffs.

Several areas of pictographs and petroglyphs are found within the park. Two archeological surveys have been made in the park and approximately 100 sites have been documented. The Courthouse Wash Rock Art Panel is listed on the National Register of Historic Places. The panel represents the easternmost known occurrence of the Barrier Canyon Style.

Physical remains of early ranching and mining pursuits, as well as traces of pioneer routes, exist within the park.

The climate of Arches National Park is arid. It is characterized by hot, dry summers and cool to cold winters. The average annual precipitation of the area is 202 millimeters (7.95 inches). Mean annual temperature is 56 degrees Fahrenheit (13.3 degrees Celsius) and the extreme temperatures are -16 degrees Fahrenheit (-26.7 degrees Celsius) and 112 degrees Fahrenheit (44.4 degrees Celsius). Potential evapotranspiration exceeds precipitation, making effective soil moisture a critical environmental factor. Precipitation peaks occur in March and August. Snow falls between November and March.

Flora: Previous research conducted in the Arches National Park area documented strong relationships between edaphic characteristics and the distribution and composition of plant communities. Loope (1977) mapped the distribution of six relatively distinct vegetation types in relation to substrate. These types include (1) shrublands dominated by blackbrush (*Coleogyne ramosissima*) on shallow (<50 cm depth), weakly developed calcareous soils formed from sandstone or sandy shales, (2) shrublands dominated by shadscale (*Atriplex confertifolia*) on shallow soils formed from shales with high clay content, (3) grasslands dominated by needle and thread grass (*Stipa comata*), indian ricegrass (*Stipa hymenoides*), galleta grass (*Hilaria jamesii*), various species of dropseed (*Sporobolus* spp.), and cheatgrass (*Bromus tectorum*) on deep (>50 cm depth) soils where plant roots cannot reach the water table or capillary zone, (4) shrublands dominated by 4-wing saltbush (*Atriplex canescens*) and sagebrush (*Artemisia tridentata*) on deep sandy soils where roots seasonally access the capillary zone, (5) communities dominated by cottonwood (*Populus fremontii*), willow (*Salix* spp.), tamarisk (*Tamarix ramosissima*) and other shrubs in riparian zones where there is immediate root access to the water table, and (6) sparse woodlands dominated by pinion (*Pinus edulis*) and juniper (*Juniperus osteosperma*) on lithic soils where water availability is controlled by hydrological effects of bedrock joints and outcrops.

Other plant communities include: Garrett saltbush/mat saltbush (*Atriplex garrettii*/*Atriplex corrugata*), (*Artemisia frigida*/*Poliomintha incana*/*Stipa hymenoides*), snakeweed/shadscale/Mormon tea (*Gutierrezia sarothrae*/*Atriplex confertifolia*/*Ephedra viridis*), purple sage/shinnery oak/Utah juniper (*Poliomintha incana*/*Quercus harvardii*/*Juniperus osteosperma*), and greasewood/four-wing saltbush (*Sarcobatus vermiculatus*/*Atriplex canescens*). Springs and seeps are also scattered throughout the park and are generally composed of maidenhair fern/Jones reedgrass (*Adiantum capillus-veneris*/*Calamagrostis scopulorum*).

Fauna:

Mammals

Major mammals common to the park are the western pipitrel (*Pipistrellus hesperus*), gray fox (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus*), whitetailed antelope ground squirrel (*Ammospermophilus leucurus*), rock squirrel (*Spermophilus variegatus*), Colorado chipmunk (*Eutamias quadrivittatus*), Apache pocket mouse (*Perognathus flavescens*), Ord kangaroo rat (*Dipodomys ordi*), canyon mouse (*Peromyscus crinitus*), deer mouse (*P. maniculatus*), piñon mouse (*P. truei*), northern grasshopper mouse (*Onychomys leucogaster*), desert woodrat (*Neotoma lepida*), porcupine (*Erethizon dorsatum*), blacktailed jackrabbit (*Lepus californicus*), desert

cottontail (*Sylvilagus auduboni*), mule deer (*Odocoileus hemionus*), desert bighorn sheep (*Ovis canadensis nelsoni*), striped skunk (*Mephitis mephitis*), ringtail (*Bassariscus astatus*) and badger (*Taxidea taxus*).

Birds

Common bird species likely to be found in the park are the mourning dove (*Zenaidura macroura*), common nighthawk (*Chordeiles minor*), white-throated swift (*Aeronautes saxatalis*), violet-green swallow (*Tachycineta thalassina*), ash-throated flycatcher (*Myiarchus cinerascens*), Say's phoebe (*Sayornis saya*), scrub jay (*Aphelocoma coerulescens*), common raven (*Corvus corax*), piñon jay (*Gymnorhinus cyanocephalus*), plain titmouse (*Parus inornatus*), cañon wren (*Catherpes mexicanus*), rock wren (*Salpinctes obsoletus*), loggerhead shrike (*Lanius ludovicianus*), gray vireo (*Vireo vicinior*), black-throated gray warbler (*Dendroica nigrescens*), black-throated sparrow (*Amphispiza bilineata*) and dark-eyed junco (*Junco hyemalis*), Cooper's hawk (*Accipiter cooperi*), golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*) and the northern harrier (*Circus cyaneus*).

Herptofauna

Common herptofauna of the park are the red-spotted toad (*Bufo punctatus*), Woodhouse toad (*B. woodhousei*), collared lizard (*Crotaphytus collaris*), short-horned lizard (*Phrynosoma douglassi*), sagebrush lizard (*Sceloporus graciosus*), eastern fence lizard (*S. undulatus*), tree lizard (*Urosaurus ornatus*), leopard lizard (*Gambelia wislizenii*), side-blotched lizard (*Uta stansburiana*), western whiptail (*Cnemidophorus tigris*), gopher snake (*Pituophis catenifer*), common garter snake (*Pituophis catenifer*) and the midget faded rattlesnake (*Crotalus viridis concolor*).

Aquatic Features: There are some exotic fish species in Courthouse Wash and Salt Wash. The bullfrog (*Rana catesbeiana*) is an exotic amphibian that is firmly established in Salt Wash. Macroinvertebrates are monitored 4 times a year, since 1997, as part of the Water Quality Monitoring Program that started in 1987. Arches NP boundary is adjacent to the Colorado River for approximately 16 km (10 miles). There are four Endangered fish in the Colorado River: bonytail chub (*Gila elegans*), humpback chub (*Gila cypha*), Colorado pikeminnow (*Ptychocheilus lucius*), and razorback sucker (*Xyrauchen texanus*). Northern river otter (*Lutra canadensis*) and beaver (*Castor canadensis*) are found along the river. There is also a great blue heron (*Ardea herodias*) rookery site along the river in the park.

Unique Features and Species of Special Concern:

Plant Communities of Concern: Riparian, River, Relict Areas, Seeps, Springs, Hanging Gardens.

Plants: Arches NP has a number of sensitive plant species but none are federally classified as Threatened or Endangered. The Canyonlands desert parsley (*Lomatium latilobum*) is a sensitive endemic that probably should be listed. Although there are populations outside the park, it's center of distribution is in Arches NP. Other sensitive endemics include the southwestern cloakfern (*Argyrochosma limitanea* ssp. *Limitanea*), Cutler milkweed (*Asclepias cutleri*), large-seeded milkweed (*Asclepias macrosperma*), alcove bog orchid (*Habanaria zothecina*), alcove rock daisy (*Perityle specuicola*), entrada rushpink (*Lygodesmia entrada*), helleborine (*Epipactus gigantea*), Howell scorpionweed (*Phacelia howelliana*), Trotter oreoxis (*Oreoxis trotteri*), alcove death camus (*Zigadenus vaginatus*), Osterhout's cryptanth (*Cryptantha osterhoutii*), Utah bladder fern (*Cystopteris utahensis*), wing-seed stickleaf (*Mentzelia pterosperma*), roseate gilia (*Gilia roseata*), Eastwood monkeyflower (*mimulus eastwoodii*), Moab woodyaster (*Xylorhiza glabriuscula* var. *linearifolia*), and resinbush (*Vanclevia stylosa*).

Animals: Birds of special concern are the federally Threatened southwestern willow flycatcher (*Empidonax traillii extimus*), the western burrowing owl (*Athene cunicularia hypugja*), and the brown-headed cowbird (*Molothrus ater*). Arches also contains American peregrine falcon (*Falco peregrinus anatum*) territories.

Arches NP has a number of sensitive bat species including: long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysandodes*), and pale Townsend's big-eared bat (*Plecotus townsendii pallesoens*).

The northern river otter (*Lutra canadensis*) is another species of concern.

Amphibians of concern include the northern leopard frog (*Rana pipiens pipiens*), tiger salamander (*Ambystoma tigrinum nebulosum*), western toad (*Bufo boreas*), and the bullfrog (*Rana catesbeiana*). The bullfrog is an exotic species that competes very successfully with other native amphibians.

Paleontological Resources: Arches National Park is rich in paleontological resources. Surveys have been conducted and many dinosaur bone and track sites have been found. A recent survey (2000) of all known sites in Arches NP will result in a final report in the near future.

Resource Management Concerns:

Increased recreational use, trespass livestock and exotic plant species invasion are the main natural resource management concerns. Damage to the many cultural resources in the park is also a concern.

Recreation Use: Visitor use increased rapidly within the park during the 1980s and early 1990s causing soil and vegetation damage in heavily used areas. Impacts from visitors hiking off trails destroy crytobiotic soils and tramples vegetation, which increases erosion.

Land Use Impacts: Although uranium mining was one of the most important economic activities in the area from 1950-1980, it has largely dissipated due to depressed prices and the discovery of more economical sources of uranium-bearing ore in other parts of the world. Currently, the significant mineral extraction activities in the area are solution mining of salt and potash at the Texas-Gulf Mine at Potash, Utah 10 km (6 miles) southwest of the park, and exploratory drilling for oil and gas on Bureau of Land Management (BLM) lands between Canyonlands and Arches National Parks.

Trespass livestock and the subsequent grazing and trampling is a problem at Arches NP. A boundary fence was finally completed in 1998 but livestock still enter into areas where the fence is damaged by natural causes (flash floods) or intentionally cut. Arches NP is surrounded by grazing allotments managed by the Bureau of Land Management (BLM).

Ambient noise levels in the park are the lowest in the country. The degree of silence one encounters in most areas of Arches National Park is astounding and one of its great resources. Any noise detected in the area may be associated with wildlife activity, other visitors or an occasional aircraft. With increased oil and gas activity in the area and the potential for mining in the future, mineral development could add significantly to noise levels. Commercial development along Highway 191 is also a concern. Monitoring and documenting background noise levels before mineral activity increases is essential.

Without the lights from a nearby metropolitan area and the relatively clear air, the night sky resources of the park are outstanding. Numerous visitors, particularly those from the eastern United States or urban areas comment on this resource. Commercial development along highway 191 and development in the Moab Valley have already impacted this resource.

Invasive Exotic Plant Species: Arches NP has about 53 exotic plants. Tamarisk (*Tamarix ramosissima*) is a problem in the riparian areas and along the river. There has been some active and aggressive management of tamarisk in the past ten years and many areas are recovering with great success. Cheatgrass (*Bromus tectorum*), Russian olive (*Eleagnus angustifolia*), and Russian knapweed (*Centaurea repens*) are also a problem.

References Cited:

Loope, W.L. 1977. Relationships of Vegetation to Environment in Canyonlands National Park. Ph.D. Dissertation, Dept. of Range Ecology, Utah State University, Logan, UT 142p.

USDI, National Park Service. 1996. Resource Management Plan, Arches National Park. Rocky Mountain Region, Denver, Colorado. 38p.

USDI, National Park Service. 1988. Arches National Park Statement for Management. Rocky Mountain Region, Denver, Colorado. 34p.

USDI, National Park Service. 1989. Arches National Park: General Management Plan, Development Concept Plan, Environmental Assessment.. Rocky Mountain Region, Denver, Colorado. 170p.

BLACK CANYON OF THE GUNNISON NATIONAL PARK (BLCA)

Size: 12,660 hectares (31,282 acres)

Park History and Purpose: President Herbert H. Hoover established Black Canyon of the Gunnison National Monument on March 2, 1933 (Presidential Proclamation No. 2033) under the provisions of the Antiquities Act (34 Stat. 225; June 8, 1906), for the purpose of "...the preservation of the spectacular gorges and additional features of scenic, scientific, and educational interest..."

Lands were added to the monument in 1935, 1938, 1939, 1958, and 1984. Public Law 98-357, which authorized the 1984 park additions, states "The purpose of this Act is to establish a boundary for the Monument in order to promote, perpetuate, and preserve the character of the land and to preserve scenic and historic resources." The language of the act recognized Black Canyon as possessing "outstanding recreational opportunities and natural characteristics of high value which...contribute as an enduring resource..." The background congressional record information provided with the boundary expansion legislation states, "Although the monument contains a multitude of scientific, educational, cultural, historical, and other benefits, the center of attraction to the area is, without a doubt, the viewshed."

In 1976, Public Law 94-567 designated 4,525 hectares (11,180 acres) of the monument as wilderness, pursuant to the Wilderness Act of 1964. Through enactment of P.L. 106-76 in October of 1999, additional lands, including another 1,790 hectares (4,423 acres) of wilderness, were added and the monument was designated Black Canyon of the Gunnison National Park. The 1999 act states "the Black Canyon of the Gunnison and adjacent upland include a variety of unique ecological, geological, scenic, historical, and wildlife components, ... extensive opportunities for educational and recreational activities, ... unique geological, paleontological, scientific, educational, and recreational resources; ... some private land adjacent to the Black Canyon of the Gunnison National Monument has exceptional natural and scenic value that would be threatened by future development pressures..."

Black Canyon's General Management Plan (NPS 1997) provides guidelines for future management. It identifies management actions that satisfy public needs while protecting the area's natural and cultural resources. The General Management Plan identifies the Park Purpose for Black Canyon is to provide for:

- Preservation and protection of the spectacular gorges and scenic values.
- Protection of natural, cultural, and scientific resources and items of educational interest.
- Educational, scientific, and interpretive opportunities.
- Preservation of the integrity and characteristics of lands designated as wilderness.
- Opportunities for public use and enjoyment of these resources in a manner that will leave them unimpaired for future generations.
- Management of monument resources as an integral part of the Gunnison River Basin.

The General Management Plan identifies the significance of Black Canyon of the Gunnison National Park as follows:

- The monument contains a diversity of plant and animal species, several of which are rare, endangered, or unique to the area. Natural resources provide an unaltered baseline from which to measure changes in regional and global conditions.
- Its position along the Gunnison River combined with its values make BLCA an integral part of ecosystem management of the Gunnison River Basin.
- The steep gradient of the Gunnison River and the depth and narrowness of the Black Canyon is a physical barrier to the migration of fish, plants, and animals. This has resulted in a diverse group of isolated biological communities that provide unique opportunities for scientific study, for example, evolution of plants and animals, impacts of migration barriers, and so on.

- The canyon is a great place for scientific discovery and environmental education. It is a living classroom providing unique insights into geology, water and wind erosion, air quality, wildlife habitat, and cultural history.

The specific management objective identified in the Black Canyon of the Gunnison National Monument Resource Management Plan (NPS 1993) for the stewardship of park natural resources are:

“...to conserve the Monument's ecological communities, geological resources, and scenic qualities, and to the degree possible, to restore areas disturbed by past human activities to the natural condition existing before disturbance. The concept of maintaining and perpetuating ecosystems rather than protecting and preserving individual features or favored species is, and must remain, a distinguishing aspect of natural resource management.”

Location: Black Canyon of the Gunnison National Park is located in Colorado's Third congressional District within Montrose County. The park is located approximately 402 kilometers (250 miles) southwest of Denver, Colorado and 24 kilometers (15 miles) east of Montrose, Colorado.

Elevation: The elevation within the park varies from 1,645 meters (5,400 feet) at the bottom of the canyon to 2,675 meters (8,775 feet) on Signal Hill.

General Description: The Black Canyon is a textbook example of a superimposed stream. The walls of the canyon rise precipitously 610 meters (2,000 feet) or more above the Gunnison River, which roars in the canyon depths at an average gradient of 29 meters (95 feet) per mile in the monument.

The Black Canyon is one of the world's foremost wild canyons. The geologic story of the Black Canyon has several different starting times. About 1.3 to 1.7 billion years ago, rocks of the canyon walls (gneiss, schist, quartz-monzonite, and granite-pegmatite) were formed far below the earth's surface. Around 60 million years ago, during the forming of the Rocky Mountains, these hard crystalline rocks were uplifted to near the earth's surface in the Gunnison uplift. From 35 to 18 million years ago, volcanic action from the West Elk and San Juan Mountains covered the area with ash, tuff, and breccia. Erosion slowly wore away these volcanic layers along with the underlying sedimentary rocks and established the course of the Gunnison River. Two million years ago, the river started cutting into igneous and metamorphic rocks and the Black Canyon of the Gunnison was formed.

Of the mosaic of biotic communities found in the park, some are representative of communities found in a broad geographical region and some are unique to the Black Canyon. The canyon rims are dominated by scrub oak and pinyon-juniper forests intermixed with patches of high desert sagebrush communities. Two sizable pinyon-juniper groves exist; one on each rim at about 2,438 meters (8,000 feet). Within these groves are many large pinyons, some over 700 years old. The north-facing slopes of the canyon have conditions that favor the Douglas fir and Colorado blue spruce. The river bottom has a number of deciduous trees and shrubs characteristic of river strands in the region. Very few ponderosa pines are found along the river bottom where they were protected from past annual high spring flows. A small amount of riparian vegetation, as well as scattered stands of ponderosa pine, Utah juniper, and box elder, also occur along the river.

Locally, the dominant shrub species is the Gambel oak, with serviceberry ranking second, and lesser amounts of mountain mahogany. Sagebrush is found in areas of good soil, and rabbitbrush is occasionally found.

Another ecosystem found within the Park is the Pinyon-Juniper Woodland.

The associated vegetational ecosystems provide habitat for a variety of wildlife including, but not limited to, river otter, mule deer, bighorn sheep, black bear, bobcat, mountain lion, elk, golden eagle, peregrine falcon, and a variety of seasonal raptors. A variety of small mammals are also represented including porcupines, weasels, and golden mantel ground squirrels. The canyon rim is especially important habitat for birds because of the air currents found there and unique interactions of rock, soil, topography, and surrounding plant communities that meet at the rim to create a distinct ecotone.

Temperatures range from a low of -9°C (15°F) in the winter to approximately 29°C (85°F) in the summer. Average annual precipitation is 400-508 millimeters (16 to 20 inches) and snowfall measures between 76 and 140 centimeters (30 and 55 inches). Most of the precipitation occurs in the form of spring and summer rains. The wind is predominantly out of the southwest with episodes of high velocity (64 to 97 kph (40 to 60 mph)). Canyon bottoms are typically 5° to 8°C (10° to 15°F) warmer than ridgetops during the summer months.

Unique Features and Species of Special Concern:

Black Canyon of the Gunnison National Park offers a unique and spectacular landscape. No other canyon in North America combines the narrow opening, sheer walls, and startling depths. A number of unique ecological niches exist in Black Canyon that harbor species not found in abundance or absent on surrounding lands because of topographic variation, soil developments, and exposure to sun and wind.

Plants and Vegetation Communities: At least four rare plants are either known or suspected to occupy lands within Black Canyon including Black Canyon gila (*Gila pentstemonoides*), hanging garden sullivania (*Sullivantia hapemanii* var. *purpusii*), *Sclerocactus glaucus*, and *Penstemon retrorsus*. The area's unique geological conditions and semi-arid environment combine to create a number of habitats of particular interest throughout the park including seeps & springs, riparian areas, and hanging gardens.

Animals: The geographic location of the park, along with the resources it has to offer, makes Black Canyon an attractive site for a number of sensitive and rare wildlife species. The topography has attracted a significant raptor population including golden eagles, bald eagles, prairie falcons, peregrine falcons, and many migrating birds of prey. It is suspected that the southwestern willow flycatcher uses riparian features scattered throughout the park. Peregrine falcons nest on the cliffs within the canyon. The Gunnison sage grouse, a recently recognized species, use the sagebrush habitats on the north boundary of the park to meet their year-round habitat needs.

The wildlife of the Monument is typical for the geography and elevations of the region. Large mammals include mule deer, black bear, bobcat, elk and an occasional mountain lion. Rocky Mountain bighorn sheep were reintroduced on Bureau of Land Management lands to the west of the park in 1985 and individuals, possibly from this transplant or from historic herds, are observed in the park although no increase in sheep numbers has been detected. River otters were reintroduced at the east (upstream) boundary of the park and are occasionally seen along the river in the park.

The upstream water impoundments have dramatically altered the historic fish population and composition. The native species of Colorado River cutthroat trout, Colorado roundtail chub, bonytail chubs, bluehead sucker, flannelmouth sucker, and other native species may be displaced by non-native rainbow and brown trout. The present excellent conditions for brown and rainbow trout have led to the Colorado "Gold Medal Waters" fishery designation for the Gunnison River through the park and lower gorge.

Resource Management Concerns:

Major natural resource issues at Black Canyon of the Gunnison National Park include:

Livestock Grazing: Livestock production and irrigated farming have been a way of life in this part of Colorado since the mid-nineteenth century. The principal use of the land surrounding Black Canyon of the Gunnison National Park continues to be the grazing of domestic livestock. Recurring problems are developing between grazing and wildlife habitat. These problems are associated with timing of seasonal grazing use, stocking levels and inadequate fencing. Lack of fencing has resulted in livestock trampling of riparian vegetation and soil compaction. Livestock grazing may be affecting Gunnison sage grouse, elk, mule deer and bighorn sheep habitat in sections of the park.

Exotic Plants and Animals: Exotic plant species are invading both disturbed and undisturbed areas throughout Black Canyon, displacing native species. Exotic vascular plants of particular concern include: cheatgrass (*Bromus tectorum*), Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), musk thistle (*Carduus nutans*), Russian knapweed (*Centaurea repens*), spotted knapweed (*Centaurea maculosa*), hoary cress (*Cardaria draba*), common mullein (*Verbascum thapsus*), houndstongue (*Cynoglossum officinale*), and tamarisk (*Tamarix ramosissima*).

While the upstream water impoundments have increased the valuable fishing resource through the park from a sport fishery standpoint, it has also impacted native species. The native fish species of particular concern are the Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*), Colorado roundtail chub (*Gila robusta*), flannelmouth sucker (*Catostomus latipinnis*), and bluehead sucker (*Catostomus discobolus*), which historically occupied the Gunnison River in the vicinity of the park.

Land Use Conversion: Increased near-park development is having visual and biological impacts on park resources. Habitat loss as a result of adjacent land development has affected Gunnison sage grouse, elk, deer, and bighorn sheep as well as numerous other species in the area.

Visitor Use: Increasing visitor use of the park and surrounding lands through the 1980s and into the 1990s contributed to direct impacts to soil and vegetative resources which have had indirect effects on sensitive habitats and wildlife species.

Altered Hydrologic Regime: Construction of dams and water diversions upstream of the park has altered the riparian habitat, stream flow patterns, temperature regime, fish spawning habitat, fish species and fish-food organisms on the Gunnison River within the Black Canyon.

Past Fire Exclusion: The natural systems within and surrounding the park have evolved with fire. It is recognized that the presence or absence of natural fire within a given habitat is one of the ecological factors contributing to the perpetuation of plants and animals in that habitat. Fire suppression has contributed to an alteration of plant communities found within the Black Canyon.

Lack of Basic Data: A great deal of baseline information about the presence or absence, abundance and distribution of park natural resources is needed to assist park managers in making informed decisions which may have effects on natural resources. The park currently has an insufficient understanding of park ecosystems and threats to them.

References Cited:

NPS. 1997. General Management Plan, Black Canyon of the Gunnison National Monument and Curecanti National Recreation Area, October 1997.

NPS. 1993. Resource Management Plan, Black Canyon of the Gunnison National Monument, 1995.

BRYCE CANYON NATIONAL PARK (BRCA)

Size: 14,502 hectares (35,835 acres)

Park History and Purpose: Bryce Canyon is known internationally for its unusual scenic beauty and scientific interest and importance. These scenic and scientific values are found in the brightly colored and towering formations of limestone, clay, and silt, which were created primarily by the erosive forces of water. The formations, which range in shades of red and white are a brilliant contrast to the colorful lowlands east of the park and the timbered hillsides and plateaus to the west. The vast, panoramic views from within the park to the outlying valleys and canyons add an outstanding quality to the aesthetic values of the park. The park also contains a rich cultural background ranging from numerous archeological sites to nationally registered historic architecture in several developed areas of the park.

Bryce Canyon National Park was originally established as a National Monument in June of 1923 by Presidential Proclamation (number 1664). The purpose of this action was to reserve certain lands within the Powell National Forest known as "Bryce Canyon" because of unusual scenic beauty, scientific interest and importance. The proclamation identified that the public interest will be promoted by reserving as much land as necessary for the proper protection as a national monument. In June of 1924 additional legislation established Utah National Park. At this time all the lands within the boundary of the original National Monument were acquired by the federal government "for the benefit and enjoyment of the people" and were

hence forth subject to the provisions of the National Park Service organic act of 1916. In February of 1928 the name was changed to Bryce Canyon National Park and administration of the area was transferred to the National Park Service in September of that year. During the intervening months between February and September, eleven sections of land were added to the National Park bringing the size of the unit to 5,860 hectares (14,480 acres).

President Hoover authorized a proclamation (number 1930) in January of 1931 that more than doubled the size of the park resulting in a new land base of 12,367 hectares (30,560 acres). This expansion extended the boundaries south and west along the Paunsaugunt Plateau to include additional scenic overlook areas as far south as Rainbow Point. Again in 1931, May this time, President Hoover increased the size of Bryce Canyon National Park by presidential proclamation (number 1952). The latest expansion extended northeast to include scenic points as far north as Shakespeare Point and resulted in a Park land base of 35,980 acres.

The purpose and significance of Bryce Canyon National Park is described in the enabling legislation, the General Management Plan (BRCA 1987), and the Statement for Management (1993). Bryce Canyon National Park is best known for its hoodoos, erosional features carved from the edge of the Paunsaugunt Plateau in southern Utah. Here routine events such as freeze-thaw cycles, water run-off and mineral oxidation combine in unique ways to create uncountable oddly shaped and multi-hued fins, spires, grottoes and windows from the limestones of the Claron Formation.

The park's location at the top of the Grand Staircase and the clarity of the air provide visitors the opportunity to regularly experience panoramic vistas of over 161 km. (100 miles). The absence of human development and artificial lights create conditions for unimpeded distant views by day and unparalleled viewing of the brilliant night skies. In conjunction with both public and private lands the park provides the unique opportunity for visitors from around the world to observe wildlife in the peaceful settings of three forest community types (pinyon/juniper, ponderosa pine or a fir/spruce/aspen mixed). A diverse range of recreational opportunities provide visitors an understanding of the park's role in the cultural history of the area.

Location: Bryce Canyon National Park is located approximately 129 kilometers (80 miles) northeast of Cedar City, Utah on the Paunsaugunt Plateau.

Elevation: Elevation ranges from approximately 1859 meters (6,100 feet) in the eastern lowlands to 2438 meters (8,000 feet) at headquarters to 2774 meters (9,100 feet) at the southern end of the park. Annual precipitation averages 381 millimeters (15 inches) with an average annual snowfall of 254 centimeters (100 inches) at headquarters.

General Description: Bryce Canyon National Park is a long, roughly rectangular shaped area located on the eastern rim of the Paunsaugunt Plateau. The Paunsaugunt Plateau is situated on the southwest edge of the Colorado Plateau at the head of the Paria River. The Paunsaugunt is an upthrust fault block forming the highest step of the Grand Staircase along the north side of the Colorado River. The fault forming the east scarp of the Paunsaugunt exposes the Pink Cliffs, a series of spectacular formations of Cretaceous age limestone, sandstone, and shale of varied color and form. The deeply eroded cliffs form a series of fourteen canyons/amphitheaters along the rim. Above the escarpment, the plateau dips gently to the west draining surface runoff in to the East Fork of the Sevier River. The vegetation on the plateau ranges from ponderosa pine forests at the north end to dense mixed conifer forests on the south. The forests are interspersed with a dozen or more mountain meadows dominated by late seral sagebrush communities. Greenleaf manzanita is very abundant in forest areas with low tree stem density. Aspen is sparse at the southern end of the park. All stands are heavily encroached by conifer and are currently very small in size. Below the rim, ponderosa pine, Utah juniper, and pinyon pine dominate the overstory vegetation. A few cottonwood trees are found along streams fed by small springs at the base of the Pink Cliffs.

Flora: The vegetation communities at Bryce Canyon National Park can be categorized in to six groups: subalpine open and semi moist meadows; fir-spruce-aspen forests; high plateau sagebrush; ponderosa pine forest; pinyon-juniper woodland; and The Breaks. The amount of soil moisture present would be the most important factor in describing the extent and profusion of flowering plants associated with each plant community. There are plant species endemic to Bryce Canyon National Park. However, there are a number

of species on the fringe of their distribution and thus considered rare in this area. The park supports an estimated 522 plant species (Foster 1995). New species are being discovered in the park periodically.

Fauna: The fauna of Bryce Canyon National Park is typical of the species expected on the Colorado Plateau. Approximately 290 species of amphibian, reptile, bird and mammal species have been observed in the park. Amphibians are rarely observed but are found in selected locations near water. The short-horned lizard and the desert whiptail are the most common reptiles seen by visitors and employees. Visitors in the breaks periodically observe the Great Basin rattlesnake. Common bird species on the plateau top include common ravens, Steller's jays, dark-eyed junco, and mountain chickadees. Below the rim, swallows of several species, swifts and scrub jays are regularly observed. The red-tailed hawk is the most common raptor. Mule deer, golden-mantled ground squirrel, and *Uta* chipmunk are the most common mammals observed and are found throughout the park. Utah prairie dogs are found in most mountain meadow habitats. Visible signs of mountain lion and black bear are regularly found but these species are observed infrequently.

Aquatic Features: The location of Bryce Canyon along the Paunsaugunt Fault provides a unique opportunity for springs to surface as ground water encounters the Tripic Shale Formation. Thirty-three springs have been located throughout the park, of which twenty have sufficient flow to measure (Ott 1996). Few streams in the park actually carry surface water year round. The ones that do are extremely small during portions of the year.

Unique Features and Species of Special Concern

Hoodoos. Hoodoos are rock spires that are left behind by erosional forces of wind and water along the eastern edge of the plateau.

Utah prairie dogs. Utah prairie dogs are listed as threatened species under the protection of the endangered species act. Numbers have fluctuated between 45 and 225 since they were re-introduced into the park in 1975.

Rare plants. Currently there are 23 taxa at Bryce Canyon National Park considered 'sensitive'. These include: Ward milkvetch (*Astragalus wardii*), Reveal indian paintbrush* (*Castilleja parvula* var. *revealii*), yellow-white catseye* (*Cryptantha ochroleuca*), Cedar Breaks biscuitroot (*Cymopterus minimus*), Abajo daisy (*Erigeron abajoensis*), Jones' gentian (*Gentianella tortuosa*), Cedar Breaks goldenbush (*Haplopappus zionis*); Jones golden-aster (*Heterotheca jonesii*), king's ivesia (*Ivesia kingii*), intermountain ivesia (*Ivesia sabulosa*), Bryce bladderpod (*Lesquerella rubicundula*), little desert parsley (*Lomatium minimum*), Jones' locoweed (*Oxytropis oreophilla* var. *jonesii*), Paria breadroot* (*Pediomelum parianse*), Red Canyon phlox (*Phlox gladiiformis*), Red Canyon beardtongue* (*Penstemon bracteatus*), Markagunt beardtongue (*Penstemon leiophyllus* var. *leiophyllus*), lepidota twinpod (*Physaria chambersii* var. *membranacea*), podunk groundsel (*Senecio malmstenii*), Peterson catchfly* (*Silene petersonii*), Wyoming rock-tansy (*Sphaeromeria capitata*) and least townsendia (*Townsendia minima*).

Most of these plants occur in the unique environment of the "breaks" community. Populations of some plants (indicated with an asterisk) have been monitored over time and seem little affected by the current level and location of tourism activities. More surveys are needed within remote areas of the park to determine the extent of each rare plant species. These surveys will also look for new occurrences of rare plants found in similar habitats outside the park boundary.

Bald Eagles and California Condors. Periodic observations of bald eagles and California condors have been recorded in the past. These two species are protected under the provisions of the endangered species act but have never been observed nesting at Bryce Canyon National Park.

Bristlecone Pines. The Bryce Canyon Breaks is the lowest elevation site in the distribution of this species.

Aspen. Aspen clones have slowly become decadent as their habitat is encroached by conifers through natural succession. Fire suppression actions have removed a source of disturbance that would have resulted in regeneration of aspen at the south end of the park.

Resource Management Concerns:

Human impacts on the landscape have seriously diminished many Bryce Canyon resources and natural processes. Plant communities in some locations have been heavily trampled, and in other areas they have changed dramatically due to fire suppression activities that became very aggressive at the turn of the 20th century. The park has focused on meeting visitor needs at the expense of basic prevention and correction of resource deterioration, quantitative resource inventorying and monitoring, and planning for mitigation/restoration actions. Total fire suppression policies of the past have caused significant changes to plant communities resulting in unnatural species abundance and an altered assemblage of species diversity.

The threatened Utah prairie dog has colonized most mountain meadow habitats and in some cases can be found in close proximity to human developments. A conservation strategy is currently being pursued to protect this threatened species and public safety.

Recreation Use: Annual visitation since 1980 has significantly increased. The annual average rate of increase in visitation was 7.5 %. Turnouts for parking along the Rim Road provide many opportunities for visitors to enjoy scenic vistas of the Grand Staircase and beyond. Annual visitation to BRCA reached a peak of 1.7 million visitors in 1996, with only slightly lower visitation rates since that time.

Visitation is primarily concentrated within the 252-acre developed area of the park. Most of the visitors never go south of the main amphitheater area and average visitation time is less than ½ day. Consequently, having a very high density of visitors in our main amphitheater area has resulted in trampling of vegetation, heavy social trailing in some areas, wildlife that are attracted to human food sources, and individual deer and rodents that are very habituated to human activities and could become a threat to visitor safety at times. A small portion of recreational use includes backcountry hiking and overnight camping.

Land Use Impacts: Cattle and sheep grazing was one of the earliest known human impacts on the land now known as Bryce Canyon National Park. Grazing was well established at Bryce Canyon National Park dating back to Mormon settlement in the 1870's. Grazing on the plateau occurred during the summer months while ranchers moved their stock to lower elevations in the winter. The Forest Service issued grazing permits from 1903 until 1929. Leniency toward resource stewardship and consumption of forage was the general practice during the years grazing practices were permitted by the US Forest Service (Buchanan 1960). During the years from 1907 to 1940, forage abundance in the park declined "inexorably" (Scrattish 1985).

Timber harvesting in the area of the park began in the late 1800's and by 1890 a sawmill was located in the northeast portion of the park. Harvesting occurred in Henderson Canyon. The mill was later moved to the mouth of Bryce Canyon. By 1896 another sawmill was constructed in Dave's Hollow west of the present day headquarters building. There were no conservation measures implemented during this time period. This mill specialized in fine finished lumber, much of which was shipped to Salt Lake City for construction work there. Harvesting occurred throughout the northern portion of the Park.

In 1889, a stock company was organized in Tropic to divert water from the East Fork of the Sevier River to the Paria River Valley to irrigate fields. The Tropic Ditch now diverts water through 15 kilometers (9 miles) of canal and over the rim into Water Canyon. The ditch now opens an avenue for aquatic life to migrate from the Great Basin to the Colorado River Basin.

Exotic Plant Species: There are 61 species of exotic plants known to occur in Bryce Canyon National Park. Most populations of exotic plants in BRCA are small in size. Systematic survey of the park was begun in 1998 to identify and quantify populations of exotic plants. While the survey is not considered complete the areas with the highest probability of invasion by exotic plants have been surveyed. The species of most concern include musk thistle (*Carduus nutans*), Canada thistle (*Cirsium arvense*), Russian thistle (*Salsola iberica*), mullein (*Verbascum thapsus*), and cheatgrass (*Bromus tectorum*).

References Cited:

- Buchanan, H. 1960. The plant ecology of Bryce Canyon National Park. Ph.D. Dissertation, Univ. Utah. Salt Lake City, UT. 138p.
- Ott, A. 1996. Natural spring inventory in Bryce Canyon National Park. Independent study project report. Southern Utah University, Cedar City. 40 p.

Scrattish, N. 1985. Historic resource study: Bryce Canyon National Park. USDA, National Park Service, Rocky Mountain Regional Office. Denver, CO. 253p.

USDI. National Park Service. 1987. Bryce Canyon National Park – General Management Plan.

CANYONLANDS NATIONAL PARK (CANY)

Size: 136,530 hectares (337,370 acres)

Park History and Purpose: Efforts to turn Utah's canyon country into a national park began about 1935 when Secretary of the Interior Harold Ickes proposed setting aside 7,000 square miles of southeast Utah as Escalante National Monument. This effort was doomed by opposition from state commercial interests and the demands of World War II (Smith 1991), but with the rise of the conservation movement in the 1960s, Senator Frank Moss, Secretary of the Interior Stewart Udall and locals such as Kent Frost took up the battle to preserve the "still untouched" canyon country near the confluence of the Green and Colorado Rivers. Their efforts resulted in congress and President Lyndon B. Johnson setting aside Canyonlands National Park on September 12, 1964. As stated in Public Law 88-590, Canyonlands was established "...to preserve an area in the State of Utah possessing superlative scenic, scientific, and archeological features for the inspiration, benefit, and use of the public...". This is the overriding legal mandate which guides the resource management program of the park today.

Location: Canyonlands National Park is located in southeast Utah along the Colorado and Green Rivers in Grand, Garfield, San Juan and Wayne Counties. The park is southwest of Moab, Utah, 161 kilometers (100 miles) west of Grand Junction, Colorado, and 386 kilometers (240 miles) southeast of Salt Lake City, Utah. Parts of the park are readily accessible by major travel routes such as Interstate I-70 and Utah Highway 191.

The area surrounding the park is sparsely populated with a density of approximately two people per square mile (0.8 people per square kilometer). Tourism is currently the most important economic activity.

Elevation: The elevation within the park ranges from approximately 1,189 meters (3,900 feet) on the Colorado River south of Cataract Canyon to 2,188 meters (7,180 feet) above Big Pocket in the Needles District.

General Description: Canyonlands National Park has been expanded since it was originally established in 1964 to its present size of 136,530 hectares (337,370 acres) centered around the confluence of the Green and Colorado Rivers. The rivers divide the park into three geographical districts: the Island in the Sky District is the triangle of land between the two rivers, the Needles District lies east of the Colorado River and the Maze District lies to the west of the Colorado and Green Rivers. The Horseshoe Canyon Detached Unit is managed as part of the Maze District. In addition, the Green and Colorado River corridors are managed as a separate River District of the park. In summary, the park is divided into the Island in the Sky, Maze, Needles and River districts.

From prehistoric Native Americans searching for chert outcrops, through the geological investigations of John Wesley Powell and other turn-of-the-century explorers, to uranium miners of the 1950s, the geologic resources of Canyonlands have been of major interest and importance. As a result of these explorers, miners and recreationists, geological publications on the park are widely available (Baars and Molenaar 1971; Huntoon, Billingsley and Breed 1982; Mutschler 1969) and the geological resources of the park are well known.

For park visitors, probably the two most important geological features of the park are the uniquely banded red and white sandstone of the Cedar Mesa formation (exposed in the Needles and Maze Districts) and the White Rim Sandstone exposed in the Island in the Sky District.

The incredible features of the park are the remote mesas, buttes, and deep canyons cut by the Green and Colorado Rivers and their tributaries. The park's name, Canyonlands, is derived from the geology term "Canyon Lands", which is defined as the province south of the Uinta Basin and between the High Plateaus on the west and the Rocky Mountains to the east. As explained by Stockes (1988:241), the park lies at the

rugged and remote heart of the Canyon Lands section of the Colorado Plateau physiographic province in southeast Utah. The park is characterized by sedimentary rock, which has been deformed by anticlines, synclines and monoclines. Uplift of the Colorado Plateau and concurrent water erosion have produced the extensive, deep canyon systems which are the defining features of the park and of the physiographic section (Lammers 1991).

There are five major sedimentary formations exposed in the park ranging in age from the Pennsylvanian Paradox formation to the Jurassic Navajo Sandstone. In stratigraphic order, formations include Paradox, Honaker Trail, Cutler Group, Moenkopi, Chinle, Wingate Sandstone, Kayenta, and Navajo Sandstone. The Paradox formation of salt and gypsum evaporates is a highly plastic formation which has formed the salt anticlinal structures and grabens in the park, which collapsed when ground water eroded the salt.

The climate of Canyonlands National Park is arid. It is characterized by hot, dry summers and cool to cold winters. Temperatures in the park vary with altitude and latitude (Brough, Jones and Stevens 1987). In the Needles District at an elevation of 1,536 meters (5,040 feet) the average maximum temperature is 68.3° F, the average minimum is 37.8° F. The average annual precipitation is 219 millimeters (8.62 inches).

In the Island in the Sky at an elevation of 1807 meters (5,930 feet) the average maximum temperature is 64.1° F, and the average minimum temperature was 42.2° F. Temperatures can reach as high as 110° F and as low as -16° F. The normal annual precipitation is 235 millimeters (9.27 inches).

Potential evapotranspiration exceeds precipitation, making effective soil moisture a critical environmental factor. Precipitation peaks occur in March and August. Snow falls between November and March.

Flora: Previous research conducted in Canyonlands National Park documented strong relationships between edaphic characteristics and the distribution and composition of plant communities. Loope (1977) mapped the distribution of six relatively distinct vegetation types in relation to substrate. These types include (1) shrublands dominated by blackbrush (*Coleogyne ramosissima*) on shallow (<50 cm depth), weakly developed calcareous soils formed from sandstone or sandy shales, (2) shrublands dominated by shadscale (*Atriplex confertifolia*) on shallow soils formed from shales with high clay content, (3) grasslands dominated by needle and thread grass (*Stipa comata*), indian ricegrass (*Stipa hymenoides*), galleta grass (*Hilaria jamesii*), various species of dropseed (*Sporobolus* spp.), and cheatgrass (*Bromus tectorum*) on deep (>50 cm depth) soils where plant roots cannot reach the water table or capillary zone, (4) shrublands dominated by 4-wing saltbush (*Atriplex canescens*) and sagebrush (*Artemisia tridentata*) on deep sandy soils where roots seasonally access the capillary zone, (5) communities dominated by cottonwood (*Populus fremontii*), willow (*Salix* spp.), tamarisk (*Tamarix ramosissima*) and other shrubs in riparian zones where there is immediate root access to the water table, and (6) sparse woodlands dominated by pinyon (*Pinus edulis*) and juniper (*Juniperus osteosperma*) on lithic soils where water availability is controlled by hydrological effects of bedrock joints and outcrops.

Other plant communities include: snakeweed/shadscale/Mormon tea (*Gutierrezia sarothrae/Atriplex confertifolia/Ephedra viridis*), purple sage/shinnery oak/Utah juniper (*Poliomintha incana/Quercus harvardii/Juniperus osteosperma*), and greasewood/four-wing saltbush (*Sarcobatus vermiculatus/Atriplex canescens*). Springs and seeps are also scattered throughout the park and are generally composed of maidenhair fern/Jones reedgrass (*Adiantum capillus-veneris/Calamagrostis scopulorum*).

There are a number of small communities scattered throughout the park in unique microsites. These include relictual Douglas fir (*Pseudotsuga mensezii*) and aspen (*Populus tremuloides*) sites.

Fauna:

Mammals

Canyonlands NP is extremely important habitat for desert bighorn sheep (*Ovis canadensis nelsonii*). Additional mammals include the western pipitrel (*Pipistrellus hesperus*), gray fox (*Urocyon cinereoargenteus*), bobcat (*Lynx rufus*), white-tailed antelope ground squirrel (*Ammospermophilus leucurus*), rock squirrel (*Spermophilus variegatus*), Colorado chipmunk (*Eutamias quadrivittatus*), Apache pocket mouse (*Perognathus flavescens*), Ord kangaroo rat (*Dipodomys ordi*), canyon mouse (*Peromyscus crinitus*), deer mouse (*P. maniculatus*), piñon mouse (*P. truei*), northern grasshopper mouse (*Onychomys leucogaster*), desert woodrat (*Neotoma lepida*), porcupine (*Erethizon dorsatum*), blacktailed jackrabbit (*Lepus californicus*), desert cottontail

(*Sylvilagus auduboni*), mule deer (*Odocoileus hemionus*), striped skunk (*Mephitis mephitis*), ringtail (*Bassariscus astutus*) and badger (*Taxidea taxus*).

Birds

Common bird species likely to be found in the park are the mourning dove (*Zenaidura macroura*), common nighthawk (*Chordeiles minor*), white-throated swift (*Aeronautes saxatalis*), violet-green swallow (*Tachycineta thalassina*), ash-throated flycatcher (*Myiarchus cinerascens*), Say's phoebe (*Sayornis saya*), scrub jay (*Aphelocoma coerulescens*), common raven (*Corvus corax*), piñon jay (*Gymnorhinus cyanocephalus*), plain titmouse (*Parus inornatus*), cañon wren (*Catherpes mexicanus*), rock wren (*Salpinctes obsoletus*), loggerhead shrike (*Lanius ludovicianus*), gray vireo (*Vireo vicinior*), black-throated gray warbler (*Dendroica nigrescens*), black-throated sparrow (*Amphispiza bilineata*) and dark-eyed junco (*Junco hyemalis*), Cooper's hawk (*Accipiter cooperi*), golden eagle (*Aquila chrysaetos*), red-tailed hawk (*Buteo jamaicensis*) and the northern harrier (*Circus cyaneus*).

Herptofauna

Common herptofauna of the park are the red-spotted toad (*Bufo punctatus*), Woodhouse toad (*B. woodhousei*), collared lizard (*Crotaphytus collaris*), short-horned lizard (*Phrynosoma douglassi*), sagebrush lizard (*Sceloporus graciosus*), eastern fence lizard (*S. undulatus*), tree lizard (*Urosaurus ornatus*), leopard lizard (*Gambelia wislizenii*), side-blotched lizard (*Uta stansburiana*), western whiptail (*Cnemidophorus tigris*), gopher snake (*Pituophis catenifer*), common garter snake (*Pituophis catenifer*) and the midget faded rattlesnake (*Crotalus viridis concolor*).

Aquatic: Macroinvertebrates are monitored 4 times a year, since 1997, as part of the Water Quality Monitoring Program that started in 1987. There are four endangered fish in the Colorado and Green Rivers: bonytail chub (*Gila elegans*), humpback chub (*Gila cypha*), Colorado pikeminnow (*Ptychocheilus lucius*), and razorback sucker (*Xyrauchen texanus*). We also have northern river otter (*Lutra canadensis*) and beaver (*Castor canadensis*).

Unique Features and Species of Special Concern:

Plant Communities of Concern: Riparian, River, Relict Areas, Seeps, Springs, Hanging Gardens, Douglas fir (*Pseudotsuga menziesii*) relict areas, and Aspen (*Populus tremuloides*) relict areas.

Plants: Canyonlands NP has a number of sensitive plant species but none are federally classified as Threatened or Endangered. Sensitive endemics include the southwestern cloakfern (*Argyrochosma limitanea* spp. *Limitanea*), large-seeded milkweed (*Asclepias macrosperma*), Rusby milkweed (*Asclepias rusbyi*), bird's nest milkvetch (*Astragalus nidularius*), Fisher milkvetch (*Astragalus piscator*), sandstone milkvetch (*Astragalus sesquiflorus*), Franklin's ceonothus (*Ceonothus greggii* var. *franklinii*), Cateract gilia (*Gilia latifolia* var. *imperialis*), Hutchin's gilia (*Gilia hutchinsonifolia*), rimrock phlox (*Phlox austromontana* var. *lutescens*), alcove bog orchid (*Habanaria zothecina*), Jane's globemallow (*Sphaeralcea janae*), resinbush (*Vanclevia stylosa*), alcove rock daisy (*Perityle specuicola*), entrada rushpink (*Lygodesmia entrada*), helleborine (*Epipactus gigantea*), Howell scorpionweed (*Phacelia howelliana*), Trotter oreoxis (*Oreoxis trotteri*), alcove death camas (*Zigadenus vaginatus*), Osterhout's cryptanth (*Cryptantha osterhoutii*), Utah bladder fern (*Cystopteris utahensis*), wing-seed stickleaf (*Mentzelia pterosperma*), roseate gilia (*Gilia roseata*), Eastwood monkeyflower (*mimulus eastwoodii*), Moab woodyaster (*Xylorhiza glabriuscula* var. *linearifolia*), San Rafael prickly pear (*Argemone corymbosa* ssp. *arenicola*), and Toft's yucca (*Yucca angustissima* var. *toftiae*).

Animals: The park has five federally listed Endangered species, four are fish: Colorado pikeminnow (*Ptychocheilus lucius*), razorback sucker (*Xyrauchen texanus*), humpback chub (*Gila cypha*) and bonytail chub (*Gila elegans*). The fifth is the southwestern willow flycatcher (*Empidonax trailii extimus*). Surveys have just been completed and this species been observed in the park but no breeding sites have been found (Johnson 1999, 2000).

The bald eagle (*Haliaeetus leucocephalus*) and the American peregrine falcon (*falco peregrinus anatum*) have recently been delisted. One species in the park that is listed as Threatened is the Mexican spotted owl (*Strix occidentalis lucida*). Extensive inventories have been conducted and a number of breeding Mexican spotted owls were found (Wiley 1999). Some monitoring for peregrine falcons and bald eagles has been

done, but more thorough and regular surveys are needed. The bald eagle uses the park primarily for winter forage. Two other birds of concern are the Western burrowing owl (*Athene cunicularia hypugia*) and the brown-headed cowbird (*Molothrus ater*).

Canyonlands NP has a number of sensitive bat species including: long-eared myotis (*Myotis evotis*), fringed myotis (*Myotis thysandodes*), and pale Townsend's big-eared bat (*Plecotus townsendii pallesoens*).

The northern river otter (*Lutra canadensis*) is another species of concern.

Amphibians of concern include the northern leopard frog (*Rana pipiens pipiens*), tiger salamander (*Ambystoma tigrinum nebulosum*), western toad (*Bufo boreas*), and the bullfrog (*Rana catesbeiana*). The bullfrog is an exotic that competes successfully with native amphibians.

Resource Management Concerns:

Increased recreational use (visitation) and exotic plant species invasion are the main natural resource management concerns. Damage to the many cultural resources in the park is also a concern.

Recreation Use: Visitor use increased rapidly within the park during the 1980s and early 1990s causing soil and vegetation damage in heavily used areas. Impacts from visitors hiking off trails destroy crytobiotic soils and tramples vegetation, which increases erosion and effects plant growth.

Land Use Impacts: Although uranium mining was one of the most important economic activities in the area from 1950-1980, it has largely dissipated due to depressed prices and the discovery of more economical sources of uranium-bearing ore in other parts of the world. Currently, the significant mineral extraction activities in the area are solution mining of salt and potash at the Texas-Gulf Mine at Potash, Utah north of the park, and exploratory drilling for oil and gas on Bureau of Land Management (BLM) lands adjacent to the park.

Ambient noise levels in the park are the lowest in the country. The degree of silence one encounters in most areas of Canyonlands National Park is astounding and one of its great resources. Any noise detected in the area may be associated with wildlife activity, backcountry hikers or an occasional aircraft. With increased oil and gas activity in the area and the potential for mining in the future, mineral development could add significantly to noise levels. Commercial enterprises, such as airplane sightseeing tours, could also have an impact.

Without the lights from a nearby metropolitan area and the clearest air in the country, the night sky resources of the park are outstanding. Located on top of a plateau, one has a nearly 360 degree view of the stars. Numerous visitors, particularly those from the eastern United States or urban areas comment on this resource. Commercial development along highway 191 and development in the Moab Valley have already impacted this resource.

Invasive Exotic Plant Species: Canyonlands NP has about 60 exotic plants. Tamarisk (*Tamarix ramosissima*) is a problem in the riparian areas and along the river. Cheatgrass (*Bromus tectorum*), Russian olive (*Eleagnus angustifolia*), and Russian knapweed (*Centaurea repens*) are also a problem. There is a full time vegetation specialist in the park and progress is being made mapping and eliminating many exotic plant sites.

References Cited:

Baars, D.L., and C.M. Molenaar. 1971. Geology of Canyonlands and Cataract Canyon. Four Corners Geological Society, Sixth Field Conference, Cataract Canyon River Expedition.

Brough, R. D., D.L. Jones, and D.J. Stevens. 1987. Utah's Comprehensive Weather Almanac. Publishers Press, Salt Lake City, UT.

Huntoon, P.W., G.H. Billingsley, Jr. and W.J. Breed. 1982. Geologic Map of Canyonlands National Park and Vicinity, Utah. Canyonlands Natural History Association, Moab, Utah.

Lammers, D.A. 1991. Soil Survey of Canyonlands Area, Utah: Parts of Grand and San Juan Counties. United States Dept. of Agriculture, Soil Conservation Service.

Loope, W.L. 1977. Relationships of Vegetation to Environment in Canyonlands National Park. Ph.D. Dissertation. Utah State University. Logan, UT.

Mutscher, F.E. 1969. River Runners' Guide to the Canyons of the Green and Colorado Rivers with Emphasis on Geologic Features. Vol. II, Labrinth, Stillwater, and Cataract Canyons. Powell Society Ltd., Denver, CO.

USDI, National Park Service. 1994. Resource Management Plan, Canyonlands National Park. Rocky Mountain Region, Denver, Colorado. 40p.

USDI, National Park Service. 1993. Canyonlands National Park Statement for Management. Rocky Mountain Region, Denver, Colorado. 34p.

USDI, National Park Service. 1977. Canyonlands National Park: General Management Plan, Rocky Mountain Region, Denver, Colorado. 170p.

CAPITOL REEF NATIONAL PARK (CARE)

Size: 97,896 hectares (241,904 acres)

Park History and Purpose: Capitol Reef was first established as a National Monument by Franklin D. Roosevelt on August 2, 1937 by Presidential Proclamation 2246 (50 Stat. 1856). The Proclamation stated that the purpose of the Monument was to reserve in the public interest "narrow canyons displaying evidence of ancient sand dune deposits of unusual scientific value, and ...various other objects of geological and scientific interest." The monument originally comprised 14,998 hectares (37,060 acres).

The monument was enlarged by Dwight D. Eisenhower through Presidential Proclamation 3249 of July 2, 1958, 3 C.F.R. 160, which added "certain adjoining lands needed for the protection of the features of geological and scientific interest," bringing the total acreage to 40,100.

In the last hours of his term on January 20, 1969, Lyndon B. Johnson signed Presidential Proclamation 3888, 3 C.F.R. 387, which served to enlarge Monument boundaries six-fold to encompass 103,259 hectares (255,156 acres). The purpose of this expansion as stated in the Proclamation was to add "certain adjoining lands which encompass the outstanding geological feature known as Waterpocket Fold and other complementing geological features, which constitute objects of scientific interest, such as Cathedral Valley."

On December 18, 1971, Congress abolished Capitol Reef National Monument and established Capitol Reef National Park, with its final boundaries encompassing 97,896 hectares (241,904 acres) (85 Stat. 639, 16 U.S.C. § 273 *et seq.*). This act made provisions for land acquisition, management of grazing privileges, and trailing and watering regulations.

The General Management Plan (USDI 1998) describes the purpose and significance statements for Capitol Reef National Park, which are derived from its enabling legislation. These purposes are:

- conserving and protecting such geologic wonders as the Waterpocket Fold, Cathedral Valley, narrow canyons, and evidence of ancient sand dune deposits, and objects of geologic and scientific interest; and
- protecting all park features from unauthorized appropriation, injury, destruction, or removal.

The General Management Plan further recognizes that "the park preserves a variety of habitat types that support diverse plant and animal life."

Location: Capitol Reef National Park is located in south central Utah within portions of Emery, Garfield, Sevier, and Wayne Counties. It is a high-elevation, cold desert park lying in the northern portion of the Colorado Plateau. It is 112 kilometers (70 miles) long and varies from 2 to 23 kilometers (1 to 14 miles)

wide. It is 119 kilometers (74 miles) by road east of Richfield, Utah and 290 kilometers (180 miles) southwest of Grand Junction, Colorado.

Elevation: The elevation within the park varies from 2731 meters (8,960 feet) on Thousand Lake Mountain in the northwest section to 1,183 meters (3,880 feet) in Halls Creek at the southern tip.

General Description: Capitol Reef National Park encompasses most of the 161 kilometer-long (100-mile) Waterpocket Fold, the largest exposed monocline in North America. The Waterpocket Fold was formed 65 to 80 million years ago and consists of a geological uplift that stretches from Thousand Lake Mountain in the north to Lake Powell in the south. The park is named for this formation and some of its features: "Capitol" comes from the white sandstone domes that tower over the Fremont River and resemble the U.S. Capitol Rotunda, and "Reef" comes from the seafaring term for obstacles to navigation. A second feature for which the park is noted is Cathedral Valley, a flat valley punctuated with sheer sandstone spires and fins.

Capitol Reef National Park is situated on a slope that drops rapidly in elevation from west to east. Over a distance of 24 kilometers (15 miles), 11,000 foot-high mountains just west of the park drop to 1,219 meter (4,000 feet) high valleys to the east. The Waterpocket Fold is deeply cut along its length with west-to-east flowing canyons, the largest of which contains the Fremont River. Between the canyons are undulating sandstone domes or tilted slickrock plates. Two north-south oriented valleys are present on the eastern side of the park. In geologic terms, these are called strike valleys. They are less than a mile wide and are bounded by the Waterpocket Fold on the west and steep cliffs on the east. The dramatic scenery of Capitol Reef is the result of the erosion of the various rock layers during more recent geologic time.

Nearly 10,000 vertical feet of sedimentary rocks are exposed in and around Capitol Reef. Seventeen identified geologic formations (Billingsley et al. 1987) within the park were originally deposited about 270 to 65 million years ago, under conditions varying from dry sand dunes to marine swamps. More recent volcanic activity formed lava dikes and sills in the northern end of the park. Debris flows from Boulder and Thousand Lake Mountains deposited volcanic boulders on top of the sedimentary formations through the northern and middle sections.

The complex terrain and the natural processes that predominate at Capitol Reef combine to provide diverse habitats for plants and animals. The parklands support a patchwork of terrain, life zones, and habitats, where even slightly different combinations of slope, aspect, exposure, elevation, moisture, mineral content, and other variables blend to create distinctive microclimates and narrow niches. As a result, many sensitive desert species that require specific conditions - and which cannot survive outside of those parameters - occupy niches at Capitol Reef (USDI 1998). The Waterpocket Fold is home to numerous threatened, endangered, and rare species, as well as endemic plant species. This is one of the greatest concentrations in the region of plant taxa of special concern. The high plant diversity in CARE reflects the great range of habitats present and the geographic location at the intersection of several biogeographic regions (Heil et al. 1993).

Flora: Capitol Reef NP supports a diverse floristic assemblage with over 900 vascular plant taxa documented within the park. Dominant vegetation communities at Capitol Reef are typical of the Colorado Plateau Physiographic Province with pinyon-juniper woodland, grassland, and upland shrub communities present. Thirty-four plant communities have been identified within the park, with 11 being unique or first described in the park. Distribution of communities is controlled primarily by gradients in elevation and geologic substrate. Dry, hot areas at the lowest elevations support various upland shrub, grassland, and badlands communities; sandstones at low elevations and a variety of substrates at middle elevations support several kinds of pinyon-juniper communities; and cool, moist sites at high elevations are covered by woodland communities dominated by conifers or aspen. Riparian areas at all elevations support woodlands and wetlands (Heil et al. 1993).

Past grazing by livestock has altered the composition and structure of many grassland and riparian communities in CARE. It may require many decades of grazing protection and possibly active intervention to restore these communities to their presettlement condition. Recovery of community structure probably will be more rapid in riparian areas than in grasslands, but restoration of original species composition may be slow in both kinds of areas. Establishment during the 20th century of exotic plants, e.g., tamarix (*Tamarix*

chinensis) and cheatgrass (*Bromus tectorum*) has permanently changed the composition of many plant communities in CARE (Heil et al. 1993). Although plant communities for the park have been described, no vegetation map has been completed.

Fauna: There are over 300 species of mammals, birds, reptiles, amphibians, and fish found in Capitol Reef. Commonly seen mammals include mule deer, yellow-bellied marmots, bighorn sheep, and coyotes. Birds are most numerous in cottonwood and willow vegetation found along streams and perennial water sources. Reptiles are found throughout the park. The most common lizards are the side-blotched and sagebrush lizards and the most common snakes are gopher snake and striped whipsnake. Amphibians are not common in Capitol Reef, being found only near streams, springs, and rock pools. Native and introduced species of fish are found here, in the Fremont River and Pleasant, Halls, Oak, and Sulphur Creeks.

Aquatic Features: Capitol Reef NP has six perennial streams and many tinajas, which give the Waterpocket Fold its name. Tinajas have been inventoried for the southern portion of the park but not the northern. Several native and introduced species of fish are found in the Fremont River and Pleasant, Halls, Oak, and Sulphur Creeks. Macroinvertebrates have been examined in a couple localities and several new species have been described. Water rights have not been adjudicated for this basin, but the park has numerous primary rights that are used to irrigate historic orchards and fields.

Unique Features and Species of Special Concern:

Vegetation Communities: Four plant communities within Capitol Reef NP are of special concern because they are unique to the park, are vulnerable to disturbance, and/or are rare throughout their range. These include: 1) bristlecone pine (*Pinus longaeva*)-cushion plant community which is very restricted in distribution, has very old trees, and contains several rare, endemic plant species; 2) waterpocket community (*Acer negundo*, *Populus fremontii*, and *Salix exigua*), which is restricted in distribution and provides value to wildlife far greater than its limited occurrence; 3) hanging garden community which is rare and fragmented in its distribution and contains several endemic plant species; and 4) hornbeam (*Ostrya knowltonii*)-boxelder (*Acer negundo*)-oak (*Quercus gambelii*) woodland is restricted to a few localities in the southern end of the park.

Plants: Capitol Reef contains populations of eight of the 20 federally listed plant species that occur in Utah. For several of the 24 National Park Service designated sensitive plant species, there are fewer than 5,000 individual plants known, and these are found primarily in Capitol Reef (Appendix G). This large number is primarily due to the diverse geology and topography of the area and extensive endemism in the flora. Numerous geologic formations (each with its own range of soil moisture, soil chemistry, texture, and mineral composition) occur in narrow bands and at various elevation. This great variety of small habitats and unique growing conditions has provided niches for a large number of plant species with limited ranges.

Animals: Capitol Reef NP supports populations of 4 federally listed animal species and 9 species considered sensitive by the NPS (Appendix F). The listed species are bald eagle (*Haliaeetus leucocephalus*) which is a winter resident; Mexican spotted owl (*Strix occidentalis lucida*) with up to 14 known nesting sites; southwest willow flycatcher (*Empidonax traillii extimus*) - status unknown; and Utah prairie dog (*Cynomys parvidens*) which is extirpated from the park. Sensitive animal species within the park include 3 birds, 2 mammals, 1 reptile, 1 amphibian, and 2 fish.

Resource Management Concerns:

Livestock grazing: A total of 1,380 Animal Unit Months (AUMs) of winter cattle grazing is permitted on 35,208 (87,000 acres) in the northern and central portions of the park. Park resources (including flora, fauna and physical resources) are impacted by the direct and indirect effects of livestock grazing including: displacement of native plant species by invasive exotic species; direct impacts to populations of rare plant species; and conversion of native plant communities. Grazing has been reduced 72% in the park since 1988 by reallocation of AUMs to areas outside the park and from willing-seller buyouts of grazing permits. Acquisition of AUMs on a willing-seller basis will continue as opportunities arise. However, because the park currently is legally obligated to provide for grazing and trailing, other options for reducing domestic livestock grazing at Capitol Reef NP are not available. Additional grazing impacts are occurring from a herd of non-native bison that were introduced in the 1940s for hunting on adjacent public lands. The animals escape

hunting pressure by entering the park and are creating intensive impacts in localized areas. Inventories of all taxa, especially sensitive species, are needed to properly evaluate the effects of grazing.

Recreation Use: Visitor use increased rapidly within the park during the 1980s and early 1990s causing soil and vegetation damage in heavily used areas. Impacts from visitors hiking off trails destroy cryptobiotic soils and tramples vegetation, which accelerates erosion. Unfortunately, many of these areas contained rare plant species, some of which could become listed if plants in those localities disappear because of these impacts. Inventories have been done in the heavily used areas around headquarters but additional work has not been done evaluate other localities.

Land Use Impacts: Agricultural practices, both upstream and within the park's historic district, continue to modify stream flows and increase nutrient loads in the Fremont River and Sulphur Creek. Water rights adjudication has not been completed for these streams, therefore instream flows are not guaranteed. We have a two-year project to inventory fish and stream habitats for the Fremont River funded by Regional Natural Resource funds.

Endemic Plant Species: The large number of listed and very rare plant species increases the difficulty in evaluating effects of any management actions and creates an additional burden for law enforcement personnel to monitor at-risk populations. The previously mentioned impacts are identified in recovery plans as threats to rare species and, in recent years, collection of rare plant species has increased dramatically. Several populations of listed species on the park and adjacent BLM lands have been decimated by commercial collecting operations and plants from the park are being offered for sale on the Internet by unscrupulous collectors. Because the park has only three patrol rangers for such a large area, all commercially valuable cultural and natural resources in the park, including rare plants, are systematically looted each year with little chance of the perpetrators being caught. We currently have an NRPP-funded three-year project to inventory all the rare plants in the park. Using information from previous limited surveys, we are monitoring visitor and cattle impacts to several species. Once the park-wide survey is completed, we would expand this monitoring to include these species.

Invasive Exotic Plant Species: There are 108 exotic plant species that occur within Capitol Reef NP. The majority of these are present in the Fruita orchards but five main problem species occur throughout the park. Tamarisk (*Tamarix chinensis*) and Russian olive (*Elaeagnus angustifolia*) are the primary invasives in riparian habitats along streams and washes. The Fremont River is the most heavily infested area and very little control efforts to date. The tree-of-heaven (*Ailanthus altissima*) is very dense locally in the Fruita and Sleeping Rainbow ranch areas and is being treated with moderate success. As a result of overgrazing, *Halogeton* (*Halogeton glomeratus*) and cheatgrass (*Bromus tectorum*) are the primary invaders in upland areas. *Halogeton* appears to be concentrated in the northern part of the park and cheatgrass is densest in the southern. Only the *Ailanthus* has been adequately mapped to be able to prioritize control efforts.

References Cited:

Billingsley, G.H., P.W. Huntoon, and W.J. Breed. 1987. Geologic map of Capitol Reef National Park and vicinity, Emery, Garfield, Millard and Wayne Counties, Utah. Utah Geologic and Mineral Survey, Salt Lake City, Utah. (4 maps + key).

Heil, K. D., J.M. Porter, R. Fleming, and W.H. Romme. 1993. Vascular Flora of Capitol Reef National Park, Utah. U.S. Department of Interior, National Park Service and Colorado Plateau Research Station at Northern Arizona University. Technical Report NPS/NAUCARE/NRTR-93/01. 82 p.

USDI. National Park Service. 1998. Capitol Reef National Park, General Management Plan.

CEDAR BREAKS NATIONAL PARK (CEBR)

Size: 2,490.8 hectares (6,154.6 acres)

Park History and Purpose: Cedar Breaks National Monument was established by President Franklin D. Roosevelt by Proclamation No. 2054 on August 22, 1933, under authority of the Act of Congress approved June 8, 1906 (34 Stat. 225), known as an Act for the Preservation of American Antiquities, and the Act of June 4, 1897 (30 Stat. 34). The Proclamation states that "it appears desirable, in the public interest to...include said lands within a National Monument for the preservation of spectacular cliffs, canyons, and features of scenic, scientific, and educational interest contained therein...." Cedar Breaks National Monument is administered by Zion National Park, which is located approximately 64 kilometers (40 miles) to the south.

The proclamation establishing the monument and the Organic Act of 1916 establishing the National Park Service direct the basic principles and objectives for the management of park resources. The proclamation describes Cedar Breaks as "spectacular" and mandates the preservation of its "features of scenic, scientific, and educational interest...." The Organic Act (39 Stat. 535) states that, "the fundamental purpose of the said parks, monuments and reservations...is to conserve the scenery and natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

The Cedar Breaks National Monument Strategic Plan for FY2001 – FY2005 summarizes the legislative intent contained within the proclamation establishing the Monument as mandating the National Park Service to:

- Preserve the geologic spectacle of the Cedar Breaks amphitheater and preserve the scenic vistas as seen from various points along the rim of the amphitheater.
- Preserve all other park resources that are of scientific interest, including geologic, floral, faunal, and cultural resources contained within the boundaries of the monument.
- Interpret the value of and promote public appreciation and enjoyment of Cedar Breaks National Monument.

Therefore, the purpose of Cedar Breaks National Monument is:

- To preserve the geology, vistas, natural and ecological processes, and other features of scenic, scientific, and education interest of Cedar Breaks National Monument.
- To provide opportunities for research, public enjoyment, inspiration, and appreciation of the resources of Cedar Breaks National Monument through interpretation and other educational endeavors.

Location: Cedar Breaks National Monument is located in southwestern Utah in Iron County, 29 kilometers (18 miles) east of Cedar City, Utah, on the western edge of the Markagunt Plateau. Its location is also on the western edge of the Colorado Plateau physiographic province, with spectacular views westward into the Basin and Range province.

Elevation: The elevation within the monument varies from 3,250 kilometers (10,662 feet) in the northeastern section of the park above the amphitheater rim, to 2,469 meters (8,100 feet) on Ashdown Creek on the monument's western boundary.

General Description: Cedar Breaks National Monument contains an outstanding scenic multi-colored geologic amphitheater, 762 meters (2,500 feet deep) and 5 kilometers (3 miles) wide, eroded from the Claron Formation, located on the western edge of the 3,353 meters (11,000-foot) Markagunt Plateau.

The Claron Formation, the primary geologic unit of the park, was a limy ooze deposited in shallow Eocene lakes near sea level about 55 million years ago. A general uplift and development of fault blocks occurred during the Miocene, dated about 14 million years before present. The Cedar Breaks amphitheater is an escarpment facing westward with rims on the north, east, and south. The cliffs and canyons of Cedar Breaks have been carved into the western edge of the Markagunt Plateau by the headwaters of Ashdown Creek and its tributaries. Iron and manganese minerals in the rock produce a wide range of red, yellow, orange and purple hues across the cliffs. While this is the same geological formation preserved at Bryce Canyon National Park, variations in the rock layers and differences in the action of the geological processes involved have produced more colorful scenic vistas at Cedar Breaks but with fewer of the spires, pinnacles and arches that are found at Bryce Canyon.

The rim area of the Cedar Breaks features a mixture of spruce/fir forest and subalpine meadows. Throughout the summer the meadows abound in a dazzling profusion of wildflowers peaking in midsummer with a magnificent display of waves of color across the meadows and into the forests. At the very edges of the cliffs throughout the monument, ancient Bristlecone pine trees are found thriving in the harsh exposed environment to which they are so well adapted. The oldest Bristlecone known in the monument is about 1,700 years old.

The climate of Cedar Breaks National Monument is influenced by the tropical Gulf, tropical Pacific, and polar Pacific air masses. Their influence, combined with the elevation, produces annual precipitation significantly higher than much of the surrounding terrain. In the winter, storms move into the area from the west, southwest, and northwest; most moisture falls as snow, closing the roads into the park from November to mid-May. A dry southwest flow prevails in summer, with occasional thundershowers that move into the area from the Gulf of Mexico or rotate around high pressure systems.

Climate data is recorded at the Blowhard Mountain radar site, located about one mile south of the monument at an elevation of 3,262 meters (10,700 feet). Mean annual precipitation is 29.73", from a low of 16.90" (1989) to a high of 47.24" (1966). Mean annual maximum temperature is 42.3 F, ranging from a January low of 27.4 to a July high of 62.5, while mean annual minimum temperature is 27.2 F, ranging from 12.4 in January to 47.4 in July. Mean monthly minimums are above 32 F only in June, July, August, and September. The result is long, cold winters, and short, cool summers. Annual cumulative snowfalls range from ten to over 9 meters (30 feet).

Flora: Plant communities found in the park are those associated with the pinyon-juniper forests of the lower Transition Zone, to ponderosa pine, blue spruce, and Douglas fir overstory with Rocky Mountain maple, greenleaf manzanita, and/or Oregon grape understory of the Canadian Zone, up to the Englemann spruce-subalpine fir overstory with monkshood, Oregon grape, and/or gooseberry understory and subalpine meadows of grasses, sedges, and forbs of the Hudsonian Zone. A wide variety of plant life exists due to the wide range in elevation in the park and the micro-habitats that are found within each of them.

Of the 269 plant species identified at Cedar Breaks National Monument in 1989 (Roberts and Jean), twelve are introduced from other continents and are exotics to the native flora. The most widespread of these is the dandelion (*Taraxacum officinale*) and smooth brome grass (*Bromus inermis*).

Fauna: As with vegetation, the topographic diversity of the monument supports a large variety of animal life. Thirty-seven mammal and 86 bird species have been identified in the monument, although a complete, intensive survey of the park has not been done. Elk, mule deer, mountain lion, and black bear are the dominant large animals and can be found throughout the various elevation ranges of the park, although sightings of mountain lions and bears are rare. The higher elevations provide habitat for the pika, marmot, badger, and porcupine. Middle elevations support gray fox and coyote. A large number of rodents and birds also inhabit the monument, including the Colorado chipmunk, golden-mantled ground squirrel, pocket gopher, golden eagle, Clark's nutcracker, common raven, violet-green swallow, and white-crowned sparrow. Peregrine falcons have been seen nesting just outside the park to the north and some have been observed in the park. There is little information on reptiles or amphibians in the park.

Aquatic Resources: The only species of fish known to exist in the monument is the brook trout (*Silvelinus fontinalis*), an introduced species. Alpine Pond contains a population of these exotic trout that remain from

several decades of artificial stocking. Prior to stocking the pond, no naturally occurring fish species were present. There is no other information available on the aquatic life of Cedar Breaks.

Description of Unique Features and Important Natural Resources:

Vegetation Communities: A large portion of the of the park has been affected by the spruce bark beetle epidemic that has killed thousands of acres Englemann spruce stands on the Markagunt Plateau. It is estimated that 80 to 90% mortality has occurred in the northern half of the park. The park has been working closely with the U.S.F.S. since the epidemic began in 1993 with monitoring activities and in determining appropriate steps to mitigate the impact of the epidemic within the park. According to the U.S.F.S. survey, the outbreak hit a new high in 1997, with a general expansion into the remaining live host occurring. Mortality had expanded in all directions from the Sidney Valley area, just northeast of the park, and continues to push into the park. It is predicted that mortality totals will increase until most of the live host trees in the affected areas are killed. This appears to be the stand replacing event that studies have shown occurs every 300 to 500 years in the process of forest succession. Subalpine fir, aspen, limber pine and bristlecone pine are unaffected by this insect, but dramatic changes in the composition and structure of the high elevation forest within the park are occurring.

Species of Special Concern: In their 1989 final report entitled "Plant Community and Rare and Exotic Species Distribution and Dynamics at Cedar Breaks National Monument," Roberts and Jean list seven plant species that are described as "rare." The report further states that plant rarity does not necessarily imply endangerment or possible extinction, but may imply a restricted geographic range or distribution due to physical, biological or man-induced factors. These plant species at Cedar Breaks are associated with the unique geologic Claron limestone formation, which provides habitat for these endemic species. The nature of endemism with its narrowly restricted plant populations led the U.S. Fish and Wildlife Service to consider many of the endemic plants of Cedar Breaks National Monument for listing as threatened or endangered. These are plants that were formerly listed as "Category 3" or "candidate" species, but are now referred to as "Special Concern" species. They include: Navajo Lake milkvetch (*Astragalus limnocharis*), Least spring parsley (*Cymopterus minimus*), Red Canyon catchfly (*Silene petersonii*), Reveal's paintbrush (*Castilleja parvula* var. *revealii*), Cedar Breaks goldenbush (*Haplopappus zionis*), cliff jamesia (*Jamesia americana* var. *zionis*); and cliff daisy (*Erigeron proselyticus*).

Since that report, another special concern species has been documented within Cedar Breaks National Monument. The U.S. Fish and Wildlife Service proposed Arizona willow (*Salix arizonica*), for listing as an endangered species with critical habitat in 1992. At that time, it was known to occur only in an area of east central Arizona; no one was aware that the species occurred in Utah. A collection dating to 1913 from what is now the Dixie National Forest prompted fieldwork in 1994 to determine the extent of this species in Utah, prior to the final determination for listing the species as endangered. The 1994 fieldwork resulted in the discovery of populations in Utah that far exceed the number of total plants from Arizona and significantly expanded the known range of Arizona willow. One of the largest known contiguous stands of Arizona willow shares a common boundary between the Dixie National Forest and Cedar Breaks National Monument. The U.S. Fish and Wildlife Service and the U.S. Forest Service developed a conservation plan for the species that would provide for implementation of short- and long-term protective measures to reduce threats to the species and its habitat (USDA Forest Service et al. 1995). Cedar Breaks National Monument is a signatory to this agreement.

Overview of Resource Management Concerns:

Recreation Use: Visitor use of Cedar Breaks National Monument has been steadily increasing over the last decade. Annual visitation has grown from just over 400,000 in 1992 to over 650,000 in 1999. Because of the inaccessibility of the geologic amphitheater to hikers, virtually all visitor use occurs on the rim along the scenic drive and at the rim overlooks. Parking areas and the campground fill to capacity much more frequently now, increasing the occurrence of off-trail hiking, off-road parking/driving, and out-of-bounds camping, with resultant damage to vegetation and soils.

Hazard Tree Management: The large number of dead trees from the spruce bark beetle epidemic (see above), and the properties of aging subalpine fir and aspen that make them prone to structural failure, has increased the occurrence of falling trees in and around developed recreation areas, in the vicinity of historic structures, and along the road corridors within the park. Hazard trees are being evaluated in accordance

with the park's Hazard Tree Management Plan, and each year numerous trees are removed from high-risk areas. The scale of this problem has grown considerably in the years following the beetle outbreak, with the potential for serious threats to visitor safety and the preservation of important cultural resources.

Adjacent Land Uses/Impacts on Vistas: Cedar Breaks National Monument is surrounded on all sides by the Dixie National Forest, with about one mile of frontage along the park's eastern boundary that is in private ownership. The Brian Head Ski Resort is less than three miles to the north. The development of private lands with summer homes, commercial logging on both private and Forest Service lands, and grazing and hunting activities occur right up to park boundary fences. Trespass grazing and illegal hunting within the park are fairly common. The extent to which these adjacent land uses are impacting the plant and animal resources of the park is largely unknown.

In addition, the expansion of the Brian Head Ski Resort, special use permits on the Dixie National Forest that have resulted in the installation of a large FAA radar dome and a NOAA Nexrad radar dome, both on Blowhard Mountain, and the growth of Cedar City to the west have all resulted in visual impacts to the vistas that are a significant and valuable park resource. The gradual expansion of housing developments and light industry to the west of Cedar City, and visible from park overlooks, has also contributed to light pollution that will eventually affect the night skies visible from within the park.

References Cited:

- National Park Service. 1992. Resources Management Plan, Cedar Breaks National Monument. Cedar City, UT: Cedar Breaks National Monument.
- Roberts, David W. and Jean, Catherine. 1989. Plant community and rare and exotic species distribution and dynamics in Cedar Breaks National Monument. Unpublished Report Contract Report No.PX-1200-9-C813 on file at Utah State University, Department of Forest Resources and Ecology Center. Logan, Utah. 185 p.
- USDA. Forest Service, Intermountain Region; USDA Forest Service, Southwestern Region; USDI National Park Service, Rocky Mountain Region; USDI Fish and Wildlife Service, Mountain-Prairie Region; USDI Fish and Wildlife Service, Southwest Region. 1995. Arizona Willow (*Salix arizonica*) Conservation Agreement and Strategy. April 1995.

COLORADO NATIONAL MONUMENT (COLM)

Size: 8,280 hectares (20,453 acres)

Park History and Purpose: Colorado National Monument was established by William Howard Taft's Presidential Proclamation (Number 1126) on May 24, 1911. In 1916 the National Park Service was created and assumed administration of Colorado National Monument. The Proclamation stated that the purpose of the Monument was to reserve in the public interest "the extraordinary examples of erosion (which) are of great scientific interest, ...together with as much public land as may be necessary for the proper protection thereof."

Subsequent proclamations have broadened the original mandate for managing Colorado National Monument. The Hoover Proclamation of 1933 added "certain adjoining lands for the purpose of including ...features of historic and scientific interest and for the protection of the rim road and for administration purposes...." The Eisenhower Proclamation of 1959 reaffirmed the above proclamation.

The Colorado National Monument Resource Management Plan (USDI 1999) describes its purpose as:

- preservation of its resources for scientific and public interest, and
- protection of the Rim Rock Drive for the general use and enjoyment of the public.

Location: Colorado National Monument is located in west-central Colorado in Mesa County just west of Grand Junction. The Monument is about 16 kilometers (10 miles) long and 5 to 10 kilometers (3 to 6 miles) wide. It is situated on the northeastern edge of the Colorado Plateau at the transition to the Rocky Mountain province.

Elevation: The elevation within the Monument ranges from 1,408 meters (4,620 feet) at the foot of the cliffs to 2,166 meters (7,107 feet) on the mesa above the canyons.

General Description: Colorado National Monument lies on the northeastern edge of the Uncompahgre Plateau where it abruptly terminates and adjoins the Grand Valley. The landscape of the area contains outstanding geologic features, exposed and sculpted by erosion. Geologic history, ranging from the ancient crystalline rocks of the Precambrian age to the soft, mixed shales and sandstones of the Jurassic age Morrison formation, is recorded in the exposed cliffs. The massive Wingate formation, lying midway in the stratigraphic sequence, forms the steep walls of the canyons and dominates the scenery (Sloan 1995).

A semi-desert upland climate prevails in the area, with an average of less than 280 millimeters (11 inches) of annual precipitation. Temperatures vary from summer highs in the high 90's to winter lows sometimes dipping into the sub-zero range. Snowfall averages 96 centimeters (38 inches), with the heaviest accumulations usually in January.

There are no perennial streams in the monument, but there are ephemeral surface flows, seeps and potholes that supply water for wildlife throughout most of the year.

Flora: Dominant vegetation communities in the Colorado National Monument are the pinyon-juniper woodland, grassland, and upland shrub communities typical of the Colorado Plateau Physiographic Province. The pinyon-juniper woodland densely covers the higher elevations above the cliffs, and sparsely covers the sides of the canyons. Thick stands of Gambel oak are found within the upper reaches of some of the drainages. Open areas dominated by big sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus* spp.), and greasewood (*Sarcobatus vermiculatus*) are scattered in the canyon bottoms. Riparian communities in the canyon bottoms include coyote willow/horsetail (*Salix exigua/Hippochaete hyemalis*) and Tamarisk/Russian olive (*Tamarix chinensis/Eleagnus angustifolia*). Other species in the riparian zone include Rocky Mountain willow (*Salix monticola*), western river birch (*Betula occidentalis*) (Lyon et al. 1996), and several orchids.

The monument provides excellent examples of plant communities in near pristine condition. One relict site on an isolated mesa with a community of pinyon pine/mountain mahogany (*Pinus edulis/Cercocarpus montanus*) was documented by researchers in 1990 (Van Pelt et al. 1991). They also found relict species including Douglas fir (*Pseudotsuga menziesii*) and manzanita (*Arctostaphylos patula*) elsewhere in the monument.

Grazing by an introduced herd of bison, eliminated in 1983, has altered vegetation cover and composition in areas of the Monument below the cliffs. Exotic invasive species have been introduced in the canyon riparian habitat, along roadsides and in other disturbed sites. A complete inventory of exotic species in the Monument has yet to be accomplished.

The vascular flora record includes more than 66 families, 250 genera and 450 species, based on specimens in the COLM herbarium and on the checklist developed in 1985 (Weber et al.). An identification guide for cacti of the Monument describes nine species (Campbell 1996). The Colorado Natural Heritage Program lists 14 sensitive plant species for the Monument. Only 55 species of lichens have been identified for the Monument.

Fauna: The checklist of mammals includes 64 species, of which 41 have actually been recorded from the Monument. Desert bighorn sheep were reintroduced in 1979. Twelve bat species are known to be present in the Monument; there is suitable habitat for five additional species (Perrotti 1995). A herd of bison was introduced and maintained on the Monument from 1925 to 1983.

The checklist for birds of the Monument includes 127 species (Kaeding 1990). Monitoring projects are ongoing for peregrine falcons and gray vireos.

The checklist of amphibians and reptiles includes 25 species: one salamander, two toads and two frogs, one turtle, nine lizards, and nine snakes. Rare species of note are the midget-faded rattlesnake (*Crotalus viridus concolor*) and Utah blackhead snake (*Tantilla planiceps*); the clouded tiger salamander (*Ambystoma tigrinum*), Great Basin spadefoot (*Saphiopus intermontanus*), and canyon treefrog (*Hyla arenicolor*).

Arthropods have been recorded for the Monument in a 23 page checklist produced in 1994 (Kondratieff et al.) A list of butterflies and moths for the Monument includes more than 200 species (Weissmann et al. 1997).

Aquatic Features: Springs, seeps and tinajas provide habitat for amphibians and riparian plants. There are no fish within the Monument.

Unique Features and Species of Special Concern:

Vegetation Communities: Riparian communities in the canyon bottoms include coyote willow/horsetail (*Salix exigua/Hippochaete hyemalis*), which is also habitat for the canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*). Two other plant associations, Utah juniper/Salina wildrye (*Juniperus osteosperma/Elymus salinus*) and pinyon pine/mountain mahogany/Salina wildrye (*Pinus edulis/Cercocarpus montanus/Elymus salinus*) are identified in the 1984 "Plant Associations of special Concern in Colorado"(USDI 1999).

Plants: Of the 14 sensitive plant species listed for the Monument by the Colorado Natural Heritage Program, at least two are in need of status surveys and monitoring. The Canyonlands lomatium (*Lomatium latilobum*) is ranked G1 S1, and described as "one of the rarest plants in Colorado" (Lyon et al. 1996). It grows on climbable shelves of the Wingate sandstone cliffs in canyons that are popular for hikers. Canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) (G4G5T3S2) depends on a reliable supply of moisture year-round, which is found only in a few canyon seeps. In addition, Uinta Basin hookless cactus (*Sclerocactus glaucus*), a listed Threatened species, has been reported (unverified) at one location in the Monument close to a suburban development.

Animals: Colorado National Monument provides a critical and protected haven for Coloradan bats. Of the 12 bat species that are known to be present in the Monument, the Townsend's big-eared bat (*Plecotus townsendii pallencens*) is listed as a former species of concern; it is the major impetus and focus of the Colorado Division of Wildlife's Bat/Abandoned Mine conservation project. The fringed myotis (*Myotis thysanodes*) and the big free-tailed bat (*Nyctinomops macrotus*) are also considered rare in the state of Colorado. There is potential habitat for the endangered spotted bat (*Euderma maculatum*).

There have been inventories, mapping and ongoing monitoring of American peregrine falcon (*Falco peregrinus anatum*), and the gray vireo (*Vireo vicinior*) and plumbeous vireos (Giroir 1999). Colorado National Monument was recently designated as an Important Bird Area by the National Audubon Society.

The desert bighorn sheep population is estimated at 75 individuals. The Colorado Division of Wildlife continues to monitor the herd (Sloan 1995).

Rare reptile and amphibian species of note are the midget-faded rattlesnake (*Crotalus viridus concolor*) and Utah blackhead snake (*Tantilla planiceps*); the clouded tiger salamander (*Ambystoma tigrinum*), Great Basin spadefoot (*Saphiopus intermontanus*), and canyon treefrog (*Hyla arenicolor*). Iguanid lizard surveys and behavioral studies were conducted by a team of researchers from the University of Windsor, Ontario, from 1988 to 1994.

Five new species of moths were discovered in the Monument by outside researchers in 1998. Independent surveys for lepidoptera should be supplemented with inventories, monitoring and documentation by NPS to enable management planning for this resource.

Resource Management Concerns:

Planning: Comprehensive biological inventories for use in planning and management of natural resources have not been completed for any of the taxa in Colorado National Monument.

Recreational Use: The number of hikers entering the Monument from public trailheads near Grand Junction and from residential developments at the mouths of the canyons is increasing rapidly. A baseline documentation and condition assessment of the trails system in the Monument is currently underway in preparation for the development of a trails management plan. Baseline inventories of riparian habitats and sensitive amphibian and plant species in these canyons need to be completed and coordinated with the trails planning.

Hiking in the canyons and off-road vehicle intrusions from BLM land in the backcountry threaten to accelerate erosion of the geologic resources that the Monument is mandated to protect. Monitoring of vegetation cover and mapping of social trails could provide measurements of the impacts of these activities.

Land Use Impacts: Growth in the Grand Valley has brought development of housing and commercial buildings up to the boundary of the monument. Increased public use of BLM lands along the western boundary also impacts Monument resources. Inventories and monitoring of Monument resources are needed to provide the information for development of a sustainable Resource Management Plan.

Sensitive Plant species: The Canyonlands lomatium (*Lomatium latilobum*) grows on climbable shelves of the Wingate sandstone cliffs in popular hiking areas where trails are unmarked. The canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) grows in wet areas of canyon bottoms that are attractive to hikers. Plant populations need to be inventoried, mapped, and protected by marking trails to route hikers around the sensitive habitat.

Vegetation Management: Utah juniper and pinyon pine tree mortality rates have increased over the past several years. They have a root fungus, probably augmented by drought stress. A determination should be made as to the causes for mortality, the sources whether natural or anthropogenic, and the effect on other NPS areas as well. Mitigation measures and monitoring of causal factors should be considered (USDI 1999).

Potential for fires is a concern because of residential areas adjacent to Monument boundaries. Increasing numbers of dead trees and increasing cheatgrass cover are two factors that contribute to the fuel load. Collection of natural fire regime data and monitoring of vegetation and ground cover is needed to provide information for fire management.

Permanent vegetation monitoring plots were established in several locations within the Monument in 1982 and read in 1985 for the purpose of measuring effects of air pollution from a refinery in Fruita. The refinery is not in operation now. Recent samples of lichens and cryptobiotic crusts show evidence of damage attributable to the effects of air pollutants (USDI 1999). Lichens on the cliffs that face the adjacent city of Grand Junction could provide a monitoring tool for measuring the effects of air pollution on vegetation in the Monument.

Invasive Exotic Plant Species: A complete inventory of exotic species in the Monument has yet to be conducted.

Tamarisk (*Tamarix ramosissima*) has received the most attention at COLM, starting in about 1995. The Lake Mead tamarisk terminators treated all except about 15 kilometers (9 miles) of canyon habitat in 1997. Monument staff and volunteers have continued treatments and follow-ups each year. Pre-treatment maps are in the monument GIS. Additional follow-up treatments and documentation are needed.

Russian olive (*Eleagnus angustifolia*) has been taken out along with the tamarisk, and also needs follow-up documentation. Other species of greatest concern are Russian knapweed (*Centaurea repens*) and cheatgrass (*Bromus tectorum*). The knapweed populations have been mapped and sprayed for several years and continue to need some followup spraying and documentation. Cheatgrass is found throughout the

Monument. In areas impacted by past bison grazing as well as other disturbances, and on some roadsides it is found in high densities to the exclusion of other species.

Yellow sweet clover (*Melilotus officinalis*) has been sprayed along some roadsides. This species and the Russian thistle (*Salsola australis*) have not had a treatment plan implemented.

Animals: There are no data on population size and movements of mountain lions in the Monument. In anticipation of potential conflicts between increasing numbers of visitors in the Monument and all around its boundaries, basic data needs to be collected and maintained for management of the mountain lion.

Amphibian reproduction is being threatened by recreational use of ephemeral pools in the lower canyons where hikers like to play in the water. Amphibian surveys and monitoring data are needed for trail planning and recreation management.

The desert bighorn sheep herd is still being monitored. There is continued mortality among adults and lambs. Recommendations are for one or two additional translocations (Singer 1998).

The Colorado Division of Wildlife and the Monument have collected many years of site data for peregrine falcons (*Falco peregrinus*). These data need to be consolidated.

Prairie dogs towns along the boundary with residential subdivisions should be monitored periodically.

References Cited:

- Armstrong, D.M., C. Rector. 1988. Annotated Checklist of Mammals of Colorado National Monument, Mesa County, Colorado. University of Colorado, Boulder.
- Campbell, D.I. 1996. Cacti of the Colorado National Monument. Unpublished.
- Girou, G.P. 1999. Progress Report; Inventory Gray and Plumbeous Vireo Populations in Colorado National Monument. Colorado Bird Observatory.
- Kaeding, B. 1990. Birds of Colorado National Monument. Grand Valley Audubon Society and Colorado National Monument Association.
- Kondratieff, B.C., M.J. Weissmann, and D.E. Walter. 1994. Arthropod Life Recorded from Colorado National Monument, Colorado. Unpublished checklist, 25 p.
- Lyon, P., C. Pague, R. Rondeau, L. Renner, C. Slater, and C. Richard. 1996. Natural Heritage Inventory of Mesa County, Colorado. Report to Mesa County Commissioners. Colorado natural Heritage Program, Fort Collins, CO.
- Perrotti, P. 1995. Survey of Bat Populations, Distribution and Abundance. Draft project proposal. Colorado National Monument, Fruita, Colorado.
- Singer, F.J., and M. Gudorf. 1998. Restoration of Bighorn Sheep Metapopulations into and near 15 National park Units; Conservaton Biology of a Severely Fragmented Species. Final report to National Park Service on Natural Resources Preservation, Project No. RMRO-N-411.101, Vol.I.
- Sloan, W.B. 1995. A Herd History of the Bighorn Sheep of the Colorado National Monument and the Black Ridge, Colorado. USDI National Park Service, Southeast Utah Group, Moab, Utah.
- USDI. National Park Service. 1999. Colorado National Monument, Resource Management Plan.
- Van Pelt, S., C.D. Schelz, and D.W. Johnson. 1991. Survey and analysis of relict plant communities within National Park system units of the Colorado Plateau, Volume I. Rocky Mountain Regional Office, USDI, National Park Service, Lakewood, CO.
- Weber, W.A, V. Siplininsky, H. Beck, and C. Rector. 1985. Checklist of Vascular Plants, Colorado National Monument. University of Colorado Museum, Boulder, CO and Colorado National Monument, Fruita.
- Weissmann, M., B. Acer, Page, S. Rodgers, and P.A. Opler. 1997. Lepidoptera of Colorado National Monument. Unpublished.

CURECANTI NATIONAL RECREATION AREA (CURE)

Size: 16,390 hectares (40,500 acres)

Park History and Purpose: Curecanti National Recreation Area is administered by the National Park Service (NPS) through a February 11, 1965 Memorandum of Agreement between the NPS and the Bureau of Reclamation and is therefore part of the National Park System. The recreation area is composed of a chain of three reservoirs impounded on the Gunnison River. The reservoirs comprise the Wayne N. Aspinall Unit (formerly the Curecanti Unit) of the Colorado River Storage Project operated by the United States Bureau of Reclamation. Curecanti draws its basic purpose from the 1965 Memorandum of Agreement as well as from the Colorado River Storage Project Act, Chapter 203 enacted April 11, 1956, as follows:

Sec. (1) "... the Secretary of the Interior is hereby authorized to construct, operate, and maintain the following initial units of the Colorado River Storage Project, consisting of dams, reservoirs, power plants, transmission facilities and appurtenant works:"

Sec. (8) "... the Secretary is authorized and directed to investigate, plan, operate and maintain (1) public recreational facilities on lands withdrawn or acquired for the development of said project or of said participating projects, to conserve the scenery, the natural, historic, and archeologic objects, and the wildlife on said lands, and to provide for public use and enjoyment of the same and of the water areas created by these projects by such means as are consistent with the primary purposes of said projects; and (2) facilities to mitigate losses of, and improve conditions for, the propagation of fish and wildlife."

Curecanti National Recreation Area's General Management Plan (NPS 1997) provides guidelines for future management. It identifies management actions that satisfy public needs while protecting the area's natural and cultural resources. The General Management Plan identifies the Park Purpose for Curecanti National Recreation Area as follows:

- "To conserve the scenery, natural, historic, and archeological resources, and wildlife of Curecanti National Recreation Area."
- "To provide for public use and enjoyment in such a way as to ensure visitor safety and resource preservation or conservation by establishing and maintaining facilities and providing protective and interpretive services."

The General Management Plan identifies one of the Park Mandates for Curecanti National Recreation Area as follows:

- "To mitigate the loss of fish and wildlife resources as a result of the Colorado River Storage Project."

Building on the objectives put forth in the General Management Plan, the specific objectives identified in the Curecanti National Recreation Area Resource Management Plan (NPS 1995) for the stewardship of park natural resources are:

- Maintain, restore, or simulate natural terrestrial, aquatic, and atmospheric ecosystem conditions and processes to the degree that is physically possible, so they may operate unimpaired from human influences.
- Maintain or restore indigenous flora, fauna, and natural communities to achieve species diversity and community structure equivalent to pre-Columbian times or post-Columbian conditions that would have been created by natural events and processes.
- Protect rare species by measures aimed at preventing extirpation but which minimize adverse influences on other indigenous species.
- Encourage and participate in efforts to acquire and analyze information through research to facilitate development of the best possible management strategies for resource protection.

- Conduct long-term ecological monitoring and work cooperatively with other agencies to minimize, mitigate or prevent resource damaging human influences resulting from activities inside and outside of the park boundaries.
- Permit only those types and levels of development that do not significantly impair park resources, and direct development to environments least vulnerable to resource degradation.

Location: Curecanti is located in Colorado's Third congressional District within Gunnison and Montrose Counties. The recreation area is located approximately 315 kilometers (196 miles) southwest of Denver, Colorado and 24 kilometers (15 miles) west of Gunnison, Colorado.

Elevation: Changes in elevation 1,981 meters (6,500 feet) at East Portal to 2,896 meters (9,500 feet) near Sheep Knob), in combination with slope, geology, and aspect, have created diverse habitats that support a wide variety of vertebrate and plant species.

General Description: The West Elk Mountains to the north, the Sawatch Range to the east, and the San Juan Mountains to the south frame the Gunnison River Valley. The modern Gunnison River became established in its current course about 10 to 15 million years ago, just after the last eruptions in the San Juans and West Elks. This coincides with the beginning of a period of rapid uplift of the Great Basin and Colorado Plateau provinces that lie between the Rockies and the Sierra Nevada Range in California. The uplift allowed the early Gunnison River to easily cut its way down through the thick layers of Tertiary volcanics and Mesozoic sedimentary rocks. Two million years ago, the river began to expose the much harder Precambrian basement rocks of the Gunnison Uplift. At the rate of about one inch per every hundred years, the Gunnison slowly worked its way through the resistant rock, forming the narrow, steep-sided Black Canyon of the Gunnison. The volcanic deposits have since eroded on the mesa faces surrounding Blue Mesa Reservoir, forming spires and pinnacles as seen on Dillon Mesa. The towering walls of the Canyon are an imposing feature of Morrow Point and Crystal Reservoirs. Morrow Point's Curecanti Needle, sculpted from the canyon wall, stands as an excellent example of North American Precambrian bedrock.

Blue Mesa Reservoir, one of three reservoirs within the recreation area and the largest body of water entirely within the State of Colorado, is situated in the Gunnison River Valley characterized by bordering steep bluffs and high mesas. Blue Mesa supports the largest Kokanee Salmon fishery in the United States. The shoreline slopes surrounding Blue Mesa Reservoir are covered with grasses, big sagebrush, rabbitbrush, and Gambel oak gradually reaching 2,743 meters (9,000 feet) mesas. The mesa tops are characteristically covered with high desert vegetation; however, there are intermittent pockets of Douglas fir, quaking aspen, and spruce. Separating the mesa tops are north-south running canyons that contain lush riparian flora. Morrow Point and Crystal Reservoirs, both narrow fiord-like lakes, are situated in the Black Canyon of the Gunnison River. Shrubs and conifers cover the north facing slopes and canyon rims along both of these lower, narrow reservoirs. Located within the park boundary are 18 kilometers (11 miles) of the Gunnison River and 85 kilometers (53 miles) of tributary streams.

There are at least 51 species of mammals and over 220 species of birds that make up the base of Curecanti's wildlife resource. Some are permanent residents, others use the park as a wintering ground and still others are migratory in nature.

Temperatures range from a low of -30°F (-34°C) in the winter to highs of approximately 85°F (29°C) in the summer. Average annual precipitation is approximately 280 millimeters (11 inches). Most of the precipitation occurs in the form of spring and summer rains. The wind is predominantly out of the southwest with episodes of high velocity. Canyon bottoms are typically 10° to 15°F (5° to 8°C) warmer than ridgetops during the summer months.

Aquatic Features: The Upper Gunnison River watershed, upstream of the western boundary of Curecanti National Recreation Area, drains approximately 3,965 square miles. Located within the recreation area boundary are approximately 18 kilometers (11 miles) of the Gunnison River and 85 kilometers (53 miles) of tributary streams. The eastern-most portion of the recreation area is comprised of a riverine system, essentially unaltered since the construction of the reservoirs. This historic system encompasses an alluvial floodplain and is therefore prone to natural flood events and channel avulsions. This diverse riparian area harbors a mature cottonwood (*Populus angustifolia*) overstory with an herbaceous understory. Numerous

ephemeral pools and wetland areas adjoin the river and harbor a diverse assemblage of vertebrate and invertebrate fauna. The Gunnison River, providing 50% of the inflow to Blue Mesa Reservoir, is of good quality and supports both native and stocked trout fisheries. Many of the high mountain streams which form tributaries that enter Curecanti's reservoirs originate from areas where the stream water quality is excellent. Many of these streams are relict and support high quality functioning aquatic systems. The effects of past mining activity, naturally occurring mineral contamination, grazing, logging, road construction, and creational activities, have degraded several streams in the upper portion of the basin. As these waters progress downstream toward Blue Mesa Reservoir, additional factors, including point and non-point sources such as municipal and industrial discharges, domestic sewage discharges, diversions for irrigation, overland agricultural runoff, and gravel mining and stream channelization, have the potential for altering their quality. Some tributaries inside CURE that flow into Blue Mesa, Morrow Point, and Crystal Reservoirs were identified as potential sites for the reintroduction of Colorado River Cutthroat Trout. The Nature Conservancy has identified several other tributaries as potential relict sites for inclusion as research natural areas. Blue Creek was noted as having significantly secluded and riparian attributes and was suggested as requiring further research.

Unique Features and Species of Special Concern:

Curecanti National Recreation Area lies in the heart of one of the most scenic areas of the Central Rockies, well known for its wide vistas and views of distant peaks. The natural environment surrounding the recreation area provided rich hunting and food gathering for the prehistoric peoples of the Gunnison area. The abundance of wildlife, natural beauty, and diversity of recreational opportunities continues to draw people today.

Plants and Vegetation Communities: The recreation area's diverse vegetative resources include native and exotic species, irrigated meadowlands and site-specific landscaped zones. This vegetation provides an opportunity for visitors to understand, experience, and enjoy the scenic and natural vegetative resources of the western slope of the Rocky Mountains. Four rare plants are either known or suspected to occupy lands within Curecanti including Black Canyon gila (*Gila pentstemonoides*), hanging garden sullivantia (*Sullivantia hapemanii* var. *purpusii*), skiff milkvetch (*Astragalus microcymbus*), and Gunnison milkvetch (*Astragalus anisus*). The area's unique geological conditions and semi-arid environment combine to create a number of habitats of particular interest throughout the recreation area including seeps & springs, riparian areas, and hanging gardens.

Animals: The geographic location of the park, along with the resources it has to offer, makes Curecanti an attractive site for a number of sensitive and rare wildlife species. Bald eagles, osprey and an occasional whooping crane employ the riparian features in the park during periods of migration. A great blue heron rookery has been established within the riparian habitat found in the eastern portions of the park and it is suspected that the southwestern willow flycatcher uses riparian features scattered throughout the park. Peregrine falcons nest on the cliffs within the Black Canyon of the Gunnison River. Western burrowing owls have been documented using prairie dog burrows within the abandoned hay meadows that make up the east-central portion of the park. The Gunnison sage grouse, a recently recognized species, uses the sagebrush habitats within and surrounding the recreation area to meet their year-round habitat needs.

Curecanti supports populations of large mammals including elk, mule deer, bighorn sheep, mountain lion, black bear, and coyote. Prior to impoundment, the area flooded by Blue Mesa Reservoir was one of the main wintering grounds for elk, mule deer and bighorn sheep. Since impoundment, the entire bottomland and associated forage has been lost and the seasonal migration of these animals has been restricted. Elk and deer presently use the area on the north shore of Blue Mesa Reservoir during the winter where as many as 1,200 elk in several herds have been observed.

The Gunnison prairie dog is an abundant species that utilizes the open grasslands around Blue Mesa Reservoir. Regionally, there is concern about the status of this species because of continued habitat loss. The Black Canyon of the Gunnison provides excellent habitat for bats, but little is known about the status of bats within the recreation area.

Although water impoundments in the Curecanti project have altered fish propagation, a fish management and stocking program on Blue Mesa has increased the valuable fishing resource and contributed to fishing

activities throughout the region. Currently kokanee salmon and four varieties of trout including brook trout, rainbow trout, brown trout, and Mackinaw trout provide fishermen of the Gunnison River, the three reservoirs, and the many side streams with a high quality fishing experience.

Resource Management Concerns:

Major natural resource issues at Curecanti National Recreation Area include:

Livestock Grazing: Livestock production and irrigated farming have been a way of life in this part of Colorado since the mid-nineteenth century. The principal use of the land surrounding Curecanti National Recreation Area continues to be the grazing of domestic livestock. Recurring problems are developing between grazing and wildlife habitat and recreational use such as camping, picnicking, shoreline fishing, and hiking. These problems are associated with stock driveways, timing of seasonal grazing use, stocking levels and inadequate fencing. Lack of fencing has resulted in livestock trampling of riparian vegetation, soil compaction, and streambank erosion. Livestock grazing may be affecting Gunnison sage grouse, elk, mule deer and bighorn sheep habitat in sections of the park.

Exotic Plants and Animals: Exotic plant species are invading both disturbed and undisturbed areas throughout Curecanti, displacing native species. Exotic vascular plants of particular concern include: cheatgrass (*Bromus tectorum*), Canada thistle (*Cirsium arvense*), bull thistle (*Cirsium vulgare*), musk thistle (*Carduus nutans*), Russian knapweed (*Centaurea repens*), spotted knapweed (*Centaurea maculosa*), hoary cress (*Cardaria draba*), perennial pepperweed (*Lepidium latifolium*), yellow toadflax (*Linaria vulgaris*), common mullein (*Verbascum thapsus*), black henbane (*Hyoscyamus niger*), and tamarisk (*Tamarix ramosissima*).

While the introduction of exotic fish species into the stream and reservoir system created within the recreation area has increased the valuable fishing resource from a sport fishery standpoint, it has also impacted native species. The native fish species of particular concern is the Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*), which still occupies some headwater streams that feed the recreation area.

Land Use Conversion: Increased near-park development is having visual and biological impacts on park resources. Habitat loss as a result of Blue Mesa Reservoir and other adjacent land development has affected Gunnison sage grouse, Gunnison prairie dogs, elk, deer, and bighorn sheep as well as numerous other species in the area.

Visitor Use: Increasing visitor use of the recreation area and surrounding lands through the 1980s and into the 1990s contributed to direct impacts to soil and vegetative resources which have had indirect effects on sensitive habitats and wildlife species.

Altered Hydrologic Regime: Construction of dams and water diversions and the destruction of riparian habitat have altered stream flow patterns, temperature regime, fish spawning habitat, fish species and fish-food organisms on the Gunnison River.

Past Fire Exclusion: The natural systems within and surrounding the recreation area have evolved with fire. It is recognized that the presence or absence of natural fire within a given habitat is one of the ecological factors contributing to the perpetuation of plants and animals in that habitat. Fire suppression has contributed to an alteration of plant communities found within Curecanti.

Lack of Basic Data: A great deal of baseline information about the presence or absence, abundance and distribution of park natural resources is needed to assist park managers in making informed decisions which may have effects on natural resources. The park currently has an insufficient understanding of park ecosystems and threats to them.

References:

NPS. 1997. General Management Plan, Black Canyon of the Gunnison National Monument and Curecanti National Recreation Area, October 1997.

NPS. 1995. Resource Management Plan, Curecanti National Recreation Area, February 1995.

DINOSAUR NATIONAL MONUMENT (DINO)

Size: 85,447 hectares (211,142 acres)

Park History and Purpose: Dinosaur National Monument was established by Presidential Proclamation 1313 on October 4, 1915 (39 Stat. 1752), as an 80-acre monument to preserve the outstanding fossil resources at the dinosaur quarry north of Jensen, Utah. In 1938 the monument was enlarged to 82,510 hectares (203,885 acres) by Presidential Proclamation 2290 (53 Stat. 2454). This proclamation cited the act of August 25, 1916, that established the National Park Service (16 U.S.C. 1a-7), thereby specifically identifying Dinosaur National Monument as an area to be administered for purposes of preservation of natural resources and public use. A major focus of the expansion of the land base was the protection of the river corridors and adjacent view sheds for the major canyons of the Green and Yampa Rivers.

On September 8, 1960, Congress passed Public Law 86-729, 74 Stat. 857. This key piece of legislation enlarged the monument to 85,447 hectares (211,141.69 acres). P.L. 86-729 also established procedures directed toward the eventual elimination of grazing from the monument.

Due to its complex natural and cultural resources, a number of other federal laws and Executive Orders influence both short-term and long-term resource management decisions in Dinosaur National Monument. Among them are the following: NPS Organic Act (including the Redwood Amendment), National Environmental Policy Act, Endangered Species Act, Fish and Wildlife Coordination Act, Migratory Bird Treaty Act, Clean Water Act, Executive Order 11988—Floodplain Management, Executive Order 11990—Protection of Wetlands, and Executive Order 13112—Invasive Species.

The primary objectives presented in the park's General Management Plan (USDI 1986) are:

- to protect and preserve the natural and cultural environments;
- to permit biological, geological, and other natural processes to continue with a minimum of human disturbance; and
- to provide opportunities for enjoyable visitor experiences as well as an understanding of the significance of monument resources.

The plan goes on to detail numerous issues and concerns related to biological, physical and cultural resources.

The Resource Management Plan specifically identifies several vertebrate and vascular plant species and groups as being of special management concern. These include the endangered Colorado River fishes, peregrine falcon, several other "rare" or sensitive vertebrates, the threatened Ute ladies'-tresses orchid (*Spiranthes diluvialis*) and some 40 other rare plants. Of particular note is the high level of endemism among native fishes and vascular plants.

Location: Dinosaur National Monument is located in northwestern Colorado and northeastern Utah on the easternmost extension of the Uinta Mountain anticline (Hansen 1986). It lies at the northern edge of the Colorado Plateau. The monument is shaped somewhat like an inverted "T"; at its widest and longest dimensions it is 35 kilometers (22 miles) north to south and 71 kilometers (44 miles) east to west. Portions of the monument are approximately 32 highway kilometers (20 miles) east of Vernal, Utah; 80 kilometers (50 miles) west of Craig, Colorado; and about 193 kilometers (120 miles) north of Grand Junction, Colorado.

Elevation: Elevations range from under 1,448 meters (4,750 feet) near the Quarry to over 2,743 meters (9,000 feet) at Zenobia Peak. Annual precipitation ranges from under 280 millimeters (11 inches) at low elevations to near 508 millimeters (20 inches) at highest elevations.

General Description: Dinosaur National Monument includes the canyons of the lower Yampa River and of the upper Green River, below Browns Park. Using the confluence of the Green and Yampa Rivers in Echo Park as a central point, the park extends upstream on the Yampa some 46 river miles, upstream on the Green about 20 river miles, and downstream on the Green another 25 river miles. The land base extends as far as five miles lateral distance from the river courses. The rivers flow through deep canyons with high velocity/high gradient stream reaches interspersed with more open parks with lower stream gradients.

The park also includes dinosaur fossils of international renown, primarily in the vicinity of the Dinosaur Quarry and its Jurassic fossils. In addition to the Quarry, some 450 other dinosaur fossil sites are exposed on the surface. Fossil materials range in age from Jurassic to Quaternary and include plant, reptilian and mammal remains. The park also displays the widest range of geologic stratigraphic history on the Colorado Plateau. These features make Dinosaur National Monument a preferred site for paleontological and geological research.

Biotic diversity is high due to Dinosaur's location at the convergence of five physiographic provinces - the Colorado Plateau, Wyoming Basin, Great Basin and central and southern Rocky Mountains. Plant communities include montane coniferous forest, pinyon-juniper woodland, mixed mountain shrub, sagebrush-grassland, cold desert shrubland, barrens, and low elevation riparian woodland. Altitudinal juxtapositions are not uncommon. Physiographic location, topography, folding/faulting of geologic substrates, and presence of large desert rivers combine to produce an unusually diverse biota.

Significant endemism is evident in the native fish populations (only 8 species) and in the vascular flora (15 Uinta Basin endemics among the over 40 rare species). The monument includes the upper/middle Green River and the lower Yampa River. The Yampa River is the only large tributary in the Colorado River system that remains unregulated by a major mainstem impoundment and, as such, is singularly important in sustaining endangered fish in the Upper Colorado River Basin.

About 40 non-native fish and nearly 70 non-native plant species now occupy monument lands and waters. Some of these (e.g., channel catfish, northern pike, tamarisk, perennial pepperweed, Russian knapweed, spotted knapweed, leafy spurge) are of particular concern because of their adverse impacts on native flora and fauna.

Flora: Great diversity of geologic substrates combines with extreme topographic variation within Dinosaur National Monument to produce plant communities that are nearly all ecotonal (transitional) to some degree. A diverse landscape supports plant communities reminiscent of several ecoregional provinces described by Bailey (1995), including Intermountain semi-desert and desert, Utah mountains semi-desert-coniferous forest, Southern Rocky Mountain steppe-open woodland-coniferous forest and Colorado Plateau semi-desert. Most of Dinosaur's vegetation falls within (Rowlands 1994) montane or submontane/cold temperate lowland zones (Colorado Plateau province). An excellent description of Uinta Basin plant communities is found in Graham (1937). Classification of plant communities within Dinosaur is problematic because of the variation within the physical environment.

More than 600 plant species have been documented in the park. Approximately 200 more are expected (Naumann, personal communication). Dinosaur's cold desert flora is particularly rich in localized endemic species. Hanging garden communities along the Yampa and Green Rivers and their tributaries exhibit a close relationship with those found lower in the Colorado River drainage (Welsh 1989). Invasive non-native plants threaten native plant communities in a variety of habitats, especially within the river corridors. Prescribed fire has been used extensively in Dinosaur National Monument in an effort to restore native grassland communities degraded by livestock grazing and fire suppression.

Fauna: Over 200 species of birds, 16 reptile species, 6 amphibian species, about 50 fish species, and nearly 70 mammalian species occur in the park. Large ungulates include elk, mule deer, bighorn sheep and moose; bison have been extirpated. Large mammalian predators include mountain lion, bobcat, coyote, fox and black bear; grizzly bear and wolf have been extirpated. Nearly the entire Colorado bat fauna is represented in Dinosaur (approximately 15 species). Raptors include peregrine and other falcons, Mexican spotted owl, bald and golden eagles, osprey, accipiters, harriers, hawks and other owls. Nonnative species are a notable problem only within the fish component where multiple non-native species prey upon or compete with various life stages of the endangered fishes.

Unique Features and Species of Special Concern:

Vegetation Communities: Plant communities of special concern include hanging gardens, riparian woodlands and related floodplain habitats, mountain mahogany tall shrublands, limestone barrens, and wetlands associated with tributary streams or upland springs and seeps. Fremont cottonwood demonstrates a unique recruitment strategy along the Green and Yampa Rivers, with Dinosaur National Monument (David Cooper, personal communication). Dinosaur represents a unique and important ecological research opportunity in that both the Yampa River (unregulated) and the Green River (regulated) drain similarly sized watersheds and have their confluence within the park. Comparisons between the two river systems have produced a great deal of useful ecological information. Several rare plants are associated with mesic habitats, including Ute ladies'-tresses orchid, alcove bog orchid (*Habenaria zothecina*), alcove death camas (*Zigadenus vaginatus*), and narrow-leaf evening primrose (*Oenothera* spp.).

Plants: Dinosaur National Monument provides habitat for approximately 40 rare plant species. Only one of these is listed as threatened—Ute ladies'-tresses orchid (*Spiranthes diluvialis*). Four species are ranked as G1; seven species are ranked as G2 by the Utah and Colorado Natural Heritage Programs. Approximately 15 species are endemic to the Uinta Basin.

The Green River District (Utah portion) of Dinosaur National Monument is an extremely important center of plant endemism in the context of the Uinta Basin (Naumann 1990). Erosion of the Split Mountain Anticline has exposed numerous geologic formations in a relatively small area. The result is pronounced partitioning of plant habitats, and a concomitant concentration of endemic plant species. Type localities for at least nine endemic plant species occur within or very near the Green River District. Though less frequent in the Yampa River District, rare plants occur throughout the Colorado portion of the monument, as well.

Animals: Listed species include the Colorado pikeminnow, humpback chub, razorback sucker, bonytail, Mexican spotted owl, and bald eagle. Species that have been proposed for protection by the Endangered Species Act include spotted bat, roundtail chub, flannelmouth sucker, sage grouse, northern goshawk, and ferruginous hawk. Black-footed ferrets have been reintroduced in the local region; it's not beyond the realm of possibility that some individuals could eventually occupy the park. Peregrine falcons, though recently delisted, remain of special concern and the focus of long-term monitoring. Also of management concern due to rarity, sensitivity and/or potential management problems are bighorn sheep, elk and bats.

Resource Management Concerns:

Livestock Grazing: There remain 11 grazing allotments on approximately 32,375 hectares (80,000 acres) within the monument with a total maximum grazing preference of about 2,300 AUMs. Most grazing remaining in the park is appurtenant to inholdings and will therefore not be terminated until the inholdings are purchased by the United States. Grazing pressure varies by allotment with some livestock use having very minimal impacts and some allotments exhibiting significant adverse impacts. Such adverse impacts include shifts in plant community composition toward non-native species, introduction and spread of invasive non-native plants, competition for resources (forage, water, cover) with native ungulates, displacement of native ungulates, potential for disease transmission (particularly with bighorn sheep), destruction of rare plants, damage to riparian resources, damage to upland water sources, damage to cultural resources, and conflicts with recreational uses.

Recreation Use: Dinosaur receives about 500,000 visitors annually. In terms of visitor numbers, the vast majority visits only the Dinosaur Quarry. However, nearly half of total visitor hours are associated with river use. Although whitewater river use (number of launches, group size) is limited by the River Management Plan, impacts of human use in the river canyons appear to be increasing. Among other things, social trails in and near campsites are proliferating; monitoring indicates an increase in bare ground area and in occurrence of human fecal matter. Recreational use impacts are increasing in side canyons and other areas adjacent to the river as a result of increasing use from travel originating both within and outside the river corridor. Mountain bike use, though nominally confined to existing roads, is increasing along with subsequent adverse impacts (e.g., to microbiotic soils).

Land Use Impacts: Only very limited agricultural cultivation occurs on private lands within the monument. Activities on adjacent federal and private lands have the potential to adversely impact resources and resource values. Various land uses, existing and proposed water depletions, and operation of Flaming Gorge Dam

significantly and adversely impact park resources. There has been an apparent significant rise in pH on the Yampa River—to the point of potential fish kills. Ongoing research is designed to determine if the pH rise is real or an artifact of sampling methodologies. If the increase is real, then the research will attempt to identify sources of the change. Pursuant to a jeopardy Biological Opinion and flow recommendations for endangered fish, the process is underway to modify operations of Flaming Gorge Dam to benefit listed species (the 4 endangered fish species and the threatened Ute ladies'-tresses orchid).

Endemic and Special Concern Plant Species: The Green River District (Utah portion of the Monument) contains a number of important developed facilities (e.g., campgrounds, boat ramp, picnic area, fossil quarry and visitor center, housing area, maintenance yard, fire cache, hiking trails, etc.). The frequency and density of sensitive plants in the Green River District require frequent clearances for surface-disturbing maintenance and construction activities. Inadequate map and inventory information makes clearance more time-consuming, resulting in occasional work delays and/or substandard clearance work.

To date, no evidence of plant poaching or intentional damage to sensitive plant species has been documented. Reports of this activity at nearby Capitol Reef NP indicate that the possibility exists for exploitation by collectors. Another potential threat arises from road improvements that may lead to increased backcountry use. Known threats to rare plants include unauthorized off-road vehicle use, recreational social trailing, increased use by horses associated with commercial trail rides, changes in livestock grazing use patterns, and invasive species encroachment.

Invasive Exotic Plant Species: Sixty-six non-native plant species have been identified in Dinosaur National Monument. Fourteen of these species are invasive; these include common burdock, cheatgrass, hoary cress, musk, bull and Canada thistle, spotted and Russian knapweed, Russian olive, leafy spurge, perennial pepperweed, Dalmatian toadflax, yellow sweet clover and tamarisk. Flaming Gorge dam operations, livestock grazing, and external vectors have contributed to invasive plant establishment and spread. NPS (internal) fire management operations, new construction, roadside vegetation management and facility maintenance operations have also contributed. Appropriate weed management and native plant restoration have lagged significantly behind identified needs.

References Cited:

- Bailey, R.G. 1995. Descriptions of the ecoregions of the United States. 2nd edition. rev. and expanded. (1st ed. 1980). Misc. Publ. No. 1391 (rev.), Washington, DC: USDA Forest Service. 108 p. with separate map at 1:7,500,000.
- Graham, E. H. 1937. Botanical studies in the Uinta Basin of Utah and Colorado. Annals of the Carnegie Museum. 26:1-432.
- Hansen, W.R. 1986. Neogene tectonics and geomorphology of the eastern Uinta Mountains in Utah, Colorado and Wyoming. U.S.G.S. Professional Paper 1356. U.S. Gov't. Printing Office, Washington, DC. 78 p.
- Naumann, T.S. 1990. Inventory of plant species of special concern and the general flora of Dinosaur National Monument 1987-1989. USDI National Park Service Report, Rocky Mountain Region, Denver, CO. 116 p. + appendices.
- Rowlands, P.G.. 1994. Colorado Plateau vegetation assessment and classification manual. Technical Report NPS/NAUCPRS/NRTR-94/06. 11 p. + appendices.
- USDI, National Park Service. 1986. Dinosaur National Monument General Management Plan. 271p.
- Welsh, S.L. 1989. On the distribution of Utah's hanging gardens. Great basin Naturalist 49-1-30.

FOSSIL BUTTE NATIONAL MONUMENT (FOBU)

Size: 3318 hectares (8,198 acres)

Park History and Purpose: According to the enabling legislation, approved October 23, 1972, Fossil Butte National Monument was created “in order to preserve for the benefit and enjoyment of present and future generations outstanding paleontological sites and related geological phenomena, and to provide for the display and interpretation of scientific specimens...”

The enabling legislation also stipulated, in Section 4 (a) that “[f]or a period of ten years, and for not more than ten years thereafter if extended by the Secretary, the continuation of existing uses of Federal lands and water within the monument for grazing and stock watering may be permitted if the Secretary finds that such uses will not conflict with public use, interpretation, or administration of the monument: Provided, That the use of lands within the monument for stock driveways shall continue in perpetuity at such places where this use will not conflict with administration of the monument.” The enabling legislation further provided in Section 4 (b), “[u]pon termination of the uses set forth in subsection (a) of this section, the Secretary of the Interior is authorized to provide for the disposition and use of water surplus to the needs of the monument, to a point or points outside the boundaries of the monument.”

Grazing was discontinued on the monument after the 1989 growing season. One remote spring was developed to provide water beyond the park boundary for use by livestock and wildlife.

Today, the monument continues to protect and preserve portions of the Green River and Wasatch formations which contain a unique fossilized assemblage of organisms that once lived in or around Fossil Lake, an ancient lake of Eocene age. Many other clues to the environment of Fossil Lake and its environs are also preserved in the stratigraphic units of the Wasatch and Green River formations.

Location: Fossil Butte National Monument (FOBU) is located in southwest Wyoming near U. S. Highway 30, approximately 21 kilometers (13 miles) west of the town of Kemmerer, and 161 kilometers (100 miles) south of Jackson.

Elevation: The lowest topographic point in the Monument is approximately 2,018 meters (6,620 feet) above mean sea level where Chicken Creek crosses the Monument boundary near the park’s main entrance. The summit of the Bull Pen, near the Monument’s northern boundary, is the highest point within the Monument. The Bull Pen summit is 2,464 meters (8,084 feet) above sea level.

General Description: The boundary of FOBU encompasses land dominated by sagebrush steppe vegetation. The area is considered to be high, cold desert. Precipitation averages between 229 and 305 millimeters (9 and 12 inches) per year; most of it falling as snow. The mean frost-free period is 59 days. Winters can be extremely cold with the temperatures occasionally falling to -30°F or less. Summer nights are cool with the temperature frequently dropping below 50°F. During the day, in summer, the temperature rarely exceeds 90°F.

The uppermost, nearly white strata of the Green River formation is exposed along the steep slopes of Cundick Ridge and along the slopes of Fossil Butte. The Wasatch formation underlies, overlies, and intermingles with the Green River formation, but, to the untrained eye, outcroppings of its colorful dull red, pink, lavender, purple, yellow, and gray strata appear to be scattered at random throughout the park.

Small, deep, steep-sided valleys, some named by the park staff, dissect the park’s highlands. Millet Canyon, on the west side of the park, lies between Ruby Point and the western extent of Cundick Ridge. Murder Hill,

Middle, and Moosebones Canyons are on the east side of the park. These valleys are separated by ridges projecting eastward from the highlands in the northern half of the Monument.

Fossil Butte, and Cundick Ridge rise to the east above the Chicken Creek, an interrupted, intermittent stream with ephemeral tributaries, which drains approximately 2/3 of the land within the Monument. Only the uppermost few hundred yards of Chicken Creek is perennial. Generally, the stream flows throughout its entire length only for a few months during late spring and early summer length when it conveys snowmelt and spring storm runoff. Slopes on the eastern side of the watershed are steep (7.5% to 20%). Below 2,073 meters (6800 feet) elevation the gradient of Chicken Creek is 1%-2%. The lower reaches of Chicken Creek are severely eroded. Historically, railroad construction reduced the stream's base level which brought about channel incision in the lower portions of the watershed.

Vegetation: In 1984, Dr. Robert Dorn, principal investigator for Mountain West Environmental Services, mapped these vegetation types at Fossil Butte National Monument: Aquatic (rooted in water), Aspen, Barren, Alkali Sagebrush (low sage); Basin Big Sagebrush, Cottonwood, Disturbed, Grass/Forb, Mixed Timber, Mountain Big Sagebrush, Mountain Shrub, Saline, Wet Meadow, and Willow. The distribution of these types is controlled primarily by soil moisture and edaphic factors, but some types, like the Barren type occurring on ridgetops, are also wind-influenced. The vegetation was mapped in 1984 on aerial photographs that contained some distortion caused by camera angle, etc. The vegetation patterns were transferred by hand to 1:24000 scale United States Geologic Survey topographic maps. This mapped was ground-truthed by the Mr. George Jones with the Wyoming Nature Conservancy several years ago. Jones made minor changes to the Mountain West map and provided a copy to FOBU. Jones' version of the map was sent to the NPS GIS Service Center in Albuquerque, NM, where it was digitized. An ArcView version of this map is now available. The vegetation patterns still need minor adjustment, because they do not perfectly overlie the vegetation patterns seen on identically scaled digital orthographic photographs.

Three sagebrush communities dominate the landscape. The Basin Big Sagebrush type occurs below approximately 2,195 meters (7200 feet) of elevation on sites with deep, loamy, fertile soils. It is dominated by basin big sagebrush (*Artemisia tridentata* ssp. *tridentata*), bluegrasses (*Poa* spp.) and wheatgrasses (*Elymus* spp.) The Mountain Big Sagebrush type, dominated by mountain big sagebrush (*A. tridentata* ssp. *vaseyana*) occupies sites above 2,195 meters (7200 feet) having characteristics similar to sites supporting the Basin Big Sagebrush type. Various wheatgrasses, bluegrasses, and forbs are present in the understory. The Alkali Sagebrush type, dominated by low sagebrush (*A. arbuscula*) occurs on deep, clay soils at all elevations. This type occurs on soils with higher salinity and alkalinity than the other sagebrush types.

The Aspen type occurs on mesic sites in these scenarios: along the base of Cundick Ridge and in valleys below springs and seeps, below ridges where the prevailing west wind causes snow accumulation during winters with average (or more) snowfall and wind, and on north-facing slopes which remain in shadow throughout much of the day. The Aspen type is dominated by aspen trees (*Populus tremuloides*).

Mixed Timber occurs primarily on steep north-facing and east-facing slopes where soils are shallow, and often calcareous. Limber pine (*Pinus flexilis*), Douglas fir (*Pseudotsuga menziesii*), and aspen dominate the Mixed Timber type. Mountain Shrub occurs on sites similar to those that support Mixed Timber. It appears to be a successional precursor to the Mixed Timber type because it sometimes dominates burned areas that once supported stands of the Aspen and Mixed Timber types. Also, conifer seedlings can be seen in many areas currently supporting Mountain Shrub communities. Mountain mahogany (*Cercocarpus montanus*), Utah serviceberry (*Amelanchier utahensis*), and mountain snowberry (*Symphoricarpos oreophilus*) are the dominant shrubs in the Mountain Shrub type.

The Grass/Forb type is dominated by Sandberg bluegrass (*Poa sandbergii*), but indian ricegrass (*Stipa hymenoides*) and wheatgrasses are also present. Common forbs include stemless goldenweed (*Haplopappus acaulis*), Hoods phlox (*Phlox hoodii*), and starveling milkvetch (*Astragalus jejenus*). This type thrives on drier sites where there is shallow soil, such as rocky ridges. The Grass/Forb type also exists where fire has destroyed shrubby vegetation types. Rock outcrops, and barren windswept ridges were mapped as the Barren type. Some areas are totally devoid of vegetation; others support widely-spaced cushion plants, grasses, and forbs such as tufted twinpod (*Physaria condensata*).

The Wet Meadow type is dominated by Baltic rush (*Juncus balticus*), and sedge species (*Carex spp.*). Many other forb and grass species are present in the Wet Meadow community. Silver sagebrush (*Artemisia cana*) dominates drier sites, and willow species (*Salix spp.*) sometimes occur in more mesic sites. The Cottonwood and Willow vegetation types occupy, at most, a few acres where seepage, or artesian springs keep the soil rather wet. The Saline type is dominated by black greasewood (*Sarcobatus vermiculatus*) and Gardner's saltbush (*Atriplex gardneri*).

Riparian and Aquatic Habitats. Riparian and aquatic habitats of limited size occur at FOBU. There are sufficient perennial sources in and around FOBU, that large native ungulates move about quite freely. Their distribution is probably affected to some degree by the availability of water, but to what extent remains uncertain. Domestic livestock, especially cattle, were observed to stay near water, and they damaged riparian and aquatic plant communities. This extent of this impact, however, was never quantified.

In a wet year, standing and flowing water covers no more than 1-2% of the Monument (percentage only a rough estimate). Three valleys (Millet Canyon, Murder Hill Canyon, and Moosebones Canyon) and the headwater area of Chicken Creek immediately downstream of Spring #1 have had, or currently have, small populations of beaver. At present, only Millet Canyon, and the area below Spring #1 have significant beaver activity. Most of the aspen near water in the other beaver activity areas have been felled, and, at most, only one or two beaver live in those areas. The majority of the aquatic habitat on the Monument was created by beaver, but land slumping has created a few additional ephemeral ponds which support aquatic vegetation during at least part of the year.

Even where there is beaver activity, and a perennial source of water, the water supply is insufficient to maintain all the ponds throughout the summer even in the wettest years. The majority of slump ponds also dry up by mid-summer or earlier. These ponds support several species of emergent vegetation, such as the common cattail (*Typha latifolia*), but they do not support a rich variety of submergent aquatic vegetation. Ephemeral ponds may actually be detrimental to FOBU's population of amphibians, including the northern leopard frog, which is a species of management concern, because the ponds frequently dry up before the larval amphibians can live out of water. Even when the ponds do not dry up completely, low water levels have been observed to concentrate the tadpoles making them easy targets for predatory birds.

There are several locations that supported beaver in the past where there is no water today. Intermittent springs probably supplied water to these locations in the past, and they are expected to begin flowing again if above normal precipitation occurs for several consecutive years.

Fauna: More than 100 species of birds, mammals, snakes, and amphibians have been documented at FOBU. Probably only the list of large mammals approaches the 90% level of completeness. Reptiles and amphibians are uncommon; only 5 species have been documented. One or two species of fish enter the park during the brief period Chicken Creek is flowing. Fry and fingerlings have been observed in ephemeral pools near the park's boundary, but they have not been identified.

Pronghorn, jackrabbits, least chipmunks, and Richardson ground squirrels are probably the mammals most often seen by visitors. A variety of songbirds are present, and kestrels, northern harriers, red-tail hawks, and golden eagles are common summer residents.

Ungulates: The Monument was grazed (and overgrazed) by domestic livestock for approximately 100 years. In 1990, livestock grazing was discontinued. The affect of livestock grazing remains unquantified, but Beetle and Marlow (1974), and Dorn, Lichvar, and Dorn (1984) made the following generalizations regarding livestock grazing:

- the Monument was grazed during most of the year, primarily by sheep prior to 1973;
- improper placement of mineral blocks concentrated cattle on riparian areas;
- most recently the grazing allotment for FOBU was 1166 animal unit months (AUMs);
- since livestock movement was uncontrolled prior to 1977 grazing may have exceeded the allotment of 1166 AUMs;
- grazing probably decreased the amount of perennial grasses;
- grazing probably increased the number and variety of annual plants; and
- grazing probably increased soil compaction and accelerated soil erosion.

Mule deer (*Odocoileus hemionus*), and a few moose (*Alces alces*) reside on the Monument throughout the year. Elk are seen occasionally in summer, as well, and a few may reside on the Monument throughout the year. More Mule deer migrate onto the Monument during the fall, and early winter, and they remain until late spring, leaving as land north of the Monument becomes snow-free. A herd of more than 100 elk (*Cervus elaphus*) has begun spending part of the winter on the Monument in recent years. Elk use appears to be increasing, and this could become a problem. Pronghorn are commonly seen from late spring into late fall or early winter. Pronghorn usually migrate to wintering areas outside the Monument as soon as the snowpack begins to accumulate in late fall or early winter.

Mule deer, elk, and moose appear to be over-browsing some of the Monument's shrub communities, especially the Mountain Shrub type, and the few stands of willow and red osier dogwood (*Cornus sericea*) that are present. Based on the type and amount of scat observed, deer and moose utilize the Mountain Shrub habitat more than elk. Moose are responsible for the damage observed in willow and red osier dogwood.

Unique Features and Species of Special Concern:

Plants: None of the vegetation types at FOBU are believed to be unique; however, management has special concerns regarding several vegetation types. Tufted twinpod (*Physaria condensata*) and starveling milkvetch (*Astragalus jejunus* Wats. var. *jejunus*) are considered to be imperiled globally and within Wyoming because their distribution is limited (Wyoming Rare Plant Field Guide, 1994), but they are not on the Fish and Wildlife Service endangered list. The largest populations of these two plant species are in the Barren and Grass/forb plant communities. Dorn's twinpod (*P. dornii*), which resembles tufted twinpod, was being considered for inclusion in the endangered species list in 1994. Dorn's twinpod occurs immediately west of FOBU, but its occurrence inside the park remains unproven at this time.

Large ungulates appear to be over-utilizing the Mountain Shrub community at many localities on the Monument. Mountain mahogany and antelope bitterbrush (*Purshia tridentata*), in particular, have many "clubbed" branches because most of the new growth has been removed by browsing for many years. The shrubs in this vegetation type already are, or are becoming, senescent. Ungulate over-browsing in the Mountain Shrub community is a management concern.

Invasive exotic plants are a concern to management. Presently, there are at least 53 species of exotic plants have been discovered growing inside the park boundary. Introduced plants account for nearly 10% of the species on the Monument. Some exotic species are designated "noxious weeds" which have to be controlled by landowners. Presently, FOBU controls these invasive exotic plants: Canada thistle (*Cirsium arvense*), bull thistle (*C. vulgare*), musk thistle (*Carduus nutans*), mullein (*Verbascum thapus*), common burdock (*Arctium minus*), spotted knapweed (*Centaurea maculosa*), perennial sowthistle (*Sonchus uliginosus*), houndstongue (*Cynoglossum officinale*), white sweetclover (*Melilotus albus*), yellow sweetclover (*Melilotus officinalis*), black henbane (*Hyoscyamus niger*), and miscellaneous other introduced species encountered while spraying.

Mammals: A list of mammal species of special concern was compiled by the FOBU natural resource manager. Input from the Wyoming Game and Fish Department, United States Forest Service, Bureau of Land Management, and the United States Fish and Wildlife Service was considered in compiling the list. At present these mammals are on the list: fringed myotis (*Myotis thysanodes*), spotted bat (*Enderma maculatum*), Townsend's big-eared bat (*Plecotus townsendii*), Idaho pocket gopher (*Thomomys idahoensis*), white tailed prairie dog, Great Basin pocket mouse, pygmy rabbit, and the mountain lion (*Felis concolor*). Some of these organisms may not occur at FOBU.

Birds: The avian species of management concern are: golden eagle (*Aquila chrysaetos*) and sage grouse. This list was compiled based on consultation with other agencies.

Amphibians: The northern leopard frog (*Rana pipiens pipiens*) is the only amphibian species considered to be a species of special concern.

Second Priority Organisms: A secondary list of organisms management is concerned about was compiled. Many of the organisms on this list could potentially alter the Monument's vegetation, or imbalance its predator/prey relationships; other species are believed to have diminishing populations.

These species compose the secondary list: moose, elk, pronghorn, beaver, badger, mule deer, bobcat, northern harrier, short-eared owl (*Asio flammeus*), black-billed magpie, mountain bluebird, prairie falcon, red-tailed hawk, Swainson's hawk, ferruginous hawk, and the American kestrel.

References:

Wyoming Natural Diversity Database. 1994. Wyoming Rare Plant Field Guide. Laramie, WY.

GOLDEN SPIKE NATIONAL HISTORIC SITE (GOSP)

Size: 1,107 hectares (2,735 acres)

Park Legislative History: The establishment of Golden Spike National Historic Site was finally realized following a 20 year effort by local citizens who strongly believed that the spot where the transcontinental railroad was completed on May 10, 1869 had tremendous historical significance. Because of the great significance of this event, it was felt that this site qualified for inclusion as a managed unit of the National Park System.

The original "Spike Site," which consisted of approximately 3 hectares (7 acres) around the Promontory town-site, was designated as a National Historic Site on April 2, 1957. This initial designation was a significant achievement in that it recognized the national significance of Golden Spike National Historic Site. However, this initial designation was in non-federal ownership. Thus, this Historic Site existed in name only. It lacked a protected land-base, staffing, and administration by the National Park Service. Subsequently, Public Law 89-102, signed into law July 30, 1965, set aside such lands as necessary "for the purpose of establishing a national historic site commemorating the completion of the first transcontinental railroad across the United States." This law provided for: an authorized boundary, staffing, a development authorization, and oversight and management by the National Park Service. At this time, the Historic Site extended over 25 kilometers (15.5 miles) of original railroad grades and consisted of 892 hectares (2,203 acres).

Following the completion of a general management plan for the Historic Site in 1978, the boundaries were expanded by an act of Congress on September 8, 1980. This public law expanded the boundary by 215 hectares (532 acres), though none of these additional lands have been acquired.

Park Mission and Purpose: Building on the Congressional intent in establishing Golden Spike National Historic Site, the following Mission Statement was originally crafted for inclusion in the 1997 Strategic Plan for Golden Spike National Historic Site. In the year 2000, this same mission statement has been used for the 2000-2005 Strategic Plan for the Historic Site:

Golden Spike National Historic Site was established to commemorate the construction and completion of the first transcontinental railroad, and its tremendous historical consequences for our nation.

Dedicated to commemorating this historic work, Golden Spike National Historic Site preserves and interprets historic resources and values for the enjoyment, education, and inspiration of this and future generations.

Flowing from the above mission statement, the following three purpose statements were also identified. They further articulate the legislative intent and the fundamental reasons for the existence of Golden Spike National Historic Site.

- To commemorate the completion of the first transcontinental railroad across the United States as a public national memorial.

- To preserve the resources, historic sites, and knowledge for public use, enjoyment, education, inspiration, appreciation, and benefit.
- To provide and maintain markers, buildings, facilities and other improvements for the care and accommodation of visitors.

Building on these statements of purpose, significance statements for Golden Spike National Historic Site have also been developed and refined in the 1997 Comprehensive Interpretive Plan for Golden Spike National Historic Site. This effort produced 18 significance statements that summarize and capture the essence of Golden Spike National Historic Site's importance to our cultural and natural heritage.

Park and Area Description: Golden Spike National Historic Site currently has 18 National Park Service employees and has an annual operating budget of \$650,000 for Fiscal Year 2001. Annual visitation to the Historic Site has ranged from 48,000 to 64,000 in recent years.

Presently, Golden Spike National Historic site extends over 25 kilometers (15.5 miles) of original railroad grades and consists of 1,107 hectares (2,735 acres) Much of this acreage is contained within a 400-foot wide right-of-way obtained from the Southern Pacific Railroad. Of the total acreage, 895 hectares (2211 acres are in Federal ownership, and 212 hectares (525 acres) still remain in private ownership.

The Historic Site can be divided into three major areas of historical interest: The Summit, the East Slope, and the West Slope.

The Summit: The summit area is the primary focal point in the Historic Site. At Promontory Summit on May 10, 1869, the final spike was driven to complete the nation's first transcontinental railroad. This is the point where the Central Pacific Railroad from Sacramento, California, and the Union Pacific Railroad from Omaha, Nebraska, joined, making cross-country rail travel a reality. However, only traces of these first railroad grades remain in the summit area; subsequent alterations and development have destroyed much of the original in-place evidence of 1869 Promontory.

By May 1, 1869, anticipating the joining of the rails, the summit tent-village of Promontory was born. It subsequently survived as a small railroad-support town until 1942. Archeological investigation in the area has yielded many traces of Promontory's occupation and use.

Some time between 1916 and 1919, the Southern Pacific Railroad erected a monument in the approximate area where the railroads first met. A plaque, added to the monument in 1958, indicates that the area is a National Historic Site. After being moved on two occasions, this monument now stands just east of the visitor center.

The East Slope: Spectacular remains reflecting the building and maintenance of the railroad stretch across the Promontory Range from its eastern base at Blue Creek to the summit. These consist of Union Pacific and Central Pacific parallel grades; parallel rock cuts, including the Union Pacific's "false cut" just west of the Big Trestle/Big Fill area; Union Pacific trestle footings; major Central Pacific earth fills; stone culverts; a number of former-trestle locations; and two wooden trestles; (Trestles 1 and 2). The grades, cuts, fills, and trestle footings represent nearly every variety of the heavy work undertaken by the railroad workers except tunneling. Drill marks are visible in the rock cuts, and borrow pits remain beside the railroad grades. The basal portions of telegraph poles march up the east slope of the Promontories on the historic Union Pacific grade.

Numerous stone foundations and rock walls, leveled tent platforms, remains of pit houses, dugouts and basements, fireplace chimneys, and hearth areas parallel the railroad grades on the east slope of the mountains. These indicate the locations of railroad construction workers camps, workshop areas (such as black-smithing), and one of the "Hell-on-Wheels" towns associated with the final days of construction (Camp Deadfall).

The West Slope: From the summit area southwest, the parallel grades follow the gently sloping floor of Promontory Summit. This segment of the park includes a 5 kilometer (3.2 mile) portion of the grade on which the Central Pacific laid its renowned "ten miles of track in one day" and those portions of the Union Pacific grade that were never completed nor used. When the April 1869 order establishing Promontory Summit as the meeting point came, all Union Pacific work to the west stopped. The incomplete rock cuts, partially built fills, uncovered culverts, and unfinished grade provide excellent examples of railroad construction processes, such as the

stockpiling and reuse of size-graded stone material for grade foundation and the stair-step type of construction undertaken at the long rock cuts. Drill marks, stone culverts, and wooden box and stave culverts also occur along the west slope.

Like the eastern slope of the mountains, the western slope contains spectacular evidence of construction worker campsites such as pit house remains, lean-to shelters, rock walls, trash pits, and rock chimneys perched against prominent limestone outcrops.

Elevation: Within Golden Spike National Historic Site elevations range from 1,329 meters (4360 feet) to 1,609 meters (5,280 feet).

Location: Golden Spike National Historic Site is located in Northern Utah, 52 kilometers (32 miles) west of Brigham City, 86 kilometers (55 miles) north of Ogden, and 145 kilometers (90 miles) north of Salt Lake City. The Historic Site is within Box Elder County.

General Description: Golden Spike National Historic Site contains hillsides, mountains, and plains at the summit of the Promontory Range in the northern basin of the Great Salt Lake and is in the Upper Sonoran Life Zone. The Historic Site lies in the northeastern reaches of the Great Basin Desert, is semiarid, and ranges in elevation from around 1,280 meters (4,200 feet) at the Blue Creek to around 1,830 meters (6,000 feet) on top of an unnamed peak on the east side of the park.

Golden Spike National Historic Site lies in the summit area of the major pass over the Promontory Range. It lies between the North Promontory and the Promontory Mountains in the northern part of the Great Salt Lake basin. During glacial times the summit was under the water of ancient Lake Bonneville. As a result, old lake terraces form prominent features visible throughout the entire area. Today's surface materials consist of fine-grained lake sediments and alluvial detritus. Subsurface deposits consist primarily of Pennsylvania sandstone, shales and limestones, and Tertiary extrusive materials. Numerous fault lines dating from the latter time run through the Promontory range. Minor earth tremors (2.5 to 4.0 on the Richter Scale) have been reported in the Golden Spike National Historic Site vicinity fairly often since the park was established in 1965. No springs or travertine deposits occur within the monument although such features are found at Rozel Point, 24 kilometers (15 miles) to the southwest of Promontory. Also, at Rozel Point is an asphalt seep that was discovered before the first organized oil exploration in the early 1900s.

Flora: Today the region is semiarid to arid and is included in the shad scale-kangaroo-rat-sagebrush biome of the northern Great Basin. The major flora found at Golden Spike consists of sagebrush (*Artemisia tridentata*), rabbit brush (*Chrysothamnus* spp.), broom snakeweed (*Gutierrezia sarothrae*), Indian rice grass (*Stipa hymenoides*) and a variety of other grasses. A few Utah Junipers and one historic box-elder tree grow on park lands. Non-native vegetation includes tumble mustard, cheatgrass (*Bromus tectorum*), crested wheatgrass (*Agropyron desertorum*), and other species.

The vegetation in Golden Spike National Historic Site is different from what existed 130 years ago at Promontory Summit. There is a much greater concentration of non-native species and noxious weeds. As a result, the vegetative landscape has changed in the Historic Site as well as on adjacent lands. However, the visual appearance of these vegetative changes do not appear to have significantly altered the cultural landscape.

The Passey Onion (*Allium passeyi*) is a member of the onion family that has been located on a rocky knoll on the east slope of the park. It is known to occur only in Box Elder County and is a candidate species for future study and possible inclusion on the list of rare plants in the United States. There are no known plant or animal species resident to park lands that are listed as either rare or endangered.

Fauna: Wildlife is varied and consists of the larger mammals such as the coyote, mule deer, bobcat, badger, and jackrabbit. There are also smaller mammals, reptiles, insects, and numerous species of birds. Large numbers of raptors inhabit this same area and are commonly seen by arriving visitors. Accipiters, falcons, hawks, and golden and bald eagles are particularly common during winter months.

Climate: Annual precipitation averages 203 to 305 millimeters (8 to 12 inches), mostly in the form of snow. Temperatures range from daytime highs of 20 degrees in the winter to an occasional 104 degrees in the

summer. July and August are the hot months, while the coldest weather is from late December through February. Winter nights are typically below 10 degrees Fahrenheit. Spring and autumn months are generally mild, although they can vary widely from day to day due to jet stream patterns and the fact that the area is desert.

Snow depths vary considerably, but average less than 305 to 356 millimeters (12 to 14 inches), with occasionally 152 to 203 millimeters (6 to 8 inches) falling per storm. Historical records for Promontory indicate that there was one snowfall of 94 centimeters (37 inches) sometime in the late 1940s.

Flash floods from occasional severe storms and spring runoff, aggravated by adjacent agriculture land use, cause erosion of historic grades, cuts, fills, and trestles. As a result, the Historic Grade and associated features have been damaged from severe storm events. Yet damage also occurs on a more gradual basis from the natural erosion process. Over the years, deterioration from water erosion has been documented at Trestles Number 1 and 2. Also, water erosion has impacted the east slope of the grade below a concrete box culvert west of these trestles. And the loss of a segment of the Union Pacific grade 2 kilometers (1 mile) east of the visitor center was a serious preservation problem because of water erosion, but seems to have been alleviated with the installation of water control gabians. Flooding in the area between the visitor center and Kings Pass was a serious problem in 1983. Severe erosion occurred at the location of the burned-out-trestle, but this area has stabilized with the installation of water control gabians.

Thunderstorms also concentrate lightning strikes on the Promontory Mountains and salt flats near the west end of the park, creating serious rangeland fire potential. Occasional prolonged windy conditions in this semiarid rangeland hasten the weathering of park facilities and equipment.

Aquatic Features: Except for the Blue Creek, which bisects the northeastern end of the park, water is not available in stream or spring from within the park. However, the park receives its water from a well (130 meters/427 feet deep) at the summit area. Water is scarce in this semiarid region, which accounts for the sparse population in the area. The water scarcity has not affected operation of the park at present visitation levels.

Description of Cultural Resources:

Golden Spike National Historic Site, like all National Historic sites, was administratively listed on the National Register of Historic Places in 1966. The National Register of Historic Places registration form for the Historic Site was approved by the Utah State Historic Preservation Office and submitted to the Keeper of the National Register in 1987. Additionally, in 1969, the historic railroad grade was designated as a National Civil Engineering Landmark.

Presently, cultural resources at Golden Spike National Historic can be best organized in the following categories identified in NPS-28, Cultural Resources Management Guidelines. A summary of the cultural resources at the historic in each of these categories follows:

Historic Structures. Beginning in 1995, a comprehensive Grade Resources Study was initiated by Historic Architect A. Sayre Hutchison and Chief Ranger Rick Wilson. This effort is well underway and will ultimately result in the preparation of a historic structures report. In 1996 and again in 1998 and 2000, the List of Classified Structures for the Historic Site was updated. It presently identifies 37 separate structures (though more will be added following an inventory of vanishing treasures resources). The majority of the structures currently listed are historic railroad culverts. Two railroad trestles are listed and also the grades themselves. The Last Spike Site is listed as a composite structure though the white obelisk is listed separately. At least three archeological structures, related to initial construction of the railroad, have significant standing walls and are identified on the List of Classified Structures.

Archeological Resources. The archeological resources at Golden Spike National Historic Site have been identified and documented in three primary work efforts. Between 1974 and 1978, Archeologist Adrienne Anderson completed a reconnaissance level inventory. She identified and mapped 340 separate features. These resources were grouped into 16 sites and were identified on 13-sheet series of maps, entitled *Cultural Resources Bases Map* (1978). Between 1976 and 1982, James E. Ayers completed a more-detailed inventory of the archeological resources around the town of Promontory. This work led to the 1982 report: *Archeological Survey of Golden Spike National Historic Site and Record Search for Promontory, Utah*. More recently, between

1995 and 1999, Byron Knudson has been compiling documentation on archeological features (his work has resulted in the discovery of numerous additional features and the reclassification of site boundaries). This effort, which is nearing the halfway point, has resulted in the documentation of 332 features at present. Beginning in 1999, the Historic Site has been funded for a complete archeological survey, and this project is currently underway.

Cultural Landscape. In 1995, Peggy Nelson completed a Level 1 reconnaissance cultural landscape inventory. This work confirmed the existence of a cultural landscape at Golden Spike National Historic Site. By 2001, a cultural landscape inventory and a cultural landscape report will be prepared for the Historic Site.

Museum Objects. The Historic Site has 9,762 objects in its collection. A Scope of Collections Statement for the Historic Site was approved in 1988 and currently needs to be reviewed and updated. A review of the park's archives was completed, but additional archival survey work and evaluation is needed.

Historic Studies. Currently, the following historic studies have been completed: In 1960, Robert M. Utey prepared, *Special Report on Promontory Summit, Utah (Golden Spike National Historic Site)*. In 1969, F.A. Ketterson prepared, *Historical Base Map, 1869, Golden Spike National Historic Site, Utah*. In 1989, Michael W. Johnson prepared, *Promontory Station, An Industrial Outpost in the American West*. In 1996, Elmer Hanover prepared, *The Development of Golden Spike National Historic Site: A History of its Creation*. While the above-mentioned studies represent some the principal history studies, a number of other studies on the Historic Site have been completed by graduate students and others.

Ethnographic Resources. Golden Spike National Historic Site is in the midst of the area defined as home for the Fremont-Promontory prehistoric culture group. The Paiutes were in the Promontory area when the region was first settled by Anglos. Currently, it is known that four American Indian tribes have some level of association or linkage to the lands now under Historic Site's jurisdiction. These four tribes include: the Paiute Indian Tribes of Utah Tribal Council, the Shoshone-Bannock (Fort Hall Business Council), the Skull Valley Goshute General Council, and the Uintah & Ouray Tribal Business Committee.

Interrelationship Between Management of Cultural and Natural Resources:

There is a strong interrelationship between the management of natural and cultural resources at Golden Spike National Historic Site. Many resource management activities involve the co-mingling of cultural resources and natural resources. Some examples of the inter-relationships between cultural and natural resources are as follows:

- The management of the cultural landscape at Golden Spike National Historic Site involves the cultural imprint on the natural landscape.
- A major objective of the fire management program is to re-establish the natural vegetation regimen and to reduce the extent of sagebrush, which did not cover the ground as much in 1869. Sagebrush is known to be responsible for long-term degradation of cultural features. Aerial photographs from 1938 to the present time also indicate changes in vegetation.
- The preservation of grade resources is highly related to hydrologic runoff during storm events, effective erosion control, natural deterioration, and vegetation root systems.
- Many of the historic photographs show natural landscape features such as hillsides, mountain peaks, and vegetation along with human-built features such as tracks, construction materials, trails, and structures.
- The location of archeological sites is highly related to the geologic terrain. It took railroad workers many extra days of labor to build the railroad grade through rocky areas and there was consequently a practical need for workers to live near their work-sites.

References Cited:

National Park Service. 1978. General Management Plan for Golden Spike National Historic Site.

National Park Service. 1997. Strategic Plan for Golden Spike National Historic Site.

National Park Service. 1999. Resource Management Plan for Golden Spike National Historic Site.

HOVENWEEP NATIONAL MONUMENT (HOVE)

Size: 318 hectares (785 acres)

Park History and Purpose: Hovenweep National Monument was first established by Warren G Harding in 1923 by Presidential Proclamation 1654 (42 Statute 2299). The Proclamation states in part, "Whereas, there are in southwestern Colorado and southeastern Utah four groups of ruins, including prehistoric structures, the majority of which belong to unique types not found in other National Monument's, and show the finest prehistoric masonry in the United States; and It appears that the public good would be promoted by preserving these prehistoric remains as a National Monument with as much land as may be necessary for the proper protection thereof, ... that there is hereby preserved, subject to prior valid claims and set apart as a National Monument to be known as Hovenweep National Monument ..."

Subsequent Presidential Proclamations 2924, April 29, 1951; 2998, November 20, 1952, 3132, April 6, 1956; and Public Land Order 2604, February 5, 1962, added other areas and adjusted the boundaries of the monument. Given the proclamations listed above and the Organic Act of August 25, 1916 (Public Law 235, 39 Stat. 535) the National Park Service's mandate is to preserve and protect the cultural and natural resources associated with the six ruin groups, and to assist visitors in understanding the life and culture of the prehistoric inhabitants and their adaptation to the environment.

Hovenweep's resource values consist of significant cultural resources and their associated pristine natural settings. The Cajon, Square Tower, Holly, Hackberry/Horseshoe, and Cutthroat units contain clusters of Ancestral Puebloan pueblos and towers situated near permanent springs at canyonhead locations on Cajon Mesa. These canyon rim towers and villages are the best preserved and protected, most visually striking, and accessible examples of 13th century Ancestral Puebloan architecture and community locations within the San Juan River Basin. Other archeological sites representative of Paleo-Indian, Archaic, and early Puebloan occupation are also found here. These five units are significant because of the large number of structures possessing a high degree of physical and locational integrity. In addition, the towers are noteworthy because of their many stylistic variations.

The Goodman Point unit consists of an immense, unexcavated pueblo in the Montezuma Valley. These remains reflect its position as a regional center for the Mesa Verde Ancestral puebloans, and it is the one of the best-preserved sites in the West. It is the first archeological site set aside by the federal government, on September 13, 1889, and represents one of the largest 13th century villages in the San Juan Basin. These villages contain elements of public architecture such as great kivas, plazas, reservoirs, enclosing walls, etc.

Hovenweep also contains some of the best examples in the nation of ancient astronomical calendars that mark important seasonal events using architecture, rock art, and sunlight.

Location: Hovenweep National Monument contains six distinct units situated in the Four Corners area. The Square Tower and Cajon units are located in San Juan County, Utah. The Goodman Point, Hackberry/Horseshoe, Holly, and Cutthroat units are located in Montezuma County, Colorado.

Elevation: The elevation within the monument varies from 1,585 meters (5,200 feet) at the Cajon unit to 2,060 meters (6,760 feet) at the Goodman point unit.

General Description: The natural environment at Hovenweep is characterized by rugged topography, with small canyons divided by narrow mesa tops. The primary geologic formation is Cretaceous age Dakota sandstone. Shallow to deep aeolian soils are found on the mesa tops, with shallow colluvium on the canyon

slopes, and shallow to deep alluvium in the canyon bottoms. While permanent water sources are limited, a few springs and seeps located in the canyonheads produce water year-round. Residual water trapped in potholes or flowing in washes after rains or snowmelt is seasonally available.

Five of Hovenweep's six units are on Cajon Mesa, which covers approximately 500 square miles on the Colorado-Utah border near Four Corners. Although the topography is fairly uniform, variations in rainfall, soil type, and plant associations occur through minor elevation and drainage pattern differences. The northern half of the mesa is higher, cooler, and wetter supporting a pinyon-juniper forest. This part of the mesa is the most productive today growing dry land pinto beans, winter wheat, and alfalfa. Most of Hovenweep's units are in the juniper-sage and sage areas in the mid-section of the mesa.

The climate in this high desert environment is dry, with an average of 305 millimeters (12 inches) of precipitation per year. Temperatures range from winter lows of -10 to 0 degrees F to summer highs averaging 100 to 105 degrees F, with a mean annual temperature of 52 degrees F.

Flora: Hovenweep National Monument contains about 320 vascular plant taxa documented within the park. Vegetation zones range from shrubland to mixed sage and juniper woodland to pinyon juniper forest. Riparian communities are also found. A thorough plant survey has yet to be done and is scheduled for the year 2000.

From the early 1900's through the 1940's all of Hovenweep NM was subjected to heavy sheep grazing eliminating much of the ground cover. Depletion of the vegetation was followed by soil loss through erosion. Thus, soils are thin and species composition is poor. Fortunately, exotic species have not had a significant impact.

Most of Hovenweep's units are in the juniper-sage and sage areas in the midportion of the mesa. In addition to the above plants, rabbitbrush, cliffrose, Mormon tea, yucca, and serviceberry are commonly found and were important plants to the prehistoric Ancestral Puebloans. It is the part of the mesa that was most heavily occupied by the ancient people when they built the settlements preserved at Hovenweep NM.

Permanent seeps and springs are common in canyonheads that cut into the mesa, especially at the point of contact between the porous Dakota Sandstone which caps the mesa and the underlying, more impervious Morrison Shales. The springs in the canyonheads and the seasonal and permanent are important sources of springtime moisture and summer floods.

South of the Square Tower Unit sagbrush blends into the mix-shrubland plant zone composed of shadscale, greasewood, snakeweed, and grasses. This zone covers the southern end of Cajon Mesa and the San Juan River Valley. In some places snakeweed has become the dominant plant, especially in overgrazed areas. The Cajon Unit is the only part of the monument in this plant zone.

The Goodman Point unit lies a few miles northwest of Cortez, Colorado, and has a higher elevation, receives more moisture, and has slightly cooler temperatures than the other Hovenweep units. The immediate environment is a pinyon-juniper forest, surrounded by modern dry farmland producing pinto beans and winter wheat. Parts of the Goodman Point unit are almost completely overgrown with a vigorous sage cover. A large spring is in the unit.

Fauna: There are over 150 species of mammals, birds, reptiles, amphibians found in Hovenweep National Monument. Common mammals include mule deer, bobcat, mountain lion, and coyotes. Birds are most numerous in cottonwood and willow vegetation found along streams and perennial water sources. The Gunnison sage grouse, a sensitive species, has been observed. Reptiles are found throughout the monument. The most common lizards are the side-blotched and sagebrush lizards, and the most common snakes are gopher snake, western rattlesnake, and striped whipsnake. Amphibians are not common in Hovenweep, being found only near streams, springs, and rock pools. Tiger salamanders have been found at some of the springs. There are no fish.

Aquatic: Very little aquatic activity is noted at Hovenweep. Macroinvertebrates are monitored 4 times a year as part of the Water Quality Monitoring Program that started in 1999. Tiger salamanders (*Ambystoma tigrinum* var. *nebulosum*) have been observed at some of the springs.

Unique Features and Species of Special Concern:

Plants: Hovenweep may contain a couple of plant species of concern. Cronquist's milkvetch (*Astragalus cronquistii*), Naturita milkvetch (*Astragalus naturitensis*), and cut-leaf gumweed (*Grindelia laciniata*) are reported in the general area but have not been found within the monument yet.

Animals: The Gunnison sage grouse (*Centrocercus urophasianus gunnisonii*), a sensitive species, has been sighted at Hovenweep National Monument. There is a possibility that the Mexican spotted owl (*Strix occidentalis lucida*) and the southwestern willow flycatcher (*Empidonax traillii extimus*) could be found once surveys are initiated.

Resource Management Concerns:

Trespass livestock and exotic plant species are the main resource management concerns.

Recreation Use. Visitor use increased rapidly within the park during the 1980s and early 1990s causing soil and vegetation damage in heavily used areas. Impacts from visitors hiking off trails destroy crytobiotic soils and tramples vegetation, which increases erosion.

Land Use Impacts. Agricultural practices surrounding the monument, primarily livestock grazing, are a concern. While the number of livestock that illegally come into the monument is low, vegetation is still damaged and lost through trampling and consumption, and invasive weeds are also introduced. Energy resource exploration and extraction is increasing in the Hovenweep area. Around the monument are deposits of oil, natural gas, uranium, vanadium, coal, and pure carbon dioxide. These activities could negatively affect some resources such as water availability and soil contamination. Sound pollution is also a problem from the mining activity in the areas. Air pollution has increased in the past 40 years due to the establishment of coal burning power plants in the region.

Invasive Exotic Plant Species. There are 27 exotic plant species that occur within Hovenweep National monument. The monument is surrounded by agricultural lands and the exotic plant source is high and constant. Tamarisk (*Tamarix ramosissima*) has invaded canyon bottoms in all the units but most of it has been controlled through mechanical cutting and herbicide.

References Cited:

- USDI, National Park Service. 1998. Resources Management Plan, Hovenweep National Monument. Rocky Mountain Region, Denver, Colorado.
- USDI, National Park Service. 1995. Hovenweep National Monument Statement for Management. Rocky Mountain Region, Denver, Colorado. 16p.
- USDI, National Park Service. 1985. Environmental Assessment for the General Management Plan and Development Concept Plan. Rocky Mountain Region, Denver, Colorado. 130p.

NATURAL BRIDGES NATIONAL MONUMENT (NABR)

Size: 3013 hectares (7,445 acres)

Park History and Purpose: Established in 1908, Natural Bridges National Monument is Utah's oldest National Park unit. A total of 49 hectares (120 acres) were originally set aside around each of the three bridges based on President Theodore Roosevelt's original Proclamation No. 804, April 16, 1908, 35 Statute 2183. The main purpose for the Monument was stated by President Roosevelt as follows:

"Whereas, a number of natural bridges situated in southeastern Utah having heights more lofty and spans far greater than any heretofore known to exist, are of the greatest scientific interest, and it appears that the public interests would be promoted by reserving these extraordinary examples of stream erosion with as much land as may be necessary for the proper protection thereof..."

Later, the Monument was enlarged to encompass 979 hectares (2,420 acres) containing the three natural bridges, prehistoric structures, and cave springs, as stated in President William H. Taft's Proclamation No. 881, September 25, 1909, 36 Statute 2502:

"...at the time this Monument was created nothing was known of the location and character of the prehistoric ruins in the vicinity of the bridges, nor of the location of the bridges and prehistoric cave springs, also hereby reserved..."

The same area was resurveyed, and set aside by President Woodrow Wilson's Proclamation No. 1323, February 11, 1916, 39 Statute 1764:

"...whose purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations."

In August of 1962, President John F. Kennedy's Proclamation No. 320 withdrew 320 acres of land around Snow Flat Spring Cave and Cigarette Spring Cave from the Monument since these caves: "...no longer contain features of archeological value and are not needed for the proper care, management, protection, interpretation, and preservation of the Monument." In this proclamation, he expanded the size of the Monument, reiterated the public and scientific communities' interest in the preservation and protection of the bridges and prehistoric sites, and he set forth the main management objectives for the Monument.

Location: The Monument is located in San Juan County, Utah, 193 kilometers (120 miles) south of Moab, Utah. The area is accessible via Utah Highway 95, which connects Blanding, Utah with Hanksville, Utah. Blanding, Utah (population 3,100) is the nearest population center, located 64 kilometers (40 miles) east of the Monument. The surrounding area (San Juan County) is sparsely populated, with a density of less than 1.5 people per square mile (0.6 people per square kilometer). The area surrounding the Monument has never been settled by Anglos and has been used only for extensive livestock grazing and minor mining activities.

Elevation: The elevation within the monument varies from approximately 1,738 meters (5,700 feet) in the canyons to 6,400 on the rims.

General Description: Nowhere else are three such extraordinary natural bridges found in such close proximity to one another. These three bridges show three different stages of development from youth (Kachina), to maturity (Sipapu), to old age (Owachomo). Together with the canyons in which they formed, these three bridges are excellent examples of the result of an entrenched meander stream system.

The Monument was also created because of its well-preserved Ancestral Puebloan standing architecture. While archaeologist now recognize that these structural sites are common throughout the region, the presence of the well-preserved structural sites, as well as a range of archaeological sites from Archaic through historic times make the Monument highly significant.

A high desert riparian environment combined with a year-round supply of standing water (the result of numerous seeps) creates a unique biological climate where relict species (Douglas fir) maintain a foothold and where moist alcoves shelter hanging garden communities. It is here that rare plants (such as the kachina daisy) find refuge, and other water-loving flora thrive in riparian corridors that also provide food, shelter, and travel paths for wildlife. The Monument provides a breeding ground for peregrine falcons, is home to at least 15 species of bats, and has extensive public lands surrounding it that are candidates for Wilderness designation.

Pristine air quality ensures extensive vistas and combined with the absence of artificial light provides outstanding opportunities to view night skies. The absence of human-generated sound leaves the visitor to confront the natural silence that is the hallmark of canyon country.

The Monument was also established to preserve outstanding Ancestral Puebloan cultural remains located throughout the Monument. The cultural resources of Natural Bridges are outstanding and the monument provides the opportunity, found in few other places, to study the interaction among indigenous cultural groups. There are numerous sites with religious and historical significance to American Indians.

The monument preserves one of the few locations of a very rare plant, the kachina daisy (*Erigeron kachinensis*). Natural Bridges contains an outstanding example of an ephemeral desert stream. The ecological processes and biological diversity of this area are found in few other places.

The Monument contains two major canyons, White and Armstrong, which are deeply incised into the Cedar Mesa sandstone. The vegetation of the area is predominately pinyon-juniper woodland, a vegetation type common to most of southeast Utah at elevations of approximately 1,220 to 2,440 meters (4,000 to 8,000 feet). Riparian vegetation occupies the surface water drainages and small pockets of Douglas fir and associated mesic vegetation grow in sheltered areas along the canyon rims. The fauna of the Monument is typical of the Cedar Mesa area of southeastern Utah. Large mammals commonly seen are mule deer, coyote and desert cottontail. Conspicuous birds are the common raven, turkey vulture, red-tailed hawk and scrub jay. A variety of lizards can be seen during the warmer months, and the Monument is home to a large population of midget prairie rattlesnakes.

Flora: Natural Bridges' flora database contained approximately 437 species. Vegetation of the Monument is divided into five communities as described below.

Pinyon-Juniper Community

This community is the most extensive vegetation type, covering approximately 1,700 hectares (4,200 acres). The pinyon-juniper vegetation type is dominated by pinyon pine (*Pinus edulis*) and Utah juniper (*Juniperus osteosperma*). Other major shrub components are broom snakeweed (*Gutierrezia sarothrae*), roundleaf buffaloberry (*Shepherdia rotundifolia*), big sagebrush (*Artemisia tridentata*), and prickly pear cactus (*Opuntia* spp.). Common forbs associated with this vegetation type are twinpod (*Physaria acutifolia*), lobeleaf groundsel (*Senecio multilobatus*), and Holboel rock cress (*Arabis holboellii*).

Rimrock Community

Next in coverage, this community accounts for 1,100 hectares (2,700 acres). The rimrock community is a shrub-dominated type found on the canyon rims and is of varied composition. The primary components are pinyon (*Pinus edulis*), Utah juniper (*Juniperus osteosperma*), manzanita (*Arctostaphylos patula*), gambel oak (*Quercus gambelii*), broom snakeweed (*Gutierrezia sarothrae*), Utah serviceberry (*Amelanchier utahensis*), longflower snowberry (*Symphoricarpos longifolius*), and Haplopappus (*Haplopappus* spp.) for roughly 160 hectares (400 acres). The riparian vegetation communities are dominated by Fremont cottonwood (*Populus fremontii*) with the shrub understory being comprised of western sandbar willow (*Salix exigua*), yellow willow (*S. lutea*), and box elder (*Acer negundo*). Of the many forbs and grasses that are incorporated in this vegetation community the principal species are phragmites (*Phragmites communis*), horsetail (*Equisitum arvense*) and (*E. laevigatum*), and hairy goldenaster (*Heterotheca villosa*).

Douglas Fir Relict Community

Encompassing less than 160 hectares (400 acres), the Douglas fir community is a relict community (a holdover from a time when climatic conditions were more favorable; now these species exist within the Monument only in narrowly defined micro-environments). This community is characterized by Douglas fir (*Pseudotsuga menziesii*), Utah serviceberry (*Amelanchier utahensis*), mountain lover (*Pachystima myrsinites*), dwarf mountain mahogany (*Cercocarpus intricatus*) and manzanita (*Arctostaphylos patula*).

Hanging Garden Community

The smallest vegetal component covering less than 30 hectares (80 acres), the hanging garden vegetation type is characterized by moisture loving plants often not found elsewhere in the desert. These include plants such as the maidenhair fern (*Adiantum capillus-veneris*), cliff-brake (*Pellaea* spp.), scarlet monkey flower (*Mimulus*

eastwoodiae), death camas (*Zigadenus* spp.), columbine (*Aquilegia* spp.) and alcove bog-orchid (*Habenaria zothecina*).

Fauna: In Natural Bridges NM there are approximately 127 species of birds, 68 species of mammals, 17 species of reptiles, and 7 species of amphibians. There are no fish.

Birds

Common bird species likely to be found in the Monument are the turkey vulture (*Cathartes aura*), northern harrier (*Circus cyaneus*), red-tailed hawk (*Buteo jamaicensis*), American kestrel (*Falco sparverius*), mourning dove (*Zenaidura macroura*), great horned owl (*Bubo virginianus*), common nighthawk (*Chordeiles minor*), white-throated swift (*Aeronautes saxatalis*), ash-throated flycatcher (*Myiarchus cinerascens*), violet-green swallow (*Tachycineta thalassina*), cliff swallow (*Hirunda pyrrhonta*), scrub jay (*Aphelocoma coerulescens*), pinyon jay (*Gymnorhinus cyanocephalus*), common raven (*Corvus corax*), plain titmouse (*Parus inornatus*), canyon wren (*Catherpes mexicanus*), and black-throated sparrow (*Amphispiza bilineata*).

Annual bird surveys have been conducted since 1986. Two transects are monitored three times over the breeding season. Among species of concern are the peregrine falcon (one breeding pair has been successfully nesting within the Monument since the 1993 breeding season), the bald eagle (occasionally seen, but not a resident), and the Mexican spotted owl (found in remote canyons nearby, but not within the Monument). Brown-headed cowbirds (*Molothrus ater*) have been recorded in Natural Bridges NM.

Mammals

Mammals were systematically surveyed within the Monument from 1987-1994. The most common mammals inhabiting the Monument are the western pipistrel bat (*Pipistrellus hesperus*), coyote (*Canus latrans*), gray fox (*Urocyon cinereoargenteus*), white-tailed antelope squirrel (*Ammospermophilus leucurus*), Colorado chipmunk (*Eutamias quadrivittatus*), canyon mouse (*Peromyscus crinitus*), deer mouse (*P. maniculatus*), pinyon mouse (*P. truei*), desert woodrat (*Neotoma lepida*), porcupine (*Erethizon dorsatum*), black-tailed jackrabbit (*Lepus californicus*), desert cottontail (*Sylvilagus auduboni*), and mule deer (*Odocoileus hemionus*). According to Mike Bogan of the USGS/BRD Albuquerque, Natural Bridges is a "hot spot" for bats on the Colorado Plateau. Of the 19 species thought to live in Utah, 15 have been captured in the Monument (including the spotted bat, a candidate species for federal listing). Mountain lion tracks are commonly seen within the Monument; actual sightings are rare. Black bear occasionally use the canyons and rim, but they, too, are rarely seen. Desert bighorn sheep were observed within the Monument prior to 1966 when the loop road was constructed. They probably still roam sections of lower White Canyon and surrounding environs.

Amphibians and Reptiles

Common herpetofauna of the Monument are the red-spotted toad (*Bufo punctatus*), Woodhouse toad (*B. woodhousei*), Great Basin spadefoot toad (*Scaphiopus intermontanus*), tiger salamander (*Ambystoma tigrinum*), plateau striped whiptail (*Cnemidophorus velox*), collared lizard (*Crotaphytus collaris*), short-horned lizard (*Phrynosoma douglassi*), sagebrush lizard (*Sceloporus graciosus*), eastern fence lizard (*S. undulatus*), tree lizard (*Urosaurus ornatus*), desert night lizard (*Xantusia vigilis*), side-blotched lizard (*Uta stansburiana*), western whiptail (*Cnemidophorus tigris*), gopher snake (*Pituophis melanoleucus deserticola*), western terrestrial garter snake (*Thamnophis elegans vagrans*), and the midget prairie rattlesnake (*Crotalus viridis viridis*).

Aquatic: Very little aquatic activity is noted at Natural Bridges NM except for tadpoles and tiger salamanders. There are no fish. Macroinvertebrates are monitored 4 times a year as part of the Water Quality Monitoring Program that started in 1997.

Unique Features and Species of Special Concern:

Plants: The rare kachina daisy (*Erigeron kachinensis*) is found within the Monument. This species was first described from Natural Bridges and is uncommon throughout its range. The kachina daisy exists in the Monument in several moist alcoves associated with hanging garden communities and has been the subject of extensive research by Allphin and Harper (1994). It is endemic to San Juan County, Utah and Montrose County, Colorado and has previously been recommended for high priority species-level management (Heil et al. 1993).

Animals: Currently the peregrine falcon (*Falco peregrinus*) has been delisted but is still of concern at Natural Bridges National Monument. A breeding pair of peregrine falcons has nested successfully within the Monument

since the 1993 breeding season. The location of the aerie has changed with each breeding season, but has remained within a discrete area. The threatened Mexican spotted owl (*Strix occidentalis mexicana*) is known to occur in similar habitats near the Monument, but surveys have not revealed their presence here. A pair of northern goshawks (*Accipiter gentilis*) nested in the monument in 1998.

Resource Management Concerns:

Increased visitation, trespass livestock, and exotic plant species are the main resource management concerns.

Recreation Use: Visitor use increased rapidly within the park during the 1980s and early 1990s causing soil and vegetation damage in heavily used areas. Impacts from visitors hiking off trails destroy crytobiotic soils and tramples vegetation, which increases erosion.

Land Use Impacts: Agricultural practices surrounding the monument, primarily livestock grazing, are a concern. Trespass cattle have been a constant problem. While lands within the Monument are withdrawn from mineral leasing, oil and gas leases exist on BLM lands within 3 to 5 kilometers (2 to 3 miles) of Natural Bridges' boundary (though none are currently in production), and there is increasing potential for oil and gas development within White Canyon. Oil and gas development is an external threat to the resources (clean air, night sky, solitude and wilderness) of Natural Bridges.

Invasive Exotic Plant Species: There are about 40 exotic plant species at Natural Bridges NM. Exotic plants such as tamarisk, horehound mint, and musk thistle have invaded Natural Bridges. The extent of the spread has been minimized so far by Monument staff who have made a concerted effort to control these exotics through both mechanical and chemical means.

References Cited:

Allphin, L. and K.T. Harper. 1994. Habitat Requirements for Erigeron Kachinsis, A Rare Endemic of the Colorado Plateau. The Great Basin Naturalist, Brigham Young University. Vol. 54 (No.3): 193-203.

USDI, National Park Service. 1993. Resources Management Plan, Natural Bridges National Monument. Rocky Mountain Region, Denver, Colorado. 34p.

USDI, National Park Service. 1994. Natural Bridges National Monument Statement for Management. Rocky Mountain Region, Denver, Colorado. 19p.

USDI, National Park Service. 1985. Final Environmental Impact Statement, General Management Plan, and Development Concept Plan. Rocky Mountain Region, Denver, CO 174p.

PIPE SPRING NATIONAL MONUMENT (PISP)

Size: 16 hectares (40 acres)

Park Purpose and History: The geologic processes which produced these desert springs have made the site a focal point for area wildlife, and these waters have supported a centuries-long continuum of human habitation. The springs were well known to Ancestral Puebloan people and bands of Southern Paiutes long before the arrival of Mormon missionaries in 1858. Following the ill-fated homesteading efforts of James Whitmore, in 1870 the Mormon Church established a tithing ranch and constructed a fort (Winsor Castle) for protection from the Indians.

Besides the business of ranching, Pipe Spring became an outpost for another church venture-the Deseret Telegraph. A spur line was established through Pipe Spring in 1871, creating the first telegraph station in the Arizona Territory. In 1909, the Kaibab Paiute Indian Reservation was established. The reservation surrounded Pipe Spring, but the ranch buildings, the springs, and the grounds immediately around them remained in private ownership until their transfer to the National Park Service in 1923.

Pipe Spring National Monument was established by President Warren G. Harding's proclamation No. 1663 (43 Stat. 1913) of May 31, 1923:

"Whereas , it appears that the public good would be promoted by reserving the land on which Pipe Spring and the early dwelling place are located as a National Monument, with as much land as may be necessary for the proper protection thereof, to serve as a memorial of western pioneer life,..."

The 1923 proclamation further addresses the water of the springs in two regards. It clarifies that the availability of water at the site was one reason for its establishment as a monument, stating:

"Whereas, there is in northwestern Arizona on the road between Zion National Park and the North Rim of the Grand Canyon National Park a spring, known as Pipe Spring, which affords the only water along the road between Hurricane, Utah, and Fredonia, Arizona, a distance of sixty-two miles"

It also declares that:

"in the administration of this Monument, the Indians of the Kaibab Reservation, shall have the privilege of utilizing waters from Pipe Spring for irrigation, stock watering and other purposes, under regulations to be prescribed by the Secretary of the Interior."

Although the proclamation does not speak to any other third party use of water, it does state that the establishment of the Monument is "subject to all prior valid claims."

Throughout the early years of the Monument, descendants and associates of the former ranch owners were allowed to continue using water for their livestock. Through those same years, the Indian Agent for the Kaibab Paiute Tribe pointed out that the Tribe's use was precluded, or made extremely difficult. As a result of disagreement between the cattlemen, the Indian Agent, and the Monument custodian, in 1933, Assistant Secretary of the Interior, Oscar L. Chapman, signed a document titled "Regulations For The Division Of The Waters Of Pipe Springs" that states the following:

" The waters of the Springs shall be divided equally, one-third to the Pipe Springs National Monument, one-third to the Indians of the Kaibab Indian Reservation, and one-third to the stockmen represented by a memorandum agreement signed June 9, 1924, by representatives of the respective interests."

In 1933, the flow of Tunnel Spring roughly approximated one-fifth of the total flow of all the springs. As this presumably met the cattlemen's needs and as a matter of engineering convenience, the totality of the Tunnel Spring flow was diverted to the cattlemen. After many years of discontent over water delivery to the Tribe, the National Park Service and Tribe entered into an agreement in 1972 whereby, in exchange for the Tribe's one-third of the spring flow, the NPS built and agreed to maintain a culinary water well and delivery system on reservation lands north of the Monument. The NPS pays the Tribe for its use of water from this system. This twenty-five agreement expired in 1997. A rewritten agreement has been mutually drafted, but is yet to be effectuated. In the interim, the old agreement has been mutually renewed in three month increments.

From the Long Range Interpretive Plan (2000) and the most recent Statement for Management (1995), the Mission and Purpose of Pipe Spring National Monument is as follows:

Mission

The mission of Pipe Spring National Monument is to:

- protect the natural and cultural resources of the monument in an unimpaired state for the enjoyment of the public,
- increase knowledge and understanding of, and convey the compelling stories of pioneer and American Indian culture, history, and relationships to the natural environment, and,
- protect the water of the springs to the greatest degree possible, yet allowing use as entitled by law.

Purpose

The purpose of Pipe Spring National Monument is to:

- serve as a memorial of Western pioneer life, Kaibab Paiute culture, and interactions between Euro-American and Indian cultures,

- preserve and protect the springs and associated natural environment,
- preserve, protect, and develop a better understanding of the cultural significance and resources present at the site, and,
- provide opportunities for visitors to experience, understand, and enjoy the site.

Location: Pipe Spring National Monument is a 16 hectare (40 acre) historic site situated in the northeast part of Mohave County, Arizona. It lies 16 kilometers (10 miles) south of the Arizona-Utah border, and is entirely surrounded by the Kaibab-Paiute Indian Reservation. Primary access is provided by Arizona State Highway 389.

Elevation: The elevations within the Monument range from 1500 meters (4923 feet) to 1555 meters (5100 feet).

General Description: The monument is on the Moccasin Terrace of the Markagunt Plateau at the southern sloping base of the Vermilion Cliffs. From this site, a dry plain slopes southward for 48 kilometers (30 miles) before it descends dramatically into the Grand Canyon.

The elevation of the monument is 1,524 meters (5,000 feet), the climate is fairly temperate, and the plant and animal species are typically semi-desert. North of the monument is pinyon-juniper woodland. Intermingled with and at the edge of this woodland community is a sagebrush grassland with sagebrush dominant on the more level areas of ground and pinyon-juniper occurring on the shallow rocky soils and broken country of adjacent higher elevations. Other on-site vegetation includes rabbitbrush, prickly pear cactus and sagebrush. Nearly half of the monument contains the aforementioned semi-desert plant species. Animal species include small rodents, reptiles, birds, bats, amphibians, and coyotes.

Culturally introduced plant materials include a variety of shade trees (ash, cottonwood, poplar, elm, locust, ailanthus), fruit trees, a grape arbor, and a vegetable garden. Temperatures highs range in the summer from 90 to 115 degrees Fahrenheit; in the winter, normal low temperatures range between 0 and 40 degrees Fahrenheit.

There are three springs at the monument: the main spring (Pipe Spring), emerging from beneath the fort itself, Tunnel Spring (located just southwest of the fort), and West Cabin spring (a seep spring once called the "calf-pasture spring"). The springs are fed by the Navajo Sandstone aquifer to the north and west, via the Sevier Fault. Only one spring, West Cabin, flows naturally in the monument, creating a very small riparian area (1/8 acre).

The monument also contains paleontological resources in the form of three tridactyl dinosaur footprints, tentatively identified as *Eubrontes*. (Cuffey et al. 1998)

Unique Features and Important/Critical Natural Resources:

The most unique/important/critical natural (and cultural) resource at Pipe Spring is water. The waters of the springs have been used for literally thousands of years by prehistoric and historic American Indian people. In the 1860's, the springs were essentially claimed by Mormon pioneers and used by Euro-Americans for settlement and ranching purposes until 1923, when Pipe Spring was proclaimed a national monument and the ranch purchased from its private owners.

As of the second week of June, 1999, the historic spring at Pipe Spring National Monument ceased to flow for the first time on record. This spring, located directly beneath the north building of Winsor Castle is divided into two flows - one which proceeds through a historic subsurface trench to an emergence point outside the west gate of the Castle, known as Big Spring and a second flow which is piped beneath the Castle courtyard into and through the Castle's Spring Room. The runoff from both Big Spring and the Spring Room feed historic masonry ponds immediately south of the Castle. The flow of the spring is critical to the historic integrity of the site, and provides life-giving sustenance to acres of shade trees, a representative historic orchard, and wildlife.

As one of few perennial water sources on the Arizona Strip, the springs of Pipe Spring provide a vital resource for resident bird populations and is also vital to migrating bird populations. A bird inventory in currently

underway, expected completion date is September 2001.

The presence of water at Pipe Spring is important for all local fauna. Reptiles and small rodents are particularly abundant, as well as bats. Complete inventories do not exist for any animal species.

Management Concerns & Threats:

While the main thrust of Pipe Spring National Monument is human history, there would be no human history here were it not for the natural resources of the area. Pipe Spring always has been an “oasis in the desert” and is critically important to the wildlife of the area, as well as migratory animals. With the exception of the bird study underway, a 70% complete plant survey, and an aquatic invertebrates survey, no other survey data exists for the floral or faunal resources of Pipe Spring National Monument.

An important part of the story of Pipe Spring is the grazing lands (as well as the water) that attracted Euroamerican pioneers to the Arizona Strip. Stories abound regarding “grass belly high to a horse”. Overgrazing reduced the range to dust by the 1890’s and what has managed to recover is mostly sage-salt bush desert scrub. A future resource management/interpretation project is to attempt to reseed a portion of the monument with native grasses.

Exotic plant species such as puncture vine, cheat grass, alanthus, and Siberian elm trees are of concern for their invasiveness. However, the trees, along with silver-leafed cottonwoods, none of which are native to the area, provide the only shade for the monument. Most of these trees were planted by the National Park Service. Efforts should be made to eliminate many exotics, however, many shade trees in public areas will be retained.

References Cited:

Cuffey, R.J. 1998. Pipe Spring Dinosaur Footprints: A Scientific/Technical Report. Unpublished Report located at Pipe Spring Resource Management files.

National Park Service. 2000. Long Range Interpretive Plan, Pipe Spring National Monument. Harpers Ferry Center.

National Park Service. 1995. Statement for Management, Pipe Spring National Monument.

National Park Service. 1995. Resource Management Plan. Pipe Spring National Monument

TIMPANOGOS CAVE NATIONAL MONUMENT (TICA)

Size: 250 101 hectares (250 acres)

Park Purpose and History: Timpanogos Cave National Monument was established by Presidential Proclamation No. 1640, signed by President Warren G. Harding on October 14, 1922. The Proclamation reserved Timpanogos Cave due to its “unusual scientific interest and importance,” stating that “the public interests will be promoted by reserving [the] cave with as much land as may be necessary for the proper protection thereof.” At the time of the Proclamation the Timpanogos Cave system was within the Wasatch National Forest and managed by the U. S. Forest Service. The Proclamation clarifies the management differences between the Monument and the Forrest by stating that the reservation of land for the National Monument was “not intended to prevent the use of the lands for the National Forest purposes under the proclamation establishing the Wasatch National Forest, and the two reservations shall both be effective on the land withdrawn but the National Monument...shall be the dominant reservation.”

Executive Order No. 6166, dated June 10, 1933, placed all national monuments under the jurisdiction of the Department of the Interior. On July 1, 1934 Timpanogos Cave National Monument was transferred to the National Park Service. In doing so, the lands within Timpanogos Cave National Monument fell under the provisions of the National Park Service Organic Act of 1916. The Organic Act requires that national park units be managed in a manner that conserves their natural and cultural resources and provides for the use

and enjoyment of current and future generations. The Organic Act provides additional purpose to Timpanogos Cave National Monument, but the Proclamation of 1922 remains the dominant purpose of the monument reservation.

Location: The Monument is located in Utah County, Utah about 19 kilometers (12 miles) east of Lehi.

Elevation: Monument elevations range from a low of 1,670 meters (5,480 feet) along the western boundary of the Monument to 2,454 meters (8050 feet) on a peak along the southern boundary.

General Description: The Timpanogos Cave System is located on the south side of the steep-walled American Fork Canyon, located in the center of the Wasatch Range, Utah County, Utah. The caves are accessed by a 2.4 kilometer (1.5 mile) paved trail that gains 325 vertical meters (1,065 vertical feet), placing visitors at 2,042 meters (6,700 feet). The cave system consists of three main caves: Hansen Cave, Middle Cave, and Timpanogos Cave. Each cave has its own natural entrance, but man-made tunnels connect all three. The man-made tunnels create a one way tour approximately 550 meters (1,800 feet) long. There is a total of 1,706 meters (5,600 feet) of passage in the cave system, with a vertical relief of 56 meters (185 feet). The caves are located an average of 46-122 meters (150-400 feet) below the surface and range in temperature between 43-49 degrees F (Horrocks and Tranel 1994). The caves have formed along three minor faults and the bedding planes in the Tetro and Uncle Joe members of the Deseret Formation. They are highly decorated and are well known for their vibrant colors and their profusion of delicate helictites and anthodites. They are also known for their unique origin and rich cultural history.

Centrally located in the Wasatch Range, American Fork Canyon's geologic history is still debated. The canyon's location marks the convergence of the Great Basin, Uinta Basin, Wasatch Range, and Uinta Mountains. This area provides the opportunity to view significant geologic features and forces such as Utah's basin/range topography, distinctive bedding planes, a maze of faults, fault blocking, karst topography, cave formation, and tectonic plate folding. The steep walls of American Fork Canyon exemplify a V-canyon and expose many thousands of feet of sedimentary rock. These rocks include Precambrian quartzite, Cambrian quartzite, shale, and limestones, dolomites, and minor sandstones. The bulk of the known cave system is confined to the Mississippian age Deseret Limestones.

The Monument's vertical relief from the visitor center to the caves not only takes visitors through geologic history, but various biological classes are evident as well. The flora makes a transition from the river's riparian environment to cliff-dwelling xeric plants mingled with a mesic forest at the caves. Near the caves there are locations where water seeps from the rocks and provides a prime environment for mosses and ferns among the sage brush and gamble oak. The fauna makes a less marked transition as the monument extends upward, but the change can be noted as well.

Plant communities within the Monument include: pinyon juniper; mountain brush (gambel oak, big-toothed maple and serviceberry); white fir and Douglas fir (restricted to north-facing slopes); and riparian areas with cottonwood, alder, box elder and red-osier dogwood.

Aquatic features in the Monument include waterways associated with the American Fork River and cave lakes. A very short section (0.7 mile) of the American Fork River flows through the Monument, however the channel is partially dewatered since waterflow is diverted to a hydroelectric pipeline that routes water around the Monument. The project is in the relicensing process under FERC, and negotiations are underway to try and find a solution to the resource impacts on the Monument. At least 6 cfs of water flows through the Monument at all times, and the typical steep mountain terrain produces heavy spring run-off with the snowmelt in the mountains. Brown, rainbow and cutthroat trout are all present in the river.

The Timpanogos Cave system contains three main bodies of water: Hansen Cave Lake, Middle Cave Lake, and Hidden Cave Lake along with several seasonal smaller bodies of water. Surface waters within the cave appear to be generally of good quality with some impact from human activities.

Unique Features:

The Timpanogos Cave system is a man-made joining of three natural caves that contain 42 types of cave formations, an unusually large variety. The cave features dramatic and rare colors and unusual combinations

of delicate helictites and anthodites in quantities not found in other developed National Park Service managed caves.

The formation of the Timpanogos Cave system is believed to be the result of rising thermal waters contacting the water table at the intersection of geologic bedding planes and faults; this process is unusual among NPS managed caves. The caves are heavily decorated with fantastic combinations of colors and formations created through the dissolution and subsequent deposition of minerals at varied depths, percolation rates, and infiltration methods.

The 2.4 kilometer (1.5 mile) paved trail to the caves ascends 325 meters (1,065 feet) from pre-Cambrian through late Mississippian -aged rocks, providing one of the best exposed, easiest accessed and varied geologic records in the nation.

Biological Resource Concerns:

Lack of Data: The lack of relevant and complete data sets is the Monument's greatest concern and threat. We have severely out-dated, incomplete, or non-existent data sets for our vascular plants, mammals, birds, fish, reptiles, amphibians, and insects. This greatly limits park management's ability to make informed, factual, decisions to better protect and preserve its resources.

There is also a complete lack of any data sets for cave biota.

Species of Special Concern: While we have not identified Threatened or Endangered Species in the monument, we do have a few sensitive species and species that the Forest Service has listed as a sensitive species in the canyon. A complete T&E survey has never been conducted.

Townsend's big-eared bats (*Corynothinus townsenii*) are occasional visitors in the caves and other locations in the monument at times

Invasive Plants: The introduction and spread of invasive exotic plant species is a growing concern in the monument. Current problems include dalmatian toadflax (*Linaria genistifolia*), spotted knapweed (*Centaurea maculosa*), houndstoung (*Cynoglossum officinale*), and small locations of hoary cress (*Cardaria draba*).

Visitor Use: Related to the invasive species concern is the concern over visitor use impacts. While cave tours have been at near capacity for a number of years, the canyon and Monument have been receiving more visitors each year. The Monument is located within an hour's drive for 1.6 million people. The transition from a rural monument to an urban one carries concerns about possible impacts on the various resources currently being maintained.

ZION NATIONAL PARK (ZION)

Size: 59,900 hectares (148,016 acres)

Park History and Purpose: Zion National Park was originally protected by Presidential Proclamation No. 877 (36Stat. 2489) on July 31, 1909 as Mukuntuweap National Monument. On March 18, 1918 the monument was enlarged and the name changed to Zion National Monument (40 Stat. 1760). The enlargement was effected to protect "unusual archeological, geologic and geographic interests...", and to provide opportunities for visitor enjoyment of its grandeur and scenic features. The area received National Park status by the provisions of the Act of November 19, 1919 (41 Stat. 356). Subsequent Presidential Proclamation No. 2221 of January 22, 1937, established a Zion National Monument adjacent to the then existing park. The park and monument were combined in 1956 by an act of Congress (70 Stat. 527).

The purposes for which Zion National Park was established are delineated in the Presidential Proclamation dated March 18, 1918. These purposes as interpreted in Zion National Park Statement for Management (1994) and the General Management Plan (USDI 1977, update in progress) are as follows:

- Preserve the dynamic natural processes of canyon formation as an extraordinary example of canyon erosion.
- Preserve and protect the scenic beauty and unique geologic features: labyrinth of remarkable canyons, volcanic phenomena, fossiliferous deposits, brilliantly colored strata, and rare sedimentation.
- Preserve the archeological features that pertain to the prehistoric races of America and the ancestral Indian tribes.
- Preserve the entire area intact for the purpose of scientific research.
- Provide a variety of opportunities for visitors to learn about and enjoy the resources
- without degrading those resources.

In addition to park purposes stated above, it is also a purpose to manage the park in compliance with 1916 Organic Act, Wilderness Act, National Environmental Policy Act, National Historic Preservation Act, Native American Graves Protection and Repatriation Act, An Act to Establish Redwoods National Park, Endangered Species Act and others that may apply. In addition, the Zion National Park Resource Management Plan (USDI 1994) supplements other park documents and legal mandates to provide guidance and direction for the long-term management of the natural and cultural resources of the park.

Location: Zion National Park is located in southwestern Utah within portions of Washington, Kane, and Iron Counties. Lying on the western extremity of the Colorado Plateau, the park is located 72 kilometers (45 miles) (by road) northeast of St. George, Utah, 523 kilometers (325 miles) south of Salt Lake City, Utah, and 254 kilometers (158 miles) northeast of Las Vegas, Nevada.

Elevation: The elevations in the park range from 1,128 meters (3700 feet) in the southwestern corner to 2,660 meters (8726 feet) on Horse Ranch Mountain in the northeastern portion of the park.

General Description: Zion National Park is characterized by high plateaus, a maze of narrow canyons, and striking rock towers and mesas. Encompassing the southern and western perimeter of the Kolob Terrace (a southern extension of the Markagunt Plateau), the Park exhibits outstanding exposures of Permian through Cretaceous rocks. Due to the downcutting of the Virgin River, Zion Canyon provides a spectacular display of Triassic and Jurassic sediments, the most spectacular of which is the 2,000-foot thick exposure of Navajo sandstone.

The park is located at or near the common boundaries of 3 major vegetative zones, the Colorado Plateau to the north and east, Mojave desert to the south and southwest, and the basin and range to the west. This intermingling of zones combines with the rugged canyons and myriad streams and springs to produce microhabitats with a heterogeneous system of flora and fauna.

Flora: Vegetative communities are varied and consist of desert scrub at the lowest elevations, pinyon-juniper woodland and mountain shrub communities at middle elevations, and coniferous forest at the highest elevations. Rock crevice communities cover large portions of the east side of the park where opportunistic vegetation grow within cracks in the slickrock. Hanging gardens are unique communities that grow on vertical rock walls hosting seeps and springs. The numerous watercourses, including the North and East Forks of the Virgin River are lined with riparian vegetation consisting largely of Fremont cottonwood (*Populus fremontii*), velvet ash (*Fraxinus velutina*), box elder (*Acer negundo*), and seepwillow (*Baccharis* spp.). Over 890 species of vascular plants have been identified within Zion.

Fauna: Over 400 birds, mammals, reptiles, amphibians, and fish occur within Zion National Park. Amphibians are numerous along the watercourses within the park. The most commonly seen amphibians are the Arizona toad (*Bufo microscaphus microscaphus*) and red-spotted toad (*Bufo punctatus*). Reptiles occur park-wide, with northern plateau lizards (*Sceloporus undulatus elongatus*), side-blotched lizards (*Uta stansburiana*) and 2 species of whiptails (*Cnemidophorus* spp.) dominating the lower elevations and sagebrush lizards (*Sceloporus graciosus*) prevailing in elevations above 5200 ft. Snakes, while present, do not seem particularly numerous. Great Basin rattlesnake (*Crotalus viridis lutosus*), desert striped whipsnake (*Masticophis taeniatus*), and California kingsnake (*Lampropeltis getula californiae*) may be the most abundant. The most commonly seen mammals include mule deer, rock squirrels, and desert cottontails. Desert bighorn sheep (*Ovis canadensis nelsoni*) have been reintroduced into the park and appear to be healthy and increasing. Mountain lions (*Felis concolor*), while secretive and elusive, are apparent through

their sign which seems to be ubiquitous. Birds are most abundant in the riparian vegetation along the Virgin River and its tributaries. Four species of native fish populate the North and East Forks of the Virgin River, and greatly outnumber the exotic species.

Aquatic Features: Water resources in Zion NP include springs, seeps, tinajas, and the Virgin River and its tributaries. The park contains one of the last mostly free flowing river systems contributing to major canyon formation on the Colorado Plateau. Only a moderate amount of water development has occurred upstream of the park, such as the construction of Kolob Reservoir in 1957. Flow regimes are characterized by snowmelt runoff during the April-June season and summer monsoonal thunderstorms during the July-August season. Flow regimes provide highly variable daily flows which are important to water-related resource attributes and ecosystem values in Zion.

A National Wetlands Inventory is currently in progress to map seeps and springs throughout the park. These ground to surface water flows support hanging gardens and grottos that nourish unique vegetation and endemic fauna.

Unique Features and Species of Special Concern:

Special Vegetation Communities: The Riparian/Wetland community consists of springs, seeps, hanging gardens, and riverine systems. These areas are critical oases in an arid environment, providing productive and unique habitats for wetland plant species and a high diversity of aquatic invertebrates, amphibians, resident and migratory birds, fish, native pollinators and other organisms that create ecological balance. The Quaking Aspen (*Populus tremuloides*)/ White Fir (*Abies concolor*) community is restricted to higher elevations in the park. These stands are becoming decadent, most likely due to past fire suppression. Little is known about the biodiversity within these stands. The many Isolated Mesa Tops within the park are believed to have undisturbed populations of relict flora, offering rare opportunities for scientific research of relatively pristine environments.

Rare and Threatened Plants: Zion NP contains one federally endangered plant species, the Shivwits milkvetch (*Astragalus erectimus* var. *ampullarioides*). This species was recently listed by the U.S. Fish and Wildlife Service because of its extremely limited range, growing only on a specific geologic formation – the Chinle. At least 20 other rare plant species occur in the park, consisting of endemics and disjunct populations. Most of the rare plants are psammophytes (i.e., plants specifically adapted to grow in sand, sandy depressions, and sandstone crevices). Distribution and abundance inventories of Zion's rare plants are needed, especially in remote areas.

Animals: Federally listed animal species present in the park include 3 listed birds, and one listed reptile. The Threatened Mexican spotted owls (*Strix occidentalis lucida*) inhabits the narrow canyon habitats so characteristic of the Park. In addition, southwest willow flycatcher (*Empidonax traillii extimus*) has been occasionally found during summer months in patches of dense riparian vegetation. In winter, bald eagles (*Haliaeetus leucocephalus*) are seen perched in the towering cottonwoods along watercourses. A small population of desert tortoise (*Gopherus agassizii*) exists at one low elevation site.

Among the sensitive species within the park is the recently delisted peregrine falcon (*Falco peregrinus*) which thrives on and around the steep canyon walls where it makes its nests. The park also hosts the Virgin spinedace (*Lepidomeda mollispinis mollispinis*), a small fish which is narrowly being kept from threatened status through a habitat conservation agreement amongst numerous land management agencies. Another sensitive species, the endemic Zion snail (*Physa zionis*) inhabits the unique hanging garden habitats. The northern leopard frog (*Rana pipiens*) is a rare park resident which seems to be disappearing region-wide due to unknown causes.

Resource Management Concerns:

Recreational Use: Visitation in Zion National Park has been on the increase throughout the 20th century. Park visitors numbered 3,692 in 1920. In 1996, visitation reached 2.5 million per year. As more visitors arrived, impacts began to be noticeable in the natural environment. Fragile ecosystems around riparian areas are being trampled and eroded while human waste and toilet paper are accumulating around camping areas threatening the quality of backcountry water sources. Other resource impacts caused by increasing

visitor use at Zion include soil erosion, loss of critical microbiotic soils, desertification, vegetation trampling and denudation, root exposure, and resultant degradation of wildlife habitat and ecological function.

As part of the Visitor Experience Resource Protection (VERP) process some soil comparisons have been made between sites impacted by recreationists and sites not impacted. With the advent of the Zion Transportation System it is thought that visitor use patterns may change. Site monitoring has been established in several locations in order to assess the impacts of these changes on vegetation and soils.

Invasive Non-native Plant Species: Over 100 non-native plant species occur in Zion NP. Nine of these species are of top management concern for control and eradication. Tamarisk (*Tamarix ramossisima*) and Russian olive (*Elaeagnus angustifolia*) are the primary invasive species along riparian areas. Scotch thistle (*Onopordum acanthium*) and wooly mullein (*Verbascum thapsus*) are most commonly seen along trails and disturbed areas in the front and backcountry. Around the developed area, showy nightshade (*Solanum elaeagnifolium*), Russian thistle (*Salsola pestifer*), tree-of-heaven (*Ailanthus altissima*) and Johnson grass (*Sorghum halapense*) are abundant. Other problem species include numerous exotic grasses, yellow sweet clover (*Melilotus officinalis*), and other exotic thistles. Control actions and some inventory are currently in place for high priority locations and problem species. Extensive inventories for invasive non-native weeds are needed throughout the park to aid in prioritization and control.

Land Use Practices: Land development continues around the park perimeter. While a water rights agreement has protected instream flows in the North and East Forks of the Virgin River, individual springs and seeps may still be impacted by the utilization of ground water by development around the park boundary. Water quality may be impacted by cattle grazing in areas upstream of the park. While the park actively controls noxious weed species within its boundary, seed sources from outside are able to establish themselves by floating downstream or arriving on wind currents blowing in from infested areas. Cattle grazing continues around the park perimeter and within inholdings. Trespass cattle damage is an ongoing problem as is degradation of habitat due to past grazing within the park.

Degradation of Riparian Areas: To a large degree native riparian vegetation is not regenerating within Zion Canyon. Flood prevention measures have been successful in preventing widespread flooding which provides the moist, bare substrate necessary for riparian plant regeneration. Control of the course of the river, provided by gabions, have prevented the stream's natural meanders and have promoted the deepening of the river channel and drying of the streamside terraces. The resultant vegetation consists largely of an overstory of mature cottonwoods, boxelder, and velvet ash, many of which are dead and dying. Little or no native midstory vegetation exists and in certain areas, only herbaceous cover is in place. Regenerating woody vegetation is mostly non-native species, specifically tamarisk, which exudes salt and effectively prevents natives from establishment. This in turn causes loss or degradation of wildlife habitat.

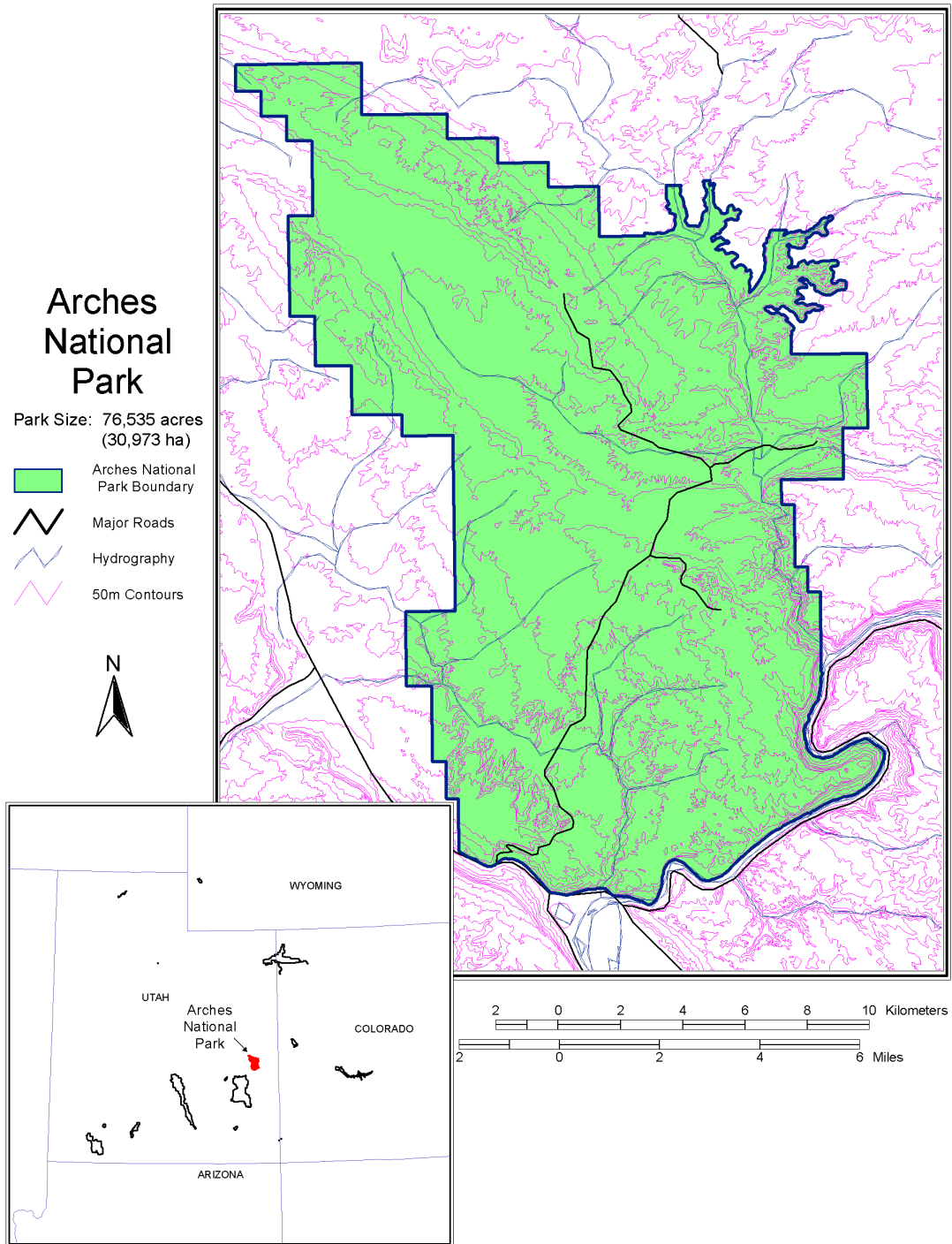
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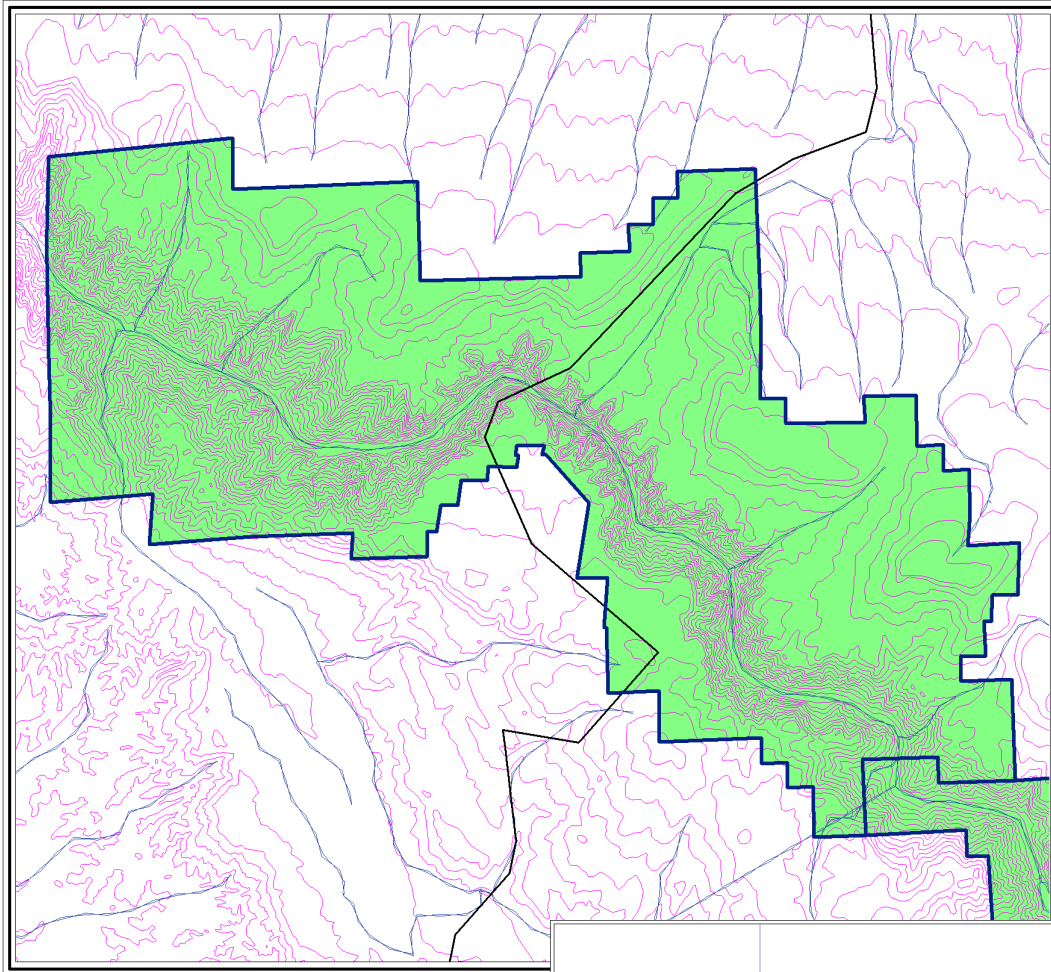
USDI, National Park Service. 1977. Zion National Park. General Management Plan. (update in progress).

USDI, National Park Service. 1994. Zion National Park Statement for Management.

USDI, National Park Service. 1994. Resource Management Plan, Zion National Park.

APPENDIX B. Northern Colorado Plateau Network - Park Maps

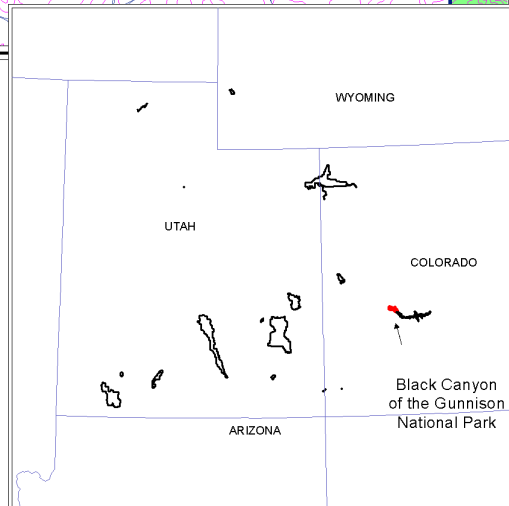


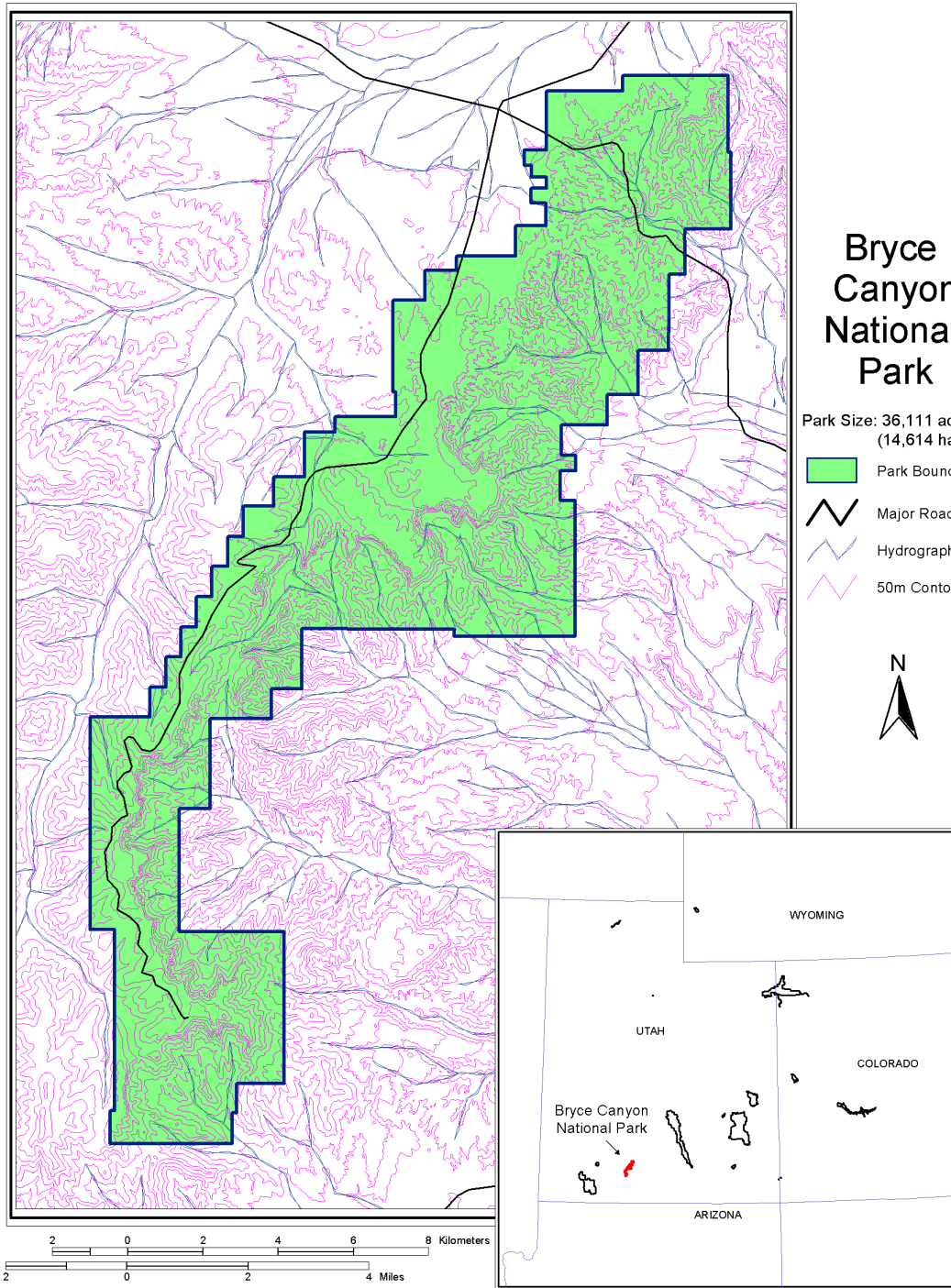


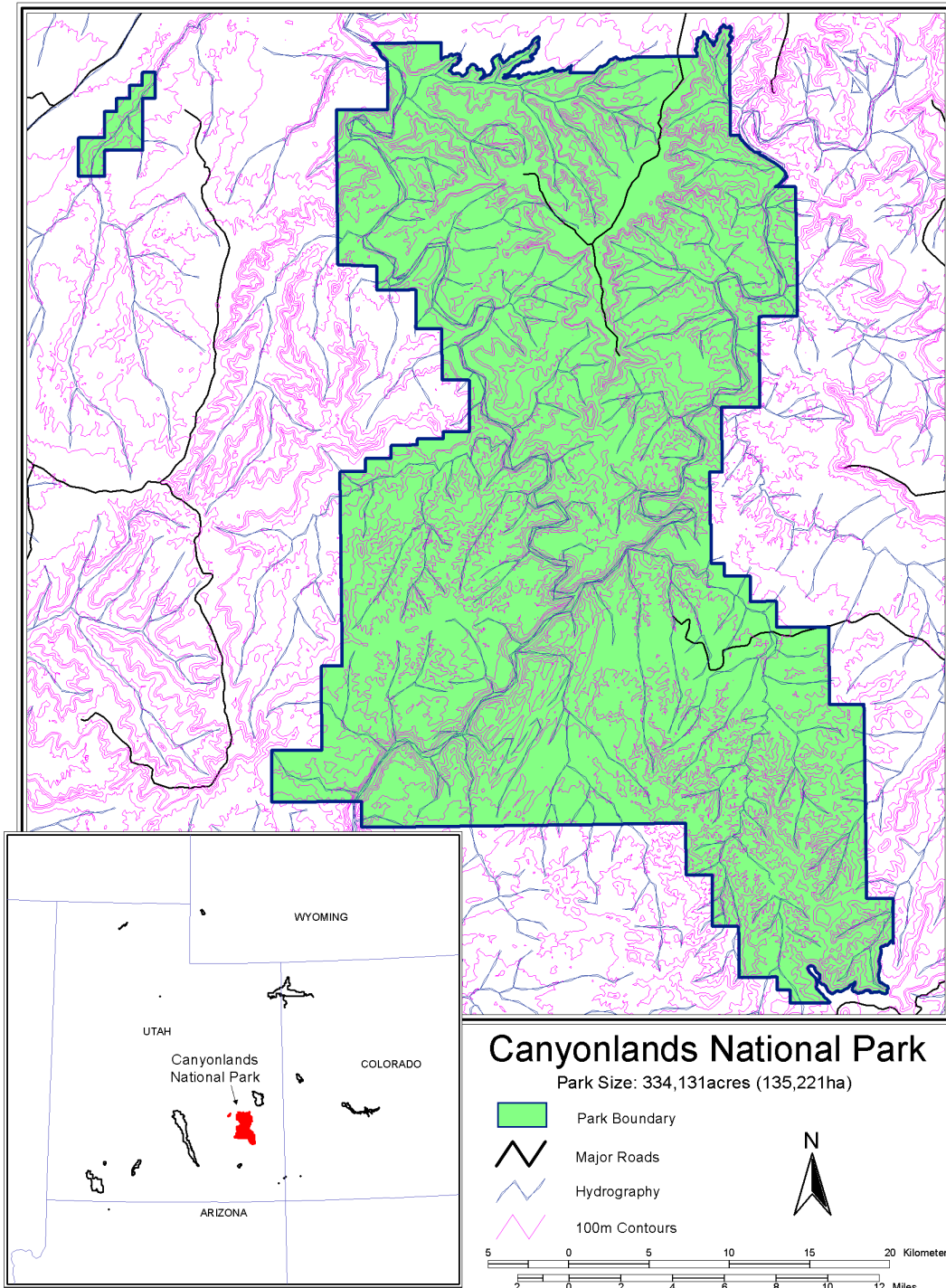
Black Canyon of the Gunnison National Park

Park Size: 21,353 acres (8,641 ha)

-  Park Boundary
-  Major Roads
-  Hydrography
-  50m Contours







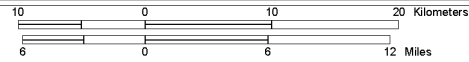
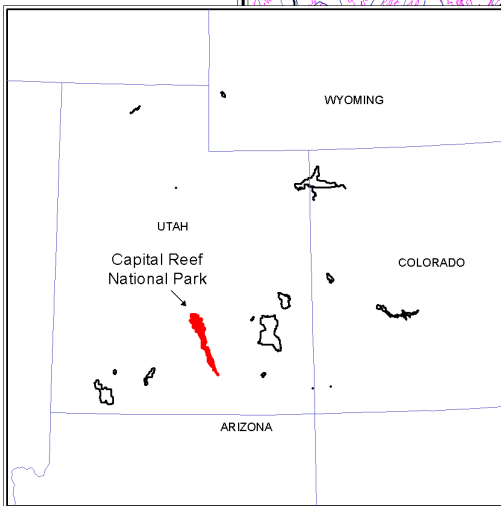
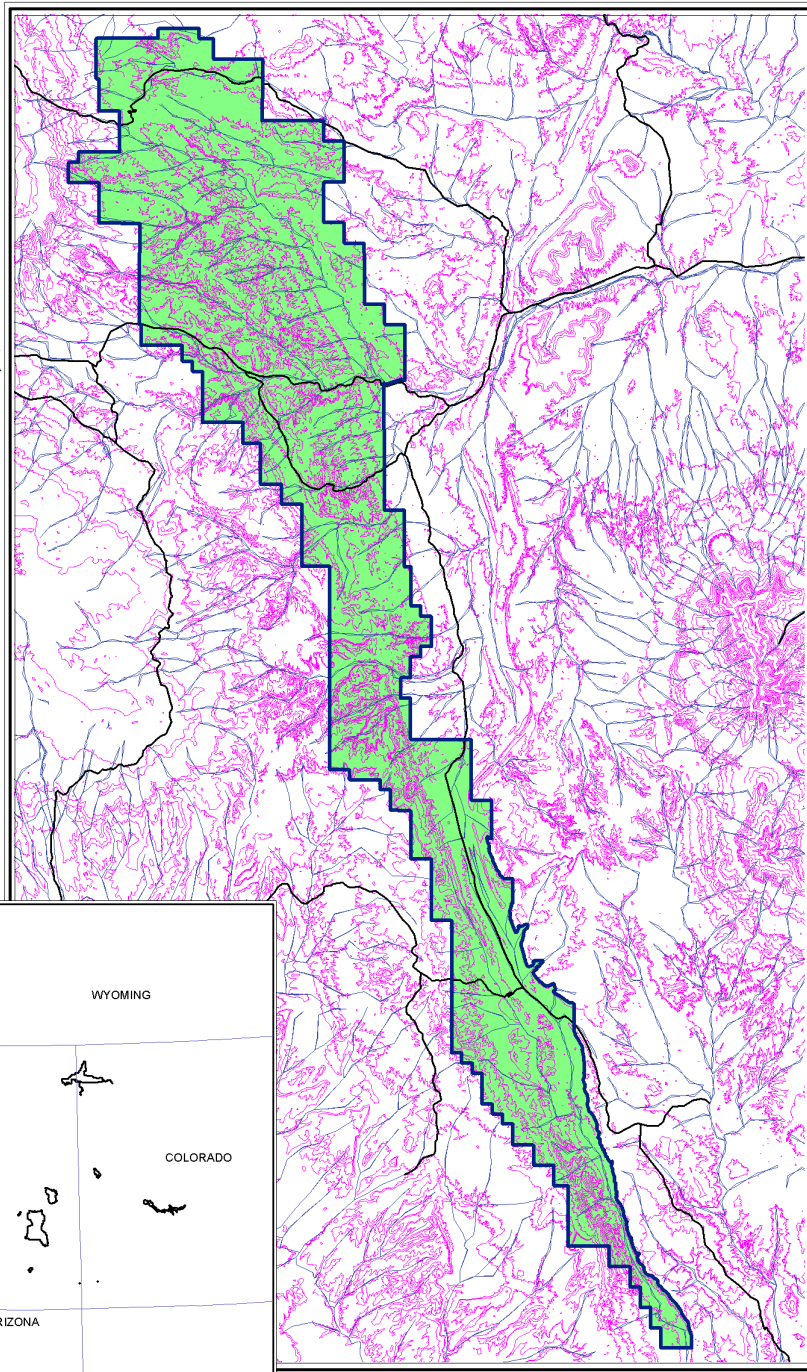


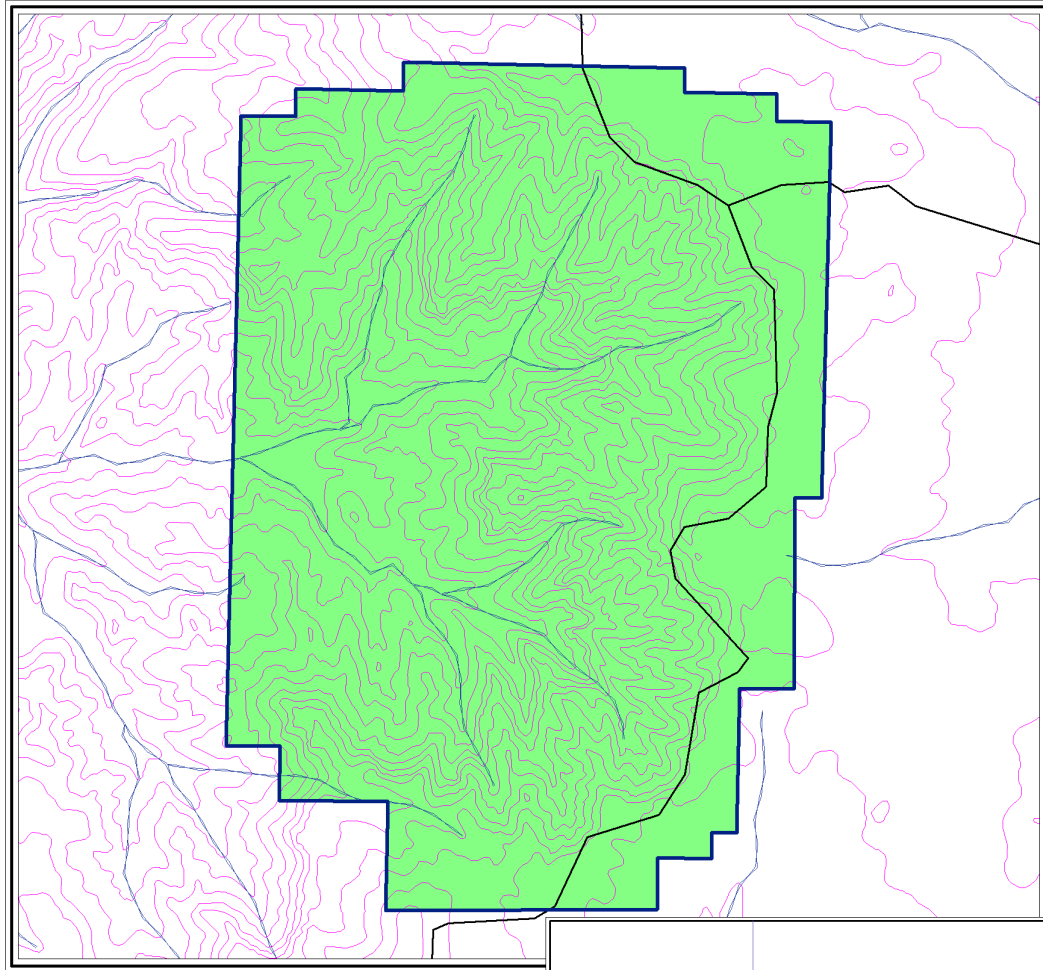


Capitol Reef National Park

Park Size: 243,765 acres
(98,650 ha)

-  Park Boundary
-  Major Roads
-  Hydrography
-  100m Contours

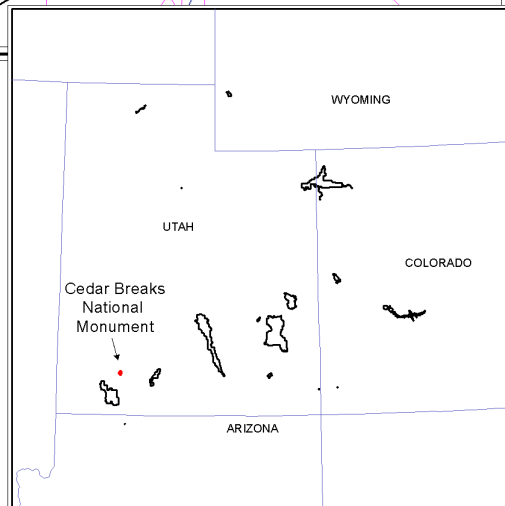
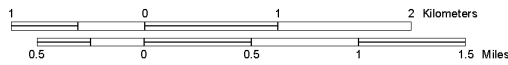




Cedar Breaks National Monument



Park Size: 6,100 acres (2,469 ha)

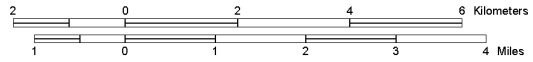
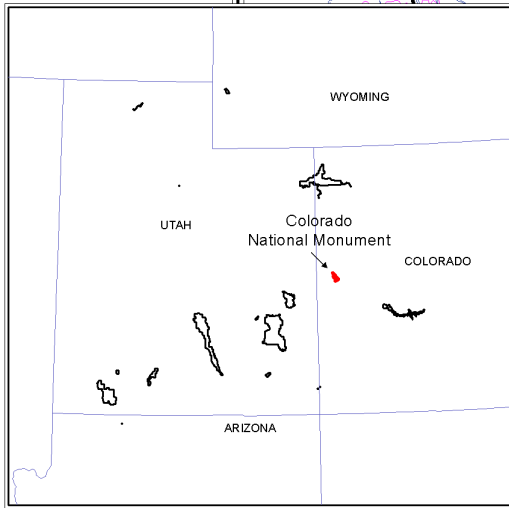
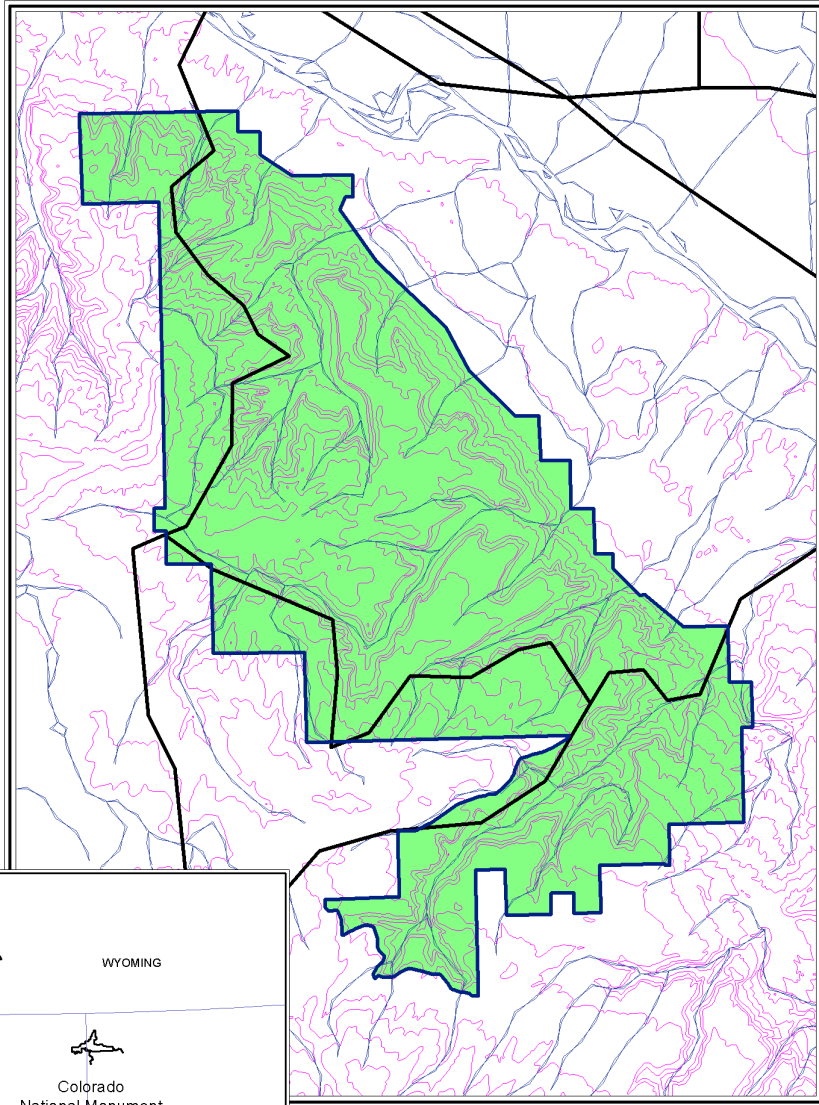
-  Park Boundary
-  Major Roads
-  Hydrography
-  50m Contours

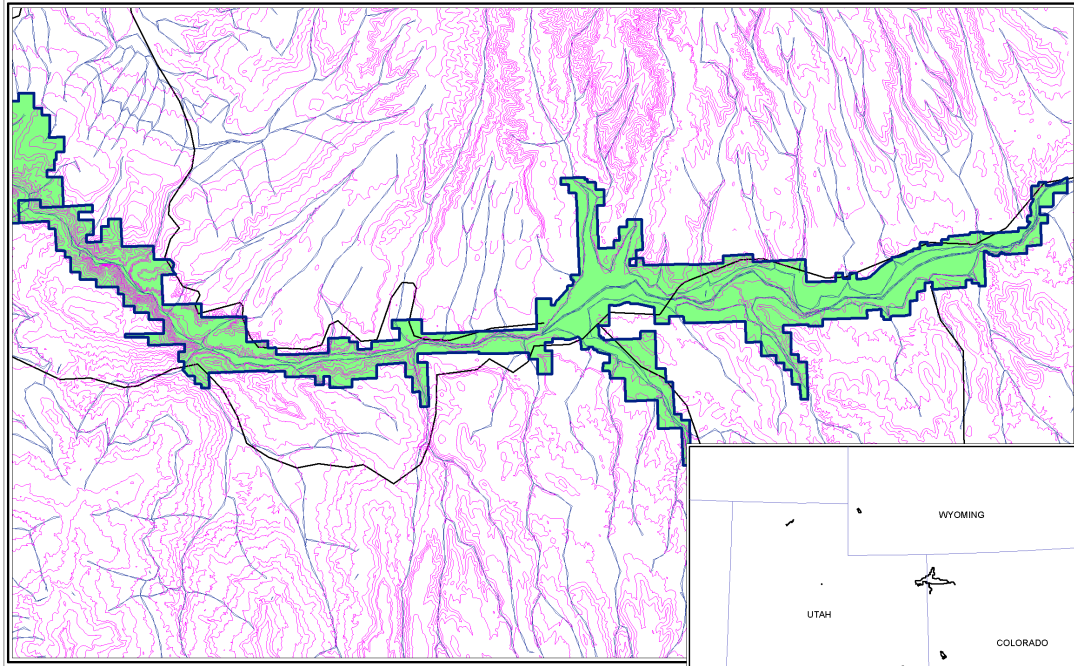


Colorado National Monument

Park Size: 20,419 acres
(8,264 ha)

-  Park Boundary
-  Major Roads
-  Hydrography
-  100m Contours

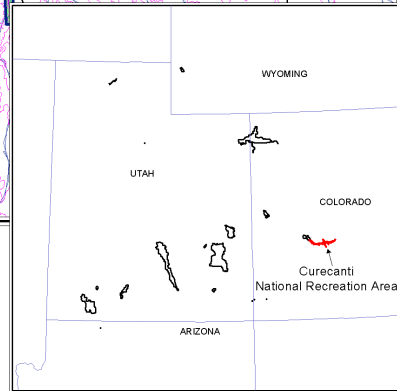


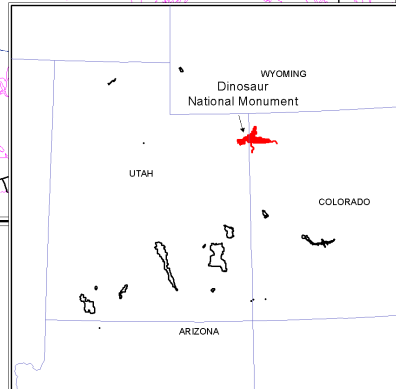
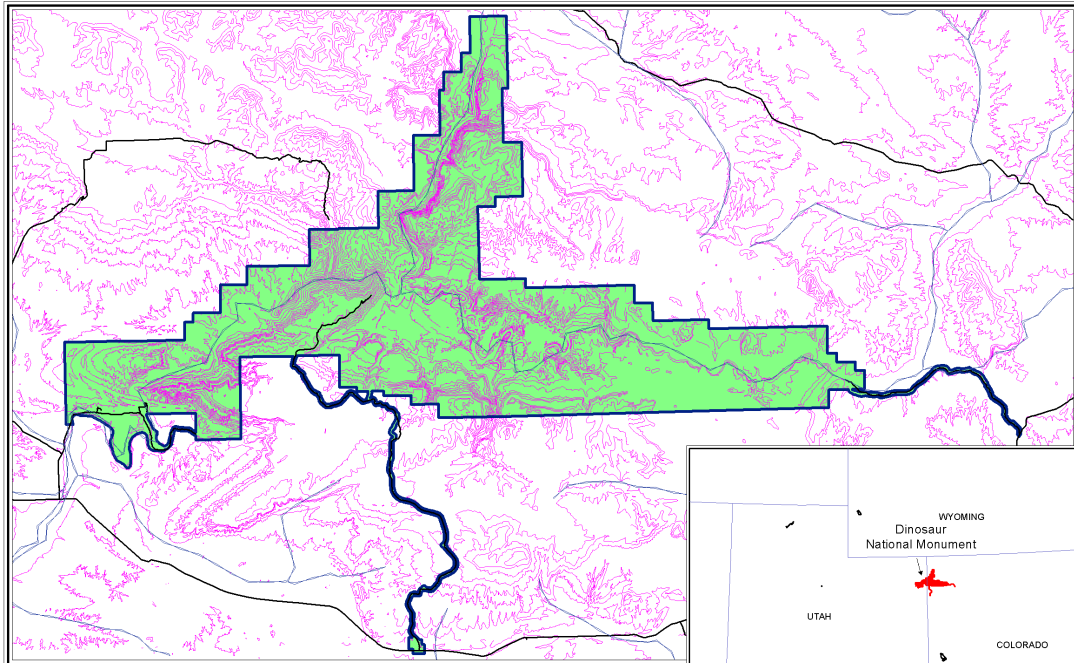


Curecanti National Recreation Area

Park Size: 41,084 acres (16,627 ha)

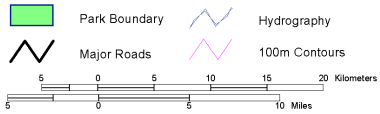
-  Park Boundary
-  Hydrography
-  Major Roads
-  100m Contours

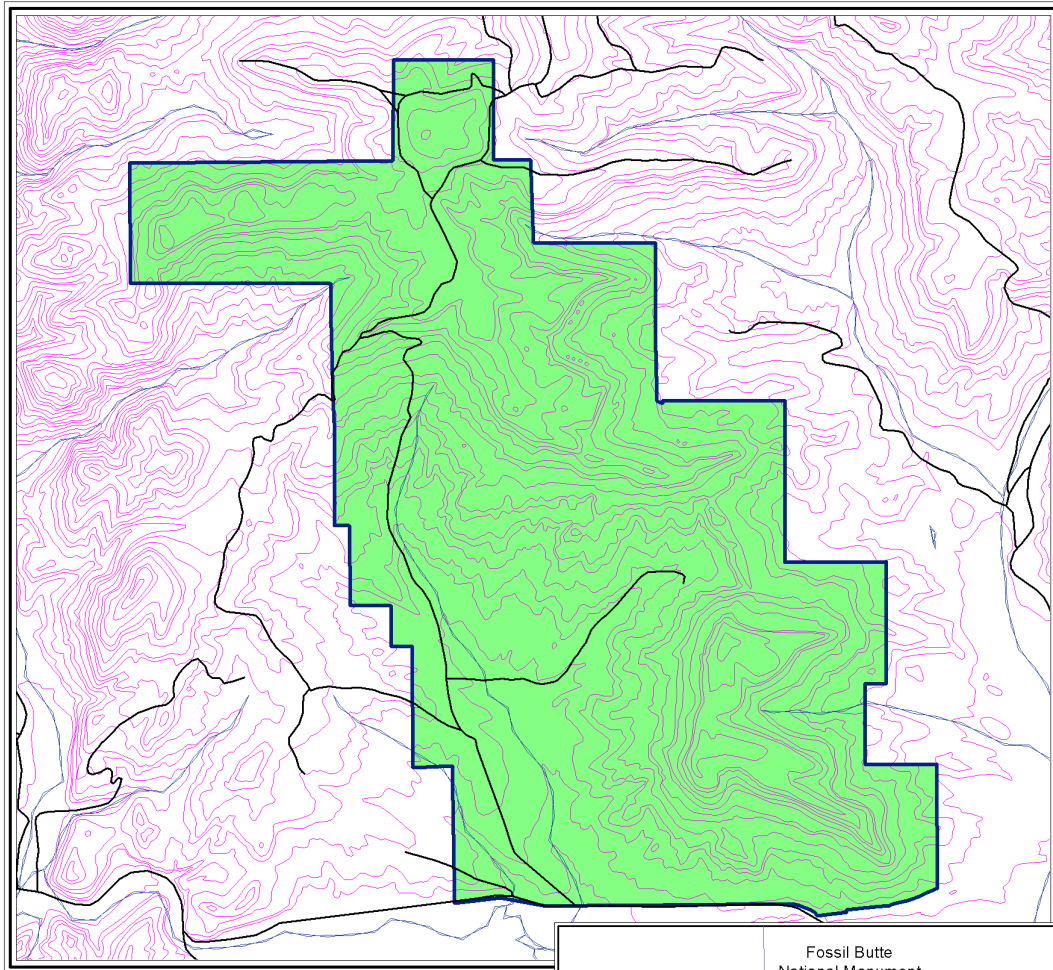




Dinosaur National Monument




Park Size: 210,805 acres (85,312 ha)

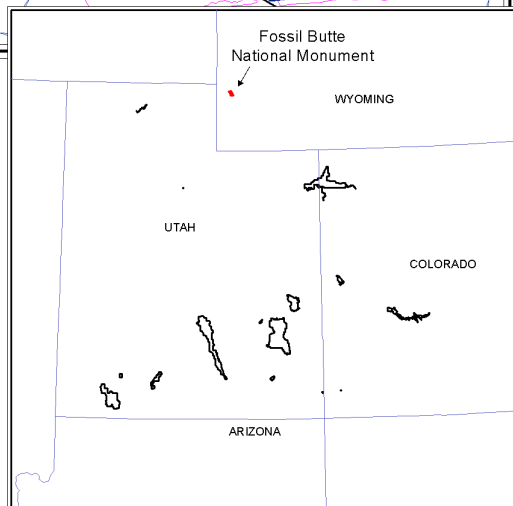


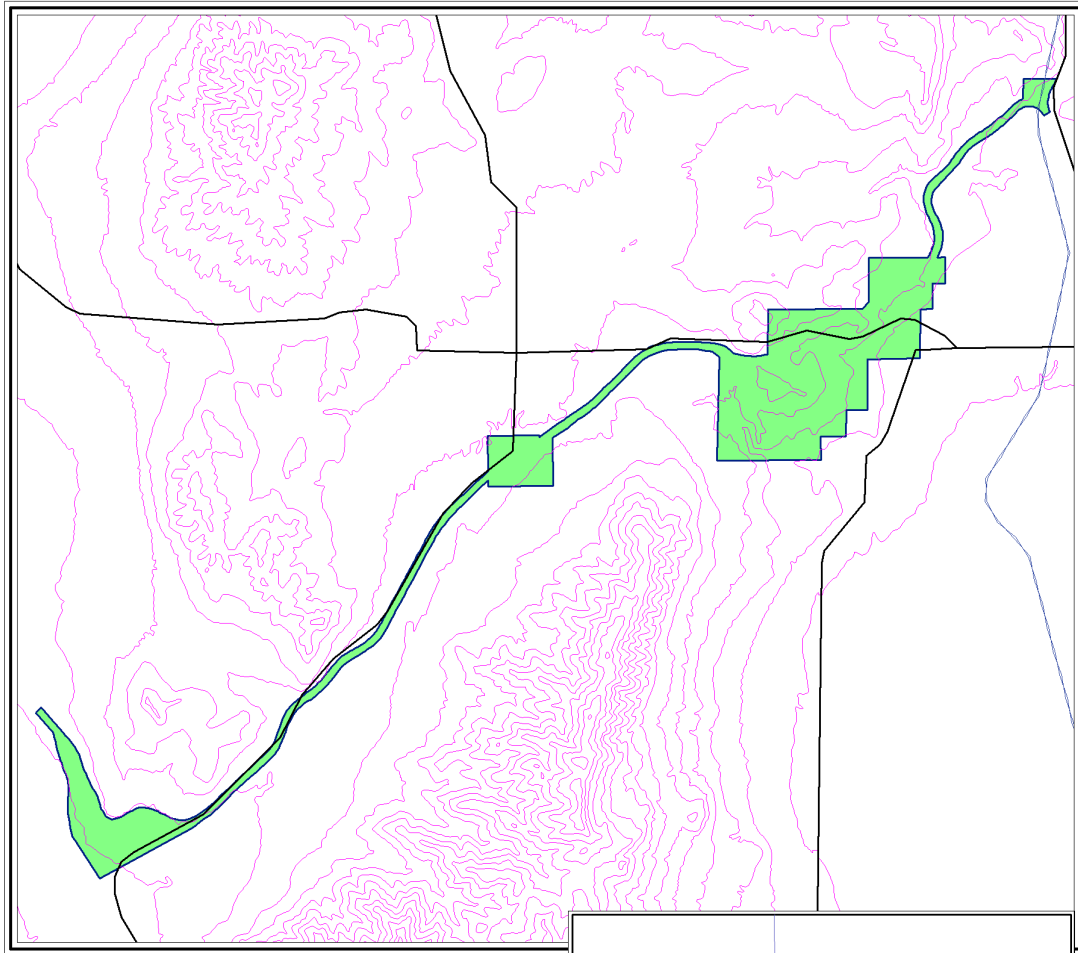


Fossil Butte National Monument

Park Size: 8,277 acres (3,350 ha)

-  Park Boundary
-  Major Roads
-  Hydrography
-  50m Contours

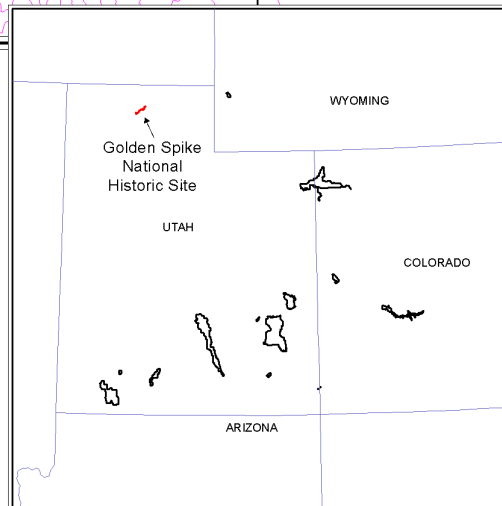


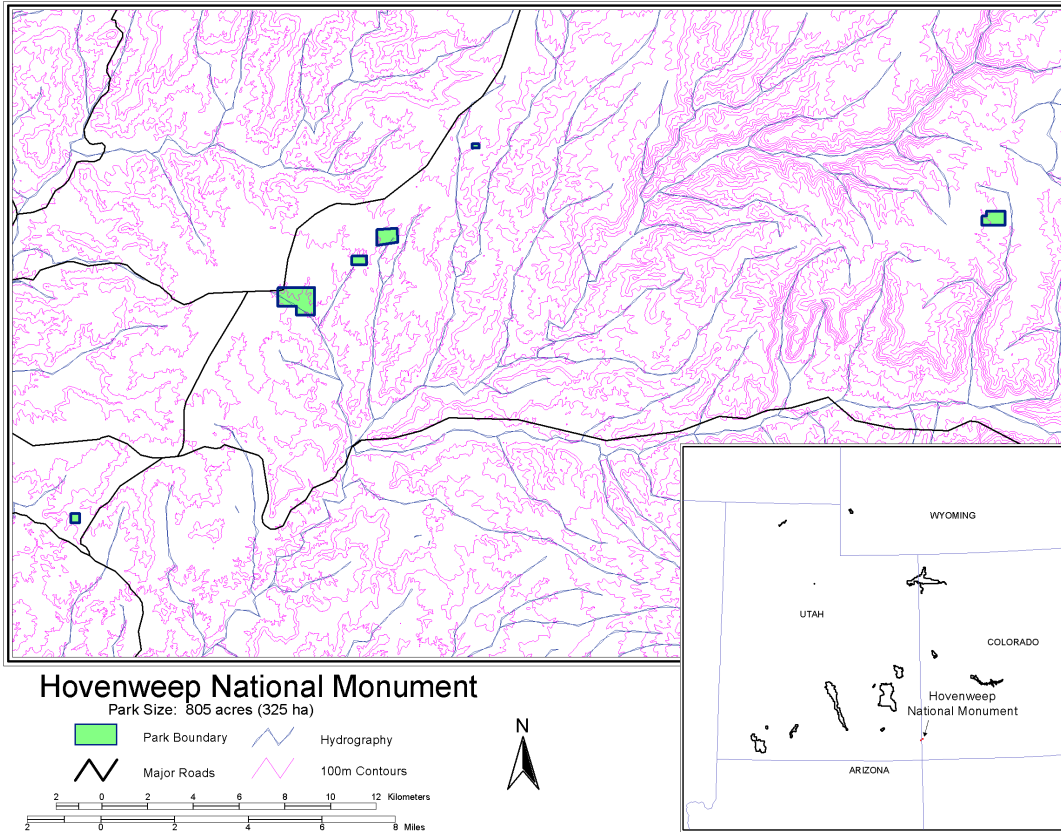


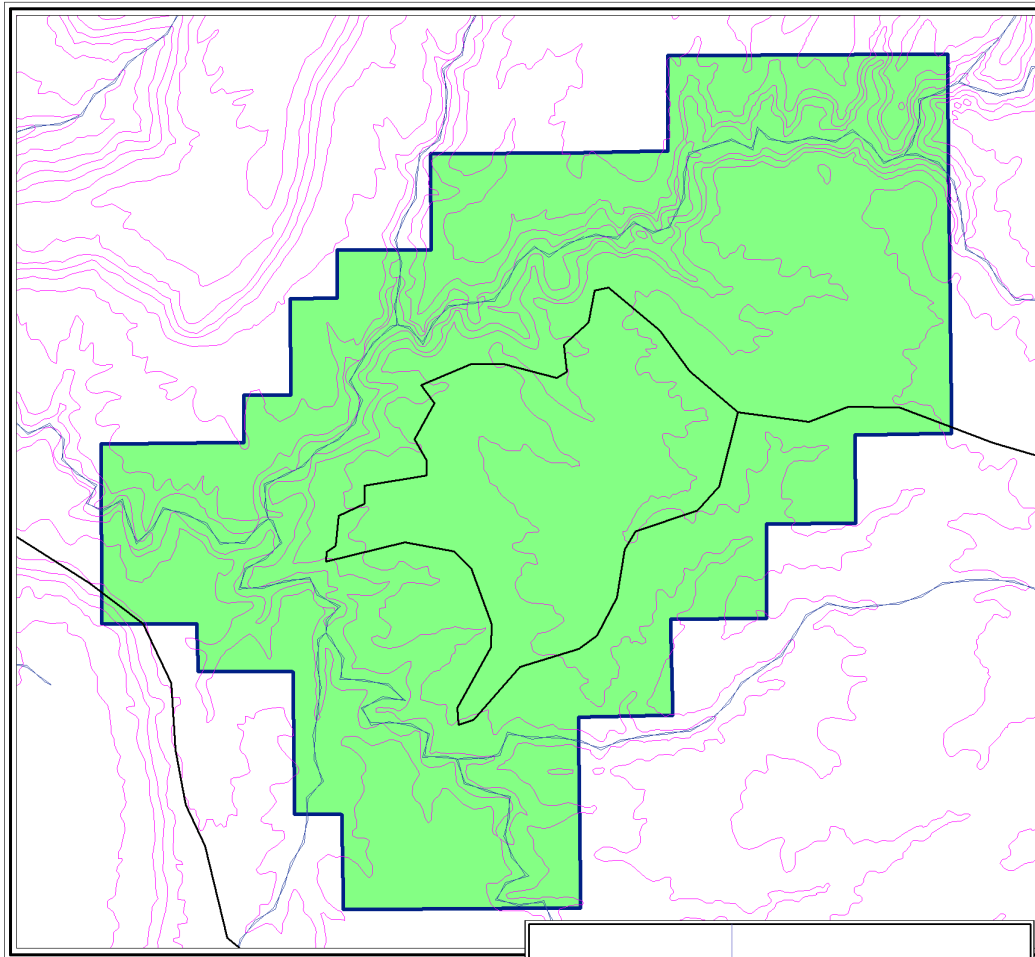
Golden Spike National Historic Site

Park Size: 2,666 acres (1079 ha)

-  Golden Spike National Historic Site Boundary
-  Major Roads
-  Hydrography
-  50m Contours



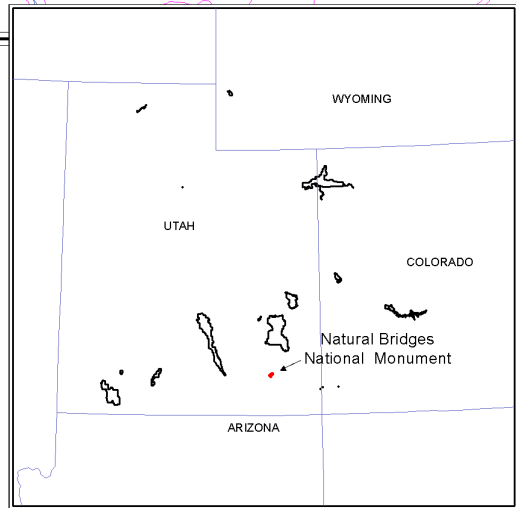
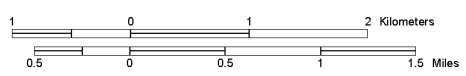


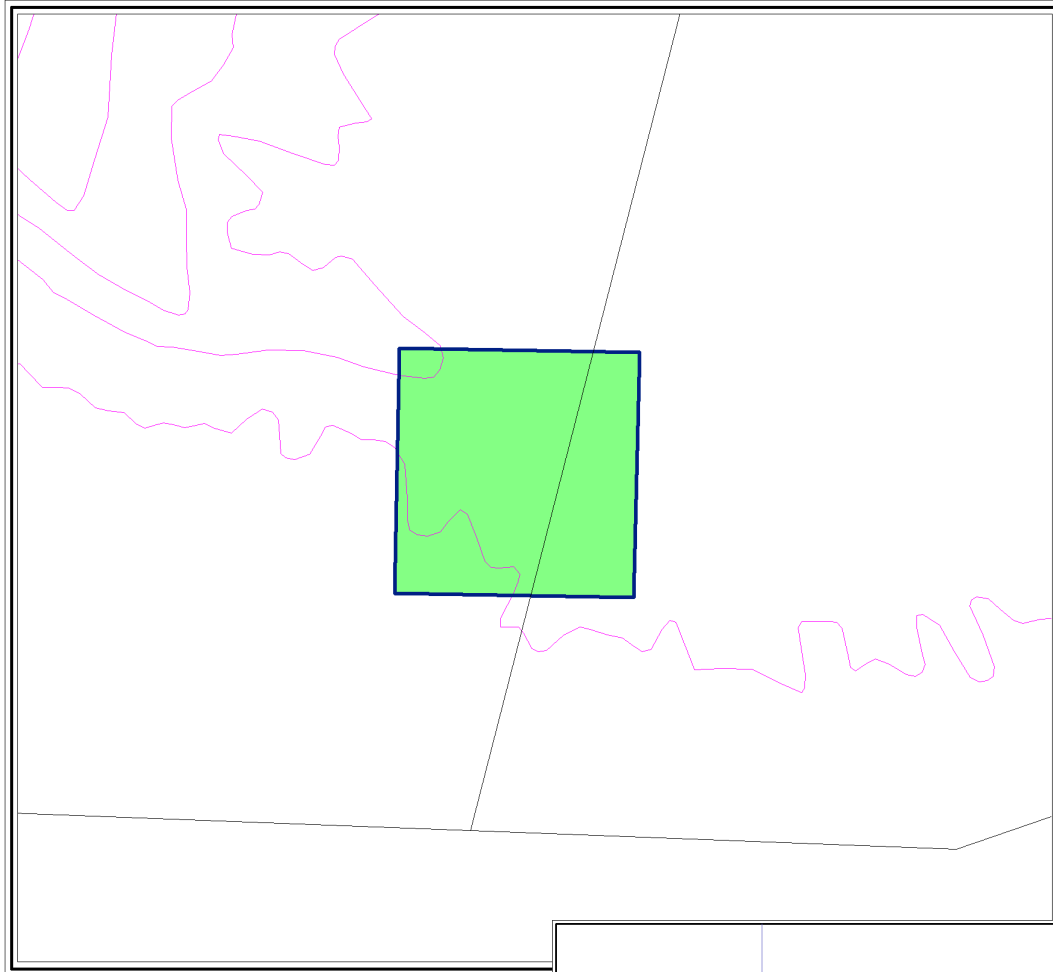


Natural Bridges National Monument

Park Size: 7,395 acres (2,993 ha)





-  Park Boundary
 -  Major Roads
 -  Hydrography
 -  50m Contours
- N
- 

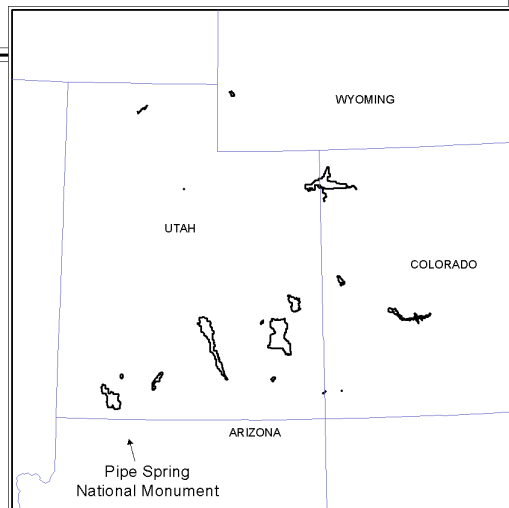
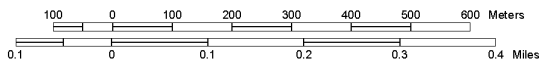


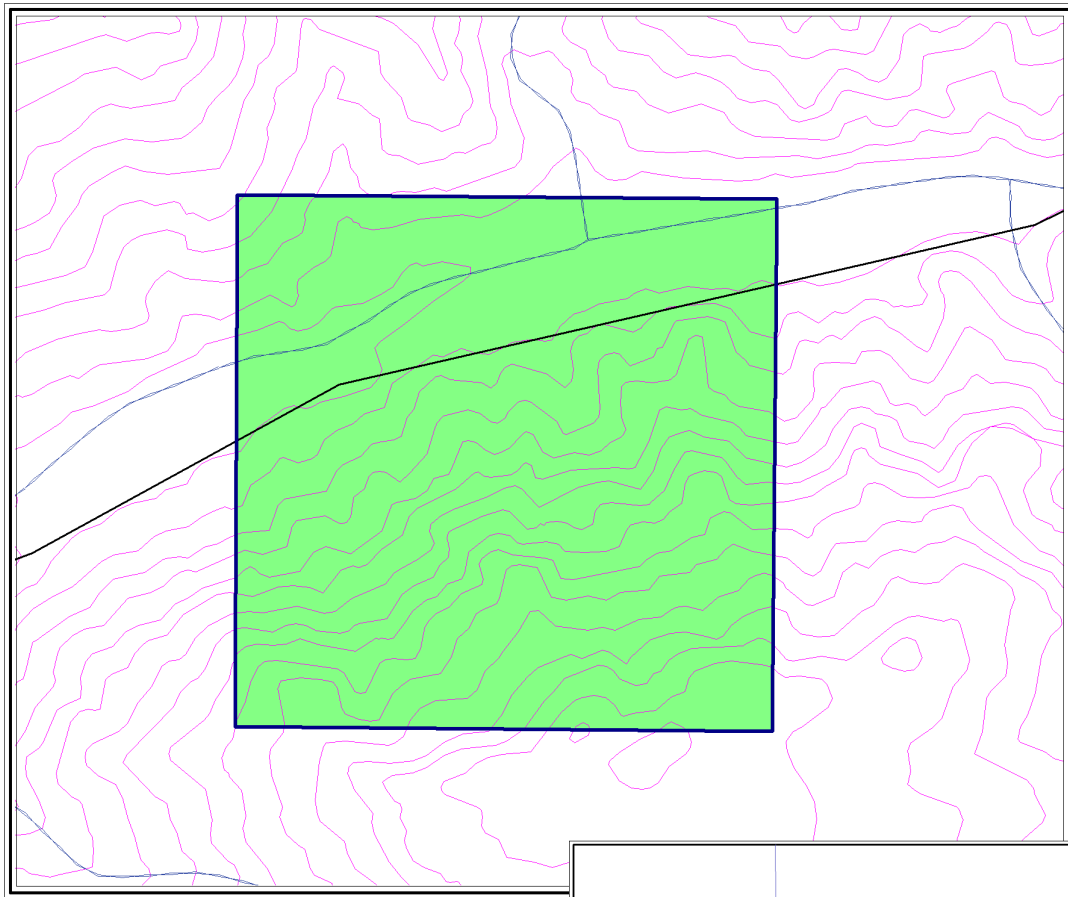


Pipe Spring National Monument

Park Size: 40 acres (16 ha)





-  Park Boundary
-  Major Roads
-  Hydrography
-  50m Contours

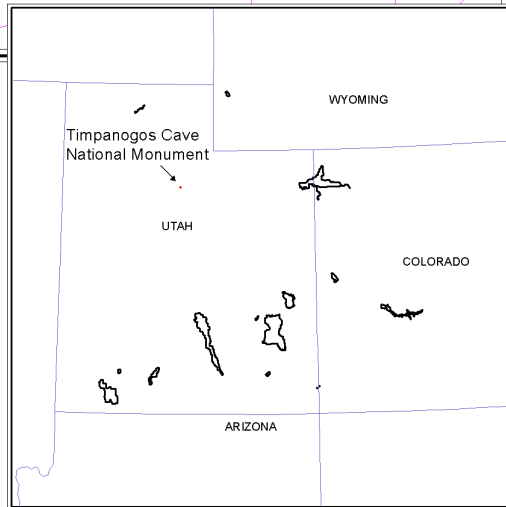
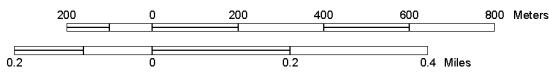




Timpanogos Cave National Monument

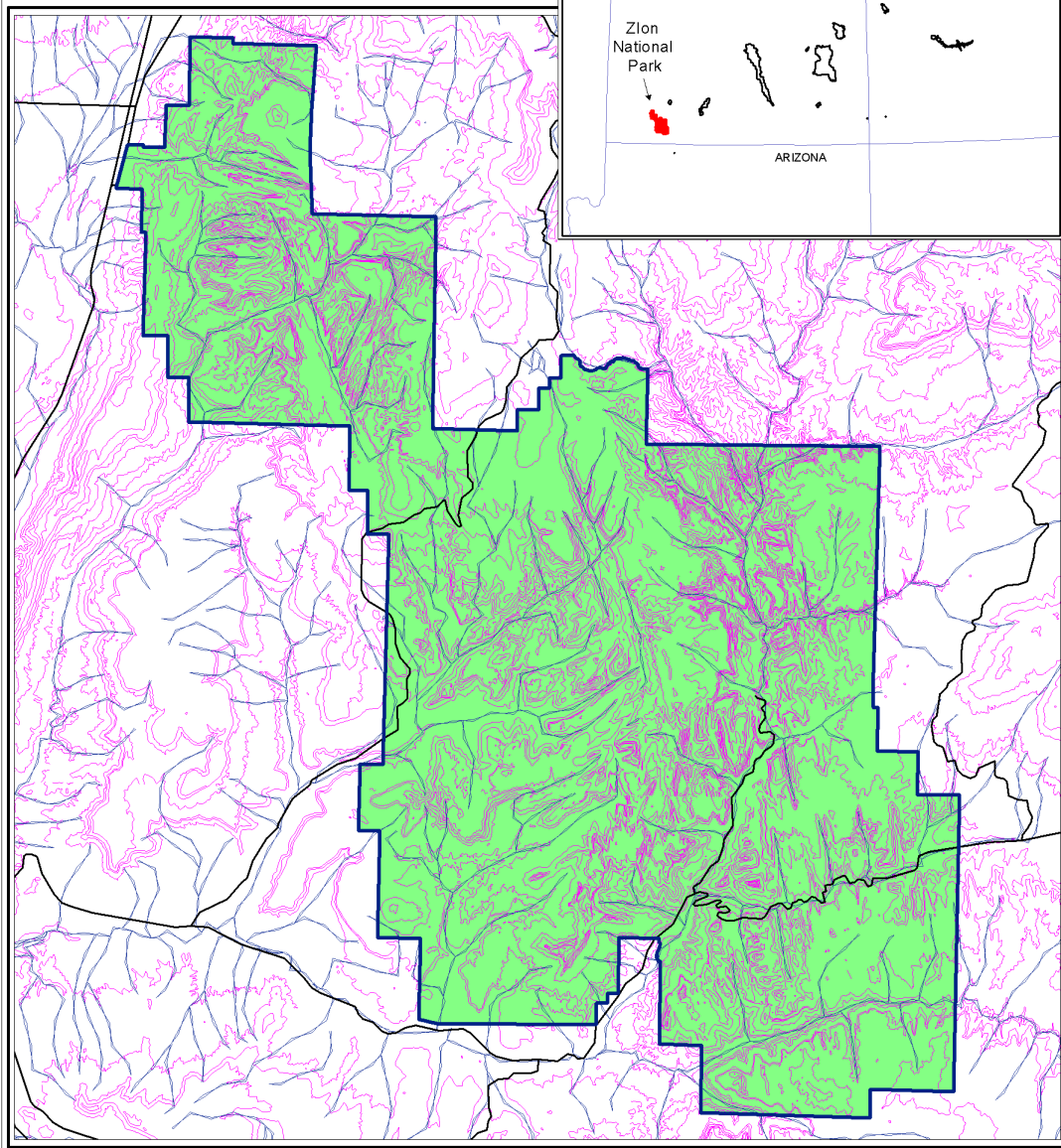
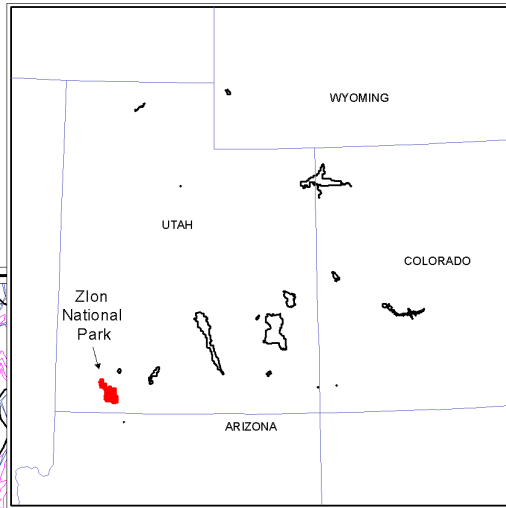
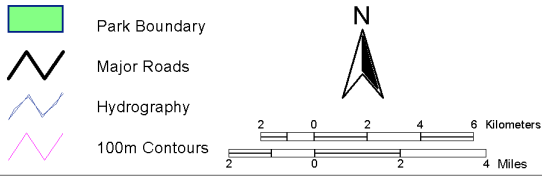
Park Size: 240 acres (100 ha)

-  Park Boundary
-  Major Roads
-  Hydrography
-  50m Contours



Zion National Park

Park Size: 147,868 acres (59,842 ha)



APPENDIX C. Summary of Completed and Ongoing Inventory Work for Northern Colorado Plateau Network Parks

ARCHES NATIONAL PARK (ARCH)

BIRDS

One-time Inventories and Miscellaneous Bird Sightings

Archived and on-going records of bird observations since 1947 (Arches National Park, 1947-1988) have contributed to the bird list for Arches National Park. One-time surveys by Hayward (1947), and Williams III, Ph. D. (1983), have contributed to the list. A walking survey by V. Wolfe (1984) documented summer riparian avifauna at Arches NP. A one-time Christmas Bird Count was conducted throughout Arches in 1978 (Borucki and Wimpfheimer).

Long-term Studies (multiple years)

Long-term monitoring of birds at Arches began in 1983 with the establishment of a 31-ha permanent Breeding Bird Census (BBC) plot in the pinyon-juniper habitat of Devil's Garden, which is currently on-going (Arches National Park, Resource Management files). Ten-year results for this BBC plot were summarized in Graham et al. (date unknown). Permanent Emlen strip transects, designed to sample all habitats in Arches NP, were monitored annually between 1987 and 1992, as part of the Long Term Monitoring Program begun for all the Southeast Utah Parks (National Park Service 1992). Problems with observer reliability and consistency led to the Emlen transects being replaced by permanent point-count transects in the Courthouse Wash riparian area, which have been on-going since 1993 (Fagan 1993, 1994, 1995, 1996, 1997; Daw 1998, 1999.) The Southeast corner of Arches National Park, between the Colorado River and Courthouse Wash, has been annually surveyed by participants in the "Moab" Christmas Bird Count since 1986 (A. Brand, personal communication with S. Daw, 8/10/2000). An on-going Breeding Bird Survey route, following United States Fish and Wildlife Service protocol, was established along the length of the Arches National Park road beginning in 1989 (USGS 2000.) Informal breeding season raptor surveys have been conducted annually at Arches National Park beginning in 1984 (Arches National Park, Resource Management files; Swanke 1986; Fagan 1988, 1989, 1990; Salamacha 1994, 1995.)

Birds of Arches National Park listed under the Endangered Species Act have all received monitoring. Peregrine falcon (*Falco peregrinus anatum*) territories were intermittently documented during the 1980's in Arches National Park, and consistently monitored since 1989 (Arches National Park Resource Management files.) No Mexican spotted owls (*Strix occidentalis lucida*) were detected during a 1995 survey in Arches National Park (Willey 1995), although they do occur throughout the Colorado Plateau. The southwest willow flycatcher (*Empidonax trailii extimus*) has been inventoried along the Colorado River portion of Arches in 1999 (Johnson 1999 and 2000), although it is not clear whether the subspecies observed regularly during migration at Arches NP is actually the endangered subspecies, *E. trailii extimus*. Aerial midwinter bald eagle surveys have been conducted during the 1980's along the Colorado River stretch within Arches NP as part of the Utah Division of Wildlife Resources Annual Midwinter Bald Eagle Survey (Connor 1983, DeGruyter 1984; Livesay 1985; Walters Jr. 1986, 1987; Utah Division of Wildlife Resources 1988; Bates 1990.) A midwinter bald eagle road survey was also conducted along the length of the Arches NP road in 1987 (Swanke).

References:

Arches National Park. 1947-1988. Log of wildlife observations from 1947-1988. Arches National Park Archives, Catalog number ARCH 2810, Folders 65-68.

Arches National Park, Resource Management files. Southeast Utah Group Headquarters, 2282 SW Resource Blvd., Moab, Utah, 84532.

Bates, B. February 10, 1990. 1990 Bald Eagle Survey. Memorandum to Linda Siebert. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.

Borucki, J., and D. Wimpfheimer. 1978. Christmas Bird Count results. Arches National Park Archives. Catalog # ARCH 2810, Folder # 64. 1p.

- Brand, A. 2000. Records compiler for Moab bird club. Personal communication with Sonya Daw, August 11, 2000.
- Connor, J. 1983. 1983 Bald Eagle Midwinter Survey Field Form. 2 p. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.
- Daw, S. 1998. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Daw, S. 1999. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- DeGruyter. 1984. 1984 Bald Eagle Midwinter Survey Field Form. 2p. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.
- Fagan, D. August 19, 1988. Memorandum. Arches Raptor Nesting Summary, FY 1988. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.
- Fagan, D. August 29, 1989. Memorandum. Arches Raptor Nesting Summary, FY 1989. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.
- Fagan, D. September 1, 1990. Memorandum. Raptor Survey - 1990. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.
- Fagan, D. 1993. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1994. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1995. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1996. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1997. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Graham, T. B., G. N. Salamacha, D. Fagan, and M. S. Salamacha. Population dynamics of birds at Arches National Park, Utah: fluctuations and trends in pinon-juniper woodlands, 1983-1992. Unpublished report on file with National Park Service, Southeast Utah Group, Resource Management Files. 14p.
- Hayward, C. Lynn. A report on birds observed and collected in the Arches National Monument Area, April 25-27, 1947. Arches National Park Archives, Catalog number ARCH 2810, Folder number 64.
- Johnson, M. J., A. Brand, H. C. English, C. Michaud, and B. Moore. 1999. Southwestern Willow Flycatcher and Western Yellow-billed Cuckoo Surveys along the Colorado River (Dewey Bridge - Canyonlands National Park Northern Boundary) and Green River (Green River, UT - Canyonlands National Park Northern Boundary) 1999. Final Report to the Utah Division of Wildlife Resources (contract # 976475), Colorado Plateau Field Station/Northern Arizona University report. 34 p.
- Johnson, M.J. 2000. Personal Communication with Charles Schelz September, 2000. (report pending).
- Livesay, J. January 23, 1985. Memorandum and data summary regarding completion of the 1985 midwinter bald eagle survey. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.
- National Park Service. 1992. 1992 Long-term Monitoring Report. Southeast Utah Group Resource Management files. 11p.
- Salamacha, G. March 6, 1994. Memorandum. Raptor Nesting Survey - 1993. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.
- Salamacha, G. January 5, 1995. Memorandum. Raptor Nesting Survey - 1994. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.

- Swanke, S. 1987. 1987 Bald Eagle Midwinter Survey Field Form. Southeast Utah Group Headquarters, 2242 SW Resource Blvd., Moab, UT 84532. Resource Management files. 2p.
- Swanke, S. July 18, 1986. Arches raptor nesting summary, 1984; Arches raptor nesting summary, 1985; Arches raptor nesting summary 1986. Arches National Park, Resource Management files. Southeast Utah Group Headquarters, 2242 SW Resource Blvd., Moab, Utah, 84532. 3p.
- Utah Division of Wildlife Resources. 1988. 1988 General Statewide Bald Eagle Survey Summary. Southeast Utah Group Resource Management files. Southeast Utah Group Headquarters, 2242 SW Resource Blvd., Moab, UT 84532.
- USGS Patuxent Wildlife Research Center. 2000. North American Breeding Bird Survey Internet data set, 10 August 2000 (<http://www.mp2-pwrc.usgs.gov/bbs/retrieval/>).
- Walters Jr., R. E. December 16, 1986. Memorandum concerning 1986 Midwinter bald eagle survey results. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.
- Walters Jr., R. E. December 18, 1987. Memorandum concerning 1987 Midwinter bald eagle survey results. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.
- Willey, D. W. 1995. Inventory For Mexican Spotted Owls within National Parks in Utah. Progress Report, 1995 field season. Unpublished National Park Service report, Headquarters files. "Birds".
- Williams III Ph.D., S. O. 1983. Birds of Arches National Park. Unpublished report on file at the headquarters of the Southeast Utah Group, National Park Service, Moab, Utah. 11p.
- Wolfe, V. 1984. Field notes on file at Southeast Utah Group headquarters from bird surveys in Courthouse Wash, Winter Camp Wash, and Anderson Gulch, Arches National Park, from July 24 to September 3, 1984.

MAMMALS

Inventory completeness at Arches National Park is estimated at 85%. At this point approximately 43 mammal species are known from the park. The most extensive work done with mammals has been the live trapping of small mammals as part of the long-term monitoring program. This was started in 1987 but was discontinued in 1993 due to the fear of Hanta virus. In this program trapping webs were set up at least once a year in most of the representative plant communities of the park. Annual or final reports were never completed but the data is still an incredible wealth of information about small mammal distribution and abundance in the different plant communities.

Several other studies of mammals have been conducted within the park over several decades. In the 1960's Wadsworth conducted M.S. thesis work (1967) on the life history of the Colorado (or Hopi) chipmunk (*Eutamias quadrivittatus*) and subsequently published (1969, 1972) two informative papers on his observations. Otherwise, there is little information available on this widespread, low-elevation chipmunk, now recognized as a separate species from the Colorado chipmunk. In 1977, Clevenger and Workman studied small mammals in relation to campgrounds and the human impacts on small mammal populations.

Bogan and colleagues have netted bats at a few sites within the park. They were primarily interested in documenting the occurrence of breeding colonies of the big free-tailed bat (*Tadarida macrotis*). The first record for breeding individuals in the park was obtained in 1991 (Bogan 1992) and a radio-tracking study on the species was conducted at ARCH in 1999 (Haymond et al., In preparation) with several maternity roosts identified in the central portion of the park. Voucher specimens for some species are in the Museum of Southwestern Biology (MSB). Bogan has also studied small mammals in the park using live and snap traps (1992 and 1993).

There have been many censuses of bighorn sheep, which were reintroduced to Arches in 1985 and 1986. Hall's (1981) map suggests that most of Utah was within the range of the Rocky Mountain bighorn (*Ovis c. canadensis*), although desert bighorns were the subspecies used in re-introductions to the park. There were scattered sightings of bighorn sheep in Arches prior to 1985 but it was feared that they had been primarily extirpated. After they were reintroduced from the population in the Island in the Sky District of Canyonlands

National Park several monitoring efforts were initiated (Canyonlands NP 1989; Utah State University 1990; Sloan 1993). Monitoring continues to this day.

Johnson (1988) studied the large carnivores of the park and experimented with and recommended various monitoring techniques.

All of these studies contributed greatly to our knowledge of the species diversity of mammals at Arches National Park. With this information a species list for mammals was put together by Schelz (1999).

References:

- Agenbroad, L. 1989. Preliminary Assessment of Bison Alcove, Arches National Park, Utah. Flagstaff, AZ: Northern Arizona University.
- Bogan, M. A. 1992. Biological Surveys in Five National Parks, Annual Report, 1991. 6 p.
- Bogan, M. A. 1992. Biological surveys in four National Parks (ARCH, BRCA, CARE, MEVE). Annual Report to National Park Service, Rocky Mountain Regional Office, 14 January 1992.
- Bogan, M. A., and C. A. Ramotnik. 1993. Biological Surveys on Colorado Plateau Nat. Parks, Ann. Rep. 6 p. Canyonlands National Park. 1989. Island in the Sky Bighorn Sheep Survey, 1989. 5 p.
- Clevenger, G. A., and G. W. Workman. 1977. The Effects of Campgrounds on Small Mammals in Canyonlands and Arches National Parks, Utah. Pp. 473-84 *In* Forty-Second North American Wildlife and Natural Resources Conference. Washington, D. C.: Wildlife Management Institute.
- Hall, E. R. 1981. The Mammals of North America. Second Ed., John Wiley and Sons, New York. 2 vols.
- Haymond, S., M.A. Bogan, E.W. Valdez, and T.J. O'Shea. In Prep. Ecology and status of the big free-tailed bat (*Myotis macrotis*) in southeastern Utah, with special reference to Allen's big-eared bat (*Idionycteris phyllotis*). Final report to National Park Service, Southeast Utah Group, Moab, UT.
- Johnson, K. A. 1988. Survey of Carnivores in Arches National Park, Utah, Spring 1988. Moab, UT: United States Department of Interior, National Park Service, Southeast Utah Parks Group, Resource Management Division.
- Schelz, C. D. 1999. Species List of Mammals of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.
- Sloan, W. B. 1991. Desert Bighorn Sheep and Salt Wash, Arches National Park, Utah. 4 p.
- USDI, National Park Service. 1964. Preliminary Investigation of Extirpated Species at Arches National Monument. Moab, UT: Arches National Monument.
- Utah State Univ. 1990. An Analysis of Composition, Distribution, and Habitat Use of Reintroduced Desert Bighorn Sheep in Arches National Park. National Park Service Project No. PX 1200-6-0112. Final Report ed. Logan, UT: Utah State University.
- Wadsworth, C. E. 1967. Life History of the Colorado Chipmunk (*Eutamias quadrivittatus hopiensis*). Paperbound photocopy, M.S. Thesis, Brigham Young University, Provo, UT.
- Wadsworth, C. E. 1972. Observation of the Colorado Chipmunk in Southeastern Utah. *Southwestern Naturalist* 16(4):451-54.
- Wadsworth, C. E. 1969. Reproduction and Growth of *Eutamias quadrivittatus* in Southeastern Utah. *Journal of Mammalogy* 50(2):256-61. Call Number: ARCH / 599.32-Wad-Arch.

REPTILES AND AMPHIBIANS

Inventory completeness is estimated at 85%. Although there have been no formal and extensive surveys for reptiles and amphibians at Arches National Park there have been many sightings from knowledgeable people and staff (USDI 1992). Lizard arrays were set up in 1983 in three plant communities and a list of reptiles by community was the result. Drogin (1991) put together a two-page pamphlet on amphibians based on her observations.

References:

- Drogin, A. M. 1991. Reptile and Amphibian List of Arches National Park. Pamphlet of the Canyonlands Natural History Association. 2p.
- Schelz, C. D. 1999. Species List of Amphibians of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.
- Schelz, C. D. 1999. Species List of Reptiles of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.
- USDI, National Park Service. 1991. Checklist of amphibians and reptiles in Canyonlands and Arches National Park. Unpublished list on file at Canyonlands National Park, Moab, Utah.
- USDI, National Park Service. 1992. Species list as compiled from wildlife observation cards, long term monitoring program data, and research and survey reports. All on file at Arches National Park, Moab, Utah.
- USDI, National Park Service, Arches National Park. 1983. Lizard Array Forms, Arches National Park.
- USDI, National Park Service, Southeast Utah Group. Checklist of Amphibians and Reptiles in Canyonlands and Arches National Parks. 2 p.
- USDI, National Park Service. 1974. Fish, Amphibians and Reptiles of Arches National Park.

FISH

Inventory completeness is estimated to be about 85%. Arches has 31 species if you include the Colorado River, only 8 of these are native. Not much fish survey work has been done in Arches NP. The only studies were those by Selby and Holden (1979). Holden did a little work in 1969-71 and provided a list in 1978. There are a number of exotic fish in Courthouse Wash and particularly in Salt Wash north of Wolf Cabin. These areas should be re-inventoried because it has been 21 years since the last inventory and unknown fish have been sighted. These are probably bluegill (*Lepomis macrochirus*) but this should be verified. Schelz (1999) compiled a fish list for Arches NP based on personal observations and previous work.

For the Colorado River there are many fish studies performed by the US Fish and Wildlife Service, various universities, and the Utah Department of Fish and Wildlife.

References:

- Schelz, C. D. 1999. Species List of Fish of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.
- Selby, D. A., and P. B. Holden. 1979. Survey of Fish, Invertebrates and Algae in Salt Wash, Arches National Park. 8 p. BIO/WEST: Aquatic and Terrestrial Resource Management and Problem Solving Logan, Utah.
- USDI, National Park Service. 1978. Checklist of Fishes: Arches and Canyonlands National Parks. 2 p.
- USDI, National Park Service. 1974. Fish, Amphibians and Reptiles of Arches National Park.
- USDI, National Park Service. Southeast Utah Group. Checklist of Amphibians, Reptiles and Fish, Canyonlands and Arches National Parks . 2 p.

VASCULAR PLANTS

Inventory completeness is estimated at 90%. There has been a lot of work done on the vegetation of Arches National Park. Approximately 645 species have been collected and there are a relatively large number of endemics. Plant identification began in earnest when the area was proclaimed a National Monument in 1929, mostly by the ranger staff. The first serious scientific effort to record the plants at Arches NP was by Harrison et al. (1964). Dr. Stanley Welsh served as a consultant for southeast Utah parks starting in the mid-1960s and collected plants in all areas. Later, the vegetation was defined by Allen (1977) with a quantitative description of the composition of the major plant communities, including a vegetation map. In 1987, permanent plant transects were installed in all the major plant communities and these have been monitored each year since then. There is approximately 12 years of data that is in the process of being analyzed. Other transects have been installed in the ensuing years and the protocol has been modified and improved.

At this point in time there are 15 permanent vegetation plots at Arches NP that are monitored annually.

Various authors have compiled plant lists for Arches NP. Schelz (1999) is the latest and most up to date. Malm (1992) constructed an identification guide that is helpful to the rangers.

Rare plant surveys were conducted by Heil et al. (1991) and the final report gives the status and extent of a number of species. There are excellent maps of population locations. Floyd-Hanna (1992) has done extensive work with the canyonlands bisquitroot (*Lomatium latilobum*). She has set up some long-term monitoring plots and has worked recently on a habitat model.

References:

- Allen, J. S. 1977. Plant Communities of Arches National Park. Ph.D. Dissertation, Brigham Young University, Provo, UT.
- Arches National Park. Arches Plant Species As Compiled From Species Lists, Reports, LTMP Data, and Observations. 13 p.
- Arches National Park. 1995. Biological Indicators for Arches National Park Visitor Experience and Resource Protection. Unpublished Report on file with Arches National Park. 15 p.
- Fagan, D., and K. Tennyson. 1984. Survey of Threatened Plant: *Zygadenus Vaginatus*, in Arches National Park. 50 p.
- Floyd-Hanna, L., and D. D. Hanna. 1992. *Lomatium latilobium umbelliferae* Population Maintenance in Arches National Park, Utah: Methods Comparison and Preliminary Data. Southwestern Rare and Endangered Plant Conference (Santa Fe, NM).
- Floyd-Hanna L. and D.D. Hanna. 1993. Population Biology of Selected Taxa in Arches and Canyonlands National Parks, 1993 Continuation. Prescott, AZ: Prescott College.
- Harrison, B. F., S. L. Welsh, and G. Moore. 1964. Plants of Arches National Monument. Brigham Young University Science Bulletin. Brigham Young University Herbarium, Paper no. 41.
- Heil, K., L. Floyd-Hanna, L. Reeves, D. Hyder and R. Fleming. 1993. Composition, Distribution, Abundance and Habitat Requirements of Endangered, Threatened and Rare Plant Species in the Southeast Utah Group of National Parks. San Juan College. Farmington, N.M.
- USDI, National Park Service. 1974. Regional Resources Basic Inventory: Biological Resources, Arches National Park, Canyonlands National Park, Capitol Reef National Park, Natural Bridges National Monument. Washington, D. C.: United States Department of Interior, National Park Service.
- Malm, M. 1992. Plant Identification Guide: a Guide to the Identification and Interpretation of the Plants of Arches National Park.
- Schelz, C. D. 1999. Species List of Plants of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.
- USDI, National Park Service. 1982. Blackbrush Data Sheets (Arches Natural Revegetation) - 1979, 1980, 1981, 1982.
- Utah Native Plant Society. Arches National Park Possible Endangered, Threatened and Sensitive Plants: Utah Native Plant Society List.
- Vanderbilt, K. Rare Plant Species of the Southeast Utah Group of National Parks. 32 p.

BLACK CANYON OF THE GUNNISON NATIONAL PARK**BIRDS**

The bird checklist for Black Canyon was compiled in 1960 (Beidleman 1960) and revised in 1971 (Dolson 1971). Park staff have collected monitoring data at locations within Black Canyon from 1996-99 using point count methodology. This monitoring effort is continuing and plans include evaluating its suitability for meeting park needs in 2001. A determination needs to be made about the adequacy of existing data and a site-specific checklist needs to be developed.

More extensive studies have focused on peregrine falcons (Boretti 1990) and territory occupancy and reproduction surveys continue today. The park initiated research on Gunnison sage grouse habitat utilization in 2000 (NPS 1999).

References:

- Boretti, R. 1990. Curecanti National Recreation Area and Black Canyon of the Gunnison National Monument 1990 Peregrine Falcon survey. National Park Service.
- Dolson, J. C. 1971. Revised Checklist of Black Canyon National Monument Summer Birds. (Original list by Beidleman, Sept. 1960).
- Chase and Ritz. 1996-1999. Park Files, Long-term Monitoring.
- USDI. National Park Service. 1999. Gunnison Sage Grouse – Significance of habitat as it relates to dispersal and genetic interchange. Black Canyon of the Gunnison National Monument Resource Management Plan. Project proposal BLCA-N-063.000.

MAMMALS

A list of mammals of Black Canyon of the Gunnison National Monument was compiled in 1966 (Hoy 1966). Very little mammal inventory work has been conducted since that time. Since it is unclear how extensive the 1966 work is, and substantial lands were added to the park since that time, the park needs a comprehensive inventory or a determination that existing lists are adequately representative.

References:

- Durant, S., and E. Robinson. 1962. Mammals of the Gunnison Basin. University of Utah, Anthropological Papers, Upper Colorado River Series.
- Hoy, B. 1966. List of Mammals – Black Canyon of the Gunnison National Monument. Unpublished checklist compiled by seasonal naturalist Bill Hoy and checked by Pat Miller, former Chief Park Naturalist. 5p.

REPTILES AND AMPHIBIANS

An annotated list of the amphibians and reptiles of Black Canyon of the Gunnison National Monument was compiled in 1966 (McCoy 1966). An additional survey, limited to the South Rim, was conducted in 1997 (Fallon 1997). Since it is unclear how extensive the 1966 work is and the 1997 work is limited in scope, the park needs a comprehensive inventory or a determination that existing lists are adequately representative.

References:

- Fallon, S.M. 1997. Herpetofauna Survey. 4p. plus appendices
- McCoy, C. J., Jr. 1966. An Annotated list of the amphibians and reptiles of Black Canyon of the Gunnison National Monument. 2p.

FISH

Fishes of the Gunnison River include introduced rainbow trout and brown trout, which support self-sustaining populations. A popular recreational fishery exists for these species from the upper boundary of BLCA downstream for about 42 kilometers (26 miles) to the confluence of the Gunnison River and the North Fork of

the Gunnison River near Delta, Colorado. Speckled dace, bluehead sucker, and roundtail chub are also found in this reach of the Gunnison River. The endangered Colorado pikeminnow and razorback sucker are native to the Gunnison River further downstream, but these species have not been reported from the vicinity of BLCA.

The section of the Gunnison River within Black Canyon of the Gunnison National Park was studied in 1964-1966 (Kinnear and Vincent 1967) and 1973-1976 (Wiltzius 1974).

A great deal of stocking of non-native sport fish of portions of the Gunnison River immediately above and below the park by the Colorado Division of Wildlife has occurred from the 1970s to present.

References:

- Kinnear, B. S., and R. E. Vincent. 1967. Fish and fish habitats in Black Canyon of the Gunnison National Monument. Colorado State University, 45 p.
- Wiltzius, W. J. 1974. Post-impound fishery investigations, Curecanti Unit, Upper Colorado River Storage Project, Final Report for Blue Mesa Reservoir. Colorado Division of Wildlife, 76 p.

VASCULAR PLANTS

A list of vascular plants of Black Canyon was compiled in 1983 (Weber 1983) and 1969 (Beidleman 1969). In addition, a list of plant species found in the inner canyon was compiled as part of a research project looking at river flows (Auble et al. 1994). Park staff have collected monitoring data at locations within Black Canyon from 1996-98 (USDI 1998). This monitoring effort is currently undergoing review to determine its suitability for meeting park needs. As substantial lands were added to the park since the 1983 inventory, and the additional surveys are limited to specific geographic areas, the park needs a comprehensive inventory or a determination that existing lists are adequately representative.

References:

- Auble, G.T., J.M. Friedman, and M.L. Scott. 1994. Relating riparian vegetation to present and future streamflows. *Ecological Applications* 4(3): 544-554.
- Beidleman, R. G. 1969. Checklist of Black Canyon National Monument Plants. Colorado College. 6p.
- USDI. National Park Service. 1998. Long-term vegetation monitoring data set. Park files.
- Weber, W.A. 1983. Checklist of Vascular Plants Black Canyon of the Gunnison National Monument. Unpublished report on file at University of Colorado Museum, Boulder, CO. July 1983. 27p.

BRYCE CANYON NATIONAL PARK

BIRDS

Several bird studies have been conducted to determine distribution and abundance of not only threatened, endangered and rare species but also inventory of species occurrence in the park. Hallows (1982) describes a basic inventory of avian species conducted from June through August of one year. Some of the information contained in the checklist is based more on understanding of species biology than on observations throughout the year. Hallows conducted a follow up sampling from September of 1982 until August of 1983 and reported no corrections to the initial checklist. Johnson (1991) reported on a survey of bird species and their association with forest areas burned by management ignited fires. The report describes study locations and methods for quantifying the species observed. However, there is no final report that summarizes the results and draws conclusions. Johnson's work documents abundance of 27 species of birds in one small area of the ponderosa pine forest community but may be representative of this habitat type. Records in the files indicate that Christmas Bird Counts were conducted annually between 1963 and 1969. Park records of the data gathered indicate 24 to 37 species were observed each year for a cumulative total of 58 species. Breeding bird surveys have been conducted in the past but no records of observations were retained in the park. These need to be requested from the US Fish and Wildlife Service.

Systematic field surveys to detect peregrine falcons were initiated in 1989. Monitoring has been conducted at known territories most years since that time (Burch 1996, Fields 1999). The park has supported one to four territories since 1985 (Fields 1999).

A pilot study to search for northern goshawks in Bryce Canyon National Park was conducted in 1993 (Foster 1993). A systematic inventory of forested habitats to detect northern goshawks was initiated in 1998 (Ames-Curtis et al. 1998). The transects have been sampled in 1999 and 2000. One territory has been occupied each of the last three years and one new territory was discovered in 2000 (Ames-Curtis and Lloyd 1999, K. Parker unpubl. Field notes).

Mexican spotted owls have been observed on lands surrounding Bryce Canyon National Park (Utah Div. Wildlife Resources, pers. Comm). The park staff developed a habitat suitability model to determine where potential habitat may be located. In 1994 and 1995, five transects were sampled but no Mexican spotted owls were detected (Burch 1994, Burch 1995).

Information to document the distribution and abundance of southwest willow flycatcher is incomplete in southern Utah. Park staff have conducted surveys along two transects since 1995. However, observation of willow flycatchers has been detected in only two locations and none have been observed since 1996 (Schreier 1996, Ames-Curtis 1999, Ames-Curtis and Wallen field notes).

References:

- Ames-Curtis, J., B. Buchanan, J. Heyn, and K. Kitchen. 1998. Northern goshawk inventory and monitoring at Bryce Canyon National Park. Unpublished report, Bryce Canyon National Park. 7p.
- Ames-Curtis, J., and L. Lloyd. 1999. Monitoring for northern goshawks in Bryce Canyon National Park. Unpublished report, Bryce Canyon National Park. 5p.
- Ames-Curtis J. 1999. Federal endangered avian species survey report: southwestern willow flycatcher. Unpublished report, Bryce Canyon National Park. 10p.
- Burch, J. 1994. Mexican spotted owl report. Unpublished report, Bryce Canyon National Park. 8p.
- Burch, J. 1995. Mexican spotted owl report. Unpublished report, Bryce Canyon National Park. 4p.
- Fields, C., and D. Neighbor. 1999. 1999 peregrine falcon report- Bryce Canyon National Park. Unpublished report, Bryce Canyon National Park. 11p.
- Foster, D.A. 1993. 1993 Northern Goshawk Report. Unpublished report, Bryce Canyon National Park. 9p.
- Hallows, G. 1982. Birds of Bryce Canyon National Park and vicinity. Southern Utah State College, Cedar City. Unpublished report. 36p.
- Hallows, G. 1983. Birds of Bryce Canyon National Park and vicinity. Southern Utah State College, Cedar City. Unpublished report. 8p.
- Johnson, T. 1991. Fire effects monitoring : Songbird surveys. Bryce Canyon National Park. Unpublished report. 13p.
- Neighbor, D. 1998. Southwestern willow flycatcher report. Unpublished report, Bryce Canyon National Park. 20p.
- Schreier, W. 1996. Federal endangered avian species survey report: southwestern willow flycatcher. Unpublished report, Bryce Canyon National Park. 21p.

MAMMALS

The majority of the studies on Bryce Canyon fauna have been conducted on mammals. Early work on mammals of Bryce Canyon, Zion and Cedar Breaks was conducted by Presnall (1938) and Presnall and Hall (1936).

More recent mammal studies were initiated at Bryce Canyon in 1988 in response to a park request for surveys of mammals in proposed prescription burn areas (Bogan 1990). Eventually, with the cooperation of the park and National Park Service Intermountain Region, the work was expanded to include baseline

inventories of mammals. Surveys subsequently were conducted in proposed burn areas as well as at a variety of other locations in the park through the summer of 1991 (Bogan 1990, 1991, 1992). Upper elevations of the park are relatively uniform and are dominated by least and Uinta chipmunks and deer mice; there is high mammal species richness in the Yovimipa Pass area. The lower-elevation areas of the park also contribute considerable mammalian diversity to the park. Study areas included Yovimipa Pass Meadow, Long Hollow, Water Canyon, Glory Cove, lower Bryce Canyon west of Tropic, Riggs Spring on lower Podunk Creek, and other areas. During these seasonal surveys (approximately 2-3 weeks per year) over four years, the presence of 47 species were confirmed, of an estimated 75 or so species believed to occur within the park. Bogan collected over 700 specimens during this work (BRCA 1996), and voucher specimens are stored at the Museum of Southwestern Biology in Albuquerque and park headquarters. In addition to Bogan's work, Bryce Canyon National Park was included as part of a larger study area to determine the species composition and the distribution of bats in high plateau forests of southern Utah. Nine species of bats were captured or detected with sonar equipment in the park at six study sites (Foster et al. 1995).

Mule deer were thought to be over abundant at one time. Censusing of the local portion of the population was conducted from 1956 to 1969 (Crafts 1969). The average number of deer observed on roadside counts during this time period ranged from 12 to 57 (Burch 1996). The same methods were used to census deer along the rim road in 1996, 1998, and 1999. No reports were written but data is filed in the Resource Mgt. Office. Mean number of deer observed in these late years was 7 to 10. An enclosure was erected in 1957 to determine the impact deer were having on woody vegetation.

Studies of prairie dog habitat led to the reintroduction of this species in to suitable habitats beginning in 1974 (Elmore and Workman 1976). The park and the Utah Division of Wildlife Resources have conducted annual index counts of adults each spring since the introduction. Mean number of Utah prairie dogs observed in spring index counts from 1974 to 2000 range from 47 to 224 (Wallen 2000). John Hoogland has been in the park conducting studies of survivorship and behavior towards predators on one colony adjacent to the mixing circle since 1994 (Hoogland 2000). John's work documents the increase in number of adults associated with the Mixing Circle colony (from 11 in 1995 to 200 in 2000).

References:

- Bryce Canyon National Park. 1996. A collections management plan. Bryce Canyon National Park.
- Bogan, M. 1990. Biological surveys in four National Parks (BRCA, CARE, DINO, MEVE), 1989. Annual Report prepared for the National Park Service, Rocky Mountain Regional Office by the U. S. Fish and Wildlife Service, Ft. Collins, CO. 16 January 1990. 6p.
- Bogan, M. 1991. Biological surveys in four National Parks (BRCA, CARE, DINO, MEVE), 1990. Annual Report prepared for the National Park Service, Rocky Mountain Regional Office by the U. S. Fish and Wildlife Service, Ft. Collins, CO. 12 February 1991. 9p.
- Bogan, M. 1992. Biological surveys in four National Parks (ARCH, BRCA, CARE, MEVE). Annual Report prepared for the National Park Service, Rocky Mountain Regional Office by the U.S. Fish and Wildlife Service, Ft. Collins, CO. 14 January 1991.
- Burch, J. 1996. A proposal to re-initiate roadside deer counts in Bryce Canyon National Park. Study proposal in Park files, Bryce Canyon National Park. 3p.
- Burch, J. 1996. 1996 peregrine falcon report- Bryce Canyon National Park. Unpublished report, Bryce Canyon National Park. 18p.
- Elmore, S. and G. W. Workman. 1976. A baseline study of the past and present status of the Utah prairie dog in Bryce Canyon National Park. Final Report to National Park Service. Depart. Of Wildlife Science, Utah State Univ., Logan. 40p.
- Foster, D. A., L. Grignon, E. Hammer, and B. Warren. 1995. Inventory of Bats in High plateau forests of central and southern Utah. Bryce Canyon National Park. 6p.
- Hoogland, J. 2000. Black-tailed, Gunnison's, and Utah prairie dogs all reproduce slowly. Draft report prepared for publication. Applacian Laboratory, Univ. of Maryland. 34p.
- Presnall, C. C. 1938. Mammals of Zion-Bryce and Cedar Breaks. Zion-Bryce Museum Bulletin, 2:1-19.

Presnall, C. C. and E. R. Hall. 1936. Ranges and relationships of certain mammals in southwestern Utah. Utah Academy of Sciences, Arts and Letters, 13:211-213.

Wallen, R. L. 2000. A strategy for providing conservation measures that protect Utah prairie dogs and their habitat within Bryce Canyon National Park. Unpublished paper, Bryce Canyon National Park. 6p.

REPTILES AND AMPHIBIANS

Four studies have been conducted to gather both qualitative and quantitative data about reptiles and amphibians found in Bryce Canyon National Park. Tanner (1930) and Hallows (1982) each discovered seven species while conducting simple searches in appropriate habitats. Burch (1994) only detected two species trying to develop a random sample of park areas. Kershaw et al. (1997) conducted a time constraint sampling of ten study sites located throughout the park. This project was able to report abundance of nine species. However, they did not detect any rubber boa or gopher snakes.

The tiger salamander and the spadefoot toad have been observed in the park (Tanner 1930) and very nearby (Hallows 1982).

References:

Burch, J. 1994. 1994 Herpetological survey of Bryce Canyon National Park. Unpublished report, Bryce Canyon National Park. 6p.

Hallows, G. 1982. Amphibians and reptiles of Bryce Canyon National Park. Unpublished summary of field notes, Southern Utah State College, Cedar City. 3p.

Kershaw, K., D. Adams, and D. Osterhoudt. 1997. Herptology study of Bryce Canyon National Park. Unpublished student research paper, Southern Utah University. Cedar City. 11p.

Tanner, V. M. 1930. The amphibians and reptiles of Bryce Canyon National Park, Utah. Copeia 166:41-43.

FISH

No systematic fish surveys have been conducted in the park. However, due to the intermittent nature of flowing or ponding water in the park, biologists suspect there is no suitable fish habitat to occupy.

The only fisheries surveys work known from Bryce Canyon National Park was done by Utah State University (Berry et al. 1975; Personal communication, Chuck McAda, U.S. Fish and Wildlife Service, Grand Junction, Colorado) and by the Smithsonian Institute (Personal communication, Wayne Starnes, Curator of Fishes, Smithsonian Institute, Washington, D.C.).

One spring in the East Creek drainage has a small introduced population of brook trout. The trout are contained in the pool originally constructed as a domestic water supply for the park. There could potentially be some non-native fish that inadvertently get trapped in the Tropic ditch within the park boundary. Since this channelized structure periodically dries up, there is no stable fish habitat present within the park.

References:

Berry, C., C.W. McAda, and C. Phillips. 1975. Fish survey of southern Utah streams. Utah Cooperative Fishery Research Unit, Utah State University, Logan.

VASCULAR PLANTS

Because of its popularity, small size, and ease of access, Bryce Canyon National Park has received much attention from botanical researchers. Major themes of research include; general floristic inventory; rare/endemic plant inventory and monitoring; long-term forest succession; and plant community classification/ecology.

Lester F. Ward, who was a member of Powell's later expeditions, made the first systematic botanical collections in this area in the 1870's. Ward collected and named a large number of narrowly restricted endemics found in this area. Rupert Barneby also collected extensively across southern Utah in the 1940's

and 50's. In 1970 Buchanan and Nebeker completed the first floristic inventory specifically for Bryce Canyon. This work was followed in 1981 by a revised checklist compiled by Buchanan and Graybosch. Spence and Buchanan published a revised and updated checklist for the park in 1993. In addition to this work, our herbarium contains more than 1500 specimens collected within the park.

Robert Graybosch accomplished the first modern work regarding the distribution of rare and endemic plants in the park in 1990. Hallsten and Roberts (1990) specifically analyzed the community composition and habitat of *Pediomelum pariense*. Inventory of endemic plants within the park was also included within broader regional studies conducted by Dr. Stanley Welsh of Brigham Young University. These studies included impact assessments of coal development in southern Utah for the U.S. Geological Survey. Voucher specimens from these studies are stored in the BRY herbarium at Brigham Young University. In 1995 Peabody completed a comprehensive survey of all rare plant populations in the more accessible areas of the park. Park personnel (Ames-Curtis et. al) re-monitored these plots (5 years after the original fieldwork) in 1997. For the time being, these populations appear to be stable or slightly increasing. However, rare plant inventory needs to be accomplished in more remote and inaccessible areas of the park.

Bryce Canyon is in the unique situation of having 40+ years of plant ecology and forest succession data for most of the park. Starting with his doctoral dissertation in 1960, Hale Buchanan has been an almost constant presence within Bryce Canyon National Park. His original work (Buchanan 1960) includes 266 inventory plots with photo points and extensive overstory, understory, and herb data. All of these plots were re-monitored and re-photographed in 1981 by Buchanan and Graybosch. Additionally, in 1992 McKnight and Buchanan (2000) re-monitored and re-photographed these plots again. This series is an invaluable resource for fuels and forest management within the park. Roberts et al. (1993) used this data to create an extensive historical study of vegetation and fuel loading.

Graybosch and Buchanan (1983) studied the vegetation types of the Bryce Canyon "breaks" areas. This work has application to rare plant management, as most of our endemics occur in these areas. Roberts et al. (1992) completed a plant community classification/mapping project for the entire park. This work created a detailed GIS layer linked to habitat and community type data. A survey and analysis of relict plant communities within Bryce Canyon National Park was done in 1991 (Van Pelt et al.). This work fills in some of the inventory needs for remoter areas of the park.

References:

- Ames-Curtis, J, Bloch Y. and C. Lindh. 1997. Rare plants of Bryce Canyon national park: five year monitoring report. National Park Service internal report. 150 p.
- Buchanan, H. 1960. The plant ecology of Bryce Canyon national park. Ph.D. Dissertation, University of Utah. 136 p.
- Buchanan, H., Graybosch, R. A. and K. T. Harper. 1981. Plant community changes at Bryce Canyon national park from 1957-1980. Final report to the National Park Service, Contract No. CX-1200-8-B016. 68. p.
- Buchanan, H. and R. A. Graybosch. 1981. Revised checklist of the vascular plants of Bryce Canyon national park. Great Basin Naturalist, 41(1):109-120.
- Buchanan, H. and G. T. Nebeker. 1971. Checklist of the higher plants of Bryce Canyon national park, Utah. Weber State College Printing Department, Ogden, Utah. 30 p.
- Graybosch, R. A. and H. Buchanan. 1983. Vegetative types and endemic plants of the Bryce Canyon breaks. Great Basin Nat. 43(4):701-712.
- Graybosch, R. 1990. Distribution of rare and endemic plants of Bryce Canyon. Pers. Comm. 6 p.
- Hallsten, G. P. 1990. Analysis of community and habitat of *Pediomelum pariense* (*Fabaceae*) in Bryce Canyon national park. Final report to the National Park Service. 14 p.
- Harper, K. T. and H. Buchanan. 1982. The ecology of shrubs in Bryce Canyon national park with special reference to *Purshia tridentata*. Paper presented at Bitterbrush and Cliffrose Symposium, Salt Lake City, Utah, April 13-15, 1982. 8 p.

- McKnight, K. B. and H. Buchanan . 2000. The dynamics of forest succession in Bryce Canyon national park. Final Report to the National Park Service. 159 p.
- Peabody, F. J. 1995. Rare plants of Bryce Canyon national park, Utah. Final report to the National Park Service. Contract No. CA-1268-1-9005. 47 p.
- Roberts, D. W., Jenkins M. J. and D. W. Wright. 1993. Historical vegetation, fuel loads, and integrated resource information system for Bryce Canyon national park. Final report for the National Park Service. Control No. 88-264. 249 p.
- Roberts, D. W., and D. Wright. 1992. Plant community distribution and dynamics in Bryce Canyon national park. Final report to the National Park Service. Contract No. PX-1200-7-0966. 202 p.
- Spence, J.R. 1992. An inventory and monitoring program of the vegetation in the Breaks, Bryce Canyon National Park, Utah, 2 Volumes. Final report to the National Park Service, Bryce Canyon National Park. Manzanita Biostudies. 77p. and 84 p.
- Spence, J. R., and H. Buchanan. 1993. Checklist of the vascular plants of Bryce Canyon national park. Great Basin Nat. 53(3):207-221.
- Van Pelt, N. S., C. D. Scheltz, J. S. Tuhy, and J. R. Spence. 1991. Bryce Canyon national park. *In* Survey and Analysis of Relict Plant Communities within the National Park system units of the Colorado Plateau, p. 29-48. Final Report to the National Park Service. Contract No. CA-1440-8-8001.
- Welsh, S. L. 1978. Problems of plant endemism on the Colorado Plateau. Great Basin Nat. Memoirs. 2:191-195.

CANYONLANDS NATIONAL PARK (CANY)

BIRDS

One-time Inventories and Miscellaneous Bird Sightings

On-going records of bird observations since 1964 (Canyonlands National Park Resource Management Files) have contributed to the bird list for Canyonlands National Park. Important contributions to the bird list also include a weekly survey of birds in the Island in the Sky District, done for a full year, by Boschen (1986), as well as his historical compilation of survey data for Canyonlands National Park (Boschen 1985). Robins and Journet (1992) did a one-time study of bird species diversity in the pinyon-juniper habitat of Canyonlands National Park (Island in the Sky District).

Long-term Studies (multiple years)

Individual Districts within Canyonlands National Park have conducted general bird surveys independent of each other. The Maze District of Canyonlands National Park conducted year-round Emlen strip bird survey transects between 1976 and 1979 (Canyonlands National Park, Resource Management files.) Island in the Sky District has had a 20-ha on-going Breeding Bird Census plot in pinyon-juniper habitat since 1991 (Canyonlands National Park, Resource Management files), as well as 2 different Breeding Bird Survey routes during the 1980's and 90's (USGS 2000). The Needles District has been involved in Endangered Species monitoring (described below), and contains 3 permanent point-count transects in riparian habitat which have been surveyed since 1993 (Fagan 1993, 1994, 1995, 1996, 1997; Daw 1998,1999.) Nesting records specifically for Cooper's hawks (*Accipiter cooperii*) in the Needles District were collected during 1987 and 1990 (Canyonlands National Park, Resource Management files) but no formal surveys have been done for this species.

Throughout all the Districts, scattered breeding season and year-round baseline monitoring was conducted by Park personnel between 1983 and 1985 (Canyonlands National Park, Resource Management files.) More consistent monitoring occurred between 1987 and 1992, when all habitats in Canyonlands were surveyed using Emlen strip transects as part of the Long Term Monitoring Program established among all Southeast Utah National Parks (National Park Service 1992.) Because of problems with observer variability,

these Long Term Monitoring transects were replaced by permanent point count transects in riparian stretches of the Needles District in 1993 (described above.)

Several species listed under the Endangered Species Act have been studied in Canyonlands NP:

The first recorded study of the Mexican spotted owls (*Strix occidentalis lucida*) in Canyonlands was for 1977 (Johnson and Johnson). With the eventual discovery of several breeding pairs of Mexican spotted owls, and its listing in 1993 as a Threatened Species under the Endangered Species Act, intensive study was conducted throughout the 1990s (Willey 1992, 1995, 1996, 1998; Steidl 1996; Swarthout and Steidl 2000). These studies, using a variety of methods (including radio-telemetry) determined demographics, sensitivity to recreational disturbance, prey, home range size, habitat use, and natal dispersal of the birds.

The Utah Division of Wildlife Resources began conducting statewide annual bald eagle (*Haliaeetus leucocephalus*) wintering surveys by aircraft in 1978, including the Cataract Canyon section of the Colorado River through Canyonlands National Park. Results for these aerial surveys during 1983-1987, and various foot and boat patrols in Cataract Canyon between 1984-1990 are summarized in Hathaway and Zinn (1990). Wintering bald eagle prey remains from Cataract Canyon were formally analyzed in 1985 (Yasuda and DeBolt) and in 1991 (Zinn).

The southwest willow flycatcher (*Empidonax trailii extimus*) has been inventoried along the Colorado River portion of Arches in 1999 (Johnson et al. 1999) and 2000, although it is not clear whether the subspecies observed regularly during migration at Arches NP is actually the endangered subspecies.

Peregrine falcon (*Falco peregrinus anatum*) territories were fairly well documented during the 1980's in Canyonlands National Park (Canyonlands National Park, Resource Management files.) Consistent inventory and monitoring (including limited banding and collection of prey remains in 1989) of peregrine falcons has been on-going since 1989 (Canyonlands National Park Resource Management files.)

References:

- Boschen, N. 1985. Canyonlands N.P. Bird Package. Canyonlands National Park, Resource Management files. 265p.
- Boschen, N. 1986. Report on the Bird Surveys performed at the Island Mesa and the Moab Sloughs in 1984 and 1985. Canyonlands National Park, Resource Management files. 97p.
- Canyonlands National Park, Resource Management files. Southeast Utah Group Headquarters, 2282 SW Resource Blvd., Moab, Utah, 84532.
- Canyonlands National Park, date unknown. Canyonlands animal species list as compiled from wildlife observation cards, LTMP data, and research and survey reports. Canyonlands National Park Resource Management files. 12p.
- Daw, S. 1998. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Daw, S. 1999. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1993. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1994. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1995. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1996. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1997. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.

- Hathaway, L., and B. Zinn. 1990. Observations of Wintering Bald Eagles from the Cataract Canyon Rim, Canyonlands National Park. Unpublished report on file with National Park Service, Southeast Utah Group, Moab, UT. 30 p.
- Johnson, M. J., A. Brand, H. English, C. Michaud, and B. Moore. 1999. Southwestern Willow Flycatcher and Yellow-billed Cuckoo Surveys along the Colorado and Green Rivers, Utah (Canyonlands Northern Park Boundaries - Colorado-Green River Confluence). Final Report to the Canyonlands Natural History Association, National Park Service and Colorado Plateau Field Station/Northern Arizona University report. 33 p.
- Johnson, P. and D. Johnson. 1977. Memorandum to Tom Wylie: Spotted Owl Survey in Needles District, Canyonlands. Canyonlands National Park, Resource Management files.
- National Park Service. 1992. 1992 Long-term Monitoring Report. Southeast Utah Group Resource Management files. 11p.
- Robins, J. H., and A. R. P. Journet. 1992. Bird species diversity in the pinyon/juniper community of southeastern Utah (Canyonlands NP) Report to Canyonlands National Park. 7p.
- Schelz, C. D. 1999. Species List of Birds of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah
- Steidl, R. J. 1996. Recreation and Mexican Spotted Owls on the Colorado Plateau: A Pilot Study. 1996 Annual Report. Southeast Utah Group Headquarter files. 21 p.
- Swarthout, E. C., and R.J. Steidl. 2000. Effects of Backcountry Recreation on Mexican Spotted Owls in National Parks on the Colorado Plateau. DRAFT Final Report to National Park Service. 42 p. On file at Southeast Utah Group Headquarters, Resource Management. Moab, UT.
- USGS Patuxent Wildlife Research Center. 2000. North American Breeding Bird Survey Internet data set, 10 August 2000 (<http://www.mp2-pwrc.usgs.gov/bbs/retrieval/>).
- Willey, D. W. 1992. Habitat Ecology of Mexican Spotted Owls on the Colorado Plateau. Annual Report 1991-1992. 34 p. Unpublished National Park Service report, HQ files.
- Willey, D. W. 1995. Inventory For Mexican Spotted Owls within National Parks in Utah. Progress Report, 1995 field season. Unpublished National Park Service report, Headquarters files. "Birds".
- Willey, D. W. 1996. Spotted owl summary info. Summary of 1996 survey results. Headquarters file "Birds".
- Willey, D. W. 1998. Ecology of Mexican Spotted Owls (*Strix occidentalis lucida*) in National Parks on the Colorado Plateau. DRAFT Ph. D. Thesis, Northern Arizona University. On file at Southeast Utah Group Headquarters files. (pages not numbered, several hundred)
- Yasuda, D. and A. DeBolt. 1985. A study of bald eagles wintering in Cataract Canyon, Canyonlands National Park. Canyonlands National Park, Resource Management files.

MAMMALS

The inventory completeness at Canyonlands National Park is estimated to be approximately 85%. The most extensive mammal work done in Canyonlands NP has been with the desert bighorn sheep (*Ovis canadensis*). In 1969, Fellows made the first attempt to determine the status of the bighorn sheep at Canyonlands. He includes a table of observations in the area from 1916-1968. Dean continued the general distribution and abundance work in the mid-1970's, he also looked at habitat requirements. The 1980's brought on an onslaught of bighorn sheep activity because of the interest in relocating some groups to areas throughout Utah where extirpation has occurred. Sloan (1991-2000) has monitored the bighorn sheep continuously and has written a number of annual reports. His program includes radio-collared sheep that he follows throughout the year.

The University of Utah did a study in 1975 looking at the possibility of reintroducing pronghorn antelope (*Antilocapra americana*). They were never reintroduced.

In 1975 Utah State University studied the ring-tailed cat (*Bassariscus Astutus Arizonensis*) in Canyonlands National Park.

River otters are known to occur in Canyonlands National Park and two studies by Boschen (1989, 1988) confirm extensive river otter activity just north of the park on the Colorado River.

Small mammals have also been studied by a number of workers. In 1976, Johnson completed a M.S. Thesis on small mammals on isolated buttes in Canyonlands NP. He also worked as a ranger in the Needles district in the 1970's and contributed to our knowledge of mammals present through his field work and species lists. Armstrong (1979) put together an excellent checklist of rodents based on his research on rodent distribution in six habitat types at Canyonlands NP. His book on the mammals of Canyonlands National Park is still used today as the definitive guide to mammals and their habitats in Canyonlands NP (Armstrong 1979). His book emphasizes ecological distribution, reproduction and populations, food habits, ecto-parasites, and patterns of activity of the mammals of Canyonlands. Extensive work with small mammals was also done as part of the long-term monitoring program. This was started in 1987 but was discontinued in 1993 due to the fear of Hanta virus. In this program live-trap webs were set up at least once a year in most of the representative plant communities of the park. Annual or final reports were never completed but the data is still an incredible wealth of information about small mammal distribution and abundance in the different plant communities. In 1977, Clevenger and Workman studied campgrounds and the human impacts on small mammal populations. Rosenstock (1991) did some small mammal trapping in ungrazed areas of the Maze District of Canyonlands in order to compare with grazed areas in Capitol Reef National Park.

The only study of the large mammals of Canyonlands is Schelz (1988). He researched and tested different monitoring techniques for large carnivores in Canyonlands NP. His report concludes with a list of large carnivores observed, and recommendations on the most effective techniques.

Mule deer (*Odocoileus hemionus*) numbers have been periodically counted in upper Salt Creek (USDI 1988) where transects were established.

Feral burros have been a constant problem in the Horseshoe Canyon section of Canyonlands National Park. No study has been done and the problem is becoming less serious because the boundary fence has been upgraded and completed.

Schelz (1999) put together a comprehensive list of mammals based on all previous work at Canyonlands NP.

Inventory deficiencies are primarily due to the lack of a thorough bat survey of Canyonlands NP. Canyonlands National Park has the potential for a number of common and rare bat species.

References:

- Author Unknown. 1974. Habitat of Woodrats (*Neotoma*) in the Needles District, Canyonlands National Park, Utah: Vegetation . Laramie, WY.
- Armstrong, D. M. 1979. Distribution Checklist of Rodents in Canyonlands National Park, Utah. Occasional Papers, The Museum, Texas Tech University (59):1-44.
- Armstrong, D. M. 1979. Ecological Distribution of Rodents in Canyonlands National Park, Utah. Boulder, Colorado: Department of Integrated Studies and University Museum, University of Colorado..
- Armstrong, D. M. 1979. Mammals of the Canyon Country: a Handbook of Mammals of Canyonlands National Park and Vicinity. Boulder, CO: National Park Service.
- Armstrong, D. M. 1973. Preliminary Observations on Mammalian Faunal Relationships, Canyonlands National Park, Utah. Golden, CO: Colorado-Wyoming Academy of Science, Annual Meeting.
- Boschen, N. S. 1989. 1989 Study of River Otters in Southeast Utah. Unpublished report on file at Headquarters of the Southeast Utah Group, National Park Service, Moab, Utah.
- Boschen, N. S. 1988. Monitoring Two River Otters on the Colorado River in Early 1988. Unpublished report on file at Headquarters of the Southeast Utah Group, National Park Service, Moab, Utah.

- Brazell, R. E., G. W. Workman, D. D. May. 1977. A Preliminary Survey on Beaver (*Castor Canadensis*) in Canyonlands National Park, Utah. National Park Service Project No. YNE-117-0. Final Report ed. Logan, UT: Utah State University, Department of Wildlife Science.
- Clevenger, G. A., and G. W. Workman. 1977. The Effect of Campgrounds on Small Mammals in Canyonlands and Arches National Parks, Utah. Pp. 473-84 in Forty-Second North American Wildlife and Natural Resources Conference. Washington, D. C.: Wildlife Management Institute.
- Dean, H. C. 1975. Bighorn Investigations in Canyonlands National Park. Pp. 7-11 in Desert Bighorn Council Transactions, 1975 (Indio, CA, Chair of Editorial Committee J. J. Spillett. Las Vegas, NE: Desert Bighorn Council.
- Dean, H. C. 1977. Desert Bighorn Sheep in Canyonlands National Park. Paperbound photocopy, M.S. Thesis, Utah State University, Logan, UT.
- Dolan, J., B. Weiss, and A. R. P. Journet. 1992. Habitat Use by Small Mammals in and Around the Hanging Garden Communities of Canyonlands National Park (Island in the Sky District), Utah. Draft ed. Cape Girardeau, MO : Southeastern Missouri State University, Dept. of Biology.
- Elmore, S. W., G. W. Workman. 1978. Campsite Impacts on Small Mammals of the Colorado River, Canyonlands National Park, Utah. Paperbound photocopy, M.S. Thesis, Utah State University, Logan, UT.
- Follows, D. S. 1969. Desert Bighorn in Canyonlands National Park, Utah. Pp. 33-42 in Desert Bighorn Council Transactions, 1969 (Monticello, UT, Chair of Editorial Committee Jim Yoakum. Las Vegas, NE: Desert Bighorn Council.
- Hull, W. B. 1984. Seasonal Nutrition of Desert Bighorn Sheep in Canyonlands National Park, Utah. M.S. Thesis, Utah State University, Logan, UT.
- Johnson, D. W. 1990. Proposal to Study the Genic and Karyotypic Variation in Natural Populations of *Peromyscus crinitus*. 12 p.
- Johnson, D. W. 1986. Desert Buttes: Natural Experiments for Testing Theories of Island Biogeography. National Geographic Research 2(2):p. 152-66.
- Johnson, D. W. 1981. Ecology of Small Mammals on Two Isolated Buttes in Canyonlands National Park, Utah. Southwestern Naturalist 26(4):395-407.
- Johnson, D. W. 1977. Mammals of the Needles District, Canyonlands National Park.
- Johnson, D. W. 1976. Populations of Small Mammals on Isolated Buttes in Canyonlands National Park, Utah. Paperbound photocopy, M.S. Thesis, University of Wyoming, Laramie, WY.
- Midcontinent Ecological Science Center. 1995. Canyonlands National Park Sightability Modelling of Bighorn Sheep Progress Report. Draft ed. Fort Collins, CO: NBS; Midcontinent Ecological Science Center.
- Mitchell, S., and B. Woodward. 1993. Man's Effect on Aquatic and Riparian Organisms in the Canyons of Canyonlands and Arches National Parks and Natural Bridges National Monument: Final Report, Reporting Period: 1990-1992. National Park Service, Southeast Utah Group.
- Rosenstock, S. 1990. A Survey of Small Mammals and Vegetative Characteristics in Grasslands of North Flat, Maze District, Canyonlands National Park, Utah. 8 p.
- Schelz, C. D. 1999. Species List of Mammals of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah
- Schelz, C. D. 1988. Large Mammal-Predator Study. 13 p.
- Singer, F. J., T. R. Spraker, E. S. Williams, M. W. Miller, and S. R. Taylor. 1991-1992. A Preliminary Survey for Select Diseases in Wild Bighorn Sheep Populations in Rocky Mountain Region National Parks. 18 p. United States Department of Interior, National Biological Survey, National Ecology Research Center, Fort Collins, CO 80525.
- Sloan, W. B. 1991. Bighorn Sheep of the Needles District, Canyonlands National Park. 6 p.

- Sloan, W. B. 1993. Bighorn Sheep Update, Canyonlands National Park and Vicinity. 9 p.
- Sloan, W. B. 1993. Bighorn Sheep Update, Lambing Season, Canyonlands and Vicinity. 9 p.
- Sloan, W. B. 1994. Desert Bighorn Sheep: the Rut Season, 1993, Canyonlands and Vicinity. 24 p.
Canyonlands National Park, Southeast Utah Group, Moab, UT 84532.
- State of Utah. 1975. Pronghorn Antelope Reintroduction into Island in the Sky at Canyonlands National Park, San Juan County, Utah: Environmental Assessment Report. State of Utah, Division of Wildlife Resources.
- State of Utah. 1990. Status of Desert Bighorn Sheep in Utah, 1989.
- University of Nevada. 1985. A Model of Climatic Variables Affecting Bighorn Lamb Survival in Canyonlands National Park, Utah. CPSU/UNLV 031/02. Las Vegas, NE: Cooperative National Park Resources Studies Unit, University of Nevada.
- University of Nevada. 1991. Predicting Bighorn Lamb Survival From Weather Patterns in Canyonlands National Park, Utah. CPSU/UNLV 031/08. Las Vegas, NE : Cooperative National Park Resource Studies Unit, University of Nevada.
- USDI, National Park Service. 1977. Interpreter's Sourcebook. Author unknown? (no author included in original record). National Park Service, Canyonlands Complex.
- USDI, National Park Service. 1978. Bighorn Sheep Annual Survey. Canyonlands National Park.
- USDI, National Park Service. 1981-1986. Bighorn Sheep Capture and Transplant Projects. Canyonlands National Park.
- USDI, National Park Service. 1985. Mice of the Canyonlands.
- USDI, National Park Service. 1986. Bighorn Sheep Capture Data. Canyonlands National Park.
- USDI, National Park Service. 1987. Report of Disease Testing of Canyonlands Bighorn Sheep. Canyonlands National Park.
- USDI, National Park Service. 1988. Bighorn Disease Studies. Southeast Utah Group.
- USDI, National Park Service. 1988. Deer Browse Transect, Salt Creek.
- USDI, National Park Service. 1989. Burros in Canyonlands.
- USDI, National Park Service. 1989. Deer Survey Data Sheets.
- USDI, National Park Service. 1989. Island in the Sky Bighorn Sheep Survey, 1989. 5 p.
- USDI, National Park Service. 1992. Desert Bighorn Capture Operations Report, Canyonlands, Potash, Needles. 3 p.
- USDI, National Park Service. Proposed Management and Environmental Assessment of the Feral Donkey (*Equus Asinus*) in Horseshoe Canyon, Canyonlands National Park.
- USDI, National Park Service. Bighorn Sheep Surveys.
- USDI, National Park Service. Bighorn Sheep Monitoring Project. 25 p.
- USDI, National Park Service. Canyonlands Animal Species List As Compiled From Wildlife Observation Cards, LTMP Data, and Research and Survey Reports. 12 p.
- USDI, National Park Service. Checklist of Mammals for Canyonlands National Park. 2 p.
- USDI, National Park Service. Desert Bighorn Studies in Canyonlands National Park.
- USDI, National Park Service. Water/Grazing Rights - Horseshoe Canyon.
- Utah State University. 1975. Requirements, Status, and Future of the Ring-Tailed Cat (*Bassariscus Astutus Arizonensis*) in Canyonlands National Park: First Year Completion Report . National Park Service Contract No. CX1200-4-B036. Logan, UT: Utah State University.

- Utah State University. 1982. Desert Bighorn Sheep Habitat Utilization in Canyonlands National Park. National Park Service Project No. YNE-165-0, Contract No. CX-1200-0-B054. Final Report (R-5) ed. Logan, UT: Utah State University.
- Utah State University. 1984. Desert Bighorn Sheep in Canyonlands National Park, Utah. National Park Service Project No. YNE-189. Logan, UT: Utah State University.
- Utah State University. 1985. Forage Selection and Habitat Utilization of Desert Bighorn Sheep in Canyonlands National Park, Quarterly Reports, 1982-84. Logan, UT : Utah State University, Department of Fisheries and Wildlife.

REPTILES AND AMPHIBIANS

Inventory completeness for reptiles at Canyonlands National Park is estimated to be approximately 80%. Not much work has been done on amphibians and reptiles. Jaenike et al. (1977) completed the most thorough study and produced a species list based on their fieldwork and observations. A couple of other specialized studies have occurred at Canyonlands NP. In 1975, Johnson and Wessels looked at the breeding behavior of the desert toad (*Bufo punctatus*) in Canyonlands National Park. Glenn (1977) looked at snakes at Canyonlands but concentrated primarily on the midget faded rattlesnake (*Crotalus viridis concolor*).

Some amphibian and reptile monitoring transects were set up in the past at Canyonlands National Park, but these have not been monitored regularly or maintained adequately. The biggest problem was having someone on staff that is familiar with the different species.

In 2000, Graham started amphibian inventory and monitoring in Canyonlands National Park. This project has just begun and is funded. The objective is to inventory all of Canyonlands NP, especially along the Green and Colorado Rivers.

References:

- Canyonlands National Park. Canyonlands Animal Species List As Compiled From Wildlife Observation Cards, LTMP Data, and Research and Survey Reports. 12 p.
- Glenn, James L. 1979. Investigation of Rattlesnake Fauna. 3 p.
- Jaenike, F., G. W. Workman, D. D. May, and S. W. Elmore. 1977. The Amphibians and Reptiles of Canyonlands National Park, Utah. 18 p.
- Johnson, M., and T. Wessels. 1975. Breeding Behavior of the Desert Toad (*Bufo punctatus*) in Canyonlands National Park. 7 p.
- Murray, R. A. 1994. Population Genetics and Biogeographic History of Canyon Tree frogs. 20 p.
- National Park Service, Southeast Utah Group. Checklist of Amphibians and Reptiles in Canyonlands and Arches National Parks. 2 p.
- National Park Service. Checklist of Amphibians, Reptiles and Fish, Canyonlands and Arches National Parks 2 p.
- Scholz, C. D. 1999. Species List of Amphibians of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah
- Scholz, C. D. 1999. Species List of Reptiles of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah
- USDI, National Park Service. 1977. Interpreter's Sourcebook. Author unknown? (no author included in original record). National Park Service, Canyonlands Complex.

FISH

Inventory completeness for fishes of Canyonlands National Park is estimated to be 90%. Extensive work on the fish of the Colorado and Green Rivers has been done by the US Fish and Wildlife Service and the State of Utah Division of Wildlife. Holden (1973) wrote a Ph. D. Dissertation on the distribution, abundance and life history of the fishes of the upper Colorado River Basin which includes Canyonlands National Park. He also put together a species list for Canyonlands National Park (Holden 1979).

Surveys of the Colorado River through Cataract Canyon were first conducted from 1979 to 1981 by the U.S. Fish and Wildlife Service (Valdez et al. 1982). Eighteen species of fish were reported from the Colorado and Green rivers by Valdez and Williams (1993) in a survey conducted from 1985 to 1990. This survey revealed that this region of the Colorado River Basin, including the Colorado pikeminnow, humpback chub, razorback sucker, and bonytail. Additional surveys were conducted by the Utah Division of Wildlife Resources (Chart et al. 1998)

The State of Utah Division of Wildlife has done yearly work since the 1980's on monitoring for various endangered fish species. They have also been involved with exotic species control. Bio-West, Inc, in studies headed by Paul Holden and Richard Valdez, completed a number of studies on spawning locations of all the endangered fish (Bio-West 1987-1990). They also concentrated on the Humpback chub (*Gila cypha*) in Cataract Canyon (Bio-West 1990), and Colorado Pikeminnow survival over winter (Bio-West 1990).

Scholz (1990) put together a fish species list for Canyonlands National Park based on all previous work.

References:

- Bio-West, Inc. 1987. Fisheries Biology and Rafting: Annual Summary Report - 1986. PR-134-1 (Contract No. 6-CS-40-03980). Logan, UT: Bio-West, Inc.
- Bio-West, Inc. 1988. Fisheries Biology and Rafting: Annual Summary Report - 1987. PR-134-2 (Contract No. 6-CS-40-03980). Logan, UT: BIO/WEST, Inc.
- Bio-West, Inc. 1990. Fisheries Biology and Rafting: Annual Summary Report - 1989. PR-134-4 (Contract No. 6-CS-40-03980). Logan, UT: Bio-West, Inc.
- Bio-West, Inc. 1990. Humpback Chub Monitoring in Cataract Canyon: Interim Report - 1990. UDWR Contract No. 90-2558. Logan, UT: Bio-West, Inc.
- Bio-West, Inc. 1990. Humpback Chub Monitoring in Cataract Canyon: Interim Report No. 2 - 1990. UDWR Contract No. 90-2558. Logan, UT: Bio-West, Inc.
- Bio-West, Inc. 1990. Overwinter Survival of Age-0 Colorado Squawfish in the Green and Colorado Rivers: Interim Report - 1990. UDWR Contract No. 90-2558. Logan, UT: Bio-West, Inc.
- Chart, T., M. Trammel, and L.D. Lentsch. 1998. Fisheries investigations of the Colorado and Green rivers in Utah. Utah Division of Wildlife Resources, Salt Lake City, Utah.
- Ecosystems Research Institute. 1985. Cataract Canyon Fish Study (Fisheries Biology and Rafting): Final Report to Bureau of Reclamation, Salt Lake City, UT. ERI (C046-07); Contract No. 5-CS-40-02820. Logan, UT: Ecosystems Research Institute.
- Holden, P. 1978. Checklist of Fishes: Arches and Canyonlands National Parks. 2 p.
- Holden, P. B. 1973. Distribution, Abundance and Life History of the Fishes of the Upper Colorado River Basin. Ph.D. Dissertation, Utah State University, Logan, UT.
- Muth, B. 1994. 1994 Red Shiner Gut Analysis Razorback Sucker Project. 29 p.
- Scholz, C. D. 1999. Species List of Fish of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah
- Starnes, W. C. 1990. Gila Taxonomy Project: Sampling Protocols (Draft). 15 p.
- USDI National Park Service, Southeast Utah Group. Checklist of Amphibians, Reptiles and Fish, Canyonlands and Arches National Parks . 2 p.

- USDI, Bureau of Reclamation. 1986. Endangered Fishes of Cataract Canyon: the Importance of the Colorado River Above Lake Powell to the Colorado Squawfish, Humpback Chub, and Bonytail. ERI (CO46-08), Contract No. 5-CS-40-02820. Logan, UT: United States Bureau of Reclamation.
- USDI Bureau of Reclamation. 1990. The Endangered Fish of Cataract Canyon. Final report; Contract No. 6-CS-40-03980, Fisheries Biology and Rafting; BIO/WEST Report No. 134-3. Salt Lake City, UT: United States Department of the Interior, Bureau of Reclamation.
- USDI, National Park Service. 1983. Arches and Canyonlands National Park Aquatic Study.
- USDI, National Park Service. 1985. Annual Aquatic Resources Report. Canyonlands National Park.
- USDI, National Park Service. 1994. Canyonlands National Park. "Endangered Fish Study in Cataract USDI, US Fish and Wildlife Service. 1978. Colorado Squawfish Recovery Plan. U.S. Fish and Wildlife Service.
- USDI US Fish and Wildlife Service. 1983. Recovery of Endangered Fishes of Upper Colorado River Basin. United States Fish and Wildlife Service, Region 6.
- USDI, US Fish and Wildlife Service. 1987. Recovery Implementation Program for Endangered Fish Species in the Upper Colorado River Basin. Denver, CO: U.S. Fish and Wildlife Service.
- USDI, US Fish and Wildlife Service. 1990. Bonytail Chub Revised Recovery Plan. Denver, CO: U.S. Fish and Wildlife Service.
- USDI, US Fish and Wildlife Service. 1990. Colorado Squawfish Revised Recovery Plan. Denver, CO: U.S. Fish and Wildlife Service, Region 6.
- USDI, US Fish and Wildlife Service. 1990. Humpback Chub (2nd Revised) Recovery Plan. (Original Approved: August 22, 1979) ed. Denver, CO: U.S. Fish and Wildlife service. Canyon: Bureau of Reclamation."
- USDI, US Fish and Wildlife Service. 1993. Overview of the Proposed Critical Habitat for the Colorado River Endangered Fishes. Draft ed. Salt Lake City, UT: U.S. Fish and Wildlife Service, Utah Field Office.
- Valdez, R.A., P.G. Mangan, R. Smith and B. Nilson. 1982. Upper Colorado River investigations (Rifle, Colorado to Lake Powell, Utah). Pages 100-279 in Colorado River Fishery Project, Final Report, Part 2: Field Investigations. U.S. Fish and Wildlife Service, Denver, Colorado.
- Valdez, R.A. and R.D. Williams. 1993. Ichthyofauna of the Colorado and Green rivers in Canyonlands National Park, Utah. Pages 2-22 in P.G. Rowlands, C. van Riper III, and M.K. Sogge (eds.). Proceedings of the First Biennial Conference on Research in Colorado Plateau National Parks. Transactions and Proceedings Series NPS/NRNAU/NRTP-93/10, National Park Service, Denver, Colorado.

VASCULAR PLANTS

Little is known of the historic vegetative cover of any of the habitats of the Southeast Utah Group. Some areas in the vicinity of Canyonlands were collected by various well-known botanists at the end of the 19th century, such as Marcus E. Jones and Alice Eastwood. The pre-grazing condition of the vegetation has been described anecdotally, but any professional scientific measurement or quantitative description does not exist. During the 1960's Welsh collected sporadically along the Colorado and Green Rivers and along some of the dirt roads throughout Canyonlands National Park. Collections were also made along the Colorado River in Canyonlands NP during the hasty studies that preceded the building of Glen Canyon Dam, although most of this work was done in what is today Glen Canyon National Recreation Area (Woodbury et al. 1959). Welsh and Moore (1973) attempted a comprehensive treatment of the flora of Utah and included many species collected in the Canyonlands NP area. They also published a flora of Natural Bridges National Park in 1968. In 1964 Harrison, Welsh, and Moore published a flora of Arches National Park. Franklin wrote a flora of the nearby La Sal Mountains in 1988. In 1984, Welsh also prepared a flora of Glen Canyon National Recreation Area. And Shultz, Neely, and Tuhy published a flora of the Orange Cliffs adjacent to Canyonlands NP in 1987.

Powell's second Colorado River expedition of 1872 had a photographer (E.O Beaman) on board and many of the original glass plates survive. Many of these photos are along the Green and Colorado Rivers but some are also in the uplands above the river. The historic and present Colorado and Green Rivers

vegetation is presently being studied by Belnap and Webb (personal comm. 1999) from the confluence of the Colorado and Green Rivers south through Cataract Canyon. The Belnap and Webb study, which is utilizing historic photos, is concentrating on the river environment without much analysis of the upland vegetation communities. Schelz (2000) has just been funded for 2 years to analyze historic photos for vegetation change and to use these photos for the establishment of permanent vegetation photo points.

Detailed botanical work on vegetation within Canyonlands National Park started with Kleiner and Harper (1971) when they analyzed and compared the grasslands at the formally grazed Chesler Park and ungrazed Virginia Park in the Needles District. Virginia Park is considered a relict area, indicating that domestic livestock grazing never occurred there. Kleiner (1983) also looked at successional trends in Chesler and Virginia Parks after a decade of his original measurements.

Loope (1977) wrote a dissertation on the relationships of vegetation to environment in Canyonlands National Park in which he also supplied a vegetation map that is presently used as the most detailed available. He described the vegetation from 157 plots located throughout CANY in which he concludes that it is strongly related to particular combinations of regolith thickness, bedrock composition, and depth to water table.

A major turning point in the detailed analysis of the vegetation at Canyonlands NP came in 1987 with the establishment of the first permanent vegetation transects by Belnap. Transects had previously been established earlier in 1983 by Kitchel and Connors but these were abandoned within 2-3 years due to faulty design. The Belnap transects were permanent as far as starting point but the location of the 100 quadrats per transect varied due to faulty technique. Thus, the information from these transects from 1987 to 1996 varies tremendously. The protocols were improved greatly by Schelz in 1997 when all quadrats within each transect were permanently marked with nails that could be relocated easily with a metal detector.

Rare plant surveys were conducted by Heil et al. (1991) and the final report gives the status and extent of a number of species. There are excellent maps of population locations. Others have done sporadic rare plant work but none were as thorough as Heil.

Boschen (1985) put together the first plant list, Belnap followed in the early 1990's and Schelz refined it in 1999. Now there are about 634 species listed for Canyonlands National Park (Schelz 1999).

References:

- Author Unknown. 1988. Community Relations of Disjunct Populations: a Comparison of an Isolated Aspen Community With Its Nearest Potential Source Community.
- Anderson, J. 1983. Rare Plant Survey of the Needles Section, Canyonlands National Park. 24 p.
- Belnap, J. Potential Role of Cryptobiotic Soil Crusts in Semiarid Rangeland. Pp. 179-85 in Symposium on Ecology, Management, and Restoration of Intermountain Annual Rangelands (Boise, ID, S. B. Monsen and S. G. Kitchen, U.S. Forest Service).
- Belnap, J. Restoration of Native Plant Communities: Breaking the Dominance of Exotic Annual Grasses (Proposal) . 20 p.
- Boschen, N. 1985. Plant List, Canyonlands National Park, Utah. 16 p.
- Boschen, N. 1985. Plant Package - Canyonlands National Park, Utah.
- Canyonlands National Park. Canyonlands Plant Species As Compiled From Species Lists, Reports, LTMP Data, and Observations. 18 p.
- Canyonlands National Park. 1981. Checklist of Plants, Canyonlands National Park. 9 p.
- Columbia Junior College. 1978. An Initial Examination of River Bottom Wildfires in and Near Canyonlands National Park, Utah. Columbia, CA: Columbia Junior College.
- Goldberg, S. B. 1993. Revegetation of Disturbed Semiarid Grassland in Canyonlands National Park. Photocopy, M.S. Thesis, Oregon State University.
- Heil, K. D. 1979. Three New Species of *Cactaceae* From Southeastern Utah. Cactus and Succulent Journal (U.S.) 51:25-30.

- Heil, K.. 1993. Composition, Distribution, Abundance and Habitat Requirements of Endangered, Threatened and Rare Plant Species in the Southeast Utah Group of National Parks. Farmington, NM : San Juan College.
- Hughes, H., and E. Weglinski. Blackbrush (*Coleogyne ramosissima*), Propagation and Revegetation of Disturbed Sites. 7 p.
- Johnson, D. W. 1976. Populations of Small Mammals on Isolated Buttes in Canyonlands National Park, Utah. Paperbound photocopy, M.S. Thesis, University of Wyoming, Laramie, WY.
- Johnston, R. 1995. Soil Biota: the Specificity of Their Higher Plant Associations and Potential Implications for Revegetation Projects (Proposal) . 25 p.
- Schafer, J., H. Roth, A. R .P. Journet. 1992. Vegetation Patterns in Three Grasslands Released From Grazing Pressure in Canyonlands National Park, Utah. Cape Girardeau, MO: Department of Biology, Southeast Missouri State University.
- Kleiner, E. F. 1968. Comparative Study of Grasslands of Canyonlands National Park . Hardbound original, PhD Dissertation, University of Utah, Salt Lake City, UT.
- Kleiner, E. F. 1968. Eleven Year Vegetational Comparison in an Arid Grassland. Proceedings of the American Philosophical Society 126(6):520-526.
- Kleiner, E. F. 1968. Successional Trends in an Ungrazed, Arid Grassland Over a Decade. Journal of Range Management 36(1):114-18.
- Kleiner, E. F., and K. T. Harper. 1972. Environment and Community Organization in Grasslands of Canyonlands National Park. Ecology 53(2):299-309.
- Kleiner, E. F., and K. T. Harper. 1977. Occurrence of Four Major Perennial Grasses in Relation to Edaphic Factors in a Pristine Community. Journal of Range Management 30(4):286-89.
- Kleiner, E. F., and K. T. Harper. 1977. Soil Properties in Relation to Cryptogamic Groundcover in Canyonlands National Park. Journal of Range Management 30(3):202-5.
- Loope, L. L., P. G. Sanchez, P. W. Tarr, W. L. Loope, and R. L. Anderson. 1988. Biological Invasions of Arid Land Nature Reserves. Biological Conservation 4495-118.
- Loope. 1978. Prospects for Revegetation of Disturbed Sites in Canyonlands National Park, Utah. Moab, UT: Canyonlands Natural History Association.
- Loope, W. L. 1977. Relationships of Vegetation to Environment in Canyonlands National Park. Paperbound photocopy, PhD Disertation, Utah State University, Logan, UT.
- Mitchell, S., and B. Woodward. 1993. Man's Effect on Aquatic and Riparian Organisms in the Canyons of Canyonlands and Arches National Parks and Natural Bridges National Monument: Final Report, Reporting Period: 1990-1992. National Park Service, Southeast Utah Group.
- Murray, R. A. 1991. Native Plant Resources Protection and Paleontological Resources Protection Questionnaires. 7 p.
- Pendleton, B., S. E. Meyer, and R. Pendleton. 1992. Regeneration Biology of Blackbrush (*Coleogyne ramosissima*)-Study Synopsis. 4 p.
- Scholz, C.D. 1990. Survey and Analysis of Relict Plant Communities Within National Park Service Units of the Colorado Plateau, Volume IV: Establishment of Long-Term Photographic Stations for Monitoring Community Change, Canyonlands National Park, Utah. Cooperative Agreement [between National Park Service and The Nature Conservancy] No. CA 1440-8-8001: Final Report. Lakewood, CO: National Park Service, Rocky Mountain Regional Office.
- Scholz, C. D. 1999. Species List of Plants of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah
- Spence J. 1991. A Comparison of Two Communities of Douglas Fir (*Pseudotsuga menziesii*) on the Colorado Plateau.

- Spence, J. 1995. Characterization and possible origins of isolated Douglas fir stands on the Colorado Plateau. Pp. 71-82 *in* Climate Change in the Four Corners Region. Proceed. of a symposium, Grand Junction, Sept. 12-14, 1994. Dept. of Energy, NTIS CONF-9409325.
- Schwartz, E. 1994. A Dendrochronological Study of Holocene Climatic Fluctuations in the Canyonlands Area of Southeastern Utah.
- Thomas, L., K. P. Kitchell, and T. B. Graham. 1987. Summary of Tamarisk Control Efforts in Canyonlands and Arches National Parks and Natural Bridges National Monument. Pp. 61-67 *in* Tamarisk Conference: Tamarisk Control in Southwestern United States (University of Arizona, Tucson, Technical Coordinators Michael R. Kunzmann, R. R. Johnson, and Peter S. Bennett. Tucson, AZ: National Park Service, Cooperative National Park Resources Studies Unit, School of Renewable Natural Resources, University of Arizona.
- University of Wyoming. 1974. Habitat of Woodrats (*Neotoma*) in the Needles District, Canyonlands National Park, Utah: Vegetation . Laramie, WY.
- Univ. of Wyoming. 1994. Biogeography of Hanging Gardens on the Colorado Plateau: Executive Summary. Laramie, WY: University of Wyoming, Department of Zoology and Physiology.
- USDI, National Park Service. 1974. Regional Resources Basic Inventory: Biological Resources, Arches National Park, Canyonlands National Park, Capitol Reef National Park, Natural Bridges National Monument . Washington, D. C.: United States Department of Interior, National Park Service.
- USDI, National Park Service. 1977. Interpreter's Sourcebook. National Park Service, Canyonlands Complex.
- USDI, National Park Service. 1988. Report on Blackbrush Seedling Project. Contract No. PX 1340-9-A021. Moab, UT: United States Department of Interior, National Park Service.
- USDI, National Park Service. 1990. Blackbrush (*Coleogyne ramosissima*) Propagation and Revegetation of Disturbed Sites: Final Report. Contract No. 5-32720. Fort Collins, CO: Colorado State University, Department of Horticulture.
- USDI, National Park Service. Community Relationships of Disjunct Populations: Relative Importance of Adjacent Communities and Geographically Remote Douglas Fir (*Pseudotsuga Menziesii*) Communities in Determining Species Composition in Isolated *P. Menziesii* Communities.
- USDI, National Park Service. No date included in original record. Arches National Park, Canyonlands National Park, Land Cover/Vegetation Map [landstat]. Denver, CO: Denver Service Center.
- Van Pelt, N., and C.D Schelz. 1991. Survey and Analysis of Relict Plant Communities Within National Park Service Units of the Colorado Plateau, Volume I: Community Site Descriptions and Unit Analyses, Canyonlands National Park, Utah, Natural Bridges National Monument, Utah, Colorado National Monument, Colorado. Cooperative Agreement [between National Park Service and The Nature Conservancy] No. CA 1440-8-8001: Final Report. Lakewood, CO: National Park Service, Rocky Mountain Regional Office.
- Vanderbilt, K. Rare Plant Species of the Southeast Utah Group of National Parks. 32 p.
- Weber. 1994. Decline of Utah Juniper in Natural Bridges National Monument and Canyonlands National Park. Co-operative Agreement: CA 1268-1-9007.
- West, N. E. Colorado Plateau-Mohavian Blackbrush Semi-Desert. Pp. Chapter 15, p. 399-411 *in* Temperate Deserts and Semi-Deserts, editor N. E. West. Amsterdam, The Netherlands: Elsevier Scientific Publishing Company.
- West, N. E. Southeastern Utah Galleta-Threeawn Shrub Steppe. Pp. Chapter 16, p. 413-21 *in* Temperate Deserts and Semi-Deserts, editor N. E. West. Amsterdam, The Netherlands: Elsevier Scientific Publishing Company.

CAPITOL REEF NATIONAL PARK**BIRDS**Inventory Completeness (proximity to 90% level)

Capitol Reef currently has a checklist of birds that documents 215 species (Spence and Borthwick 1995). Since no known specimens and few photographs of birds in the park exist, this checklist is based on all previous records from small studies, wildlife observations by experienced park staff, and additional observations by the authors from 1991-93. Since 1994, seven additional species have been added to the list by current staff bringing the total to 222 species. Utah currently has 406 bird species recorded on the state checklist (UT Ornithological Society 1998). To determine if CARE has reached the 90% threshold identified in the National Park Service I&M guidance documents, the two checklists were compared. First, the 99 irregularly occurring UT species (four of which have been seen at CARE) were eliminated from the lists and next, the 22 birds which are typical of the southern hot desert regions (none of which have been seen at CARE) were removed. That leaves 295 UT birds and 218 at CARE. By reviewing the remaining 77 species that have not been seen at the park, 50 of those birds are those found on lakes, in marshes, and on shorelines. These habitats are not found at CARE and any observation of these species here would be considered an irregular transient. Thirteen other birds are only found in very high elevation habitats that are not found in the park. This leaves 14 species that could potentially be found and makes the park's potential list 232 birds. The current list is 94% of that total. Therefore, Capitol Reef will not request addition funding in this plan to supplement its bird checklist.

Three species of birds with little information known are of management concern in the park. Southwest willow flycatcher is a listed species that is seen in the park during breeding season almost every year. These records consist of observations of individuals, pairs, and singing males but no nesting has been documented. Similarly, the yellow-billed cuckoo, a species of concern, is seen sporadically in the park but no surveys have been done. Golden eagles are of concern because of recent interest by the Hopi Tribe in capturing them off park service lands. Eagles probably nest in the park but none have been found. Additional survey and distribution work is needed for these species to address management concerns.

Much work has been done on both peregrine falcons (Grebence 1987, Teresa 1989, Willey 1989, 1990, 1991) and Mexican spotted owls (Willey 1993, 1995, 1997, 1998a, 1998b) in Capitol Reef. Nesting surveys and reproduction has been monitored for many years and continues by park staff. No additional work for these species is needed.

Other relevant studies and sources of information

There is almost no information on the park's avifauna until the mid 1970's. Regional information of birds can be found in Hayward et al. (1976) and Behle (1986). After the park creation in 1971, small area specific studies were done on newly acquired portions that contained anecdotal descriptions and small lists of species observed (Hoddenbach 1977, Camp 1978). Wildlife observations of birds began to be recorded by park staff in earnest in 1972 and continue to present. These records are maintained by the park on a MSAccess database developed in the early 1990's that contains fields on numbers seen, location, and additional notes. A study to determine impacts of grazing on birds of arid and semi-arid shrublands and grasslands was done by Willey (1992) and describes many of the birds found in upland areas and less popular portions of the park. This was the first study to determine relative abundance of birds in the park and statistically determined habitat preferences of species. A popular guide to birding was published which concentrated on the riparian and orchard habitats in the Fruita Valley (Spence 1991) and describes the rare species to be found there. Two Breeding Bird Survey routes have been done since 1987, one in the northern part of the park and one in the central (Sauer et al. 2000). These are both in upland plant communities and are run once a year in June in accordance with the national standards. As part of another national program, the park and Utah Department of Wildlife Resources (UDWR) are running a Mapping Avian Productivity and Survivorship (MAPS) station in riparian habitat along the Fremont River. UDWR has been running the point count portion of the project since 1993 and since 1996, park staff has been doing the mist-netting and banding portion. Information from both these national programs is sent to the respective coordinator and they compile and interpret the results (DeSante et al. 2000).

References:

- Behle, W. H. 1986. Utah Birds: geographic distribution and systematics. Utah Museum of Natural History Occasional Publication No. 5 147p.
- Camp, P. A. 1978. Ecological Reconnaissance Halls Creek. Unpublished National Park Service manuscript. 27p.
- DeSante, D. F., K. M. Burton, P. Velez, and D. Froehlich. 2000. MAPS Manual, 2000 Protocol. The Institute for Bird Populations, Point Reyes Station, CA. 67 p.
- Grebence, B. 1987. Physiographic Characteristics of Peregrine Falcon Nesting Habitat along the Colorado River. Masters Thesis, Brigham Young University, Utah. 34p.
- Hayward, C. L., C. Cottam, A. M. Woodbury, and H. H. Frost. 1976. Birds of Utah. Great Basin Naturalist Memoirs No. 1 229p.
- Hoddenbach, G. A. 1977. Preliminary Biological Evaluation of Halls Creek. Unpublished National Park Service manuscript. 17p.
- Sauer, J. R., J. E. Hines, I. Thomas, J. Fallon, and G. Gough. 2000. The North American Breeding Bird Survey, Results and Analysis 1966 - 1999. Version 98.1. USGS Patuxent Wildlife Research Center, Laurel, MD.
- Spence, J. R. 1991. Spring Birding in the Fruita Historic Area, Capitol Reef National Park. Utah Birds 7:41-48.
- Spence, J. R., and S. Borthwick. 1995. A Preliminary Account of the Birds of Capitol Reef National Park, Utah. Utah Birds 11:1-12.
- Teresa, S. 1989. Characteristics of Breeding Habitat for Peregrine Falcons on the Colorado Plateau. Masters Thesis, University Of California, Los Angeles. 154p.
- Willey, D. W. 1989. Distribution and ecology of peregrine falcons in Capitol Reef National Park and the Dirty Devil and Escalante River Corridors, Utah. High Desert Research, Torrey, UT. Contract No. PX-I350-9-0124. 55p.
- Willey, D. W. 1990. Distribution and Nesting Ecology of Peregrine Falcons in Capitol Reef National Park and Adjacent Environs. Draft Report. High Desert Research, Flagstaff, AZ. Contract No. PX-I350-9-0124 and No. PX-I350-9-0152. 37p.
- Willey, D. W. 1991. Distribution and Abundance of the American Peregrine Falcon (*Falco Peregrinus Anatum*) in Capitol Reef National Park and Adjacent Environs: Project Final Report. High Desert Research, Flagstaff, AZ. Contract Numbers: PX-1350-0-0086; PX-1350-1-0110; PX1350-0101. 30p.
- Willey, D. W. 1993. Home-Range Characteristics and Juvenile Dispersal Ecology of Mexican Spotted Owls in Southern Utah: Final Report 1992-93. UDWR Contract Number: 91-2577. 43p.
- Willey, D. W. 1994. Effects of Livestock Grazing on Grassland Birds in Capitol Reef National Park, Utah. Technical Report NPS/NAUCARE/NRTR-94/05. Flagstaff, AZ: National Park Service/Colorado Plateau Research Station. 27p.
- Willey, D. W. 1995. Mexican Spotted Owls in Canyonlands of the Colorado Plateau. Pp. 330-331 i-n E.T. LaRoe, G.S. Farris, C.E. Puckett, P.D. Doran, and M.i. Mac [eds.], Our Living Resources: a report to the nation on the distribution, abundance, and health of U.S. plants, animals, and ecosystems. U.S. Department of the Interior, National Biological Service, Washington, D.C.
- Willey, D. W. 1997. Distribution and Ecology of Mexican Spotted Owls in National Parks in Utah. Final Report to the National Park Service Intermountain Region, Lakewood, CO.
- Willey, D. W. 1998a. Movements and Habitat Utilization by Mexican Spotted Owls in the Canyonlands of Southern Utah. Dissertation, Northern Arizona University, Flagstaff, AZ.
- Willey, D. W. 1998b. Ecology of Mexican Spotted Owls in National Parks on the Colorado Plateau. Draft Report to the National Park Service Intermountain Region, Lakewood, CO.

Utah Ornithological Society. 1998. Field Checklist of the Birds of Utah. Wasach Audubon Society, Ogden, UT.

MAMMALS

Inventory Completeness (proximity to 90% level)

Recent information on small mammal (lagomorphs, rodents, and bats) occurrence in the park is based largely on the work of M. Bogan (1991, 1992, 1993). Between 1989 and 1992, crews conducted surveys at 12 general locations in the park and caught 28 species of small mammals (12 bats, 2 rabbits, 1 shrew, and 13 rodents). This inventory work was conducted between elevations of 1,463 to 2,134 meters (4800 to 7000 feet) at the following sites: including Pleasant Creek, Peek-a-boo Rock, Cottonwood Tanks, South Desert area, Cathedral Campground, Fruita vicinity, Sulphur Creek, The Post, Upper Muley Twist Canyon, Cohab Canyon, and near Chimney Rock. A number of specialized habitats in the park remain unsampled, these include: Bristlecone Pine-Cushion Plant Community, Ponderosa Pine-Bitterbrush Woodland Community, Mesic Montane Woodland Community, Aspen Woodland Community, Alder-Birch Riparian Community, Dogwood-Spruce Riparian Woodland Community, Hornbeam-Box Elder-Oak Woodland Community, and Spiny Hopsage-Grassland Community. Additional work is needed in these areas to complete a park-wide survey. Bogan and Ramotnik (1993) summarize the results of their surveys, and generated a mammal species list for the park. Small mammal work since 1992 has been minimal. Some small mammal surveys were conducted in the oxbow area of the Fremont River by park staff to determine if predators of a federally listed orchid were present. Bogan and Romotnik (1993) document a local low-elevation record for a water shrew at the Fremont River oxbow.

Bogan surveyed two mines for bats in the summer of 1992 and found evidence that suggested the mines were only being used as night roosts. The park biologist has conducted some bat surveys in 1999 and 2000, primarily in Hall's Creek. Although 13 species of bats have been found in the park, five potential species have not been found during surveys. Additional inventory work is needed on bats in Capitol Reef, and is included in the study plan.

The largest gap in knowledge about large mammals is in the carnivores. Only wildlife observation card records exist (some may be questionable) for many of the species and several species identified on the checklist as present, don't have any documentation. More survey work is needed specifically on carnivores.

Excluding species that have been extirpated from the park, there are 84 mammals that could potentially occur here (based on a list from Bogan and Ramotnik (1993) and range maps from Burt and Gossenheider (1976), Hall (1981)). There are 32 species represented by specimens, 23 with observation records, 4 recorded as present on the checklist with no documentation, and 25 that could potentially occur on the park. This puts the park's mammal inventory at 65% to 70% completed. At least 17 of the potential species would be found at higher elevation habitats of the park, an area that has had no survey work in the past. Additional survey work will be done at Capitol Reef to fill in the gaps as identified previously.

Other relevant studies and sources of information

Forty desert bighorn sheep were reintroduced to the park in two transplants in 1996 and 1997. Sheep status in the park is discussed in Singer and Gudorf (1999). For two years, the radio-collared bighorn were monitored by fixed-wing aircraft every other month and the location data entered into GIS. In addition, park staff and an SEUG biologist have monitored sheep status from the ground. Their field notes contain the most current information on the status of bighorn sheep in the park. Surveys of deer numbers in the headquarters area of the park were conducted by park staff from 1985-1994, but have not occurred in several years. This work was done to justify relocation efforts due to overpopulation of deer in the Fruita Valley. The data is in a MS Access database within the park. A re-introduction of the federally listed, Utah prairie dog was done in 1980 in the northern portion of the park (Player and Urness 1982). The transplant failed and the last prairie dogs were seen in the mid-1980's. Several studies have occurred in the park looking at ecological and behavioral aspects of the yellow-bellied marmot (Van Vuren 1989, Hopkinson 1993, Blumstein et al. 1997a, 1997b). These studies concentrated in the Fruita area, which contains the lowest elevation population of the species. A free-roaming bison herd exists in the Henry Mountains adjacent to the park. Because they cause such severe impacts to vegetation, there have many studies done on distribution, ecology, and history (Winn and Collet 1959, Van Vuren 1979, 1982, 1983, 1984, 1992, Van Vuren and Bray

1983, 1986). Rosenstock (1992a, 1992b) studied the effects of grazing on small mammals at Capitol Reef, Canyonlands, and BLM lands. At a macrohabitat scale, he found ungrazed areas had 50% more diversity and 80% more abundance than ungrazed areas.

References:

- Blumstein, D. T., and K. B. Armitage. 1997a. Alarm calling in yellow-bellies marmots: I. The meaning of situationally variable alarm calls. *Animal Behavior* 53:143-171.
- Blumstein, D. T., J. Strinmetz, K. B. Armitage, and J. C. Daniel. 1997b. Alarm calling in yellow-bellies marmots: II. The importance of direct fitness. *Animal Behavior* 53:173-184.
- Bogan, M. A. 1990. Annual Report: Biological Surveys in Four National Parks (BRCA, CARE, DINO, MEVE), 1989. USF&WS memo to Rocky Mountain Region, National Park Service.
- Bogan, M. A. 1991. Annual Report: Biological Surveys Four National Parks (BRCA, CARE, DINO, MEVE), 1990. USF&WS memo to Rocky Mountain Region, National Park Service.
- Bogan, M. A. 1992. Annual Report: Biological Surveys Five National Parks, 1991. USF&WS memo to Rocky Mountain Region, National Park Service.
- Bogan, M. A., and C. A. Ramotnik. 1993. Annual Report: Biological Surveys Colorado Plateau National Parks, 1992. USF&WS memo to Rocky Mountain Region, National Park Service.
- Burt, William H. and Richard P. Gossenheider. 1976. *A Field Guide to the Mammals*. Houghton Mifflin Company, Boston, MA. 289p.
- Camp, P. A. 1978. Ecological Reconnaissance Halls Creek. Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 27p.
- Hall, E. R. 1981. *The Mammals of North America*, Volume I and II. Second Edition. John Wiley and Sons. New York, N.Y. 1175 p.
- Hoddenbach, G. A. 1977. Preliminary Biological Evaluation of Halls Creek. Unpublished National Park Service manuscript. 17p.
- Hopkinson, P. J. 1993. Population Dynamics and Dispersal Patterns of Yellow-Bellied Marmots in Capitol Reef National Park. Research Study Proposal # 155. University of Kansas, Kansas.
- National Park Service. 1992. Mule Deer Population Trends Within Capitol Reef National Park, 1985 - 1991. Capitol Reef National Park, Resource Management Division, Unpublished manuscript.
- National Park Service. 1991. Beaver Damage Assessment, 1988-1989: Capitol Reef National Park, Resource Management Division, Unpublished manuscript.
- Player, R. L., and P. J. D. Urness. 1982. Habitat Manipulation for Reestablishment of Utah Prairie Dogs in Capitol Reef National Park. *Great Basin Naturalist* 42(4):517-23.
- Rosenstock, S. S. 1992a. Final Report: Part I: Ecology of Small Mammal Species and Communities in Capitol Reef National Park, Utah. Purchase order # PX-1350-0-0181.
- Rosenstock, S. S. 1992b. Final Report: Part II: Effects of Livestock Grazing on Shrub-Grassland Small Mammal Fauna and Habitats in Capitol Reef National Park, Utah. Purchase order # PX-1350-0-0181.
- Singer and Gudorf . 1999. Restoration of Bighorn Sheep Metapopulations in and Near 15 National Parks: Conservation of a severely Fragmented Species, Vols. I-III.
- Van Vuren, D. 1979. Ecology and behavior of bison in the Henry Mountains, Utah. M.S. Thesis, Oregon State Univ., Corvallis, 39 p.
- Van Vuren, D. 1982. Comparative ecology of bison and cattle in the Henry Mountains, Utah. Pages 449-457 *in* Proc. Wildlife-Livestock Relationships Symp. (J. M. Peek and P. D. Dalke, eds.). Univ. Idaho For., Wildl. and Range Exp. Sta., Moscow, Idaho.
- Van Vuren, D. 1983. Group dynamics and summer home range of bison in southern Utah. *Journal of Mammalogy* 64:329-332.

- Van Vuren, D. 1984. Summer diets of bison and cattle in southern Utah. *Journal of Range Manage.* 37:260-261.
- Van Vuren, D. 1989. Management of Yellow-Bellied Marmots at Capitol Reef National Park. Capitol Reef National Park, Resource Management Division, Unpublished manuscript. Purchase Order No. PX-1350-9-0085. 12p.
- Van Vuren, D. 1992. Bison in Capitol Reef National Park. University of California, Davis. Unpublished manuscript. 17p.
- Van Vuren, D., and M. P. Bray. 1983. Diets of bison and cattle on a seeded range in southern Utah. *Journal of Range Manage.* 36:499-500.
- Van Vuren, D., and M. P. Bray. 1986. Population dynamics of bison in the Henry Mountains, Utah. *Journal of Mammalogy* 67:503-511.
- Winn, J., and G. Collett. 1959. Utah's buffalo herd. *Utah Fish and Game* 15(8):6-7.

REPTILES AND AMPHIBIANS

Very little has been done at Capitol Reef to inventory for reptiles and amphibians. From 1989 to 1992, some survey work was done in scattered locations in the park (Bogan 1991, 1992, Bogan and Ramotnik 1993). They collected 11 species of reptiles and 4 species of amphibians during the study. Hoddenbach (1977) noted that leopard frogs were found along Halls Creek and that they were to be expected to occur there. In recent years, despite numerous trips every year, no leopard frogs have been seen along Halls Creek. The potential reptile list for Capitol Reef contains 25 species: 12 with specimens and one observed. The amphibian list of 9 potential species has 4 specimens and one observed. The represents about 50% documented for each taxa group. A park-wide survey is needed to complete the inventory for these groups.

References:

- Bogan, M. A. 1991. Annual Report: Biological Surveys Four National Parks, 1990. USF&WS memo to Rocky Mountain Region, National Park Service.
- Bogan, M. A. 1992. Annual Report: Biological Surveys Five National Parks, 1991. USF&WS memo to Rocky Mountain Region, National Park Service.
- Bogan, M. A., and C. A. Ramotnik. 1993. Annual Report: Biological Surveys Colorado Plateau National Parks, 1992. USF&WS memo to Rocky Mountain Region, National Park Service.
- Hoddenbach, G. A. 1977. Preliminary Biological Evaluation of Halls Creek. Unpublished National Park Service manuscript. 17p.

FISH

The upper Fremont River supports rainbow trout, cutthroat trout, brown trout, speckled dace, mountain sucker, mottled sculpin, and possibly roundtail chub. A total of four native and seven non-native fish species are known from three streams on Capitol Reef. The Fremont River, Pleasant Creek, and Halls Creek all have had fish surveys done in the past. Fremont River surveys were done in response to the proposed construction of a dam (Hardy et al. 1989, Winget 1975) or as a result of an accidental fish kill by the Utah Division of Wildlife Resources in 1991 (Hepworth et al. 1993). The other two streams have had general surveys just to document the species present (Hoddenbach 1977, UDWR 1980).

Fisheries surveys were also conducted within Capitol Reef and surrounding areas by Utah State University (Berry et al. 1975; Personal communication, Chuck McAda, U.S. Fish and Wildlife Service, Grand Junction, Colorado) and by the Smithsonian Institute (Personal communication, Wayne Starnes, Curator of Fishes, Smithsonian Institute, Washington, D.C.). Berry et al. (1975) reported roundtail chub in the upper reaches of the Fremont River, but W. Starnes failed to find this species.

No other species are likely to occur in the park according to these reports. A two-year fish survey along the Fremont River within the park is underway (2000-2001) to document species occurrence, relative abundance

by habitat, and age class structure. No further work should be needed to complete the 90% level of inventory work.

References:

- Berry, C., C.W. McAda, and C. Phillips. 1975. Fish survey of southern Utah streams. Utah Cooperative Fishery Research Unit, Utah State University, Logan.
- Capitol Reef Natural History Association. 1984. Reptiles, Amphibians, and Fishes Checklist: Capitol Reef National Park. 2p.
- Hardy, T. B., B. A. Bartz, and W. Carter. 1989. Impact Analysis of the Proposed Fremont River Hydropower Project. Twelve-nine, Inc., Logan, UT. 34p.
- Hepworth, D. K., M. Ottenbacher, and D. Archer. 1993. An Evaluation of Native Fishes of the Fremont River in or Near Capitol Reef National Park. Utah Division of Wildlife Resources Publication No. 93-5. 27p.
- Hoddenbach, G. A. 1977. Preliminary Biological Evaluation of Halls Creek. Research: RSP-04, Preliminary Evaluation of Hall's Creek (National Park Service, Hoddenbach). 1 folder.
- Utah Division of Wildlife Resources. 1980. An Aquatic Inventory of Streams Flowing Across Lands Administered by the Bureau of Land Management: Part IV - Richfield District. BLM Contract Number UT-910-CTO-006.
- Winget, R. N. 1975. Aquatic Habitat Evaluation of the Fremont, Muddy, and Dirty Devil Rivers and Caine Springs. Report to Westinghouse Corporation P.O. ESD-428-75. 81p.

VASCULAR PLANTS

Inventory Completeness (proximity to 90% level) – presence/absence

Capitol Reef National Park lies in a portion of the Colorado Plateau that has been relatively poorly explored botanically (Heil et al. 1993). Floristic studies conducted in the general region include the San Rafael Swell (Harris 1980), Henry Mountains (Stanton 1931, Everitt 1970, Neese 1981), Uinta Basin (Goodrich and Neese 1986), Natural Bridges National Monument (Welsh and Moore 1968), Arches National Park (Harrison et al. 1964), Canyonlands National Park (Loope 1977, Welsh 1970), and Glen Canyon National Recreation Area (Tuhy and MacMahon 1988). Within Capitol Reef itself, Susan Meyer conducted a preliminary inventory in 1981-1982 and identified over 500 plant taxa, but acknowledged that her inventory was not exhaustive. Additionally, Pamela Camp and Alice Lindahl conducted a survey of the flora of the Halls Creek drainage, including lands both in and out of CARE (Camp 1978). Heil et al. (1993) inventoried vascular plants by walking east-west transects, spaced several kilometers apart, across the park. They covered the entire range of elevations, geologic substrates, and topographic features in the park from April to October during 1986-1988. All of this work documented 759 species of plants in the park (Heil et al. 1993). General observations by park staff during other resource management work in the 1990's added 46 plants bringing the current park total to 805 species.

There are a large number of listed, endemic, and/or rare plant species that occur on Capitol Reef. Early work on these species simply documented presence and was done in conjunction with general surveys discussed previously (Camp 1978, Heil et al. 1993). Inventory of endemic plants within the park was also included within broader regional studies conducted by Dr. Stanley Welsh of Brigham Young University in the 1970s. These studies included impact assessments of coal development in southern Utah for the U.S. Geological Survey. Voucher specimens from these studies are stored in the BRY herbarium at Brigham Young University. The first study specifically addressing rare plants was done to document their occurrence in grazing allotments and to evaluate the effect grazing has on the species (San Juan College 1994). Several new localities were discovered and anecdotal information was described on cattle trampling for three species. The park received a two-year Canon grant to survey for rare plants in the heavily used headquarters area in 1996-97. Several new localities were found for the six species studied and numbers, habitat characteristics, and distributions were identified. For five species, monitoring plots were established to determine if visitors were impacting the species and to gather some basic life history information (Clark 1997, 1998b, Clark and Clark 1999). In 1997-98, BLM and the park funded a joint survey team to inventory for one proposed listed and one endangered species that occur on both agencies land. Field crews surveyed the entire distribution of the two closely related species (Clark 1998a, 1999a) and the genetic

relationship of the two was evaluated with DNA testing (Porter et al. 1999). Because Capitol Reef and surrounding BLM and FS lands have so many rare endemic plants, the agencies developed an Interagency Agreement in 1999 to hire and fund an interagency botany technician position. Since the agencies share management responsibilities for many of the same listed and rare plants, having an employee survey for these species throughout their ranges, regardless of agency boundaries, will provide essential information for proper management of these species. Opportunities for leveraging federal dollars with non-federal partners have also been increased through establishment of this agreement. Each agency can use funds provided by another agency to leverage funding within its agency or through matching funds from non-governmental organizations. By pooling the agencies scarce funding for T & E plant species to fill this position, each agency gets more all encompassing information about each species and increases services for each individual agency dollar spent. In 1999, seven species were surveyed throughout their range using funds from all three agencies (Clark 1999a, 1999b, 1999c, 1999d, 1999e, 1999f). In 2000, the park received an NRPP-funded three-year project to survey the entire park for 31 of the rarest species known to occur at Capitol Reef. BLM, the two National Forests, and the Capitol Reef Natural History Association have added an additional \$33,500 to support the project and expand the surveys to include adjacent habitats. With funding over the next two years, the partners will be able to complete the survey and distribution work for these rare plants, not only on the park, but in potential habitat on adjacent lands.

Other relevant studies and sources of information

Endowments through the Center of Plant Conservation have been established for three species that occur on the park. Two endowments were established for cactus species by Capitol Reef through the Red Buttes Garden. This money will help fund genetic seed bank storage to prevent extinction of these species. An endowment for *Gilia caespitosa* helped fund basic life history and monitoring work through the Denver Botanic Garden (Dawson 1998). Researchers analyzed the genetic relationship between this same species and a close relative and found species level differences in DNA (Wolf and McCracken 1998). Four federal agencies developed a Conservation Agreement to protect this *Gilia* in 1997 and have implemented many of the recommendations. Additional monitoring looking at life history of Maguire's daisy is being done by Utah Valley State College and Brigham Young University professors (Van Buren 1999, Van Buren and Harper 2000). A general life history plot was established for Winkler's cactus in 1995 and four monitoring plots are being established on the park and BLM land to determine if grazing is effecting this listed species.

The vegetation of CARE has been classified into 34 community types using plant assemblages identified from 344 sampling plots (Heil et al. 1993). The types were crosswalked to the system developed by Brown, Lowe, and Pase (Romme et al. 1993). It was difficult to use that system since 11 of the plant assemblages are unique to Capitol Reef or have not been described before (Romme et al. 1993). In 1997, park staff began mapping the vegetation types developed in these studies and has completed 2/3 of the park. In several years, the mapping will be completed and the information digitized into our GIS. In the 1980's, several Congressionally mandated projects began to study the effects of grazing on park resources. Barth and McCullough (1988) analyzed the effects of current and historic livestock grazing on riparian vegetation in CARE, and Welsh (1988) described the riparian vegetation along the Fremont River in the context of an assessment of a proposed water development upstream. Fisher et al. (1991) and Cole (1991) have reconstructed changes in grassland and woodland vegetation that occurred during the last several centuries. They found that major changes in species composition and abundance had occurred since the time grazing began in this area. Other vegetation research in CARE includes studies of the effects of soil microphytic crusts on erosion (West 1990, Williams et al. 1995) and of plant community dynamics in waterpockets (Haefner and Lindahl 1988, 1991; Lafrancois 1995, Baron et al. 1999).

References:

- Baron, J. S., T. Lafrancois, and B. C. Kondratieff. 1998. Chemical and biological characteristics of desert rock pools in intermittent streams of Capitol Reef National Park. *Great Basin Naturalist* 58(3):250-263.
- Barth, R. C., and E. J. McCullough. 1988. Livestock grazing impacts on riparian areas within Capitol Reef National Park. Final Report to National Park Service, Contract Number CT1200-4-A065. 126p.
- Camp, P. A. 1978. Ecological Reconnaissance Halls Creek. Unpublished National Park Service manuscript. 27p.
- Clark, D. J. 1997. Progress Report: Expedition into the Parks; rare plant survey at Capitol Reef National Park. Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 7p.

- Clark, D. J. 1998a. 1998 Field Survey Results for Winkler and San Rafael Cacti. Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 22p.
- Clark, D. J. 1998b. Final Report: Expedition into the Parks; rare plant survey at Capitol Reef National Park. Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 6p.
- Clark, D. J. 1999a. 1999 Field Survey and Final Results of a two year Winkler and San Rafael Cactus Study. Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 55p.
- Clark, D. J. 1999b. Survey Results for Alpine Greenthreads (*Thelesperma subnudum* var. *alpinum*). Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 5p.
- Clark, D. J. 1999c. Survey Results for Barneby's Reed-mustard (*Schoenocrambe barnebyi*). Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 3p.
- Clark, D. J. 1999d. Survey Results for Maguire's Daisy (*Erigeron maguirei*). Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 3p.
- Clark, D. J. 1999e. Survey Results for Pinnate Spring Parsley (*Cymopterus beckii*). Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 6p.
- Clark, D. J. 1999f. Survey Results for Rabbit Valley Gilia (*Gilia caespitosa*). Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 12p.
- Clark, D. J., and T. O. Clark. 1999. Rare plant survey at Capitol Reef National Park. Park Science Journal: 19(2):27-29.
- Dawson, C. 1998. *Gilia caespitosa* monitoring project update. Denver Botanic Gardens Research Department. 5p.
- Everitt, B. L. 1970. A survey of the desert vegetation of the northern Henry Mountains region, Hankville, Utah. Ph.D. Dissertation, John Hopkins University, Geography. 320p.
- Goodrich, S., and E. Neese. 1986. Uinta Basin flora. U.S. Forest Service and Bureau of Land Management, U.S. Government Printing Office. 320p.
- Haefner J. W., and A. M. Lindahl 1988. The Ecology of Small Pools in Capitol Reef National Park, Utah. Final Report to the National Park Service. Contract Number PX-1350-7-0259. 27p..
- Haefner J. W., and A. M. Lindahl. 1991. The Ecology of Small Pools in Capitol Reef National Park, Utah: Phase II. Final Report to the National Park Service. Contract Number PX-1350-8-0187. 172p.
- Harris, J. G. 1980. A vascular flora of the San Raphael Swell, Utah. Great Basin Naturalist 43:79-87.
- Harrison, B. F., S. I. Welsh, and G. Moore. 1964. Plants of Arches National Monument. Brigham Young University Sci. Bull. Biol. Ser. 5 (1).
- Heil, K. D., J. M. Porter, R. Fleming, and W. H. Romme. 1993. Vascular Flora and Vegetation of Capitol Reef National Park, Utah. Cooperative Studies Unit at Northern Arizona University Technical Report NPS/NAUCARE/NRTR-93/01. 82p.
- Lafrancois, T. 1995. Biology and Ecology of Rock Pools in Capitol Reef National Park, Utah. Master's Thesis, Colorado State University, Fort Collins, Colorado. 64p.
- Neese, E. J. 1981. A vascular flora of the Henry Mountains, Utah. Unpublished Ph.D. Dissertation, Brigham Young University, Provo, Utah.
- Porter, J. M., E. H. Roalson, and K. D. Heil. 1999. Population structure in *Pediocactus winkleri* and *P. despainii* (Cactaceae), based upon chloroplast haplotypes, inferred from TRNL-*F* DNA sequences. Rancho Santa Ana Botanic Garden. 22p.
- Romme, W. H., K. D. Heil, J. M. Porter, and R. Fleming. 1993. Plant Communities of Capitol Reef National Park, Utah. Cooperative Studies Unit at Northern Arizona University Technical Report NPS/NAUCARE/NRTR-93/02. 35p.
- Spence, J.R., and N. R. Henderson. 1993. Tinaja and hanging garden vegetaion of Capitol Reef National Park, southern Utah. J. Arid Environments 24:21-36.

- Stanton, W. D. 1931. A preliminary study of the flora of the Henry Mountains of Utah. Master's Thesis, Brigham Young University, Provo, Utah.
- Van Buren, R., and K. T. Harper. 2000. Status Report 1999; *Erigeron maguirei*. Bureau of Land Management Contract #J910A81041. 12 p.
- Welsh, S. L. 1970. Flora of Canyonlands. Great Basin Naturalist 21:26-37.
- Welsh, S. L and G. Moore. 1968. Plants of Natural Bridges National Monument. Proceedings of the Utah Academy of Sciences 45:220-248.
- West, N. E. 1990. Structure and function of soil microphytic crusts in wildland ecosystems of arid and semi-arid regions. Adv. Ecol. Res. 20:179-223.
- Williams, J. D., J. P. Dobrowolski, and N. E. West. 1995. Microphytic crust influence on soil stability and hydrologic properties of a sandy-loam soil in Capitol Reef National Park, Utah, USA. Proc. of the Fifth International Rangeland Congress Vol. 1:601-602.
- Wolf, P. G., and C. L. McCracken. 1998. Final Report: Population structure of two rare plant species, *Gilia caespitosa* and *G. tenuis*. Department of biology, Utah State University, Logan, UT. 14p.

CEDAR BREAKS NATIONAL MONUMENT

BIRDS

No complete or intensive survey of bird species within Cedar Breaks National Monument has been accomplished. An unpublished checklist, completed by various seasonal interpreters over the years and containing 86 bird species, has been compiled for visitor use and as a guide for park employees. The percent level of completeness for the presence of bird species in the Monument is unknown.

A general listing of bird species for the Monument is also contained in one published bulletin (Grater 1947) but this bulletin considers a vast amount of terrain communities and the birds that inhabit them on the plateau country in southern Utah, including Cedar Breaks, Bryce Canyon, and Zion.

The only professional level surveys conducted within the Monument were for the following special concern species in 1993 and 1994: peregrine falcon (*Falcon peregrinus anatum*) (USDI National Park Service 1993 and 1994), northern goshawk (*Accipiter gentilis atricapillus*), and Mexican spotted owl (*Strix occidentalis lucida*).

References:

- Grater, R. K. 1947. The Birds of Zion, Bryce, and Cedar Breaks. Pp. 1-91 in Zion-Bryce Museum Bulletin. Abstract: The areas to be considered in this bulletin are not especially large, but are representative of a vast amount of terrain communities and the birds that inhabit them, on the plateau country in southern Utah.
- USDI. National Park Service. 1993. Zion National Park, Cedar Breaks National Monument and Pipe Spring National Monument 1993 Peregrine Falcon (*Falcon Peregrinus Anatum*) Survey. Zion National Park, Utah: National Park Service.
- USDI. National Park Service. 1994. Peregrine Falcon Monitoring. Springdale, UT: Zion National Park. Abstract: This is a section of the report and details a site near Cedar Breaks National Monument that yielded at least one fledging.

MAMMALS

As with bird species, no complete or intensive survey of mammal species within Cedar Breaks National Monument has been accomplished at a professional level. An old checklist from 1938 was compiled by Presnall. An unpublished checklist, completed by various seasonal interpreters over the years and containing 37 mammal species, has been compiled for visitor use and as a guide for park employees. The

percent level of completeness for the presence of mammal species in the Monument is unknown.

References:

Presnall, C. C. 1938. Mammals of Zion-Bryce and Cedar Breaks. 2 p.

REPTILES AND AMPHIBIANS

Very little is known of the herpetological resources of Cedar Breaks National Monument. A reference search shows one checklist for amphibians and reptiles for the Monument compiled by Walker in 1939, but its level of completeness is unknown. Environmental and climatic considerations limit the distribution and abundance of reptiles and amphibians to the lower-most elevations in the park, which are located along the western boundary on Ashdown Creek. This area is difficult to access and little in the way of any biological resource inventories have been completed in that area.

References:

Walker, M. V. 1939. A Key to the Amphibians and Reptiles for Zion, Bryce, and Cedar Breaks. 6 p.

FISH

The only species of fish known to exist in the monument is the brook trout (*Silvelinus fontinalis*), an introduced species, found in Alpine Pond. There is no other information available on the aquatic life of Cedar Breaks. No professional level surveys for presence/absence, or distribution/abundance have been conducted.

VASCULAR PLANTS

Of all the taxonomic groups for which inventory and monitoring is needed at Cedar Breaks National Monument, the only group that approaches or meets the 90% level is vascular plants. Although adequate work on the presence or absence of plant species has been completed, additional work is needed on the relative abundance of species, especially as it relates to the inventory and monitoring of special concern and non-native species.

A checklist of the vascular plant species of Cedar Breaks National Monument was compiled by Dr. Brent Palmer and Catherine Jean of Southern Utah State College in 1980. This was followed by a parkwide survey conducted by David W. Roberts and Catherine Jean from Utah State University in 1988. This survey met the Level 1 standard (minimum level) at that time, as described in the Servicewide draft NPS-75, Standards for Natural Resources Inventory and Monitoring (1988). This survey identifies 269 vascular plant species within the Monument.

Inventory of endemic plants within the park was also included within broader regional studies conducted by Dr. Stanley Welsh of Brigham Young University in the 1970s. These studies included impact assessments of coal development in southern Utah for the U.S. Geological Survey.

The occurrence of relic plant communities within the Cedar Breaks geologic amphitheater was documented in 1991, and benchmark photo sites were established by the Nature Conservancy (Van Pelt et al. 1992).

The occurrence and distribution of Arizona willow (*Salix arizonica*), a special concern species, within Cedar Breaks National Monument was documented in 1995 by Dr. Duane Atwood and Ron Rodriguez. Voucher specimens were collected for all populations located within Cedar Breaks NM and adjacent Forest Service administered lands and deposited in the BYU herbarium. Field work for Arizona willow was completed by Atwood, Rodriguez and two graduate students as part of the baseline data for development of an Interagency Conservation Agreement and Strategy (USFWS 1995).

A few additional published checklists in popular field guide form are available for Cedar Breaks National Monument, but these are not considered complete inventories.

References:

Buchanan, H. 1974. Living Color: Wildflower Communities of Bryce Canyon and Cedar Breaks, Weber State College, Department of Botany. Bryce Canyon, UT: Bryce Canyon Natural History Association.

- Jepson C. E., and L. F. Allen. 1958. Wild Flowers of Zion and Bryce Canyon National Parks and Cedar Breaks National Monument. Zion-Bryce Natural History Association..
- Malm, M. 1987. Plant Identification Guide: A Guide to the Identification and Interpretation of the Plants of Cedar Breaks National Monument. 300? p.
- Palmer, B. and C. Jean. 1980. The Vascular Plants of Cedar Breaks National Monument. Cedar City, UT: Southern Utah State College.
- Roberts, D. W. and C. Jean. 1989. Plant community and rare and exotic species distribution and dynamics in Cedar Breaks National Monument. Unpublished Report Contract Report No.PX-1200-9-C813 on file at Utah State University, Department of Forest Resources and Ecology Center. Logan, Utah. 185 p.
- USDI. Fish and Wildlife Service. 1995. Interagency Conservation Agreement and Strategy Arizona Willow (*Salix Arizona*) between the U.S. Fish and Wildlife Service, Dixie National Forest and Cedar Breaks National Monument.
- USDI. National Park Service. 1990. Sumarized Endemic Plant Distribution, Cedar Breaks National Monument. Unpublished report on file at Cedar Breaks National Monument.
- Van Pelt, N.S., C.D. Schelz, J.S. Tuey and J.R. Spence. 1992. Survey and analysis of relict plant communities within National Park systems units of the Colorado Plateau: Vol. II – community site descriptions and unit analyses: Bryce Canyon National Park, UT; Capitol Reef National Park, UT; Cedar Breaks National Monument, UT; Zion National Park, UT. Final report ed; Cooperative agreement CA 1440-8-8001. 155p.

COLORADO NATIONAL MONUMENT

BIRDS

The checklist for birds of the Monument includes 127 species, based on Kaeding (1990). Monitoring projects are ongoing for peregrine falcon and gray vireo. Many years of site data have been collected for peregrine falcon (*Falco peregrinus*) by the Colorado Division of Wildlife and the Monument. The data needs to be consolidated. There have been inventories, mapping and ongoing monitoring of the gray vireo (*Vireo vicinior*) and plumbeous vireos (Giroir 1999).

References:

- Coleman, S., Tucker, S. 1995. Final Report, Colorado National Monument (Peregrine Falcon Data)." 4 p.
- Colorado Division of Wildlife. 1991. Peregrine Falcon Survey and Monitoring in Colorado National Monument, 1991. Ft. Collins, CO.
- Giroir, G.P. 1999. Progress Report; Inventory Gray and Plumbeous Vireo Populations in Colorado National Monument. Colorado Bird Observatory.
- Kaeding, B. 1990. Birds of Colorado National Monument. Grand Valley Audubon Society and Colorado National Monument Association.

MAMMALS

The checklist of mammals includes 64 species, of which 41 have actually been recorded from the Monument. Desert bighorn sheep were reintroduced in 1979. Twelve bat species are known to be present in the Monument; there is suitable habitat for five additional species (Perrotti 1995). The Townsend's bigeared bat (*Plecotus townsendii pallencens*) is listed as a Category 2 candidate species; it is the major impetus and focus of the Colorado Division of Wildlife's Bat/Abandoned Mine conservation project. The fringed myotis (*Myotis thysanodes*) and the big free-tailed bat (*Nyctinomops macrotus*) are also considered rare in the State of Colorado. There is potential habitat for the endangered spotted bat (*Euderma maculatum*).

The desert bighorn sheep population is estimated at 75 individuals. The Colorado Division of Wildlife continues to monitor the herd (Sloan 1995; Singer 1998).

There is no data on population size and movements of mountain lions in the Monument. In anticipation of potential conflicts between increasing numbers of visitors in the Monument and all around its boundaries, basic data needs to be collected and maintained for management of the mountain lion.

A herd of bison was introduced and maintained on the Monument from 1925 to 1983.

Prairie dogs towns along the boundary with residential subdivisions were surveyed in 1991 as part of the COLM Prairie Dog Management Plan (1989).

References:

- Armstrong, D.M.; Rector, C. 1988. Annotated Checklist of Mammals of Colorado National Monument, Mesa County, Colorado. University of Colorado, Boulder. 11p.
- Miller, Pat H. 1964. "The Ecological Distribution of Mammals in Colorado National Monument, Mesa County, Colorado." M.S. thesis, Oklahoma State University.
- National Park Service. 1989-1990. Bat Species Abundance and Distribution in Colorado National Monument: a Two Year Survey,. Unpublished technical report.
- National Park Service. 1993. Follow-Up Study on Bat Species Abundance and Distribution at Colorado National Monument-. Addendum to 1989-90 report.
- National Park Service. 1994. Continued Census of the Bat Fauna at Colorado National Monument. Addendum to 1989-90 report.
- National Park Service. 1989. Prairie Dog Management Plan (includes maps). Colorado National Monument.
- Perrotti, P. 1995. Survey of Bat Populations, Distribution and Abundance. Draft project proposal. Colorado National Monument, Fruita, Colorado.
- Singer, F.J.; Gudorf, M. 1998. Restoration of Bighorn Sheep Metapopulations into and near 15 National park Units; conservaton Biology of a Severely Fragmented Species. Final report to National Park Service on Natural Resources Preservation, Project No. RMRO-N-411.101, Vol.I.
- Sloan, W.B. 1995. A Herd History of the Bighorn Sheep of the Colorado National Monument and the Black Ridge, Colorado. USDI National Park Service, Southeast Utah Group, Moab, Utah.

REPTILES AND AMPHIBIANS

The checklist of amphibians and reptiles includes 25 species: one salamander, two toads and two frogs, one turtle, nine lizards, and nine snakes. Rare reptile and amphibian species of note are the midget-faded rattlesnake (*Crotalus viridus concolor*) and Utah blackhead snake (*Tantilla planiceps*); the clouded tiger salamander (*Ambystoma tigrinum*), Great Basin spadefoot (*Saphiopus intermontanus*), and canyon treefrog (*Hyla arenicolor*). Iguanid lizard behavioral studies conducted by R. T. M'Closkey et al. from the University of Windsor, Ontario, from 1988 to 1994 did not include inventory data.

An amphibian survey was conducted at COLM by Paul Creeden of Colorado DOW for three days in the spring of 1994.

References:

- Creeden, P. 1994. Amphibian Surveys – GMU 40. Unpublished memo with field data sheets. Colorado Division of Wildlife. 17p.

FISH

Fish do not occur with Colorado National Monument.

VASCULAR PLANTS

The vascular flora record includes more than 66 families, 250 genera and 450 species, based on specimens in the COLM herbarium and on the checklist developed in 1985 (Weber et. al.). An identification guide for cacti of the Monument describes nine species (Campbell 1996). The Colorado Natural Heritage Program lists 14 sensitive plant species for the Monument (Lyon et.al 1996). Only 55 species of lichens have been identified for the Monument.

Of the 14 sensitive plant species listed for the Monument by the Colorado Natural Heritage Program, at least two are in need of status surveys and monitoring: Canyonlands lomatium (*Lomatium latilobum*), G1 S1, and Canyon bog orchid (*Platanthera sparsiflora* var. *ensifolia*) (G4G5T3S2) (Lyon et.al 1996).

A relict plant community survey and analysis was performed by the Nature Conservancy in 1990 (Van Pelt et.al. 1991).

Permanent vegetation monitoring plots were established in several locations within the Monument in 1982 and read in 1985 for the purpose of measuring effects of air pollution from a refinery in Fruita.

A complete inventory of exotic species in the Monument has yet to be conducted. Tamarisk (*Tamarix ramosissima*) has received the most attention at COLM, starting in about 1995. The Lake Meade tamarisk terminators treated all except about 15 kilometers (9 miles) of canyon habitat in 1997. Monument staff and volunteers have continued treatments and follow-ups each year. Pre-treatment maps are in the monument GIS. Additional follow-up treatments and documentation are needed. Russian knapweed (*Centaurea repens*) populations have been mapped and sprayed for several years and continue to need some follow-up.

References:

- Campbell, D.I. 1996. Cacti of the Colorado National Monument. Unpublished. 7p.
- Lyon, P; Pague, C.; Rondeau, R.; Renner, L.; Slater, C; Richard, C. 1996. Natural Heritage Inventory of Mesa County, Colorado. Report to Mesa County Commissioners. Colorado natural Heritage Program, Fort Collins, CO.
- National Park Service. 1995. Tamarisk Survey: Colorado National Monument, October 1994 - February 1995.
- Van Pelt, S.; Schelz, C.D.; Johnson, D.W. 1991. Survey and analysis of relict plant communities within National Park system units of the Colorado Plateau, Volume I. Rocky Mountain Regional Office, USDI, National Park Service, Lakewood, CO.
- Weber, W.A; Siplininsky, V.; Beck, H; Rector, C. 1985. Checklist of Vascular Plants, Colorado National Monument. University of Colorado Museum, Boulder, CO and Colorado National Monument, Fruita.

CURECANTI NATIONAL PARK

BIRDS

The bird checklist for Curecanti is derived from the Check List of Birds of Gunnison County, Colorado (Hyde 1977). Park staff have collected monitoring data at locations within Curecanti from 1992-99 using a point count methodology. This monitoring effort is continuing and plans include evaluating its suitability for meeting park needs in 2001. A determination needs to be made about the adequacy of existing data and a site-specific checklist needs to be developed.

More extensive studies have focused on peregrine falcons (Burnham 1981, Canterbury 1982, Krampetz 1989, Boretti 1990) and territory occupancy and reproduction surveys continue today; and bald eagles (Canterbury 1983). The park initiated research on Gunnison sage grouse habitat utilization in 2000.

References:

- Boretti, R. 1990. Curecanti National Recreation Area and Black Canyon of the Gunnison National Monument 1990 Peregrine Falcon survey. National Park Service.
- Burnham, W., and J. Enderson. 1981. Blue Mesa Peregrine Falcon study. The Peregrine Fund.
- Canterbury, J. 1982. Raptor survey and proposals for the Curecanti National Recreation Area. Requirements for internship, Western State College.
- Canterbury, J. 1983. Habitat utilization by the Northern Bald Eagle in the Curecanti National Recreation Area. Management Report, National Park Service.
- Hyde. 1977.
- Krampetz, F. J., B. C. Hastings, and G. R. Craig. 1989. Peregrine Falcon survey effort in Curecanti National Recreation Area 1989. Colorado Division of Wildlife.
- USDI, National Park Service. 1999. Long-term bird monitoring data set. Park files.
- USDI, National Park Service. 1999. Gunnison Sage Grouse Significance of habitat as it relates to dispersal and genetic interchange. Black Canyon of the Gunnison National Monument Resource Management

MAMMALS

A list of mammals of Curecanti was compiled in 1968 (Einwalter 1968). Very little mammal inventory work has been conducted since that time. Park staff collected monitoring data at limited locations within Curecanti from 1993-95 (USDI 1995). This monitoring effort was suspended because of the heightened concern over Hantavirus. Since it is unclear how extensive the Einwalter work is, and the additional surveys are limited, the park needs a comprehensive inventory or a determination that existing lists are adequately representative. The general region surrounding the park is covered in regional faunal works such as Armstrong (1972) and Fitzgerald et al. (1995).

References:

- Armstrong, D.M. 1972. Distribution of mammals in Colorado. Monogr., Univ. Kansas Mus. Nat History, 3:1-415.
- Einwalter, D. C. 1968. List of Mammals Curecanti Recreation Area. Unpublished list on file with park headquarters. 3p.
- Fitzgerald, J. P., C .A. Meaney, and D. M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and Univ. Press of Colorado.
- USDI, National Park Service. 1995. Long-term small mammal monitoring dataset. Park files.

REPTILES AND AMPHIBIANS

No comprehensive survey for reptiles or amphibians has ever been conducted for Curecanti National Recreation Area.

FISH

Fishes of Blue Mesa Reservoir and Morrow Point Reservoir include rainbow trout, brown trout, lake trout, and kokanee salmon. Speckled dace, bluehead sucker, and roundtail chuyb are found in downstream reaches of the Gunnison River.

The fisheries in the park have been studied more extensively than any other facet of the biota. The section of the Gunnison River from the town of Gunnison to the historic town of Sapinero (a portion of this stretch is now inundated by Blue Mesa Reservoir) was studied in 1889 (Jordan 1891), 1926 (Pratt 1937, 1938), and 1964-1976 (Wiltzius 1966, 1967, 1970, 1971, 1974). The section of the Gunnison River from Blue Mesa Dam downstream to Cimarron (this stretch is now inundated by Morrow Point Reservoir) was studied from 1968-1976 (Wiltzius 1970, 1971, 1974). The lower section of the Gunnison River within the Recreation area, from Cimarron to the recreation area boundary (this stretch is now inundated by Crystal Reservoir), was studied from 1964-1976 (Wiltzius 1966, 1967, 1970, 1971, 1974).

A great deal of stocking of non-native sport fish by the Colorado Division of Wildlife has occurred from the 1970s to present. Recent studies are focusing on the predator prey interaction between Mackinaw and kokanee salmon. The Colorado Division of Wildlife conducts annual fisheries surveys of Blue Mesa Reservoir and Morrow Point Reservoir.

References:

- Jordan, D. S. 1891. Report of explorations in Colorado and Utah during the summer of 1889, with an account of the fishes found in each of the rivers examined. Bull. U. S. Fish. Comm., Vol. 9 (1889). p 1-40.
- Pratt, H. P. 1937. Population studies of the trout of the Gunnison River. Univ. of Colorado Studies. Vol. 24 No. 2, p. 107-116.
- Pratt, H. P. 1938. Ecology of the trout of the Gunnison River, Colorado. Univ. of Colorado Ph.D. Thesis. 197 p.
- Wiltzius, W. J. 1966. Pre-impoundment investigations of the Curecanti Unit, Upper Colorado River Storage Project. Federal Aid Job Completion Report, F-31-R-1, 70 p.
- Wiltzius, W. J. 1967. Pre-impoundment investigations of the Curecanti Unit, Upper Colorado River Storage Project. Federal Aid Job Completion Report, F-31-R-2. 48 p.
- Wiltzius, W. J. 1970. Pre-impoundment investigations of the Curecanti Unit, Upper Colorado River Storage Project, Federal Aid Job Completion Report, F-31-R-3. 51 p.
- Wiltzius, W. J. 1971. Post-impoundment fishery investigations, Curecanti Unit, Upper Colorado River Storage Project, Section 8, Progress Report No. 2, 202 p.
- Wiltzius, W. J. 1974. Post-impound fishery investigations, Curecanti Unit, Upper Colorado River Storage Project, Final Report for Blue Mesa Reservoir. Colorado Division of Wildlife, 76 p.

VASCULAR PLANTS

A list of vascular plants of Curecanti was compiled in 1968 (Einwalter 1968). Additional inventories, limited to specific geographic areas within the recreation area, were conducted in 1980 for the Neversink area (Engel 1980) and 1997 for the Elk Creek Marina area (USDI 1998a). Park staff have collected monitoring data at locations within Curecanti from 1993-98 (USDI 1998b). This monitoring effort is currently undergoing review to determine its suitability for meeting park needs. Since it is unclear how extensive the Einwalter work is, and the additional surveys are limited to specific geographic areas, the park needs a comprehensive inventory or a determination that existing lists are adequately representative.

References:

- Einwalter, D. C. 1968. List of Vascular Plants Curecanti Recreation Area. Unpublished list on file with park headquarters. 13 p.
- Engel, Susan. 1980. Floristic survey of the Riverway-Neversink area. Field Investigations Western State Foundation Grant #280-098.
- Ritz, T. 1998. Preliminary list of vascular plant taxa of Curecanti National Recreation Area. Unpublished list on file at park headquarters. 16p.
- USDI, National Park Service. 1998a. Plant species found in drainage east of Elk Creek Marina parking lot. Park files.
- USDI, National Park Service. 1998b. Long-term vegetation monitoring dataset. Park Files.

DINOSAUR NATIONAL MONUMENT (DINO)**BIRDS**

No formal park-wide inventories have been conducted in Dinosaur National Monument. Information consists of a "bird list" and Latilong Reports from both Colorado and Utah wildlife agencies. A few specimen records exist from salvaged specimens (primarily raptors - at USGS-BRD, Albuquerque, NM). The bird list includes 217 species with notes on status and abundance.

The Colorado Bird Atlas Project conducted breeding bird surveys over several years in the early 1990s. Survey blocks were established in each 7 ½ minute quadrangle statewide. Two survey blocks occur in Dinosaur National Monument. A database containing records from this project is available through the Colorado Bird Union. Dinosaur has also conducted breeding bird surveys in many areas of the park as a portion of on-going long-term (1984-present) fire effects studies.

Extensive inventory and monitoring information has been collected on peregrine falcons since 1976 (annual reports compiled since 1980), including locations and characterization of eyries, with photos, behavior observations, fledging success, etc.

Systematic surveys for Mexican spotted owls were conducted in 1995 and 1996 by David Willey under a NPS contract through Northern Arizona University. A single male owl was observed in both years in a remote slickrock location north of the Yampa River. Although no further attempts have been made to monitor this site, peregrine falcon observers heard the calls of two owls from that location during the spring of 2000.

References:

- Chase, C. A., S. J. Bissell, H. E. Kingery, and W. D. Graul, eds. ca. 1983. Colorado Bird Distribution Latilong Study. Colorado Field Ornithologists and Colorado Division of Wildlife. 81p.
- USDI. National Park Service. 1980-2000. Peregrine Falcon Monitoring Report. Annual reports on file at Dinosaur National Monument, Resource Management Program Files, Dinosaur, CO.
- Willey, D.W. 1997. Distribution and Ecology of Mexican Spotted Owl in National Parks in Utah. Final Report to the National Park Service Intermountain Region, Lakewood, CO.

MAMMALS

Most recent inventory conducted over several years in the mid-1980s under direction of Dr. Mike Bogan (then with National Ecology Research Center, FWS, Fort Collins, CO; now with USGS-BRD, Albuquerque, NM). Total number of mammalian species identified was 65. Several species (at least 4) have been added to known fauna since then through fire effects studies and incidental collections. All but a few large mammals are represented by specimen records in USGS-BRD collections at Albuquerque.

References:

- Armstrong, D. M. 1972. Distribution of mammals in Colorado. Monograph, University of Kansas Museum of Natural History 1:1-415.
- Bogan, M. A. 1990. Biological surveys in four National Parks (BRCA, CARE, DINO, MEVE). Annual Report to National Park Service, Rocky Mountain Regional Office, 16 January 1990.
- Bogan, M. A. 1991. Biological surveys in four National Parks (BRCA, CARE, DINO, MEVE). Annual Report to National Park Service, Rocky Mountain Regional Office, 12 February 1991.
- Bogan, M. A., R. B. Finley and S. J. Petersburg. 1988. The Importance of Biological Surveys in Managing Public Lands in the Western United States. *In* Proceedings of the Symposium: Management of Amphibians, Reptiles, and Small Mammals in North America, July 19-21, 1988, Flagstaff, Arizona. USDA Forest Service General Technical Report, RM-166. p.254-261.

Bogan, M. A., S. J. Martin, and R. B. Bury. 1983. Baseline studies of riparian vertebrates of the Yampa and Green river corridors within Dinosaur National Monument, June and July 1982. Final (unpublished) report submitted to Regional Office, Rocky Mountain Region, National Park Service, 16p.

Bogan, et al. cite several earlier studies making reference to mammalian inventories in Dinosaur and environs. These include:

Cary, M. 1911. A biological survey of Colorado. North American Fauna 33:1-256.

Lechleitner, R. R. 1969. Wild mammals of Colorado: their appearance, habits, distribution, and abundance. Pruett Publishing Company, Boulder. 254 p.

Newmark, W. A. 1986. Mammal richness, colonization, and extinction in western North American national parks. Unpubl. Ph.D dissertation, University of Michigan, Ann Arbor. 172p.

Warren, Edward. 1942. The mammals of Colorado. University of Oklahoma Press, Norman. Second revised edition. 330p.

see also:

Barmore, W.J. Jr. 1962. Bighorn sheep and their habitat in Dinosaur National Monument. M.S. Thesis, Utah State Univ., Logan, UT. 134p.

Fitzgerald, J. P., C. A. Meaney, and D. M. Armstrong. 1994. Mammals of Colorado. Denver Museum of Natural History and University Press of Colorado. 467p.

Meaney, C. A., ed. ca. 1991. Colorado Mammal Distribution Latilong Study. Colorado Division of Wildlife and The Denver Museum of Natural History. 31p.

Petersburg, M.L. In press. Emigration and survival of two-year old male elk in northwest Colorado. Wildlife Society Bulletin.

Petersburg, M.L. 1997. Emigration, fidelity, distribution, and survival of elk on a northwest Colorado winter range. M.S. Thesis, Colorado State Univ., Fort Collins, CO.

Skiba, G.T. 1981. Ecological evaluation of the Dinosaur National Monument bighorn sheep herd. M.S. Thesis, Colorado State Univ., Fort Collins, CO. 107p.

REPTILES AND AMPHIBIANS

Herpetological inventory work occurred along the rivers in 1982 (Burry). Upland herpetological inventory work was conducted in 1991 and 1992 by Dr. Steve Corn (then with National Ecology Research Center, FWS, Fort Collins, CO; now with Aldo Leopold Wilderness Institute, Missoula MT 406-542-4191). Voucher specimens from this work are under the care of Cindy Ramotnik with USGS-BRD in Albuquerque (505-346-2870 ext. 11). Nineteen species represented by specimen records (presently housed at NERC in Fort Collins; soon to be moved to USGS-BRD in Albuquerque) have been documented; three other species suspected but not documented. No record of final report by Corn.

References:

Bury, R.B.. 1982. Final report not yet located.

Corn, P.S. 1991 and 1992 . These final project reports have not yet been located.

Hammerson, G. A., and D. Langlois, eds. 1981. Colorado Reptile and Amphibian Latilong Distribution. Colorado Division of Wildlife. 24p.

Schwinn, M. A., and L. Minden, eds. 1979. Utah Reptile and Amphibian Latilong Distribution. Utah Division of Wildlife Resources Publ. No. 80-1. 11p.

FISH

The Green and Yampa rivers flow through DNM with their confluence near the center of the monument. Several small tributaries flow into the Green River (e.g., Jones Hole Creek, Vermillion Creek).

Fisheries surveys of the Green River through Dinosaur National Monument were first conducted in about 1960, as pre-impoundment surveys before construction of Flaming Gorge Dam (Binns 1965; Bosley 1960; Gaufin et al. 1960; Smith 1960; Holden 1991). Additional studies were conducted following completion of the dam and impoundment of the Green River (Vanicek 1967; Vanicek and Kramer 1969; Holden 1968, 1970; Holden and Stalnaker 1975a, 1975b; Seethaler 1978; Smith et al. 1979). Studies were also conducted following modification of the dam penstocks in 1975 to release warmer water from Flaming Gorge Reservoir into the Green River (Holden and Crist 1981). Extensive investigations of the endangered Colorado pikeminnow, humpback chub, razorback sucker, and bonytail began in DNM in 1979 with the Colorado River Fishery Project (Tyus et al. 1982; Karp and Tyus 1990; Ruppert et al. 1993; Tyus 1988, 1990, 1991, 1992, 1995, 1998; Tyus and Beard 1990; Tyus and Haines 1991; Tyus and Karp 1989; Tyus and McAda 1984; Tyus and Minckley 1988; Tyus and Nikirk 1990; Tyus and Saunders 1996). Recently, studies of the Green River in Lodore Canyon have been initiated to assess the reinvasion of historic habitat by the native and endangered fishes of the Colorado River Basin (Besten and Crist 2000). Additional literature on fisheries investigations exists for DNM in addition to that cited below. Because the Green and Yampa rivers through DNM supports the largest populations of Colorado pikeminnow and razorback sucker, as well as populations of humpback chub and historic habitat of bonytail, this region of the Upper Colorado River Basin has received much attention.

References:

- Bestgen, K. and L.W. Crist. 2000. Response of the Green River fish community to construction and re-regulation of Flaming Gorge Dam, 1962–1996. Final Report of Colorado State University Larval Fish Laboratory to Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.
- Binns, N.A. 1965. Effects of rotenone on the fauna of the Green River, Wyoming. Wyoming Game and Fish Commission, Fisheries Technical Bulletin 1:1–114.
- Bosley, C.E. 1960. Pre-impoundment study of the Flaming Gorge Reservoir. Wyoming Game and Fish Commission, Fisheries Technical Report No. 9.
- Gaufin, A.R., G.R. Smith, and P. Dotson. 1960. Aquatic survey of the Green River and tributaries within the Flaming Gorge Reservoir basin, Appendix A. Pages 139–162 in A.M. Woodbury (ed.) Ecological studies of the flora and fauna of Flaming Gorge Reservoir basin, Utah and Wyoming. University of Utah Anthropological Papers 48.
- Holden, P.B. 1968. Systematic studies of the genus *Gila* (Cyprinidae) of the Colorado River Basin. M.S. Thesis. Utah State University, Logan.
- Holden, P.B. 1991. Ghosts of the Green River: Impacts of Green River poisoning on management of native fishes. Pages 43–54 in W.L. Minckley and J.E. Deacon (eds.). Battle against extinction: native fish management in the American Southwest. University of Arizona Press, Tucson.
- Holden, P.B. and L.W. Crist. 1981. Documentation of changes in the macroinvertebrate and fish populations in the Green River due to inlet modification of Flaming Gorge Dam. Final Report PR-16-5 of Bio/West, Inc., Logan, Utah.
- Holden, P.B. and C.B. Stalnaker. 1970. Systematic studies of the cyprinid genus *Gila* in the Upper Colorado River Basin. Copeia 1970:409–420.
- Holden, P.B. and C.B. Stalnaker. 1975a. Distribution of fishes in the Dolores and Yampa river systems of the upper Colorado basin. Southwestern Naturalist 19:403–412.
- Holden, P.B. and C.B. Stalnaker. 1975b. Distribution and abundance of mainstream fishes of the middle and upper Colorado River basins, 1967–1973. Transactions of the American Fisheries Society 104:217–231.
- Karp, C.A., and Tyus, H.M. 1990. Humpback chub (*Gila cypha*) in the Yampa and Green Rivers with observations on other sympatric fishes. Great Basin Naturalist 50:257–264.
- McAda, C.W., W.R. Elmblad, M.A. Trammel, and T.E. Chart. 1999. Interagency Standardized Monitoring Program: summary of results, 1998. Annual Report to Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.
- McDonald, D.B., and P.A. Dotson. 1960. Pre-impoundment investigation of the Green River and Colorado River developments, in Federal Aid In Fish Restoration Investigations of Specific Problems in Utah's

- Fishery. Federal Aid Project No. F-4-R-6, Departmental Information Bulletin No. 60-3. State of Utah, Department of Fish and Game, Salt Lake City.
- Muth, R. T., L. W. Crist, K. E. LaGory, J. W. Hayse, K. R. Bestgen, T. P. Ryan, J. K. Lyons, and R. A. Valdez. 2000. Flow and Temperature Recommendations for Endangered Fishes in the Green River Downstream of Flaming Gorge Dam. U.S. Fish and Wildl. Serv., Upper Colorado River Recovery Program Project FG-53. 264p. + app.
- Ruppert, J.B., R.T. Muth, and T.P. Nesler. 1993. Predation on fish larvae by adult red shiner, Yampa and Green rivers, Colorado. *Southwestern Naturalist* 38:397–399.
- Seethaler, K. 1978. Life history and ecology of the Colorado squawfish (*Ptychocheilus lucius*) in the upper Colorado River basin. M.S. Thesis. Utah State University, Logan.
- Smith, G.R. 1960. Annotated list of fishes of the Flaming Gorge Reservoir basin, 1959. Pages 163–168 in A.M. Woodbury (ed.). *Ecological Studies of the Flora and Fauna of Flaming Gorge Reservoir Basin, Utah and Wyoming*. University of Utah Department of Anthropology, Anthropology Paper 48, Upper Colorado Basin Series 3.
- Smith, G.R., R.R. Miller, and W.D. Sable. 1979. Species relationships among fishes of the genus *Gila* in the upper Colorado drainage. Pages 613–623 in R.M. Linn (ed.). *Proceedings of the First Conference on Scientific Research in the National Parks*. U.S. Department of the Interior, National Park Service. *Transactions and Proceedings Series No. 5*.
- Tyus, H.M. 1998. Early records of the endangered fish *Gila cypha* Miller from the Yampa River of the Colorado with notes on its decline. *Copeia* 1998:190–193.
- Tyus, H.M. and J. Beard. 1990. *Esox lucius* (Esocidae) and *Stizostedion vitreum* (Percidae) in the Green River Basin, Colorado and Utah. *Great Basin Naturalist* 50:33–39.
- Tyus, H.M., B.D. Burdick, R.A. Valdez, C.M. Haynes, T.A. Lytle, and C.R. Berry. 1982. Fishes of the upper Colorado River basin: Distribution, abundance, and status. Pages 12–70 in W.H. Miller, H.M. Tyus, and C.A. Carlson (eds.) *Fishes of the upper Colorado River system: Present and future*. Western Division, American Fisheries Society, Bethesda, Maryland.
- Tyus, H.M. 1985. Homing behavior noted for Colorado squawfish. *Copeia* 1985:213–215.
- Tyus, H.M. 1988. Long term retention of implanted transmitters in Colorado squawfish and razorback suckers. *North American Journal of Fisheries Management* 8:264–267.
- Tyus, H.M. 1990. Potamodromy and reproduction of Colorado squawfish in the Green River basin, Colorado and Utah. *Transactions of the American Fisheries Society* 119:1035–1047.
- Tyus, H.M. 1991. Ecology and management of Colorado squawfish. Pages 379–402 in W.L. Minckley and J.E. Deacon (eds.) *Battle against extinction: native fish management in the American west*. The University of Arizona Press, Tucson.
- Tyus, H.M. 1992. An instream flow philosophy for recovering endangered Colorado River fishes. *Rivers* 3:27–36.
- Tyus, H.M. and G.B. Haines. 1991. Distribution, habitat use, and growth of age-0 Colorado squawfish in the Green River basin, Colorado and Utah. *Transactions of the American Fisheries Society* 120:79–89.
- Tyus, H.M. and C.A. Karp. 1989. Habitat use and streamflow needs of rare and endangered fishes, Yampa River, Colorado and Utah. U.S. Fish and Wildlife Service Biological Report 89:1–27.
- Tyus, H.M. and C.W. McAda. 1984. Migration, movements, and habitat preferences of Colorado squawfish, *Ptychocheilus lucius*, in the Green, White, and Yampa rivers, Colorado and Utah. *Southwestern Naturalist* 29:289–299.
- Tyus, H.M. and W.L. Minckley. 1988. Migrating Mormon crickets, *Anabrus simplex* (Orthoptera: Tettigoniidae), as food for stream fishes. *Great Basin Naturalist* 48:25–30.
- Tyus, H.M. and N.J. Nikirk. 1990. Abundance, growth, and diet of channel catfish, *Ictalurus punctatus*, in the Green and Yampa rivers, Colorado and Utah. *Southwestern Naturalist* 35:188–198.

- Tyus, H.M. and J.F. Saunders. 1996. Nonnative fishes in the upper Colorado River basin and a strategic plan for their control. Final Report of University of Colorado Center for Limnology to Upper Colorado River Endangered Fish Recovery Program, Denver, Colorado.
- Vanicek, C.D. 1967. Ecological studies of native Green River fishes below Flaming Gorge Dam, 1964–1966. Doctoral Dissertation. Utah State University, Logan.
- Vanicek, C.D. and R. Kramer. 1969. Life history of the Colorado squawfish, *Ptychocheilus lucius*, and the Colorado chub, *Gila robusta*, in the Green River in Dinosaur National Monument 1964–1966. Transactions of the American Fisheries Society 98:193208.

VASCULAR PLANTS

The earliest types from Utah were taken in the Uinta Basin by John Charles Fremont in 1844 when he collected specimens of *Senecio multilobatus*, and *Penstemon fremontii* (Welsh 1982). Fremont's route through the Uinta Basin was up the northeast rim onto Diamond Mountain and into Brown's Park thence east into Colorado, through the northern portion of the Monument. Other early plant collections we know of from Dinosaur National Monument were made by O.A. Peterson and Earl Douglass in 1912 (Graham 1937). Peterson and Douglass were "members of early Carnegie Museum paleontological field parties to the Uinta Basin..." Their specimens are now in the Carnegie Museum Herbarium. Edward H. Graham (1937) made further collections for the Carnegie Museum during the summers of 1931, 1933 and 1935.

H. D. Harrington (Colorado State University) made collections during 1945, 1946, 1947, 1948, 1957 and 1966. Several additional collectors were active in the area in 1948: A. A. Beetle and C.L. Porter (specimens at COLO), R. A. (Wolf) Bradley and K. S. Dever (specimens at COLO), H. G. Rodeck (specimens at COLO and UTC). R. A. (Wolf) Bradley also collected in 1949 and 1958 (see Bradley 1950).

W. A. Weber (University of Colorado) made collections in 1950, 1952, 1956, 1965, 1967 and 1978. S. L. Welsh (Brigham Young University) made collections in 1953, 1955, 1956, 1969 and 1979 (see Welsh 1957).

During the 1960s, A. H. Holmgren and N. Holmgren, along with T. Jensen and J. Reveal, collected at various times between 1961 and 1965 (specimens at UTC). Their work included a pre-Flaming Gorge Dam inventory of riparian vegetation associated with the Green River below the dam (Holmgren 1962a). J. Brotherson made collections in 1965 and 1966 (specimens at BRY).

Very little collecting occurred in the 1970s, but a few specimens were taken by D. Atwood (BRY) in 1976 and 1979, N. Holmgren (UTC) and L. Schultz (UTC).

Dinosaur National Monument staff, J. Friedlander and S. Wathen, made several collections in 1983 (specimens at DINO). Extensive collections were made by Colorado Natural Areas Program staff between 1987 and 1989, under contract with National Park Service. Collectors associated with this inventory included S. O'Kane, B. Neely, T. Naumann, B. Painter and W. Kelly, specimens were deposited at DINO, CS, COLO and BRY (Naumann 1990). L. Riedel collected vouchers in 1991 for a study in Hog Canyon, on the south flank of Split Mountain, Utah. These specimens are housed at DINO.

The Colorado Natural Areas Program inventory (Naumann 1990) represents the most systematic effort to document the entire monument flora through herbarium and literature research, augmented with field collections. This National Park Service funded project also provided detailed maps and information on species of special concern, although drought conditions in 1989 hampered efforts to complete work for the Utah portion of the monument (Green River District).

"Precipitation collected for the water year beginning October 1988 and ending 1989 in Dinosaur National Monument (Monument Headquarters, Dinosaur, Colorado) was a record low (155 millimeters/6.09 inches). The 25-year average (1964-1989) was 295 millimeters/11.61 inches (Petersburg, personal communication). The previous record low was 158 millimeters/6.19 inches recorded in 1977. Drought conditions in 1989 had a noticeable effect on plant growth and reproduction. Many taxa remained dormant or failed to reproduce during the growing season in 1989. This reduced the number of sensitive taxa documented, and probably reduced the total number of taxa recorded during the course of the study."

Among recommendations included in the final report is the following:

“The 1988-89 drought prevented a thorough inventory and mapping of sensitive plant species in the Green River District. Completion of the inventory in the Quarry area will insure comprehensive information for ground clearances and other potential development activities.”

References:

- Beidleman, R. G. 1957. An annotated checklist of the flora and fauna of Dinosaur National Monument. Unpublished Report on file at Dinosaur National Monument, Dinosaur, Colorado.
- Bradley, R. A. W. 1950. The vascular flora of Moffat County, Colorado. Unpublished Thesis, Univ. of Colorado, Boulder, Colorado. 71 p.
- Goodrich, S., and E. Neese. 1986. Uinta Basin Flora. USDA Forest Service, Intermountain Region. 320 p.
- Graham, E. H. 1937. Botanical studies in the Uinta Basin of Utah and Colorado. *Annals of the Carnegie Museum* 26:1-432.
- Holmgren, A. H. 1962a. The vascular plants of the Green River from Flaming Gorge to Split Mountain Gorge. Unpubl. Report prepared for Dinosaur National Monument. Utah State University, Logan, Utah. 40 p.
- Holmgren, A. H. 1962b. The vascular plants of Dinosaur National Monument. Unpubl. Report prepared for Dinosaur National Monument. Utah State University, Logan, Utah. 21 p.
- Naumann, T. S. 1990. Inventory of plant species of special concern and the general flora of Dinosaur National Monument 1987-1989. USDI National Park Service Report, Rocky Mountain Region, Denver, Colorado. 116 p. (+ appendices, maps and data files).
- Welsh, S. L. 1957. An ecological survey of the vegetation of Dinosaur National Monument, Utah. M.S. Thesis, Brigham Young University, Provo, Utah. 86 p.
- Welsh, S. L. 1982. Utah Plant Types-Historical Perspective 1840 to 1981 – Annotated List, and Bibliography. *Great Basin Naturalist* 42(2):129-195.

Invasive Species: Prior to 1996, almost no work had been conducted in Dinosaur National Monument on invasive species. Some preliminary inventory work occurred in 1996 on high priority species in sites most likely to be infested. Target species included tamarisk, Russian knapweed, perennial pepperweed, Russian olive and Canada thistle. Roadways, river corridors, campgrounds, developed facilities and frequently used trails were surveyed by seasonal National Park Service staff. This work resulted in identification of approximately 400 affected acres and has directed management efforts to the present time. A more complete inventory is needed; this should include more target species, provision for inclusion in a GIS data layer, and greater area sampled.

FOSSIL BUTTE NATIONAL MONUMENT

BIRDS

Dr. Robert Dorn, in his 1984 grazing study, recorded the presence of 72 species of birds his research team observed on the monument. Permanent and seasonal rangers have compiled a bird checklist for visitor use, but it is short, containing only the names of the more commonly seen species. Visitors occasionally complete wildlife observation forms, but such information is always suspect. An exhaustive study of the avian fauna of Fossil Butte National Monument has never been undertaken, and the species list falls short of the 90% completeness benchmark established under the present inventory guidelines.

References:

- Dorn, R., R. Lichvar, and J. Dorn. 1984. Grazing impact study on Fossil Butte National Monument, Wyoming. Cheyenne, WY: Mountain West Environmental Services.

MAMMALS

The combined efforts of park rangers, visitors, and other researchers have resulted in the documentation of 90% of the large mammals likely to occur at FOBU, but it is doubtful the number of species of small mammals, especially bats, attains the 90% benchmark.

Clark (1977) conducted a preliminary survey of mammals at the monument and reported at least 45 species of mammals. Whether or not Clark prepared and repositied voucher specimens needs to be determined. If he did, his specimens are not in the Fossil Butte study collection. Ted Rado, a National Park Service employee, conducted several small mammal surveys at Fossil Butte. Rado compiled a list of mammals from captured specimens, sightings and indirect evidence. Study skins of a number of the organisms Rado captured are in the Fossil Butte study collection.

The Mountain West Environmental Services staff compiled a list of 34 mammals it either trapped, observed directly, or identified by the presence of scat or tracks (this list included 7 not directly observed, but reported by Rado or park rangers) (Dorn, et al, 1984).

Katzner (1994) studied the winter ecology of pygmy rabbits at Fossil Butte and confirmed that species' presence.

References:

- Clark, T. 1977. Preliminary mammal survey of Fossil Butte National Monument, Wyoming. Great Basin Naturalist 37(1):91-94.
- Dorn, R., R. Lichvar, and J. Dorn. 1984. Grazing impact study on Fossil Butte National Monument, Wyoming. Cheyenne, WY: Mountain West Environmental Services.
- Rado, T. 1976. A mammal survey of Fossil Butte National Monument. Kemmerer, WY: Fossil Butte National Monument; In-house report.
- Rado, T. 1977. Rodent species composition and distribution patterns at Fossil Butte National Monument, Wyoming. Kemmerer, WY: Fossil Butte National Monument; In-house report.
- Rado, T. 1977. A faunal evaluation of a proposed exhibit center site at Fossil Butte National Monument, Wyoming. Kemmerer, WY: Fossil Butte National Monument; In-house report.
- Katzner, T. 1994. Winter ecology of the pygmy rabbit (*Brachylagus idahoensis*) in Wyoming. M. S. thesis. Laramie, WY: University of Wyoming; unpublished.

REPTILES AND AMPHIBIANS

Although the species lists for reptiles and amphibians occurring at Fossil Butte are short, they probably approach the 90% benchmark. Mountain West Environmental Services compiled the most complete list of herptiles (5 species) observed at Fossil Butte (Dorn, et al, 1984). Ted Rado also recorded the reptiles and amphibians he observed (Rado, 1976).

References:

- Dorn, R., R. Lichvar, and J. Dorn. 1984. Grazing impact study on Fossil Butte National Monument, Wyoming. Cheyenne, WY: Mountain West Environmental Services.
- Rado, T. 1976. A mammal survey of Fossil Butte National Monument. Kemmerer, WY: Fossil Butte National Monument; In-house report.

FISH

At least one species of fish ventures onto the monument occasionally. Following the spring runoff event, small fish, probably a variety of dace or chub, have been observed by the park staff in Chicken Creek. This stream is an ephemeral tributary to Twin Creek which is perennial and supports several varieties of fish. The type, or types of fish entering the park have not been identified, but they always die because the stream dries up over the course of the summer. The number of fish species present, even temporarily, probably does not exceed two or three.

VASCULAR PLANTS

The plant list for FOBU may contain the names of 90% of the species occurring on the Monument, but this is not known for certain, and with continued collecting the list continues to grow. The park has a collection of herbarium specimens which contains voucher specimens of many of the plants whose presence was recorded by various researchers. William Litzinger contributed the first specimens to the monument's herbarium; since then, Clayton Kyte, an NPS seasonal biotechnician with a master's degree in plant ecology, has added several hundred more. Mr. Walter Fertig, a botanist with the Wyoming National Diversity Database, recently examined the monument's herbarium collection. He revised some identifications, and took 113 "difficult" specimens back to the University of Wyoming in order to verify their identities. When Mr. Fertig finishes his work, the FOBU plant list will be revised, and every specimen in the Monument's herbarium will have had its identity verified or determined by a qualified expert. Presently, the plant list includes approximately 450 species and the herbarium collection exceeds 700 specimens.

Kyte (2000) compiled his plant list from these sources: 1) a vegetation study conducted by Dr. A. Beetle, a professor of Range Management at the University of Wyoming, and C. Marlow, Beetle's graduate assistant, in 1974 (81 species of plants belonging to 59 genera and 19 families); 2) a grazing impact study conducted in 1984 by Mountain West Environmental Services, under the direction of Dr. R. Dorn, a plant taxonomist and qualified wildlife biologist (347 plant species belonging to 196 genera and 52 families); 3) plants collected by William Litzinger (qualifications unknown) and curated in the park's herbarium (approximately 200 species, 137 genera, and 46 families); and 4) plants collected from 1994 to the present by Kyte who collected approximately 100 species of plants previously not known to occur in the park.

Beetle and Marlow (1974) prepared the first vegetation map of Fossil Butte. In the early 1980s the National Park Service contracted Mountain West Environmental Services, to conduct a grazing impact study on the Monument (Dorn et al, 1984). During this study, Dr. Dorn and his team of investigators, generated another vegetation map of the monument. It differed from the one produced by Beetle and Marlow, and was more detailed. The Mountain West Environmental Services researchers described 13 vegetation types, including an aquatic type (plants living in water), and a disturbed type. They also compared and contrasted their types to the types described and mapped by Beetle and Marlow in 1974. In 1993, Bruce Jones, with the Wyoming Natural Diversity Database, field-checked Dorn's vegetation map, and certified it with minor modifications. A digital version of this map was produced by the National Park Service GIS services in 1998.

References:

- Beetle, A., and C. Marlow. 1974. University of Wyoming cooperative research report to the Yellowstone Environmental Studies Center. Part II, Vegetation of Fossil Butte National Monument. Laramie, WY: University of Wyoming.
- Dorn, R., R. Lichvar, and J. Dorn. 1984. Grazing impact study on Fossil Butte National Monument, Wyoming. Cheyenne, WY: Mountain West Environmental Services.
- Jones, B. 1993. Vegetation mapping, Fossil Butte National Monument. Wyoming Natural Diversity Database. Project No. MORU-R92-0065. Laramie, WY: The Nature Conservancy.
- Kyte, C. R. 2000. Fossil Butte Vegetation Database. Kemmerer, WY: Fossil Butte National Monument; In-house Microsoft Works Database.
- Litzinger, W. J. 1977. Vegetation transect study, Fossil Butte National Monument. Kemmerer, WY: Fossil Butte National Monument: In-house report.
- Litzinger, W. J. Pressed plants housed in the FOBU herbarium collection

GOLDEN SPIKE NATIONAL HISTORIC SITE (GOSP)**BIRDS**

A general bird inventory was conducted in the late 1970s and early 1980s for Golden Spike National Historic Site by Van Vuren and Boyce (1981). No additional inventory work is known to have occurred since that time within Golden Spike Boundaries.

Bird Inventory work on adjacent lands managed by the Bureau of Land Management has been documented in several reports (Evans and Smith 1998; USDI – BLM 1986; USDA – BLM 1998).

References:

- Evans K., and V. A. Smith. 1998. Breeding Bird Survey for Golden Spike Heritage Foundation
- USDI. Bureau of Land Management. 1986. Box Elder Resource Management Plan
- USDI. Bureau of Land Management. 1998. Box Elder Plan Amendment
- Van Vuren, K. and B. Boyce (Compilers). 1981. The Birds of Golden Spike National Historic Site. 4p.

MAMMALS

A systematic inventory of mammals within Golden Spike National Historic Site has not been completed. Some mammal work has been conducted on nearby lands managed by the BLM. This work is referenced in the BLM's Box Elder Resource Management Plan (BLM 1986 and 1998).

References:

- USDI. Bureau of Land Management. 1986. Box Elder Resource Management Plan
- USDI. Bureau of Land Management. 1998. Box Elder Plan Amendment

REPTILES AND AMPHIBIANS

A comprehensive inventory of amphibians and reptiles has not been completed for Golden Spike. Some inventory work on amphibians has occurred on nearby lands managed by the BLM (Hovingh 1998).

References:

- Hovingh P. 1998. Breeding Biological Assessment of Amphibian, Leech, and Mollusk Distribution in Wetlands North of the Great Salt Lake with Emphasis on Rare, Threatened, and Endangered Aquatic Fauna.

FISH

No fish are present within Golden Spike NHS.

VASCULAR PLANTS

A detailed plant inventory of Golden Spike was conducted by students from Utah State University in 1995 (Allen and Curto). The species list generated from this study documents the occurrence of 121 vascular plant taxa and is annotated with habitat, location, and voucher information. Specimens from this project are deposited at the herbarium at Utah State in Logan. Earlier vascular plant species lists were compiled in the mid-1970s (Hansen 1975). A cultural resource report prepared this year provides an overall description of the site vegetation. The status and distribution of the species of special concern, Passey Onion (*Allium passeyi*), within Golden Spike was studied by Boyce in 1980.

References:

- Allen L., and M. Curto. 1995. Golden Spike National Historic Site: Species List.
- Boyce, B. N. 1980. The Passey Onion, Its History, Discovery, and Current Status at Golden Spike National Historic Site.
- Hansen, K. 1975. Plant Inventory, Golden Spike National Historic Site: Species List.
- USDI. National Park Service. 2000. Draft Cultural Landscape Inventory, Golden Spike National Historic Site

HOVENWEEP NATIONAL MONUMENT (HOVE)**BIRDS**

The species list of birds occurring at Hovenweep is based largely on field notes from Marilyn Colyer, Biologist with Mesa Verde National Park, during the time that Hovenweep was associated with Mesa Verde NP. Colyer visited Hovenweep several times per year between 1980 and 1997 to conduct informal field surveys, recording bird sightings as part of a general biological survey (Colyer 2000, personal communication with S. Daw; Southeast Utah Group, Resource Management files). Bird sightings before this time were compiled two times in the form of lists for Hovenweep NM (Southeast Utah Group, Resource Management files.) Results of a formal bird survey by the Audobon Society during the mid-1980's at Hovenweep have not been located.

Although Mexican spotted owls occur throughout the Colorado Plateau, and surveys have occurred in surrounding areas (El Malpais National Monument, Colorado National Monument, Navajo National Monument, Natural Bridges National Monument) (Willey 1998) no surveys have been done in Hovenweep. Presumably, habitat for the spotted owl is lacking at Hovenweep NM (Elliot Swarthout, personal communication, August 2000.)

A more formal bird survey in Hovenweep may reveal the presence of uncommon and rare birds, as well as species of concern, such as the sage grouse (*Centrocercus urophasianus*), or the southwest willow flycatcher (*Empidonax traillii extimus*) (Colyer 2000, personal communication with S. Daw.)

References:

- Colyer, M. 2000. Personal communication with Sonya Daw, May 5, 2000.
- Southeast Utah Group, National Park Service. Resource Management files. Southeast Utah Group Headquarters. 2282 SW Resource Blvd., Moab, UT. 84532.
- Swarthout, E. 2000. Personal communication with Sonya Daw, August, 2000.
- Willey, D. W. 1998. Ecology of Mexican Spotted Owls (*Strix occidentalis lucida*) in National Parks on the Colorado Plateau. Ph. D. Thesis, Northern Arizona University. On file at National Park Service, Southeast Utah Group Headquarters. (pages not numbered, several hundred)

MAMMALS

Inventory completeness of mammals at Hovenweep National Monument is estimated to be about 75%. Thirty-eight species are listed as being observed at Hovenweep.

Few mammal studies have been undertaken in the Hovenweep National Monument area. Durrant (1952, 1953) gave a general description of the mammals of Utah. A survey of the the mammals of Mesa Verde National Park by Anderson (1961) and a study of its deer mice (*Peromyscus maniculatus*) and pinyon mice (*P. truei*) by Douglas (1969) were much more specific. Little research has been done, however at Hovenweep National Monument. Richart (1941) provided a list of the mammals of Hovenweep and Yucca

House National Monuments. A master's thesis report by Zortman (1968) contains a listing of mammals present in the Rare Lizard and Snake Natural Area, located about 6 kilometers (4 miles) northeast of the Hovenweep NM ranger station. These studies yielded no information about the population dynamics and interactions of these animals in the different communities of the area. Winter (1974, 1975) studied small mammal distribution at Hovenweep and found that species diversity and density varied greatly between the major plant communities. He did not set up any systematic trap grid, however, so his conclusions are weak. He believed that grazing by domestic sheep in the sage mesa-top community had a profound detrimental effect on rodent diversity and distribution.

Rado (1977) performed the first systematic study of small mammals at the Square Tower Ruin Group at Hovenweep National Monument. He focused on rodents and set up a grid of quadrats that were trapped intensely. This study provides an excellent list of small mammals and their distribution in the different plant communities of the Square Tower area of Hovenweep National Monument. Rado (1975a, 1975b) also put together a list of Mammals at Hovenweep National Monument that he had personally observed. This is the primary source of mammal information we have for Hovenweep National Monument. Schelz (1999) amassed a mammal list of 26 species based on all previous studies and observations from known knowledgeable people.

References:

- Colyer, M. 1996. Field Notes from 1993-1996. On file in Biologist Office at the Southeast Utah Group Headquarters, Moab, Utah.
- Durrant, S. D. 1952. Mammals of Utah. University of Kansas. 549p.
- Holst, M. 1974. Faunal Remains at Hovenweep National Monument. *In* Winter, J.C. (editor). Archaeological Report #1. San Jose State University, CA.
- Rado, T. A. 1977. Rodent Distribution Patterns at the Square Tower Ruin Group, Hovenweep National Monument. Master of Arts Thesis. San Jose State University. 54p.
- Rado, T. A. 1975a. The Mammals of Hovenweep National Monument. National Park Service pamphlet. 2p.
- Rado, T. A. 1975b. A Faunal Analysis of the Hovenweep National Monument Area. San Jose State University. 15 p.
- Richart, R. S. 1941. Fauna and Flora of Hovenweep and Yucca House National Monument. Southwest National Monuments. Supplement for June, 1941.
- Schelz, C. D. 1999. Species List of Mammals of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.
- Winter, J. C. (editor). 1975. Hovenweep 1974. Archaeological Report #1. San Jose State University, CA.
- Winter, J. C. (editor). 1976. Hovenweep 1975. Archaeological Report #2. San Jose State University, CA
- Zortman, R. D. 1968. Natural Areas in Colorado, their administration by the Bureau of Land Management. Appendix F: A List of the Vertebrates Associated with the Rare Lizard and Snake Natural Area. Unpublished M.A. thesis, Colorado State University, 86 p.

REPTILES AND AMPHIBIANS

Inventory completeness for reptiles and amphibians is estimated to be about 70%. Only one researcher (Rado 1975b, 1975c) has done systematic surveys for amphibians and reptiles. Marilyn Colyer completed some surveys but no reports were written and her method included the use of general observations while surveying for plants, birds, mammals etc. Schelz (1999) compiled a list based on all previous works and reliable observations.

The lists by Schelz (1999) show 7 snakes, 4 amphibians, and 8 lizards.

References:

- Colyer, M. 1996. Field Notes from 1993-1996. On file in Biologist Office at the Southeast Utah Group Headquarters, Moab, Utah.

- Rado, T. A. 1975c. The Mammals of Hovenweep National Monument. National Park Service pamphlet. 2p.
- Rado, T. A. 1975b. A Faunal Analysis of the Hovenweep National Monument Area. San Jose State University. 15 p.
- Scholz, C. D. 1999. Species List of Reptiles of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.
- Scholz, C. D. 1999. Species List of Amphibians of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.

FISH

At first it was presumed that fish do not exist in Hovenweep National Monument but some field notes of Marilyn Colyer indicate she saw some minnows at a pool in the monument. So at this point the inventory completeness is 0%.

References:

- Colyer, M. 1996. Field Notes from 1993-1996. On file in Biologist Office at the Southeast Utah Group Headquarters, Moab, Utah.

VASCULAR PLANTS

Inventory completeness for plants at Hovenweep National Monument is estimated at 75%. No formal botanical surveys have been completed for general plants or for rare plants. Formal inventories should begin in 2001. There is an herbarium with 137 specimens based primarily on the collections of Dale Schmid (1973), but this work was done as a corollary interest of the collector. Redfield and M. Schmid also collected with Dale Schmid in 1973. Marilyn Colyer, a biological technician at Mesa Verde National Park, collected at Hovenweep NM from 1990-1995. The Colorado Native Plant Society conducted a survey in 1998, however it was for only two days, May 9-10, and as far as we know no collections were made. However a plant list was produced (1998). Currently, there is a plant checklist compiled by Vernon Mayes (1997), a volunteer at Hovenweep. He also produced an incomplete vegetation map of a couple of the units. This was compiled using information from previous lists and report. It lists fifty-eight families, one hundred eighty-two genera and three hundred and twenty species.

Marilyn Colyer read about 20 "Threatened and Endangered Plant Species Inventory" relevés from 1993 to 1996. We have the data sheets but no report. The locations are general with no permanent stakes or markers established, no photographs either.

There are various archeological reports that look at the vegetation of Hovenweep and the general area, and they are a good source of information (Winter 1975, 1976, 1977, 1978; Weir 1976). However, these studies were performed primarily by archaeologists and thus are useful but not thorough enough by most botanical standards. For example, many species listed are identified only to genus.

An unknown author put together a list of Exotic Plants at Hovenweep National Monument, 31 plants are listed.

References:

- Colorado Native Plant Society. 1998. Hovenweep National Monument Plant List. On file in Biologist Office at the Southeast Utah Group Headquarters, Moab, Utah. 3p.
- Colyer, M. 1996. Data sheets for 18 Threatened and Endangered Plant Species Inventory Relevés established from 1993-1996. On file in Biologist Office at the Southeast Utah Group Headquarters, Moab, Utah.
- Litzinger, W. J. 1975. Vegetation Study and Annotated Checklist of Plants of Cajon Mesa, Colorado-Utah. *In* Hovenweep 1974, edited by J.C. Winter. Archaeological Report #1. San Jose State University, CA.
- Litzinger, W. J. 1976a. Plant Zones of the Hovenweep Area. *In* Hovenweep 1975, edited by J.C. Winter. Archaeological Report #2. San Jose State University, CA..

- Litzinger, W. J. 1976b. Annotated Checklist of the Vascular Plants of Cajon Mesa, Colorado-Utah. *In* Hovenweep 1975, edited by J.C. Winter. Archaeological Report #2. San Jose State University, CA.
- Mayes, V. 1997. Check-list: Wild Seed Plants - Hovenweep National Monument.
- Mayes, V. 1997. Vegetation Map of some Units of Hovenweep National Monument. On file at Biologist Office at the Southeast Utah Group Headquarters, Moab, Utah. 8p.
- Richart, R. S. 1941. Fauna and Flora of Hovenweep and Yucca House National Monument. Southwest National Monuments. Supplement for June, 1941.
- Schelz, C. D. 1999. Species List of Plants of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.
- Schmidd, D. 1973. Vascular Plants Collected at Hovenweep National Monument. Specimens only in the Hovenweep Herbarium.
- Weir, G. H. 1976. Palynology, Flora and Vegetation of Hovenweep National Monument: Implications for Aboriginal Plant Use on Cajon Mesa, Colorado and Utah. Ph.D. Dissertation, Graduate College, Texas A&M University
- Winter, J. C. (editor). 1975. Hovenweep 1974. Archaeological Report #1. San Jose State University, CA.
- Winter, J. C. (editor). 1976. Hovenweep 1975. Archaeological Report #1. San Jose State University, CA.
- Winter, J. C. (editor). 1977. Hovenweep 1976. Archaeological Report #1. San Jose State University, CA.
- Winter, J. C. (editor). 1978. Ansazi Agriculture at Hovenweep, I: Field Systems. Contributions to Archaeological Studies, Albuquerque Center for Anthropological Studies 1:83-97.
- Winter, J. C., and W. J Litzinger. 1976. Floral Indicators of Farm Fields. *In* Hovenweep 1975, edited by J. C. Winter. p.123-168. Archaeological Report #2. San Jose State University, CA

NATURAL BRIDGES NATIONAL MONUMENT (NABR)

BIRDS

One-time Inventories and Miscellaneous Bird Sightings

Because of its long history within the National Park System (established 1908), Natural Bridges has extensive records of bird sightings (Southeast Utah Group, Resource Management files), which include a variety of unusual species for the area, mostly seen at the residence area sewage pond during migration. Mexican spotted owl surveys were conducted in 1994 (Willey) in Armstrong, Deer and White Canyons, and again in 1995 (Willey) in White Canyon and along the Natural Bridges road. No Mexican spotted owls were found in the Park. Bald eagles were surveyed midwinter in 1984 (Connor).

Long-term Studies (multiple years)

Long-term surveys in Natural Bridges began with the Emlen strip transects set up as part of the Southeast Utah Group Long Term Monitoring Program (National Park Service 1992) during 1987 to 1992. In 1993, these Emlen transects were replaced by on-going point-count transects in upper and lower White Canyon riparian habitat (Fagan 1993,1994,1995,1996,1997; Daw 1998, 1999.) An historical peregrine falcon (*Falco peregrinus anatum*) territory has been monitored annually at Natural Bridges NM since 1995 (Southeast Utah Group, Resource Management files.)

References:

- Connor, J. 1984. 1984 Midwinter Bald Eagle Survey. Memorandum to Resource Files. Southeast Utah Group Headquarters. Resource Management Files. Moab, UT.
- Daw, S. 1998. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.

- Daw, S. 1999. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1993. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1994. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1995. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1996. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- Fagan, D. 1997. Avian Population Monitoring in Riparian Habitats within National Parks of the Southeast Utah Group. USDI, National Park Service, Southeast Utah Group, unpub. Final report.
- National Park Service. 1992. 1992 Long-term Monitoring Report. Southeast Utah Group Resource Management files. 11p.
- Scholz, C. D. 1999. Species List of Birds of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.
- Southeast Utah Group, Resource Management files. Southeast Utah Group Headquarters. 2282 SW Resource Blvd., Moab, UT. 84532.
- Willey, D. W. 1995. Inventory For Mexican Spotted Owls within National Parks in Utah. Progress Report, 1995 field season. Unpublished National Park Service report, Southeast Utah Group, Resource Management files, Headquarters. 2242 SW Resource Blvd., Moab, UT 84532.
- Willey, D. W. 1994. Spotted Owl Survey 1994 map. Southeast Utah Group Resource Management files. Southeast Utah Group Headquarters, 2242 SW Resource Blvd., Moab, UT 84532.

MAMMALS

Inventory completeness for mammals at Natural Bridges National Monument is estimated to be approximately 85%. Nix et al. (1977) and Bogan (1992, 1995) have done the most extensive work on mammals at Natural Bridges National Monument. Nix (1977) spent an entire season trapping small mammals at 15 sites in four different habitats at Natural Bridges. Although he developed a checklist based on what he trapped and observed, it does not appear he saved any vouchers.

Bogan (1992, 1995) has also trapped a number of species including many bats. He is convinced that Natural Bridges is a "hotspot" for bat diversity. Bogan (1992) visited the park in 1991 and netted 10 species of bats at Owachomo and Sipapu bridges during two nights. Subsequently, Bogan and Romotnik (1993, 1994) returned and worked in four areas (mesa top, canyon rim, canyon bottom, and slickrock) and netted bats near the three bridges. The mesa top and canyon bottom sites had the greatest diversity although all sites had similar fauna. Additional work was completed in 1994 (Romotnik and Bogan 1995), a year after the outbreak of Hanta virus in the Four Corners area, and special attention was devoted to addressing discrepancies between the results of Nix and current studies (primarily chipmunks and woodrats). Vouchers from these studies are located at the Museum of Southwestern Biology in Albuquerque.

So far Bogan has found 15 of the 18 known bat species in Utah at Natural Bridges NM. In 1999, Bogan and colleagues (Haymond et al., In preparation) returned to the park to net big free-tailed bats but were unsuccessful in netting them, perhaps due to the heavy precipitation during the visit. The bat fauna is well known in terms of species but little is known of where bats on the monument roost. Haymond et al. (In prep.) radio-tracked two female Allen's big-eared bats to crevices in Sipapu Bridge.

Little is known of insectivores (shrews) on the monument, the rodent fauna is reasonably well-known, and additional data on carnivores and ungulates would be useful.

Extensive work with small mammals was also done as part of the long-term monitoring program of the Southeast Utah Group. This was started in 1987 but was discontinued in 1993 due to the fear of Hanta virus. In this program, live-trap webs were set up at least once a year in most of the representative plant communities of the park. Annual or final reports were never completed but the data is still an incredible wealth of information about small mammal distribution and abundance in the different plant communities.

Scholz (1999) put together a mammal list for Natural Bridges NM based on past studies and reliable observations.

References:

- Bogan, M. A. 1992. Biological Surveys in Five National Parks, Annual Report, 1991. 6 p.
- Bogan, M. A. 1995. Baseline Surveys for Mammals at Natural Bridges National Monument, Utah . Annual Report ed. Albuquerque, NM: National Biological Service.
- Bogan, M. A. and C. A. Ramotnik. 1993. Biological surveys on Colorado Plateau National Parks, with updated lists of mammals from the parks and mammal capture summaries for 1992. Annual Report to National Park Service, Rocky Mountain Regional Office, February 1993.
- Mitchell. 1993. Man's Effect on Aquatic and Riparian Organisms in the Canyons of Canyonlands and Arches National Parks and Natural Bridges National Monument: Final Report, Reporting Period: 1990-1992. National Park Service, Southeast Utah Group.
- Natural Bridges National Monument. 1979. Browse Utilization Transects.
- Natural Bridges National Monument . Mammals of Natural Bridges National Monument. 2 p.
- Natural Bridges National Monument. Natural Bridges Animal Species List As Compiled From Wildlife Observation Cards, LTMP Data, and Research and Survey Reports. 7 p.
- Natural Bridges National Monument. Natural Bridges National Monument Mammal List. 8 p.
- Nix, P. J., G. W. Workman, and E. C. Oaks. 1977. A Small Mammal Survey of Natural Bridges National Monument, Utah. National Park Service Project No. YNE-118-0, Grant No. PX120060887. Final Report ed. Logan, UT: Utah State University.
- Ramotnik, C. A. and M. A. Bogan. 1994. Baseline surveys for mammals at Natural Bridges National Monument, Utah. Annual Report to National Park Service, Rocky Mountain Regional Office, 1 March 1994.
- Ramotnik, C. A. and M. A. Bogan. 1995. Baseline surveys for mammals at Natural Bridges National Monument, Utah. Annual Report to National Park Service, Rocky Mountain Regional Office, 7 February 1995.
- Scholz, C. D. 1999. Species List of Birds of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah
- USDI, National Park Service. 1977. Interpreter's Sourcebook. Author unknown? (no author included in original record). National Park Service, Canyonlands Complex.

REPTILES AND AMPHIBIANS

Inventory completeness of amphibians and reptiles of Natural Bridges is estimated to be approximately 85%. Other than research on the western rattlesnake (*Crotalus Viridis*) at Natural Bridges National Monument, not much has been done concerning amphibians and reptiles. Rose (1989) researched the ecology of the midget faded rattlesnake (*Crotalus viridis concolor*) at Natural Bridges NM. Persons (1990) worked with Graham (1992) on a rattlesnake study and put together an excellent list and habitat guide to the amphibians and reptiles of Natural Bridges National Monument. Graham (1992) reported on the movements and other habits of rattlesnakes at Natural Bridges. This study was commissioned because of the unusually high number of rattlesnakes found around the visitor center. Glenn (1992) worked with rattlesnake venom in 1991 and Graham et al. (1991) looked at the thermal ecology of rattlesnakes.

Some long-term monitoring lizard transects were set up in the late 1980's but no significant data was collected.

Schelz (1999) put together lists of reptiles and amphibians at Natural Bridges National Monument based on all previous work and reliable observations.

References:

- Glenn, J. L. 1991. Rattlesnake Venom Data, Natural Bridges National Monument, Utah. 4 p. Venom Research Lab, VA Medical Center, Salt Lake City, UT 84148.
- Graham, T. B. 1992. *Crotalus Viridis* at Natural Bridges National Monument: Implications for Management of Visitors and Rattlesnakes. 7 p.
- Graham, T. B. 1989-1991. Snake Study..
- Graham, T. B. Western Rattlesnake Ecology at Natural Bridges National Monument, Utah. 2 p.
- Graham, T. B., T. Persons, W. Schaedla, and D. Moore. 1991. Temperature Patterns of Rattlesnakes (*Crotalus viridis*) at Natural Bridges National Monument, Utah. 15 p.
- Natural Bridges National Monument. 1985. Lizard Array - Natural Bridges National Monument.
- Natural Bridges National Monument. Natural Bridges Animal Species List As Compiled From Wildlife Observation Cards, LTMP Data, and Research and Survey Reports. 7 p.
- Natural Bridges National Monument. Natural Bridges National Monument Amphibians and Reptiles List. 4 p.
- Natural Bridges National Monument. 1991. Summary of Sightings of the Midget Faded Rattlesnake (*Crotalus Viridis Concolor*) at Natural Bridges National Monument, Utah, 1971-1990. 3 p.
- Persons, T. 1992. A Checklist of the Amphibians and Reptiles of Natural Bridges National Monument. Intermontanus 1(1):1-2.
- Persons, T. 1990. A Checklist of the Amphibians and Reptiles of Natural Bridges National Monument. 2 p. Natural Bridges National Monument.
- Rose, David E. 1989. Ecology of Midget Faded Rattlesnakes. 5 p. Canyonlands National Park, Division of Resource Management, Moab, UT 84532.
- Schelz, C. D. 1999. Species List of Reptiles of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah.
- Schelz, C. D. 1999. Species List of Amphibians of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah
- USDI, National Park Service. 1991. Research on the Western Rattlesnake (*Crotalus viridis*), Natural Bridges National Monument, Utah: 1991 Year-End Report. Moab, UT: National Park Service, Canyonlands National Park, Division of Resource Management.
- USDI, National Park Service. 1977. Interpreter's Sourcebook. Author unknown? (no author included in original record). National Park Service, Canyonlands Complex.

FISH

No fish occur within Natural Bridges NM.

VASCULAR PLANTS

Inventory completeness for plants at Natural Bridges National Monument is estimated to be 90%. Some of the earliest plant collections in the Monument were made by B. F. Harrison of Brigham Young University beginning in 1933. In 1968 Welsh and Moore made numerous collections as part of an interpretive study of the Monument. Welsh and Moore (1968) published "Plants of Natural Bridges National Monument" based on their collections and some collections by B. F. Harrison. Their original list included 225 taxa, which

is far short of a complete list. Several collecting trips were made in the late 1960s and early 1970s by Welsh, Higgins, and Atwood resulting in additional collections and additions to the species list (Atwood 2000, Personal Communication). All subsequent plant lists are based on Welsh and Moore including Schelz (1999), Austin (1990), and Malm (1987). About 435 species are now listed as occurring in Natural Bridges National Monument and an extensive herbarium has been assembled and is at the headquarters of the Southeast Utah Group Headquarters in Moab, Utah.

Other botanical work at Natural Bridges National Monument includes vegetation mapping by Heil (1993) and Floyde-Hanna (1993). Through the work of these two investigators we have a good detailed vegetation map of the monument. Other botanical work revolved around the unique hanging gardens of Natural Bridges NM and the rare plant species demography work of Allphin (1992) and Allphin and Harper (1994). Allphin (1992) set up a long-term demography study of the kachina daisy (*Erigeron kachinensis*) that she monitors periodically to this day. Allphin and Harper (1994) wrote the definitive work on habitat requirements of the kachina daisy.

Rare plant surveys were systematically done for a couple of species by Heil (1993). He includes location maps and abundance information on most of the known rare species at Natural Bridges National Monument.

Tamarisk has been the biggest exotic plant problem in the past but thanks to the dedicated and thorough work of former ranger Jim Dougan, there is hardly any within or near the monument.

References:

- Allphin, L. 1992. Demography and Factors Influencing Seed Set in *Erigeron kachinensis*, a Colorado Plateau Endemic. Photocopy, M.S. Thesis, Brigham Young University, Provo, UT.
- Allphin, L., and K. T. Harper. 1994. Habitat Requirements for *Erigeron kachinensis*, a Rare Endemic of the Colorado Plateau. *Great Basin Naturalist* 54(3):193-203.
- Austin, S. B. 1990. Plants Reported for Natural Bridges National Monument. 27 p.
- Belnap, J. 1988. Kachina Daisy Survey.
- Blackburn, F. M. Plants in Herbarium at Natural Bridges National Monument. 9 p.
- Culmer, H. A. 1937. Personal Diary of H. A. Culmer, 1905. Southwestern Monuments Special Report No. 18.
- Floyde-Hanna, L., and K. Heil. 1993. Vegetation Community Analysis and Preparation of a Working Vegetation Map of Natural Bridges National Monument. NPS contract# CA1463-5-0001. Div. Of Math and Science. San Juan College, Farmington NM. 12p.
- Heil, K. 1993. Vegetation Community Analysis and Preparatio of a Working Vegetation Map of Natural Bridges National Park. Contract Number: CA1463-5-0001. Farmington, NM: San Juan College.
- Heil, K. 1993. Composition, Distribution, Abundance and Habitat Requirements of Endangered, Threatened and Rare Plant Species in the Southeast Utah Group of National Parks. Farmington, NM: San Juan College.
- Malm, M. 1987. Plant Identification Guide: a Guide to the Identification and Interpretation of the Plants of Natural Bridges NM.
- Mitchell. 1993. Man's Effect on Aquatic and Riparian Organisms in the Canyons of Canyonlands and Arches National Parks and Natural Bridges National Monument: Final Report, Reporting Period: 1990-1992. National Park Service, Southeast Utah Group.
- Natural Bridges National Monument. Checklist of Plant Species Collected From Natural Bridges National Monument. 7 p.
- Natural Bridges National Monument. Natural Bridges Plant Species As Compiled From Species Lists, Reports, LTMP Data, and Observations. 12 p.
- Schelz, C. D. 1999. Species List of Plants of the Southeast Utah Group of the National Park Service. Biologist files. Southeast Utah Group Headquarters, Moab, Utah

- Thomas, L., K. P. Kitchell, and T. B. Graham. 1987. Summary of Tamarisk Control Efforts in Canyonlands and Arches National Parks and Natural Bridges National Monument. Pp. 61-67 *in* Tamarisk Conference: Tamarisk Control in Southwestern United States (University of Arizona, Tucson, Technical Coordinators Michael R. Kunzmann, R. R. Johnson, and Peter S. Bennett. Tucson, AZ: National Park Service, Cooperative National Park Resources Studies Unit, School of Renewable Natural Resources, University of Arizona.
- USDI, National Park Service. 1976. Tamarisk Eradication Project, Natural Bridges National Monument, Utah, 1972-1976. 23p.
- USDI, National Park Service. 1977. Interpreter's Sourcebook. Author unknown? (no author included in original record). National Park Service, Canyonlands Complex.
- USDI. 1974. Regional Resources Basic Inventory: Biological Resources, Arches National Park, Canyonlands National Park, Capitol Reef National Park, Natural Bridges National Monument . Washington, D. C.: United States Department of Interior, National Park Service.
- Univ. of Wyoming. 1993. Biogeography of Hanging Gardens on the Colorado Plateau: Executive Summary. Laramie, WY: University of Wyoming, Department of Zoology and Physiology.
- Van Pelt, N., and Schelz C.D. 1991. Survey and Analysis of Relict Plant Communities Within National Park Service Units of the Colorado Plateau, Volume I: Community Site Descriptions and Unit Analyses, Canyonlands National Park, Utah, Natural Bridges National Monument, Utah, Colorado National Monument, Colorado. Cooperative Agreement [between National Park Service and The Nature Conservancy] No. CA 1440-8-8001: Final Report. Lakewood, CO: National Park Service, Rocky Mountain Regional Office.
- Vanderbilt, K. Rare Plant Species of the Southeast Utah Group of National Parks. 32 p.
- Welsh, S. L., and G. Moore. 1968. Plants of Natural Bridges National Monument. Proceedings of Utah Academy of Sciences, Arts & Letters 45(1):220-248.
- Weber. 1994. Decline of Utah Juniper in Natural Bridges National Monument and Canyonlands National Park. Co-operative Agreement: CA 1268-1-9007.
- Woodbury, A. M., S. L. Welsh, G. Moore, M. C. Powers, and S. G. Canter. 1963. Planning Study for Natural Bridges National Monument.

PIPE SPRING NATIONAL MONUMENT

BIRDS

We are currently in the midst of a three year bird survey by Matt Johnson, biologist for the Colorado Plateau Field Station. At the end of 2001 we will have a 100% complete species list. Christmas Bird Counts have been done on the monument since 1991. The work journals of the first monument superintendent (C. Leonard Heaton) spans 35 years and contains numerous references to bird species. This information will be incorporated into the final report for the bird survey.

References:

- Johnson, M. J. 1999. Avian Community Structure and Population at Pipe Spring National Monumnet, AZ. Annual Report 1998-99.

MAMMALS

As mentioned above, the work journals of the first monument superintendent contain numerous references to animals on the monument. No specific studies on the mammals of Pipe Spring have taken place, with the exception of a single night bat survey done by Michael Bogan, biologist for the USGS Biological Resource Division in 1996. Buildings were searched for roosting bats (some were found), and bats were netted at the pools near the 'castle'. A total of 27 bats of 6 species were identified that night. One additional bat species was positively identified in 1997.

References:

Bogan, M. A. 1998. Bat observations at Pipe Spring National Monument, 1996. Report to Pipe Spring National Monument, 15 September 1998.

REPTILES AND AMPHIBIANS

No herp work has been done on the monument. However, because of the presence of water reptiles and amphibians are plentiful.

FISH

There are no native species on monument.

VASCULAR PLANTS

The first botanist to collect in or near Pipe Spring was A.O. Siler who collected the type of *Utahia sileri* (Welsh 1982). Siler made several collecting trips to the Kanab area and adjacent Mohave County, Arizona in the 1870s. It is very likely that he visited Pipe Spring for water and may have taken collections from the area. However, based on scant label data on his collections it is not possible to know for sure.

More recently a floristic investigation of the Monument was completed by King (1977) Most recently and most complete is a 1998 a species list and Presettlement Vegetation Literature Survey which was done by Jason Alexander, botanist for Zion National Park. The species list is approximately 70% complete, spring and fall plant species still need to be verified.

References:

Alexander, J. 1998. Pipe Spring National Monument Vegetation Literature Survey. Unpublished Report.

Alexander, J. 1998. Pipe Spring National Monument, Master Vegetation Species List. (approx. 80% complete).

King, R. J. 1977. The Flora of Pipe Spring National Monument. Unpublished Report.

Welsh, S. 1982. Utah Plant Types – Historical Perspective 1840 to 1981-Annotated List, and Bibliography. Great Basin Naturalist 42(2): 129-195.

Other:

Oberlin, G. E. 1998. Aquatic Invertebrate Identification Project, Pipe Spring National Monument. Final Report.

TIMPANOGOS CAVE NATIONAL MONUMENT (TICA)**Inventory Completeness**

A general survey is needed at Timpanogos Cave National Monument for each taxonomic group within the park to establish a database, as well as determine species presence-absence information. Currently there is a 50% or less inventory completeness on all taxonomic groups within the monument. Accuracy of current datasets is suspect due to haphazard collection methods and/or lack of data concerning inventory methods or locations.

BIRDS

Very little information has been scientifically collected on the birds that use Timpanogos Cave N.M. through the seasons. The bird list present in the monument's I&M binder is an SPMA amateur birder publication that was published in 1976 using information collected from an unknown study performed in 1974. A major flaw in this study is that it includes information from the mouth of the canyon to Timpooneke and Granite Flats Campgrounds, both of which are far up canyon in distance and elevation.

The only other information located that concerns the birds of Timpanogos Cave NM is from the book The Visitor's Guide to the Birds of the Rocky Mountain National Parks, in which the author writes about his experiences of birding while visiting Timpanogos Cave NM.

References:

Southwest Parks and Monuments Association. 1976. Timpanogos Cave National Monument Bird Checklist.
Wauer, R. H. 1993. The Visitor's Guide to the Birds of the Rocky Mountain National Parks: U.S. and Canada. John Muir Publications. Santa Fe. NM.

MAMMALS

The only collected information on the monument's mammals is from an un-authored list compiled in 1974. As with the other lists, this list contains information obtained from the entire length of the canyon instead of the 101 hectares (250 acres) that make up the monument.

References:

Timpanogos Cave National Monument Mammal List. 1974. Unpublished Data.

AMPHIBIANS AND REPTILES

The only information concerning amphibians and reptiles from the monument is contained in the monument's museum collection in the form of six specimens preserved in alcohol.

References:

Bahr, Q. F. 2000. Personal observation.

FISH

There is no information on fish that live within the monument's boundaries.

INSECTS

In 1970 a Monument Insect Checklist was created. There is no author named and no information concerning the inventory methods of the extent of the inventory.

Dr. Theodore Hubbell identified a dark cave cricket, *Ceuthophilus utahensis*, in 1972. Dr. Richard Baumann, from Brigham Young University, collected around 200 of this and another unknown species of light-colored cave cricket in 1984.

In 1973, Park Naturalist Neal Bullington used various insect traps to capture various insects from inside the caves. He sent these specimens to Bill Elliott, a graduate student and cave biologist from Texas, for identification.

References:

Elliott, B. February 19, 1973. [personal letter]. Letter to Neal R. Bullington. Timpanogos Cave National Monument Archives.
Horrocks, R. D. 1996. Timpanogos Cave National Monument: Biological Species Inventory. Unpublished Project Proposal.
Timpanogos Cave National Monument Vascular Plant List. 1970. Unpublished Data.

VASCULAR PLANTS

Timpanogos Cave NM has information on plants that exist inside the caves and on the surface. Unfortunately, this information is not reliable or recent information.

In 1964 Stephan A. Douglas identified some algae that grew near the lights inside the caves. His conclusions stated that there was an unknown single celled blue-green algae as well as *Chrisophyta*, a yellow-brown algae (Douglas 1964).

Kelly Allred conducted a floristic study of Mt. Timpanogos as part of a graduate study through Brigham Young University in the early 1970s. As part of this effort he compiled a comprehensive vascular plant list for Mt. Timpanogos. This list has been variously labeled as the list for Timpanogos NM (Allred 1974), however, the list is for the entire mountain area, not just the Monument (Allred 2000).

Larry St.Clair and Samuel Rushforth completed another study of the algae and mosses from inside the caves in 1976. In an article published in the American Journal of Botany, St.Clair and Rushforth identify 26 different diatom species, claiming that their study "yielded the greatest diversity of cave diatoms thus far recorded from America" (StClair 1976).

References:

- Allred, K. 1974. Timpanogos Cave National Monument Vascular Plant List. Unpublished Data. (List is for entire Mt. Timpanogos area, not just the Monument)
- Allred, K. W. 1975. Timpanogos Flora. Master's Thesis. Brigham Young University, Provo, UT. 178p.
- Allred, K. 2000. Personal communication with A. Evenden. July 2000.
- Douglas, S. A. November 8, 1964. [personal letter]. Letter to David H. Huntzinger. Timpanogos Cave National Monument Archives.
- St.Clair, L. L., and S. R. Rushforth. 1976. The Diatoms of Timpanogos Cave National Monument, Utah. American Journal of Botany, Vol 63, no. 1, p. 49-59.

ZION NATIONAL PARK

BIRDS

Zion has had a considerable amount of bird inventory and monitoring work done during its history. Eighteen peregrine falcon territories and nests have been located throughout the park. Probably many more exist, but due to the inaccessibility of the terrain, some may never be found. Nesting activity and reproductive success has been monitored for the past 25 years (Sinton 1995, 1996; Hunnicutt and Pruett 1999).

Mexican spotted owls have been surveyed and monitored at some level since 1997. It is likely that 90% of the owl territories have been located (Hetzler 1995, 1996, 1997; Hunnicutt and Pruett 1999; Orth 1999a).

Southwestern willow flycatchers have been surveyed in 1994, 1997-2000. Only approximately 50 percent of the possible habitat is typically covered (Zion Division of Resource Management 1994, 1997, 1998, 1999, 2000).

Northern goshawk surveys have taken place in selected areas in 1993, 1999 (Orth 1999), and 2000 (Friggens, 2000). In 2000 GIS model was developed to predict occurrence of goshawks in Zion National Park. Unfortunately, even previously known territories did not support birds that year.

Songbirds are among the best known groups in the park. Throughout the years many bird watchers have worked in the park and many field notes are in the park's possession. In particular, Jerome Gifford (1971-88) left behind copious field notes from his observations in and around Zion and the adjacent town of Springdale. Wauer (1997) documented sightings of birds and their distribution in Zion. From 1997-2000 Zion Resource Management personnel surveyed breeding birds in pinyon-juniper, riparian, and ponderosa pine habitat types. (Hunnicutt and Pruett 1999). Utah Division of Wildlife Resources (Parrish 1995) surveys birds annually in Parunuweap Canyon as part of their statewide bird monitoring effort. A bird survey was also done during 1974 by Scott and Gifford in a portion of Coalpits Wash. In addition, Wauer banded birds during the 1960's in the Oak Creek area, and Hunnicutt banded during migration periods during 1998-2000 (Hunnicutt

and Pruett 1999, Hunnicutt 2000). In addition Audubon Christmas Count data has been collected in the park since 1962. All these observations have contributed to the "Zion National Park and Vicinity Bird Checklist" (Zion National Park 1999). It is believed that the bird inventory is at or exceeds 90% completeness

References:

- Friggens, J. 2000. Northern Goshawk Survey Report 2000.
- Hetzler, B. C. 1997. Mexican spotted owl surveys, Zion National Park, 1996. Zion National Park Resource Management Report.
- Hetzler, B. C. 1996. Mexican spotted owl surveys, Zion National Park, 1997. Zion National Park Resource Management Report.
- Hetzler, B. C. 1995. Mexican spotted owl nesting survey, Zion National Park, 1995. Zion National Park Resource Management Report.
- Hunnicutt, M., and S. Pruett. 1999. Wildlife monitoring report 1997-98, Zion National Park, Utah. Zion National Park Resource Management Report.
- Hunnicutt, M. 1998. Peregrine falcon monitoring, Zion National Park. 1997. Zion National Park Resource Management Report.
- Orth, G. R. 1999a. Mexican spotted owl report, 1999. Zion National Park Resource Management Report.
- Orth, G. R. 1999b. Peregrine falcon monitoring report, Zion National Park, 1999. Zion National Park Resource Management Report.
- Parrish, J. R. 1995. Population monitoring of Utah neotropical migratory birds in riparian habitat: 1994 report. Contract No. 94-2921. Submitted to Utah Division of Wildlife Resources, March 1995.
- Scott, P., and J. Gifford. 1974. Breeding bird census of Coalpits Wash. Unpubl. report.
- Gifford, J. L. 1971. Bird Notes, books 1-4. Unpublished notes, Zion National Park.
- Sinton, D. T. 1995. Peregrine falcon monitoring, 1995: Annual Report, Zion National Park. Zion National Park Resource Management Report.
- Sinton, D. T. 1996. Peregrine falcon monitoring, 1996: Annual Report, Zion National Park. Zion National Park Resource Management Report.
- Wauer, R. H. 1997. Birds of Zion National Park and Vicinity. Utah State University Press. Logan, Utah.
- Willey, D. W. 1995. Home range and roost habitat of Mexican spotted owls in southern Utah. Report submitted to Utah Division of Wildlife Resources.
- Willey, D. W. 1998. Ecology of Mexican spotted owls (*Strix occidentalis lucida*) in National Parks on the Colorado Plateau. Report submitted to National Park Service Intermountain Region.
- Zion Division of Resource Management and Research. 1998-2000. Unpublished bird banding data.
- Zion Division of Resource Management and Research. 1994, 1997-2000. SW Willow Flycatcher Surveys. Unpublished Data.
- Zion National Park. 1999. Checklist of birds of Zion National Park. Park brochure.

MAMMALS

Reports of mammals from Zion date from the time of Cliff Presnall who reported (1938) on mammals at Zion, Bryce and Cedar Breaks as well as on other mammal records for the area (Presnall and Hall 1936). Long (1940) reported on some mammals from the region and Hardy (1941) provided new records of bats.

Mammal inventories within Zion National Park have included bighorn sheep observations and radio telemetry (Zion Division of Resource Management 1991, 1993, 1995), and various studies of mule deer, both within Zion Canyon and on the surrounding plateaus (Zion Division of Resource Management files). Mule deer population numbers have been assessed at various times through the park's history, but not on a regular basis.

Stocks (1970) study of the mammals of Washington County is an important contribution to our understanding of taxonomy and distribution of mammals of the area.

Lengas (1993) trapped bats in various locations within Zion National Park, as did Bogan (1995; Ramotnik and Bogan 1996). Haraden (1998-2000) has continued trapping bats in Zion. The park now has and has documented 17 species. Our bat inventory is likely above the 90% complete level.

Small mammals have been inventoried and monitored by Bogan (1995; Ramotnik and Bogan 1996) and Hunnicutt and Pruett (1999). While most rodents are accounted for, it is thought that moles and shrews may not be adequately surveyed in the park. Also, some clarification needs to be done on which lagomorphs are present.

Zion Division of Interpretation revised the "Zion National Park Checklist of Mammals" in 1996 after consultation with the Division of Resource Management and Research and M. Bogan. Zion potentially has a mammal fauna in excess of 70 species. Ramotnik and Bogan (1996) confirmed the occurrence of about 40 species during their project. Based on this and other documentation it is estimated that mammal inventory may be around 80% complete. In addition to lagomorphs, and moles and shrews, predator populations need additional work. Abundance and distribution information is needed for all mammal groups.

References:

- Bogan, M. 1995. Investigator's Annual Report. Zion National Park.
- Haraden, T. 1997-00. Miscellaneous bat data collected in Zion N.P
- Hardy, R. 1941. Some notes on Utah bats. *Journal Mammalogy*, Vol. 22:289-295.
- Hunnicutt, M., and S. Pruett. 1999. Wildlife monitoring report 1997-98, Zion National Park, Utah. Zion National Park Resource Management Report.
- Lengas. 1993. Zion National Park and Cedar Breaks Monument Bat Survey. Unpublished report for Zion National Park, Utah. 3p.
- Long, W. S. 1940. Notes on the life histories of some Utah mammals. *Journal Mammalogy*, 21:170-180.
- Presnall, C.C. 1938. Mammals of Ziong-Bryce and Cedar Breaks. *Zion-Bryce Museum Bulletin*, 2:1-19.
- Presnall, C. C., and E. R. Hall. 1936. Ranges and relationships of certain mammals in southwestern Utah. *Utah Academy of Sciences, Arts and Letters*, 13:211-213.
- Ramotnik, C .A., and M .A. Bogan. 1996. Baseline surveys for mammals at Zion National Park, Utah. Annual Report to National Park Service, Rocky Mountain Regional Office, 22 February 1996.
- Stock, A. D. 1970. Notes on mammals of southwestern Utah. *Journal Mammalogy*, 51:429-433.
- Zion National Park. 1997. Checklist of Mammals of Zion National Park. Park brochure.
- Zion Division of Resource Management and Research. 1993. Deer Population in Main Zion Canyon 1992-1993. Binder of unpublished data.
- Zion Division of Resource Management and Research. 1994. Mule Deer Notebook: Pinkeye Disease Pathology and Demographics 1993-1994. Binder of unpublished data.
- Zion Division of Resource Management and Research. No Date. Deer Data. Binder of unpublished data.
- Zion Division of Resource Management and Research. 1991. Bighorn Sheep Records 1991. Binder of unpublished data.

Zion Division of Resource Management and Research. 1993. Bighorn Sheep 1992 and 1993. Binder of unpublished data

Zion Division of Resource Management and Research. 1995. Bighorn Sheep Observation Records Oct. 1991-1995. Binder of unpublished data files.

AMPHIBIANS

Very little survey work on amphibians has been done in Zion National Park, despite numerous checklists of amphibians and reptiles created through time (Walker 1939, Wauer 1963, Tinkle 1971, Zion National Park 1983, Zion National Park 1994). The only substantial survey of the park's amphibians was accomplished by a volunteer herpetologist, and it is nowhere near a complete survey (Bartholomew 1994). Fortunately, there appear to be few species of amphibians within the park, and we may be nearing the 90% level of completeness for presence/absence surveys. However, as with other wildlife groups, abundance and distribution information is totally lacking.

References:

Bartholomew, B. 1994. The herpetofauna of Zion National Park. Unpublished report. Zion Resource Management files.

Tinkle, D. W. 1971. Reptiles and Amphibians, Zion National Park. 29p.

Walker, M. V. 1939. A Key to the Amphibians and Reptiles for Zion, Bryce, and Cedar Breaks. 6p.

Wauer, R. 1963. Checklist of Amphibians and Reptiles for Zion National Park, Utah. 3p.

Zion National Park 1993 ??

Zion National Park. 1994. Checklist of Reptiles and Amphibians of Zion National Park.

REPTILES

Generalized herpetological surveys are rare within Zion, though several species specific studies have been done through the years. Tinkle (1973), Tinkle et al. (1993), and Sears (in progress) have studied population demographics of the sagebrush lizard (*Sceloporus graciosus*) at various locations within the park.

Desert tortoise were surveyed in one small area in the southern portion of the park as part of a Section 7 (ESA) consultation for a construction project (Topham 1994). This small population is being surveyed in its entirety this year (2000) by Utah Division of Wildlife Resources (UDWR 2000). The population is likely introduced to the area, but appears to be thriving and reproducing on site.

Hunnicut and Pruett (1999) began a series of lizard transects in 3 habitat types—riparian, pinyon-juniper woodland, and ponderosa pine—to assess trend information in lizard populations. Transects were run for 3 years.

Bartholomew (1994) surveyed the park for reptiles by using groups of volunteers. This is probably the best survey the park has had, though not at all complete. The results of the survey has resulted in the most recent version of the park's reptile checklist (Zion National Park 1994). This most current list is not considered complete, and in fact on the last page of the list, makes suggestions as to other species which may occur in the park but have not yet been found. It is thought that the information we currently have is particularly inadequate for snakes. Overall the inventory of reptiles may be approximately 75% complete. As with all species groups within the park, abundance and distribution information is incomplete.

References:

Bartholomew, B. 1994. The Herpetofauna of Zion National Park. Unpublished report. Zion Resource Management files.

Hunnicut, M., and S. Pruett. 1999. Wildlife monitoring report 1997-98, Zion National Park, Utah. Zion National Park Resource Management Report.

- Sears, M. In progress. Population Biology and Physiological Ecology of the Sagebrush Lizard (*Sceloporus graciosus*).
- Tinkle, D. W. 1973. A population analysis of the sagebrush lizard (*Sceloporus graciosus*) in Southern Utah. *Copeia* 1973(2).
- Tinkle, D. W., A. E. Dunham, and J. D. Congdon. 1993. Life History and Demographic Variation in the Lizard *Sceloporus graciosus*: A Long Term Study.
- Topham, M. 1994. Biological survey report: desert tortoise (*Gopherus agassizii*). Report prepared for Zion National Park.
- Utah Division of Wildlife Resources. 2000. Survey of Desert Tortoise in Zion National Park. In progress.
- Zion National Park. 1994. Checklist of Reptiles and Amphibians of Zion National Park.

FISH

The primary drainages of Zion National Park are the North Fork and East Fork of the Virgin River, Shunes Creek, North Creek (Left Fork and Right Fork), and upper LaVerkin Creek. Fishes in the Virgin River and its tributaries include rainbow trout, brook trout, speckled dace, mountain sucker, and mottled sculpin in higher elevations, and Virgin spinedace, bluehead sucker, and desert sucker at middle elevations. The endangered spinedace and Virgin River roundtail chub are found downstream of Zion National Park.

Much fish work in the park has centered on the Virgin spinedace. This small fish is being kept off the federal endangered species list by a conservation agreement. However, in the process of studying this rare fish, much knowledge has been acquired about the species composition of the Virgin River and its tributaries within Zion National Park.

Fisheries investigations in and around the park began in the 1960s and 1970s with studies of the distribution of fishes of the Virgin River and their ecological requirements (Miller and Hubbs 1960; Davis 1962; Rinne 1971; Cross 1975). This was followed by investigations associated with extensive water development in the drainage and a concern for threatened and endangered fish species (Radant and Coffeen 1986; Deacon et al. 1987; Deacon and Rebane 1989; Hardy et al. 1989). Comprehensive surveys of the Virgin River Drainage, including Zion National Park were conducted during 1986 to 1990 (Valdez et al. 1990) and during 1991 to 1992 (Hardy and Addley 1993). This excellent report by Addley and Hardy detailed a complete survey for spinedace the Virgin River Basin. Their techniques also assess locations and populations of all species at these sites. Later, Sappington (1998), in his study of recreation impacts on native fish, assessed population numbers and species composition at each of his sampling sites.

References:

- Addley, R. C., and T. B. Hardy. 1993. The current distribution and status of spinedace in the Virgin River Basin. Report Prepared for Washington County Conservation District.
- Cross, J.N. 1975. Ecological distribution of the fishes of the Virgin River (Utah, Arizona, Nevada). M.S. thesis, Univ. Nevada, Las Vegas. 187p.
- Davis, J.D. 1962. Fishes of the Virgin River and side pools. National Park Service mimeograph. Zion National Park, Utah. 3 p.
- Deacon, J.E., P.B. Schumann, and E.L. Stuenkel. 1987. Thermal tolerances and preferences of fishes of the Virgin River System (Utah, Arizona, Nevada). *Great Basin Nat.* 47(4): 538-546.
- Deacon, J.E. and A. Rebane. 1989. Annual Report to National Park Service: A habitat preference analysis of the Virgin Spinedace in Zion National Park, Utah. Univ. of Nevada, Las Vegas. 54p.
- Hardy, T.B. and C. Addley. 1993. Distribution of Virgin spinedace in the Virgin River Drainage. Department of Engineering, Utah State University, Logan.
- Hardy, T.B., B. Bartz, and W. Carter. 1989. Population dynamics of the fishes in the Virgin River from 1984 through 1987 and impact analysis of the Quail Creek and North Creek Reservoir systems. Dept. Civil and Env. Eng., Utah State Univ., Logan. 183p.

- Holden, P.B. 1977. Investigation of the status and critical habitat of the Virgin River chub. PR-11-1. BIO/WEST, Inc. Logan Ut. 27p.
- Miller, R.R. and C.L. Hubbs. 1960. The spiny-rayed cyprinid fishes (Plagopterini) of the Colorado River system. Misc. Publ. Mus. Zool. University of Michigan. 39p.
- Radant, R.D. and M. Coffeen. 1986. Virgin River chub population monitoring 1985. Utah Div. Wildlife Resources, Salt Lake City, Utah. 45p.
- Rinne, W.E. 1971 The life history of *Lepidomeda mollispinis mollispinis* (The Virgin River Spinedace), a unique Western Cyprinid. M.S. thesis, Univ. Nevada, Las Vegas. 109p.
- Sappington, J. M. 1998. Recreational Disturbance of a desert stream fish community: detecting ecological effects of environmental impact. MS thesis. Dept. of Biological Sciences, University of Nevada, Las Vegas. 46p
- Valdez, R.A., W.J. Masslich, R. Radant, and D. Knight. 1990. Status of the Virgin spinedace (*Lepidomeda mollispinis mollispinis*) in the Virgin River Drainage, Utah. Project Report prepared for the Utah Division of Wildlife Resources, Salt Lake City, Utah. Contract No. 90-0633, Amendment No. 1. BIO/WEST Report No. PR-197-1. 43 p.

VASCULAR PLANTS

Botanical investigations in the vicinity of Zion NP began in the late 1800s. The first collectors who may have made collections from Zion National Park were Edward Palmer (1870 and 1877). Of his collections 58 were used as types for species from the region. Charles Christopher Parry (1874 and 1877) made numerous collections of which 38 of the collections were used as type material. Most of their label data listed collections from "southern Utah". Some of these were actually from what is now Mohave County, Arizona. Parry was in the St. George area from April to June during his 1874 trip (Welsh).

More focused floristic studies at Zion NP were initiated in the 1930s. Checklists and floras were developed by Woodbury (1933), Persnall (1937), and Jepson and Allen (1958). More recent floras include *Plants of Zion National Park* by Ruth Nelson (1976) and the updated *Wildflowers of Zion National Park* by Dr. Stanley Welsh (1990). A relatively thorough examination of the park's flora has been accomplished with more work needed in wetlands and remote/inaccessible areas. The current Zion NP species list (over 890 species) is based upon the work of authors listed in Table 1, the Zion NP herbarium, Welsh (1981), Welsh (1995), and Meretsky (2000). Although Welsh (1995) examined portions of the Zion NP herbarium, a comprehensive verification of herbarium specimens is needed.

A limited amount of baseline inventory work has been done with browse transects established between 1944-1951 (Zion NP files), an ecological study of Zion National Park (Bradley 1973), and biomonitoring plots (in ponderosa pine vegetation type) established by park personnel in 1996 (Zion NP 1996). No subsequent monitoring of any of these plots has occurred except for fire effects monitoring plots which began in 1995 (Zion National Park 2000a).

Nineteen study plots were established by Harper et al. (1988) to analyze riparian and aquatic vegetation. A current study by Dr. Vicky Meretsky is examining vegetation dynamics at seeps and springs that are not hanging gardens. Resulting from this work, five new vascular plant species have been added to Zion's plant list this year (Meretsky 2000).

Although hanging gardens and ledge and rock crevice communities in Zion have been studied by a number of researchers (Table 1), the extent of these unique communities throughout the park is not fully known. Increasing visitation may have adverse effects making a monitoring program specific to these sensitive habitats a priority.

A partial survey of the park for threatened, endangered, and rare species was conducted in 1988 and 1989 by Dr. Stanley Welsh. At that time, Welsh identified 10 rare (endemic) plants known specifically to Zion and its vicinity. Additionally, 20 species were identified as occurring at the margins of their range. In 1995 Welsh surveyed for rare plants in Zion Canyon where shuttle system construction was proposed. Much of the west

side of the park remains to be adequately surveyed. Other areas to be surveyed such as hanging canyons and isolated mesa tops, will require the use of a helicopter.

Invasive non-native plant control and inventory has occurred at Zion since the late 1980's. However, concentrated efforts did not begin until 1995 (Zion National Park 1995-1998). A comprehensive inventory is needed parkwide to aid in exotic plant management and prioritization.

A parkwide vegetation map was completed by Harper (1993). Harper defined ten vegetation mapping units based upon sample plots placed throughout the park. These plots could provide the basis for long-term ecological monitoring. Although valuable, Harper's map has only 66% accuracy. A more accurate and comprehensive vegetation classification map is currently in progress through the National Park Service inventory and monitoring program (Zion National Park 2000b).

Significant floristic treatments for specific areas, plant groups, or processes are listed in Table 1.

Table 1. Significant floristic treatments at Zion National Park

Cacti	Walker 1939, Trapp 1969
Hanging Gardens	Malanson 1980, Malanson and Kay 1980, Malanson 1981, Welsh and Toft 1981, Johansen et al. 1983, Welsh 1989a, Wong 1999
Rare Plants	Smith and Heil 1989, Tuey 1990, Welsh 1989b, Welsh 1995, Zion National Park 1999
Non-native Plants	Welsh 1989b, Zion National Park 1995-1998
Vegetation Communities	Harper et al. 1992, Harper 1993, Keller 1935, Vegetation Map 2000
Riparian Habitat	Woodbury 1933, McArthur et al. 1989, Harper et al. 1992
Parunuweep Canyon, Horse Ranch Mountain	Harper 1992 Palmer 1966
Relict Plant Communities	Van Pelt et al. 1991
Fire	West and Loope 1977, Madany and West 1980, 1981, 1983, Zion National Park 2000a

References:

- Bradley, W. G. 1973. Ecological study of Zion National Park. University of Nevada. Las Vegas, NV.
- Jepson, C. E., and L. F. Allen. 1958. Wildflowers of Zion and Bryce Canyon National Parks and Cedar Breaks National Monument. Zion-Bryce Natural History Association. 876p.
- Johansen, J. R., S. R. Rushforth, R. Orbendorfer, N. Fungladda and J. A. Grimes. 1983. The algal flora of selected wet walls in Zion National Park, UT. *Nova Hedwigia: Zeitschrift Fur Kryptogamkunde*. 765-808.
- Harper, K. T. 1992. Parunuweap Canyon Vegetation. Unpublished report. Zion Resource Management files.
- Harper, K. T. 1993. Vegetation map of Zion NP. Zion Resource Management files.
- Harper, K. T., S. C. Sanderson, and E. D. McArthur. 1988. Vegetative communities in Zion National Park. *In: University of Wyoming National Park Service Research Center, Eleventh Annual Report, 1987. Laramie, WY: University of Wyoming: 191-196.*
- Harper, K. T., S. C. Sanderson, and E. D. McArthur. 1990. Vegetative communities in Zion National Park. *In: University of Wyoming National Park Service Research Center, Eleventh Annual Report, 1989. Laramie, WY: University of Wyoming: 234-240.*
- Harper, K. T., S. C. Sanderson, and E. D. McArthur. 1992. Riparian Ecology in Zion National Park. Pp. 32-42 *in Proceedings-Symposium on Ecology and Management of Riparian Shrub Communities (Sun Valley,*

- ID, W. P. Clary, E. D. McArthur, D. Bedunah, and C. L. Wambolt. Ogden, UT: Intermountain Research Station.
- Harper, K. T., S. C. Sanderson, and E. D. McArthur. 1994. Zion National Park Vegetation Map/ Vegetation Communities. Unpublished report. Zion Resource Management files.
- Harper, K. T., S. C. Sanderson, E. D. McArthur, and J. S. Tuhy. 1989. Vegetative communities in Zion National Park. *In*: University of Wyoming National Park Service Research Center, Eleventh Annual Report, 1988. Laramie, WY: University of Wyoming: 207-214.
- Jepson and Allen 1958
- Johansen et.al. 1983
- Keller, L. F. 1935. Report of Naturalist Assistant L.F. Keeler on Zion National Park activities. Zion National Park Archives.
- Madany, M. H. and N. E. West. 1980. Fire history of two montane forest areas of Zion National Park. Rocky Mountain forest and Range Experiment Station, US Forest Service.
- Madany, M. H. and N. E. West. 1981. Fire history of the Horse Pasture Plateau, Zion National Park. Final report to the National Park Service. Contract no. CX-1200-9-B048.
- Madany, M. H. and N. E. West. 1983. Livestock grazing- fire regime interactions within montane forests of Zion National Park, UT. *Ecology* 64(4):661-667.
- Malanson, G. P. 1980. Habitat and plant distributions in hanging gardens of the Narrows, Zion National Park, Utah. *The Great Basin Naturalist*. 40:2:178-182.
- Malanson, G. P. 1981. The assembly of hanging gardens: Effects of age, area and location phytosociology, Zion National Park, UT. *The American Naturalist*. 118(6):145-150.
- Malanson, G. P. and J. Kay. 1980. Flood frequency and the assemblage dispersal types in hanging gardens of the Narrows, Zion National Park, UT. *The Great Basin Naturalist*. 40:365-371.
- McArthur, E. D., S. C. Sanderson, and K. T. Harper. 1989. Expansion of the known distribution of the rare Zion tansy, *Sphaeromeria ruthieae* (Asteraceae). *The Southwestern Naturalist* 34(3):441-443.
- Meretsky, V. 2000. Herbarium records of 5 new wetland plant species to add to the Zion species list. Zion National Park Herbarium.
- Nelson, R. A. and T. Blaue. 1976. Plants of Zion National Park: Wildflowers, Trees, Shrubs and Ferns. Zion Natural History Association. Springdale, UT.
- Palmer, B. C. 1966. Flora of Horse Ranch Mountain, Zion National Park. Unpublished report. Zion National Park Library files.
- Presnall, C. C. 1937. Plants of Zion National Park. Zion-Bryce Natural History Association. Springdale, UT.
- Smith, F., and K. Heil. 1989. Status report: Black spleenwort (*Asplenium adiantum-nigrum*L). 121p.
- Trapp, C. 1969. The cacti of Zion National Park. Zion Natural History Association. Springdale, UT. 21p.
- Tuey, J. S. 1990. Rare Plants of Zion National Park. Unpublished report. Zion Resource Management files.
- Van Pelt, N. S., C. D. Schelz, J. S. Tuey and J. R. Spence. 1991. Survey and analysis of relict plant communities within National Park systems units of the Colorado Plateau: Vol. II – community site descriptions and unit analyses: Bryce Canyon National Park, UT; Capitol Reef National Park, UT; Cedar Breaks National Monument, UT; Zion National Park, UT. Final report ed; Cooperative agreement CA 1440-8-8001. 155p.
- Walker, M. V. 1939. A key to the Cactaceae (Cactus) of Zion National Park. Unpublished report. Zion National Park Resource Management files.
- Welsh, S. L. 1989a. Preliminary report (third quarter): hanging gardens of Zion National Park. Endangered Plant Studies, Inc. Orem, UT.

- Welsh, S. L. 1989b. Zion National Park threatened and endangered and exotic plant surveys (CS 1590-7-0001), final report 1988-1989. Endangered Plant Studies, Inc. Orem, UT. 164p.
- Welsh, S. L. 1990. Wildflowers of Zion National Park. Zion Natural History Association. Springdale, UT.
- Welsh, S. L. 1995. Annual report 1994-1995: Rare plant survey of shuttle system and vascular plant scientific and common name list. Unpublished report. Zion Resource Management files. 28p.
- Welsh, S. L. and C. A. Toft. 1981. Biotic communities of hanging gardens in Southeastern Utah. National Geographic Society Research Reports. 13:663-681.
- West, N E. and W. L. Loope. 1977. Annual progress report to Zion National Park and USU-NPS Cooperative Studies Unit regarding studies of frequency and role of fire in ecosystems of Zion National Park. Unpublished report. Zion Resource Management files. 129p.
- Wong, D. 1999. Community analysis of hanging gardens at Zion National Park, Utah and the Colorado Plateau. M.S. Thesis. Northern Arizona University. Flagstaff, AZ.
- Woodbury, A. M. 1933. Biotic relationships of Zion Canyon, Utah with special reference to succession. Ecological Monographs. 3:147-245.
- Zion National Park. 1995 – 1998. Exotic plant annual reports. Unpublished report. Zion Resource Management files.
- Zion National Park. 1996. Biodiversity monitoring program. Unpublished report. Zion Resource Management files.
- Zion National Park. 1999. Rare plant survey of burn units in Pocket Mesa and Lava Point. Unpublished report. Zion Fire Management files.
- Zion National Park. 2000a. Fire effects monitoring data from 1995 to present. Unpublished report. Zion Fire Management files.
- Zion National Park. 2000b. Vegetation classification map in progress. Unpublished report. Zion Resource Management files.

Cottonwood		S															
Oaks		S															
Aspen		S															
LTMP Sites		P						P									
EXOTIC PLANTS																	
Weeds		P		X				P						X			
Exotic Plant Distribution					PX												P
Tamarisk Locations	P		P	P	PX		X										
Russian Olive					PX												
Russian Thistle									S								
Dalmation toadflax									P								
Hoary cress									P								
Musk Thistle		P							P								
Russian Knapweed	P						P		P								
Spotted Knapweed									P								
Yellow Toadflax									P								
Canada Thistle		P							P								
Bull Thistle		P							P								
Black Henbane		P							P								
Other Exotics		P							P								
SPECIAL FEATURES																	
Springs			P	X		X				S				X			X
X = Available Data site (http://www.nps.gov/gis/available_data.html)																	
P = Available at Park																	
S = Data Summary Table (http://165.83.20.26/default.cfm Metadata search)																	
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** veg map for CARE at 1:500,000 scale, not very useful																	

APPENDIX E. Project Statements for Studies Proposed for Inventory Funding (IM)

Inventory Project Coordination and Data Management	ALLTAX-01
Plant and Animal Species of Special Concern: Lists and Occurrence Data	ALLTAX-02
Cave Biota Inventory – TICA	CAVE-01
General Bird Inventory at High Priority Parks	BIRDS-01
Bird Inventory Black Canyon of the Gunnison NP and Curecanti NRA	BIRDS-02
Southwest Willow Flycatcher and Yellow-billed Cuckoo Inventory	BIRDS-03
Baseline inventories for selected Parks	MAMMALS-01
Focused inventories for selected Parks	MAMMALS-02
General Amphibian and Reptile Inventory for NCPN Parks	HERPS-01
National Park and Regional Herbaria Searches (<i>partially funded</i>)	PLANTS-01
General Floristic Survey of Hovenweep National Monument	PLANTS-02
General Vegetation Inventory of Timpanogos Cave National Monument	PLANTS-03
General Floristic Inventory of Black Canyon of the Gunnison NP and Curecanti NRA	PLANTS-04
Plant Inventory in the Green River District, Dinosaur National Monument	PLANTS-05
Fossil Butte National Monument Sensitive Plant Inventory	PLANTS-08

PROJECT TITLE: Inventory Project Coordination and Data Management

TAXONOMIC GROUP: ALLTAX – 01

FUNDING STATUS: IM

BACKGROUND AND APPROACH:

A network level inventory and monitoring program is most efficiently run with some level of coordinated staffing and oversight. The Northern Colorado Plateau Network intends to hire two permanent full-time positions at the network level: program coordinator and data manager. In addition, two full-time term positions to assist with data compilation and analysis of existing inventory data sets are planned. We are also considering hiring a GIS tech to assist with conversion of existing tabular data to spatial formats. It is envisioned that these positions will be jointly funded by the inventory and the monitoring portions of the program. The network has been advised by the National I&M program that we can anticipate up to \$250,000 start-up funding for monitoring in Fiscal Year 2001 (FY01) and full-funding in subsequent years. In this study plan for biological inventory we are requesting partial funding to support coordination and data management work associated with the inventory portion of the overall program..

The Northern Colorado Plateau Network I&M Project Manager will provide oversight and coordination for all aspects of the inventory phase of the program in order to achieve network objectives. This work involves managing the suite of multi-year biological inventories; all contracts, hiring, logistics and other arrangements.

The network is placing a high priority on data management (Section VII of Study Plan). The first work priority for the new data manager will be to help develop a data management plan for the network inventory and monitoring program. Envisioned is a centralized data management effort that will establish network data standards and centralized web-based databases for I&M distribution and abundance data. Database work will also include population of national I&M databases including Dataset Catalog, NPSpecies and NRBib. A significant amount of effort will be placed on developing spatial datasets with species occurrence (distribution) information. This work will include the conversion of tabular location data, as well as GPS data input directly from field work. We will also continue to assemble other spatial data layers that will be useful to monitoring and eventually be incorporated into the GIS databrowser.

Additional voucher work will also be completed as part of overall data management, as well as individual taxonomic group inventory projects. This work will emphasize obtaining voucher information from museums, universities and other institutions housing park specimens. This data will be incorporated into the NPSpecies database and will contribute to the overall completion of park biological inventories.

FUNDING:

The table below outlines the overall budget for project coordination and data management over the next four years. Please note that we are requesting inventory funding to cover a portion of the costs associated with the proposed staffing and data project work. Monitoring funding will cover the remaining costs.

Budget Item	FY 2001	FY 2002	FY 2003	FY 2004
Coordination and Data Mgt. - Salaries and Contracts, Travel, Equipment	86,729	42,500	21,250	19,244
Estimated Overhead (15%)	15,305	7,500	3,750	3,396
TOTAL	102,034	50,000	25,000	22,640

PROJECT TITLE: Development of Standardized Lists of Plant and Animal Species of Special Concern & Documentation of Occurrences

TAXONOMIC GROUP: ALLTAX – 02

FUNDING STATUS: Partial IM funding

BACKGROUND AND APPROACH:

Presently parks within the network have no consistent means of tracking sensitive species of special concern. The Washington Office of NPS has recently released a database with all listed threatened and endangered species, plus species of limited distribution (based on the national ranking system -- Global/State) utilized by state natural heritage programs and The Nature Conservancy (Appendix G). These lists need to be carefully reviewed and modified to reflect more up-to-date information on the status of these species within each park. This review would involve specialist input from state natural heritage programs, park resource staff and others. This effort will result in standardized lists of species of special concern.

For these species of special concern we would assemble information on species occurrences within each of the network parks and devise a strategy for managing this data (tabular and spatial) data across network parks. In order that we may share this data across agency boundaries it will be important to develop data standards which are compatible with state natural heritage program databases. A partnership with heritage programs enhances to opportunity to share data across agency boundaries. There are also potential problems with such partnerships. For example, recently in Utah the Natural Heritage Program posted sensitive data on National Park species of special concern occurrences on the internet. We will have to proceed carefully with such partnerships to ensure that sensitive data are secure. Assuming we can overcome some of these potential difficulties, the opportunity to share data and provide individual parks with a landscape "context" in which to managed these important species seems worthwhile.

OBJECTIVES:

1. Develop standardized lists of species of special concern for network parks.
2. Assemble existing data on distribution and abundance of species of special concern in network databases and GIS.

PARTNERSHIP: The Network I&M Coordinator will oversee this project and will seek additional funding through partnership, perhaps with the IM Regional Office and/or state natural heritage programs and other land management agencies.

FUNDING:

Budget Item	FY 2001	FY 2002	FY 2003	FY 2004
Contract for Expert Review; and Acquisition of Species of Special Concern Data	8,500			
Overhead (estimated at 15%)	1,500			
TOTAL	10,000			

PROJECT TITLE: Cave Biota Inventory - TICA

TAXONOMIC GROUP: CAVE-01

FUNDING STATUS: IM

PROBLEM STATEMENT:

The cave ecosystem at Timpanogos Cave National Monument is the primary resource feature that the Monument is charged with managing (enabling legislation). Despite this, very little is known about the biotic communities that utilize the cave resources. A comprehensive basic inventory of cave biota has not been conducted at the Monument. Existing information on Timpanogos Cave biota is extremely limited and has only been acquired through incidental observations of Monument employees and visiting professionals. Baseline information is needed to ensure that cave biological resources are understood and protected.

The cave ecosystem of Timpanogos Cave is very fragile, with low energy inputs and low diversity. A pre-development baseline inventory of biota within the cave does not exist. Therefore impacts associated with development and maintenance of cave trails and more than 80,000 annual visitors are poorly understood. It is known, however, that visitors are vectors for significant energy inputs to the cave ecosystem, in the form of lint, hair, and skin cells. Pumping of cave lakes along the tour route significantly reduces the volume and rate of natural discharge from those lakes.

In terms of biological populations and food input, the Timpanogos Cave System is unique compared to other caves managed by the National Park Service. Mammoth Cave and Oregon Caves have active streams with high organic input while Wind and Jewel Caves have only seeping water entering the meteoric recharge from conduit flow along faults. This water probably brings organics, bacteria, and fungi with it. Biological sources, especially cricket guano, probably play an important role at Timpanogos Cave as well. Other energy sources include artificial lights that cause algae to grow, wood that supports fungi, natural-fiber lint and skin cells from visitors, and spores.

A baseline inventory of terrestrial and aquatic cave biota will be designed and implemented to determine which species are found in the caves, and which habitats they are utilizing. This inventory will provide a baseline for monitoring changes in species composition over time and for additional research. Future research may address more specifically questions on the impacts of visitor use on biota including cave tours, cleaning and artificial energy inputs. Also of interest is the movement of biota into and/or out of the cave, and food web relationships in the cave.

OBJECTIVES:

1. Conduct a basic inventory of cave flora and fauna including microinvertebrates and vertebrates.
2. Determine which species are using the twilight, middle, and dark zones of the caves, and which species are lured into the dark zone by the artificial lights.
3. Establish inventory plots as initial sampling for long-term monitoring of cave biota.

STUDY DESIGN AND METHODS:

A stratified random sampling design will be employed. Stratification will be based on cave habitats and zones. At individual sampling points a combination of techniques will be utilized to sample cave fauna including Dung bait and pitfall traps, and Tullgren funnel extraction. Flora will also be sampled.

Specimens will be collected only as needed to document species presence within a cave. Where possible photographic vouchers will be utilized in lieu of specimen vouchers. The cave ecosystem is very fragile and easily impacted, and collection will be kept to a minimum.

Note: In the timeframe of this project we were unable to fully scope out this work. Our intent will be to secure further cave specialist input into the actual design of this project.

SCHEDULE: Inventories will be conducted during all seasons over a two-year period. Ideally four one-month sessions would be conducted during fall, winter, spring and summer. Pitfall traps will need to be changed every week during these periods.

PRODUCTS: This project will generate presence/absence and distribution data for cave flora and fauna found within Timpanogos Cave NM. This data will be incorporated into tabular and spatial datasets to be developed by the network data management team.

IMPLEMENTATION:

No source has been identified to complete this work. The network will explore options through the Cooperative Ecosystem Study Unit (CESU) and other contracting options.

FUNDING:

Budget Item	FY 2001	FY 2002	FY 2003	FY 2004
Contract for Cave Biota Study	5,525	5,525		
Overhead (estimated at 15%)	975	975		
TOTAL	6,500	6,500		

PROJECT TITLE: General Bird Inventory at High Priority Parks**TAXONOMIC GROUP:** BIRDS - 01**FUNDING STATUS:** IM**PROBLEM STATEMENT:*****Background Priority 1 Parks (Golden Spike N.M. and Timpanogos Cave N. M.)***

Priority 1 parks have some documented bird species presence/absence, but little information on abundance or distribution; or have not sampled or have undersampled birds in some habitats. General information on bird distribution, nativity, and habitat in Utah is compiled in a Latilong Report (Walters and Sorensen 1983), but this information is too general to interrelate to individual parks. These parks need a baseline inventory of breeding birds in major habitats within the park with the goal of documenting 90% of the species present.

Golden Spike N. H. S. is located 52 kilometers (32 miles) west of Brigham City and 89 kilometers (55 miles) north of Ogden, UT. Plant communities include Great Basin sagebrush (*Artemisia spp.*), with small patches of pinyon (*Pinus spp.*)/juniper (*Juniperus spp.*). The only documented bird checklist was compiled from sightings from 1975 - 1981 (Van Vuren and Boyce 1981). Species of management concern likely include golden eagle (*Aquila chrysaetos*), ferruginous hawk (*Buteo regalis*), and greater sage grouse (*Centrocercus urophasianus*).

Timpanogos Cave N. M. is located 40 kilometers (25 miles) south of Salt Lake City and 19 kilometers (12 miles) east of Lehi, UT. Vegetation communities include riparian and canyon woodlands, pinyon/juniper woodland, mountain mahogany-oak shrublands, and fir forests. A bird checklist "designed for amateur interest" for American Fork Canyon, but not specific to the monument was revised in 1974. This list has neither an author nor details on how data were collected. Both of these sites lack reliable baseline information on population status and distribution of birds, and will require parkwide systematic surveys for 2 years.

Background Priority 2 Parks (Dinosaur N. M., Fossil Butte N. M., Cedar Breaks N. M.)

Priority 2 parks have documented bird species presence/absence, distribution and abundance in 60-80% of the habitats, but have not sampled or have undersampled birds in some habitats. General information on bird distribution, nativity, and habitat in Utah and Colorado are compiled in Latilong Reports (Walters and Sorensen 1983 and Chase et al. 1983), but this information is too general to interpolate to individual parks. These parks need additional surveys of birds with the goal of rounding out knowledge of the avian fauna present and documenting 90% of the species present.

Dinosaur N. M. straddles northeastern Utah and northwestern Colorado, 32 kilometers (20 miles) east of Vernal, Utah. Plant communities include montane coniferous forest, pinyon-juniper woodland, mixed mountain shrub, sagebrush-grassland, cold desert shrubland, barrens, and low elevation riparian woodland. In Dinosaur N. M. no formal park-wide bird inventories have been conducted. The only information that exists is a monument bird list with notes on status and abundance. The monument has inventoried and monitored peregrine falcons (*Falco peregrinus*) extensively since 1976, including locations and characterization of eyries and nesting success. Species of management concern include Mexican spotted owl (*Strix occidentalis lucida*), bald eagle (*Haliaeetus leucocephalus*), northern goshawk (*Accipiter gentilis*), ferruginous hawk, peregrine falcon, and greater sage grouse.

Fossil Butte N. M. is located in southwest Wyoming 21 kilometers (13 miles) west of Kemmerer, WY. Plant communities present in the Monument include: sagebrush; aspen (*Populus spp.*); mixed timber of limber pine (*Pinus flexilis*) and Douglas fir (*Pseudotsuga menziesii*); meadows of Baltic rush (*Juncus balticus*) and sedge species (*Carex spp.*); and small stands of cottonwood (*Populus spp.*) and willow (*Salix spp.*). Limited presence/absence data on birds has been collected within the Monument by Rado (1977) and a grazing study by Dorn et al. (1984). Species of management concern are golden eagle and greater sage grouse.

Cedar Breaks N. M. is located in southwest Utah 29 kilometers (18 miles) east of Cedar City, UT. Plant communities include: pinyon-juniper woodlands; mixed forests of ponderosa pine (*Pinus ponderosa*), blue spruce (*Picea pungens*), and Douglas fir; Englemann spruce (*Picea Englemannii*) - subalpine fir (*Abies lasiocarpa*) forests with bristlecone pine (*Pinus longaeva*); and subalpine meadows. The Monument has a bird checklist with no information on abundance or distribution, and has not had any formal surveys. Species of management concern include peregrine falcons.

OBJECTIVES:

Priority 1 Parks: The overall goals of these inventories are to: 1) provide each park with a baseline inventory of breeding birds in major habitats within the park with the goal of documenting 90% of the species present; 2) identify park-specific species of special concern (which could become part of future "vital signs" monitoring); and 3), based on the inventory, to recommend an effective monitoring program so that Resource Management staff at each park can assess the condition of bird populations over time, and detect significant changes in those populations.

Priority 2 Parks: The overall goals of this inventory are to: 1) provide the park with additional surveys of birds stratified by major habitats within the Park, with the goal of rounding out knowledge of the avian fauna present (and documenting 90% of the species present); 2) identify park-specific species of special concern (which could become part of future "vital signs" monitoring); and 3) based on the inventory, to recommend an effective monitoring program so that Resource Management staff can assess the condition of the bird populations over time, and detect significant changes in those populations.

METHODS:

Variable circular plot (VCP) surveys, area search surveys, and tape playback surveys for nocturnal species will be conducted. During each visit, conduct at least one survey per habitat.

Estimating Richness, Relative Abundance and Density of Breeding Birds

It is rarely possible to count all birds actually present in an area, and therefore to estimate abundance or density, sampling methods must be used. Distance sampling has been used for more than 30 years to estimate animal abundance and has been found to be a reliable method for estimating relative abundance and population trends for many bird species (Fancy 1997, Nelson and Fancy 1999).

Distance sampling is based on the intuitive knowledge that the distance between an observer and an object will effect the probability of detection; the further away an object, the less likely it is to be detected. Data collected are the horizontal distances from an observer to an object. Using these distances we calculate a detection function, which is the probability of detecting an object given its distance from the observer. This detection function is used to estimate bird density and allows birds to go undetected during a survey (Buckland et al. 1993). For many surveys, the majority of birds are heard but not seen, and the observer estimates the distance to a tree or bush or other object where they think the bird is located.

Distance sampling includes two approaches to estimate density: both line transects and variable circular plots will be considered for the sampling technique depending on the habitat type (Ralph et al 1995).

Line Transect Sampling:

For line transect sampling, an observer walks along a transect and records either the perpendicular distance to each bird heard or seen, or else records the sighting angle and sighting distance instead of the perpendicular distance. Line transects can be very efficient because you continually collect data as you walk down the transect, whereas during VCP counts you count birds only from stations located every 250 m or some other interval along the transect.

Variable Circular Plot Sampling:

Variable Circular counts are the preferred approach in patchy habitats where the objective is to correlate bird data to vegetation or other habitat information, and in dense, rugged or hazardous terrain where you need to watch your footing as you walk through an area. In the case of variable circular sampling the observer stands at a sampling station and records the horizontal distance between the observer and the bird.

Depending on stand size and shape, point count stations will be located 250 meters apart in each habitat type. Between each habitat type a 200 meter buffer will be implemented. Three visits will be conducted to cover the period in which the greatest number of passerine bird species would be exhibiting breeding behavior such as territorial calling and singing. Visits will start at one-half hour after sunrise and completed by 1000. At each point count station one observer will record all individual birds seen or heard for 7 minutes with counting being subdivided into 3 periods: 0-3 minutes, 3-5 minutes and 5-7 minutes. Counting will begin 1 minute after arriving at a station. Bird detections will be recorded to the nearest 5 meters. Laser rangefinders will be used to estimate distance, which can measure the distance to a rock or tree where the species is detected within 1% accuracy.

Flyover species will be recorded in the same time periods but with no estimates of distance. Additional notes will be taken regarding whether detections were songs, calls, or other (i.e. drumming wings), whether the detection is aural, visual or both, and whether the bird was detected at a previous point count station to avoid double counting individuals. Birds flushed while walking between point count stations will be counted and estimate their distance to the nearest point count station. Field sheets will be modeled after those recommended by Ralph et al. (1995).

For Analysis, Distances will be placed into distance intervals and analyzed as grouped data, such as 0-10 m, 11-20 m, 20-30 m, etc., as long as the distance is placed in the correct interval there will be no error.

Data Analysis:

Species richness will be calculated as the number of species detected. In order to estimate species richness we will use models based on mark-recapture designs (Dawson et al. 1995, Boulinier et al. 1998). This procedure does not identify species that are not seen, but provides an estimate of the number of species that have not been detected but are probably present. Species Richness estimates will be used assess the adequacy of the sampling technique, such as the percent of species recorded that have been detected in the park.

Relative abundance and density of each species with >50 detections will be estimated for each habitat using DISTANCE (Thomas et al. 1999). The distance data will be used to model detection functions, from which we can obtain unbiased estimates of abundance for each species (Buckland et al. 1993). The advantages in using Distance Sampling data include 1) multiple surveys can be combined to increase sample sizes. By combining surveys, it is possible to estimate densities of many rare species, even in situations where only 1 or 2 birds are detected while sampling many stations; 2) allows for adjustment of different covariates such as

the observer effect, effects of dense vegetation and detection distances; and 3) able to use historical count data if the park collected bird data using unadjusted point counts and the park then switches to VCP counts.

Additional Breeding and Non-breeding Surveys

Most bird survey methods provide good information for common species and relatively sparse information for rare or secretive species. This does not mean the survey method is invalid, it is simply a reflection of the difficulty of sampling rare and secretive species using general methods. Therefore, in addition to the point counts, an area search of all habitats during breeding and non-breeding periods will be completed to increase the chance of detecting rare and secretive species that occur in the park.

Personnel will go to the different habitats (i.e. where point counts have been established) in the park and record all species they see or hear. These surveys will be conducted in conjunction with the standard survey protocol (i.e. point counts) during the breeding season. During the non-breeding season (November – February) we will conduct three additional visits. These surveys will be conducted between sunrise and 1000, extra visits will be made in the late afternoon that may reveal presence of vultures, buteos, or any other birds not found in early morning (Robbins 1981). Survey data will include species encountered, habitat, location, dates, and evidence of breeding status (i.e. courtship behavior, nests).

Nocturnal Species

Nocturnal birds (i.e. owls) will be surveyed using taped broadcasts. Caprimulgids (i.e. poor-wills *Phalaenoptilus nuttallii*; lesser nighthawks *Chordeiles minor*) are vocal enough that playback recordings are rarely needed during surveys. Owls, however, have been effectively surveyed using tape broadcasts of the owl species songs and calls (Springer 1978, Forsman 1983). These surveys will be conducted in all habitats which may be suitable for owls or where historical sightings have been noted. Tape broadcasts will be played for 15 minutes at each designated point. Surveys times will occur between 1 hour after sunset and 1 hour before sunrise. We will conduct two surveys during the breeding season and two surveys during the non-breeding season. Survey data will include species encountered, habitat, location, dates, and evidence of breeding status (i.e. courtship behavior, nests). All other nocturnal and crepuscular species will also be noted.

Species of Concern

Playback recorded calls will be implemented to increase the probability of detecting rare species (i.e. species of concern). Broadcasting tape playbacks has been effectively used to survey for marsh-breeding species (Marion et al. 1981) and endangered species (i.e. southwestern willow flycatcher; Sogge et al. 1997). We will include the playback procedure in habitats that target these species, increasing our chance of detecting these targeted species (Verner and Milligan 1971). Broadcasting of taped calls will occur in the habitats that the standard count survey is not being done or after the standard count period is completed.

PARTNERSHIP:

Additional funding will be dependent on state, federal or private lands that are adjacent to these National Parks. Potential partners may include; Bureau of Land Management, Bureau of Reclamation, U. S. Forest Service, state of Utah and Wyoming and any other agency or organization that is responsible for the management of these lands

SCHEDULE:

Field efforts will be conducted by contracted personnel under the direction of the Northern Colorado Plateau inventory coordinator. The network will provide logistical and other support when possible. Field activities will

occur over two field seasons (2001 – 2002) in order to provide adequate time for survey efforts and to allow for annual environmental variability which may affect sampling conditions and population/distribution parameters.

PRODUCTS:

Progress reports will be submitted on an annual basis throughout the duration of this study. These reports will include: (a) a summary of overall progress during each year including data; (b) indications of any problems encountered during that reporting period; (c) synopsis of work to be undertaken during the following year; and (d) other information pertinent to future needs of the study. These annual reports will be provided at the end of each calendar year and will summarize all progress made during the year of the study.

The final written report will be published as a National Park Service Technical Report. Prior to publication, comments will be solicited from the individual park and the Northern Colorado Plateau inventory coordinator. Published copies of the Technical Report will be provided to the Park superintendent and resource manager in accordance with the delivery schedule outlined in the proposal.

Delivery Schedule

Year 1 – 1 January 2001 – 31 December 2001

Year 2 – 1 January 2002 – 31 December 2002

<u>Dates</u>	<u>Task</u>
Year 1 - 1 January 2001 – 31 December 2001	
January 2001 – March 2001	Compile background material. Orientation to the parks and establishment of transects in each habitat.
April 2001 – July 2001	Conduct non-breeding winter censuses.
August 2001 – December 2001	Conduct breeding bird censuses. Compilation of avian distributions, relative abundance. Prepare and finish annual report. Conduct non-breeding surveys.
Year 2 - 1 January 2002 – 31 December 2002	
January 2002 – March 2002	Continue non-breeding winter censuses
April 2002 – July 2002	Conduct breeding bird censuses.
August 2002 – December 2002	Compilation of avian distributions. Prepare and finish final report. Conduct non-breeding surveys.

IMPLEMENTATION:

We will explore options to conduct this work cooperatively with the U.S. Geological Survey, Biological Resources Division in Flagstaff (Colorado Plateau Field Station), principal investigator Matthew Johnson. Other alternatives include contracting or hiring seasonal staff. Working with staff of the Colorado Field Station would allow for closer collaboration with bird work in the Southern Colorado Plateau Network and help ensure a coordinated effort.

FUNDING:

Budget for Breeding Birds

Avian Inventory for GOSP, TICA, DINO, FOBU, CEBR:		
Priority 1 and 2 National Parks 2001-2002		
Item	FY2001	FY2002
Personnel Costs		
Project Leader		
1 Project Leader x 20 weeks @ \$350 per week (half time)	\$7,000	\$7,000
Benefits @ 33%	\$2,310	\$2,310
Field Technicians		
2 technicians x 16 weeks @ \$400 per week (full time)	\$12,800	\$12,800
Fringe Benefits @ 9.31% (workman comp. Etc.)	\$1,192	\$1,192
Personnel costs total	\$23,302	\$23,302
Travel and Per diem		
Vehicle and Mileage costs		
Vehicles		
2 vehicles @ \$150 per week x 20 weeks	\$6,000	\$6,000
Travel to parks (breeding surveys, 4 visits) @ \$0.18 per mi x 7400 mi	\$1,332	\$1,170
Travel to parks (non-breeding surveys, 3 visits) @ \$0.18 per mi x 4900 mi	\$882	\$882
Per diem		
Per diem @ \$20 per day per person x 3 (60 days)	\$3,600	\$3,600
Travel costs total	\$11,814	\$11,652
Miscellaneous Costs		
Binoculars: 2 pair @ \$350.00 per pair	\$700	0

Rangefinders: 2 @ \$350.00 per pair	\$700	0
Global Positioning System: 1 @ \$150.00 per pair	\$150	0
Tape Recorders: 4 @ \$30.00 per set	\$120	0
Camping Supplies (Tents, coolers etc.)	\$400	\$150
Film, Batteries, clipboards, data books etc.	\$200	\$200
Xeroxing, report reproduction, etc.	\$200	\$400
Miscellaneous Costs Total	\$2,470	\$750
Total Direct Costs	\$37,586	\$35,704
Total Indirect Costs (CESU @15% direct cost)	\$5,638	\$5,356
Total Costs	\$43,224	\$41,060

REFERENCES CITED:

- Boulinier, T., Nichols, J.D., Sauer, J.R., Hines, J.E. & Pollock, K.H. (1998). Estimating species richness: the importance of heterogeneity in species detectability. *Ecology* 79: 1018–1028.
- Boyce B. 1981. Bird Checklist of Golden Spike National Historical Site.
- Buckland, S. T., D. R. Anderson, K.P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. Chapman and Hall, New York. 446 pp.
- Chase, C.A., S.J. Bissell, H.E. Kingery, and W.D. Graull 1983. Colorado Bird Distribution Latilong Study. Colorado Field Ornithologists and Colorado Division of Wildlife. 81 pp.
- Dawson, D.K., Sauer, J.R., Wood, P.A., Berlanga, M., Wilson, M.H. & Robbins, C.S. (1995). Estimating bird species richness from capture and count data. *Journal of Applied Statistics* 22: 1063–1068.
- Dorn, R., Lichvar, R. and Dorn J. 1984. Grazing impact study on Fossil Butte National Monument, Wyoming. Cheyenne, WY: Mountain West Environmental Services.
- Fancy, S.G. 1997. A new approach for analyzing bird densities from variable circular-plot counts. *Pacific Science* 51:107-114.
- Forsman, E. 1983. Methods and materials for studying Spotted Owls. Pacific Northwest Forest and Range Experiment Station Gen. Tech. Rpt. PNW-162. 8 pp.
- Marion, W. R, T.E. O'meara and D. S. Maehr. 1981. Use of playback recordings in sampling elusive or secretive birds. *Studies in Avian Biology*. 6:81-85.
- Nelson, J. T. and S. G. Fancy. 1999. A test of the variable circular-plot method when exact density of a bird population was known. *Pacific Conservation Biology* 5:139-143.
- Rado, T. 1977. A Faunal evaluation of a proposed exhibit center site at Fossil Butte National Monument, Wyoming. Kemmerer, WY. Fossil Butte National Monument.

- Ralph, C.J., S. Droege, and J. R. Sauer. 1995. Managing and monitoring birds using point counts: standards and applications. Pages 161-168 in C.J. Ralph, J.R. Sauer and S. Droege, eds. Monitoring Bird Populations by Point Counts, USDA Forest Service, Pacific Southwest Research Station, General Technical Report PSW-GTR-149.
- Robbins, C. S. 1981. Reappraisal of the Winter-Bird-Population Study technique, Oo, 52-57 in C. J. Ralph and J. M. Scott (eds.) Estimating the numbers of terrestrial birds. Stud. Avian biol. 6.
- Sogge, M.K., R.M. Marshall, S.J. Sferra and T.J. Tibbitts. 1997. A Southwestern Willow Flycatcher Natural History Summary and Survey Protocol. Technical Report NPS/NAUCPRS/TR-97/12.
- Springer, M.A. 1978. Foot surveys versus owl calling surveys: a comparative study of two Great Horned Owl censusing techniques. Inland Bird Banding News. 50:83-92.
- Thomas, L., J. Laake, and J. Derry DISTANCE V3.5. Research Unit for Wildlife Population Assessment, University of St. Andrews, Scotland, U.K.
- Verner, J., and M. M. Milligan. 1971. Responses of White-crowned Sparrows to playback of recorded songs. Condor 73:56-64.

PROJECT TITLE: Bird Inventory Black Canyon of the Gunnison NP and Curecanti NRA**TAXONOMIC GROUP:** BIRDS - 02**FUNDING STATUS:** IM**PROBLEM STATEMENT:**

Background: Priority 2 parks are parks that have undersampled portions of their breeding and non-breeding bird habitats, and therefore lack information on bird species presence/absence and/or abundance and distribution.

Black Canyon National Monument is located 24 kilometers (15 miles) east of Montrose, Colorado. The biotic communities within the monument include scrub oak (*Quercus* spp.) and pinyon-juniper forests with inter-mixed patches of sagebrush. North-facing slopes within the canyon support Douglas Fir (*Pseudotsuga menziesii*) and Colorado blue spruce (*Picea pungens*). The river bottom within the canyon has limited riparian vegetation as well as scattered stands of ponderosa pine (*Pinus ponderosa*) and box elder (*Acer negundo*). In Black Canyon of the Gunnison National Park limited park-wide bird inventories have been conducted. A bird checklist was compiled in 1960 (Beidleman 1960) and revised in 1971 (Dolson 1971). Park staff have collected inventory data at various locations within the park from 1996-1999 using point count systematic surveys.

Curecanti National Recreation Area is located 24 kilometers (15 miles) west of Gunnison, Colorado. The recreation area is mainly Blue Mesa Reservoir, situated in the Gunnison River Valley. The shoreline slopes surrounding the reservoir are mainly grasses, big sagebrush (*Artemisia tridentata*), rabbit brush and Gambel oak (*Quercus gambelii*). The mesa tops are characterized as high desert vegetation with pockets of Douglas fir, quaking aspen (*Populus tremuloides*) and spruce. Canyons separating the mesa tops contain riparian flora. Historical avian fauna data at Curecanti National Recreation Area consists of a bird checklist (Hyde 1977) and systematic point count inventory data collected between 1992-99 by park staff at various locations in the park. A number of raptor studies have been conducted along the reservoir, emphasizing peregrine falcons and bald eagles (Borretti 1990, Burnham and Enderson 1981, Canterbury 1982, Canterbury 1983).

OBJECTIVES:

Priority 2 Parks: The overall goals of this inventory are to: 1) provide the park with additional surveys of birds stratified by major habitats within the Park, with the goal of rounding out knowledge of the avian fauna present (and documenting 90% of the species present); 2) identify park-specific species of special concern (which could become part of future "vital signs" monitoring); and 3) based on the inventory, to recommend an effective monitoring program so that Resource Management staff can assess the condition of the bird populations over time, and detect significant changes in those populations.

METHODS:

Variable circular plot (VCP) surveys, area search surveys, and tape playback surveys for nocturnal species will be conducted. During each visit, conduct at least one survey per habitat.

STUDY DESIGN AND METHODS:

It is rarely possible to count all birds actually present in an area, and therefore to estimate abundance or density, sampling methods must be used. Distance sampling has been used for more than 30 years to

estimate animal abundance and has been found to be a reliable method for estimating relative abundance and population trends for many bird species (Fancy 1997, Nelson and Fancy 1999).

Distance sampling is based on the intuitive knowledge that the distance between an observer and an object will effect the probability of detection; the further away an object, the less likely it is to be detected. Data collected are the horizontal distances from an observer to an object. Using these distances we calculate a detection function, which is the probability of detecting an object given its distance from the observer. This detection function is used to estimate bird density and allows birds to go undetected during a survey (Buckland et al. 1993). For many surveys, the majority of birds are heard but not seen, and the observer estimates the distance to a tree or bush or other object where they think the bird is located.

Distance sampling includes two approaches to estimate density: both line transects and variable circular plots will be considered for the sampling technique depending on the habitat type (Ralph et al. 1995).

Line Transect Sampling:

For line transect sampling, an observer walks along a transect and records either the perpendicular distance to each bird heard or seen, or else records the sighting angle and sighting distance instead of the perpendicular distance. Line transects can be very efficient because you continually collect data as you walk down the transect, whereas during VCP counts you count birds only from stations located every 250 m or some other interval along the transect.

Variable Circular Plot Sampling:

Variable Circular counts are the preferred approach in patchy habitats where the objective is to correlate bird data to vegetation or other habitat information, and in dense, rugged or hazardous terrain where you need to watch your footing as you walk through an area. In the case of variable circular sampling the observer stands at a sampling station and records the horizontal distance between the observer and the bird.

Depending on stand size and shape, point count stations will be located 250 meters apart in each habitat type. Between each habitat type a 200 meter buffer will be implemented. Three visits will be conducted to cover the period in which the greatest number of passerine bird species would be exhibiting breeding behavior such as territorial calling and singing. Visits will start at one/half hour after sunrise and completed by 1000. At each point count station one observer will record all individual birds seen or heard for 7 minutes with counting being subdivided into 3 periods: 0-3 minutes, 3-5 minutes and 5-7 minutes. Counting will begin 1 minute after arriving at a station. Bird detections will be recorded to the nearest 5 meters. Laser rangefinders will be used to estimate distance, which can measure the distance to a rock or tree where the species is detected within 1% accuracy.

Flyover species will be recorded in the same time periods but with no estimates of distance. Additional notes will be taken regarding whether detections were songs, calls, or other (i.e. drumming wings), whether the detection is aural, visual or both, and whether the bird was detected at a previous point count station to avoid double counting individuals. Birds flushed while walking between point count stations will be counted and estimate their distance to the nearest point count station. Field sheets will be modeled after those recommended by Ralph et al. (1995).

For Analysis, Distances will be placed into distance intervals and analyzed as grouped data, such as 0-10 m, 11-20 m, 20-30 m, etc., as long as the distance is placed in the correct interval there will be no error.

Data Analysis:

Species richness will be calculated as the number of species detected. In order to estimate species richness we will use models based on mark-recapture designs (Dawson et al. 1995, Boulinier et al. 1998). This procedure does not identify species that are not seen, but provides an estimate of the number of species that have not been detected but are probably present. Species Richness estimates will be used to assess the adequacy of the sampling technique, such as the percent of species recorded that have been detected in the park.

Relative abundance and density of each species with >50 detections will be estimated for each habitat using DISTANCE (Thomas et al. 1999). The distance data will be used to model detection functions, from which we can obtain unbiased estimates of abundance for each species (Buckland et al. 1993). The advantages in using Distance Sampling data include 1) multiple surveys can be combined to increase sample sizes. By combining surveys, it is possible to estimate densities of many rare species, even in situations where only 1 or 2 birds are detected while sampling many stations; 2) allows for adjustment of different covariates such as the observer effect, effects of dense vegetation and detection distances; and 3) able to use historical count data if the park collected bird data using unadjusted point counts and the park then switches to VCP counts.

Additional Breeding and Non-breeding Surveys

Most bird survey methods provide good information for common species and relatively sparse information for rare or secretive species. This does not mean the survey method is invalid, it is simply a reflection of the difficulty of sampling rare and secretive species using general methods. Therefore, in addition to the point counts, an area search of all habitats during breeding and non-breeding periods will be completed to increase the chance of detecting rare and secretive species that occur in the park.

Personnel will go to the different habitats (i.e. where point counts have been established) in the park and record all species they see or hear. These surveys will be conducted in conjunction with the standard survey protocol (i.e. point counts) during the breeding season. During the non-breeding season (November – February) we will conduct three additional visits. These surveys will be conducted between sunrise and 1000, extra visits will be made in the late afternoon that may reveal presence of vultures, buteos, or any other birds not found in early morning (Robbins 1981). Survey data will include species encountered, habitat, location, dates, and evidence of breeding status (i.e. courtship behavior, nests).

Nocturnal Species

Nocturnal birds (i.e. owls) will be surveyed using taped broadcasts. Caprimulgids (i.e. poor-wills *Phalaenoptilus nuttallii*; lesser nighthawks *Chordeiles minor*) are vocal enough that playback recordings are rarely needed during surveys. Owls, however, have been effectively surveyed using tape broadcasts of the owl species songs and calls (Springer 1978, Forsman 1983). These surveys will be conducted in all habitats which may be suitable for owls or where historical sightings have been noted. Tape broadcasts will be played for 15 minutes at each designated point. Survey times will occur between 1 hour after sunset and 1 hour before sunrise. We will conduct two surveys during the breeding season and two surveys during the non-breeding season. Survey data will include species encountered, habitat, location, dates, and evidence of breeding status (i.e. courtship behavior, nests). All other nocturnal and crepuscular species will also be noted.

Species of Concern

Playback recorded calls will be implemented to increase the probability of detecting rare species (i.e. species of concern). Broadcasting tape playbacks has been effectively used to survey for marsh-breeding species (Marion et al. 1981) and endangered species (i.e. southwestern willow flycatcher; Sogge et al. 1997). We

will include the playback procedure in habitats that target these species, increasing our chance of detecting these targeted species (Verner and Milligan 1971). Broadcasting of taped calls will occur in the habitats that the standard count survey is not being done or after the standard count period is completed.

PARTNERSHIP:

Additional funding will be dependent on state, federal or private lands that are adjacent to these National Parks. Potential partners may include; Bureau of Land Management, Bureau of Reclamation, U. S. Forest Service, state of Utah and Wyoming and any other agency or organization that is responsible for the management of these lands

SCHEDULE:

Field efforts will be conducted by contracted personnel under the direction of the Northern Colorado Plateau inventory coordinator. The network will provide logistical and other support when possible. Field activities will occur over two field seasons (2001 – 2002) in order to provide adequate time for survey efforts and to allow for annual environmental variability which may affect sampling conditions and population/distribution parameters.

PRODUCTS:

Progress reports will be submitted on an annual basis throughout the duration of this study. These reports will include: (a) a summary of overall progress during each year including data; (b) indications of any problems encountered during that reporting period; (c) synopsis of work to be undertaken during the following year; and (d) other information pertinent to future needs of the study. These annual reports will be provided at the end of each calendar year and will summarize all progress made during the year of the study.

The final written report will be published as a National Park Service Technical Report. Prior to publication, comments will be solicited from the individual park and the Northern Colorado Plateau inventory coordinator. Published copies of the Technical Report will be provided to the Park superintendent and resource manager in accordance with the delivery schedule outlined in the proposal.

Delivery Schedule

Year 1 – 1 January 2002 – 31 December 2002
 Year 2 – 1 January 2003 – 31 December 2003

<u>Dates</u>	<u>Task</u>
Year 1 - 1 January 2002 – 31 December 2002	
January 2002 – March 2002	Compile background material. Orientation to the parks and establishment of transects in each habitat. Conduct non-breeding winter censuses.
April 2002 – July 2002	Conduct breeding bird censuses.
August 2002 – December 2002	Compilation of avian distributions, relative abundance. Prepare and finish annual report. Conduct non-breeding surveys.
Year 2 - 1 January 2003 – 31 December 2003	
January 2003 – March 2003	Continue non-breeding winter censuses

April 2003 – July 2003
 August 2003 – December 2003

Conduct breeding bird censuses.
 Compilation of avian distributions.
 Prepare and finish final report.
 Conduct non-breeding surveys

IMPLEMENTATION:

We will explore options to conduct this work cooperatively with the U.S. Geological Survey, Biological Resources Division in Flagstaff (Colorado Plateau Field Station), principal investigator Matthew Johnson. Other alternatives include contracting or hiring seasonal staff. Working with staff of the Colorado Field Station would allow for closer collaboration with bird work in the Southern Colorado Plateau Network and help ensure a coordinated effort.

FUNDING:

Budget for Breeding Birds

Avian Inventory BLCA, CURE:		
Priority 2 National Parks 2002-2003		
Item	FY 2002	FY 2003
Personnel Costs		
Project Leader		
1 Project Leader 8 weeks @ \$350 per week (half time)	\$2,800	\$2,800
Benefits 33%	\$924	\$924
Field Technicians		
1 technician x 16 weeks @ \$400 per week (full time)	\$6,400	\$6,400
Fringe Benefits @ 9.31% (workman comp. Etc.)	\$596	\$596
Personnel Costs total	\$10,720	\$10,720
Travel and Per diem		
Vehicle and Mileage costs		
Vehicles		
1 vehicle @ \$150 per week x 16 weeks	\$2,400	\$2,400
Travel between parks (breeding, 3 visits) @ \$0.18 per mi x 3500	\$630	\$630

Per diem		
Per diem @ \$20 per day per person (60 days)	\$1,800	\$1,800
Travel costs Total	\$5,100	\$5,100
Miscellaneous Costs		
Binoculars 1 pair @350 per pair	\$350	0
Rangefinder 1 @350 per pair	\$350	0
Global Positioning System 1 @150 per pair	\$150	0
Camping Supplies (Tents, coolers etc.)	\$200	\$100
Film, Batteries, clipboards, data books etc.	\$100	\$100
Xeroxing, report reproduction, etc.	\$100	\$200
Miscellaneous Costs Total	\$1,250	\$400
Total Direct Costs	\$16,800	\$15,950
Total Indirect Costs (Cooperative Ecosystem Systems Unit @15%) direct costs	\$2,560	\$2,433
Total Costs	\$19,360	\$18,343

REFERENCES CITED:

- Beidleman. 1960. Bird Checklist of Black Canyon of the Gunnison National Park.
- Boretti, R. 1990. Curecanti National Recreation Area and Clack Canyon of the Gunnison National Monument 1990 Peregrine Falcon Survey. National Park Service.
- Boulinier, T., Nichols, J.D., Sauer, J.R., Hines, J.E. & Pollock, K.H. (1998). Estimating species richness: the importance of heterogeneity in species detectability. *Ecology* 79: 1018–1028.
- Buckland, S. T., D. R. Anderson, K.P. Burnham, and J. L. Laake. 1993. Distance sampling: Estimating abundance of biological populations. Chapman and Hall, New York. 446 pp.
- Burnham, W. and J. Enderson. 1981. Blue Mesa Peregrine Falcon Study. The peregrine Fund.
- Canterbury, J. 1983. Raptor survey and proposals for the Curecanti National Recreation Area. Western State College.
- Canterbury, J. 1983. Habitat utilization by the Northern Bald Eagle in the Curecanti National Recreation Area. Management Report, National Park Service.
- Dawson, D.K., Sauer, J.R., Wood, P.A., Berlanga, M., Wilson, M.H. & Robbins, C.S. (1995). Estimating bird species richness from capture and count data. *Journal of Applied Statistics* 22: 1063–1068.

- Dolson. 1971. Revised Bird Checklist of Black Canyon of the Gunnison National Park.
- Fancy, S.G. 1997. A new approach for analyzing bird densities from variable circular-plot counts. *Pacific Science* 51:107-114.
- Forsman, E. 1983. Methods and materials for studying Spotted Owls. Pacific Northwest Forest and Range Experiment Station Gen. Tech. Rpt. PNW-162. 8 pp.
- Hyde. 1977. Bird Checklist of Curecanti National Recreation Area.
- Marion, W. R, T.E. O'meara and D. S. Maehr. 1981. Use of playback recordings in sampling elusive or secretive birds. *Studies in Avian Biology*. 6:81-85.
- Nelson, J. T. and S. G. Fancy. 1999. A test of the variable circular-plot method when exact density of a bird population was known. *Pacific Conservation Biology* 5:139-143.
- Sogge, M.K., R.M. Marshall, S.J. Sferra and T.J. Tibbitts. 1997. A Southwestern Willow Flycatcher Natural History Summary and Survey Protocol. Technical Report NPS/NAUCPRS/TR-97/12.
- Springer, M.A. 1978. Foot surveys versus owl calling surveys: a comparative study of two Great Horned Owl censusing techniques. *Inland Bird Banding News*. 50:83-92.
- Ralph, C.J., S. Droege, and J. R. Sauer. 1995. Managing and monitoring birds using point counts: standards and applications. Pages 161-168 in C.J. Ralph, J.R. Sauer and S. Droege, eds. *Monitoring Bird Populations by Point Counts*, USDA Forest Service, Pacific Southwest Research Station, General Technical Report PSW- GTR-149.
- Robbins, C. S. 1981. Reappraisal of the Winter-Bird-Population Study technique, Oo, 52-57 in C. J. Ralph and J. M. Scott (eds.) *Estimating the numbers of terrestrial birds*. *Stud. Avian biol.* 6.
- Thomas, L., J. Laake, and J. Derry DISTANCE V3.5. Research Unit for Wildlife Population Assessment, University of St. Andrews, Scotland, U.K.
- Verner, J., and M. M. Milligan. 1971. Responses of White-crowned Sparrows to playback of recorded songs. *Condor* 73:56-64.

PROJECT TITLE: Southwestern Willow Flycatcher and Yellow-billed Cuckoo Surveys – BLCA, CURE, DINO, HOVE, CARE and ZION

TAXONOMIC GROUP: BIRDS - 03

FUNDING STATUS: IM

PROBLEM STATEMENT:

This project will focus on southwestern willow flycatcher and western yellow-billed cuckoo surveys to determine presence/absence and determine if these species are breeding within Black Canyon of the Gunnison National Park, Curecanti National Recreation Area, Dinosaur National Monument, Hovenweep National Monument, Capital Reef National Park and Zion National Park. These parks have no information on southwestern willow flycatcher or western yellow-billed cuckoo presence/absence, distribution and abundance and breeding information, but may have potential breeding habitat which may be inhabited by these species. One to two-year inventories will be conducted at each park depending on the amount of work needed to complete these inventories of each park.

Southwestern Willow Flycatcher

Background

The southwestern willow flycatcher (*Empidonax traillii extimus*) is an endangered species currently known to breed at only about 75 sites in riparian areas throughout the southwest. The known breeding population is estimated at between 300 and 500 pairs. The flycatcher nests only in dense riparian vegetation associated with streams, rivers, lakes, springs, and other watercourses and wetlands.

Willow flycatcher populations have declined during the twentieth-century, primarily because of habitat loss and modification. In 1991 the U.S. Fish and Wildlife Service (USFWS) designated the southwestern willow flycatcher as a candidate category 1 species (USFWS 1991). In July 1993, the USFWS proposed to list southwestern willow flycatchers as an endangered species and to designate critical habitat (USFWS 1993). A final ruling listing southwestern willow flycatcher as endangered was published in February 1995, although designation of critical habitat was postponed (USFWS 1995).

The southwestern willow flycatcher is also listed as an endangered species or species of concern in Arizona (Arizona Game and Fish Department, in prep.), New Mexico (New Mexico Department of Game and Fish 1996), and Utah (Utah Division of Wildlife Resources 1997).

Breeding Range and Taxonomy

Four subspecies of willow flycatcher are recognized in North America (Hubbard 1987, Unitt 1987). The subspecies occupy distinct breeding ranges and are differentiated by subtle differences in color and morphology. The breeding range of the southwestern willow flycatcher includes southern California (from the Santa Ynez River south), Arizona, New Mexico, southwestern Colorado, extreme southern portions of Nevada and Utah, and western Texas (although recent breeding records from west Texas are lacking). Records of probable breeding southwestern willow flycatchers in Mexico are few and restricted to extreme northern Baja California del Norte and Sonora (Unitt 1987).

The southwestern willow flycatcher was described by A. R. Phillips (1948), from a collection by G. Monson from the San Pedro River in southeastern Arizona. It is generally paler than other willow flycatcher subspecies, although this difference is indistinguishable without considerable experience and training, and

study skins as comparative reference material. The southwestern subspecies differs in morphology (primarily wing formula) but not overall size. The taxonomic status of southwestern willow flycatcher was reviewed and confirmed by Hubbard (1987), Unitt (1987), and Browning (1993), and accepted by most ornithologists (e.g., Aldrich 1951, Behle and Higgins 1959, Phillips et al. 1964, Oberholser 1974, Monson and Phillips 1981, Harris et al. 1988, Schlorff 1990, Harris 1991, USFWS 1991 and 1992).

Habitat

The southwestern willow flycatcher breeds in dense riparian habitats in all or part of seven southwestern states, from sea level in California to over 2600 m in Arizona and southwestern Colorado. Although other willow flycatcher subspecies may breed in shrubby habitats away from water, southwestern willow flycatchers breeds only in dense riparian vegetation near surface water or saturated soil. Other characteristics such as dominant plant species, size and shape of habitat patch, canopy structure, vegetation height, etc., vary among sites.

Southwestern willow flycatcher breeding habitat characterization can be based on plant species composition and habitat structure. These two habitat characteristics are the most conspicuous to human perception, but are not the only important components. However, they have proven useful in selecting and evaluating suitable survey habitat, and in predicting where breeding flycatchers are likely to be found.

Western Yellow-billed Cuckoo

Background

Western yellow-billed cuckoos have shown a marked reduction in breeding range within the last 60 years due to riparian habitat alteration and destruction (Franzreb 1987), decreased water tables (Milhous 1994) and the use of pesticides (Gaines 1974). The western yellow-billed cuckoo requires riparian areas for nesting habitat and uses large patches (>10ha) of continuous, late successional stage cottonwood/willow stands. Currently only small numbers of these birds remain in the southwest, and are listed as threatened or endangered on several state wildlife lists, including Utah. The U.S. Fish and Wildlife Service is currently considering listing the western yellow-billed cuckoo as a federal endangered species. In Utah and Colorado, yellow-billed cuckoos have been detected along many sections of riparian corridors, however, very little is known about the birds distribution or breeding status along these riparian corridors.

OBJECTIVES:

1. Determine and map existing willow flycatcher habitat.
2. Document the number of willow flycatchers in the study area during the breeding season, and determine if flycatchers are territorial and/or breeding
3. If breeding flycatchers are found, determine breeding habitat and territory characteristics, nesting status and nest placement characteristics, and evidence of brown-headed cowbird parasitism
4. Determine and map existing yellow-billed cuckoo habitat
5. Document the number of yellow-billed cuckoos in the study area during the breeding season, and determine if cuckoos are territorial and/or breeding
6. Develop recommendations for future southwestern willow flycatcher and yellow-billed cuckoo monitoring and management alternatives.

STUDY DESIGN AND METHODS:**Methods Southwestern Willow Flycatcher**

We will survey all potential willow flycatcher habitat within the survey areas. A total survey, rather than sub-sampling of potential habitat, is the preferred approach when searching for a potentially rare widely distributed species such as the southwestern willow flycatcher.

Survey methods described below will document the presence or absence of willow flycatchers, and determine their status (territorial vs migrant). The tape-playback technique will be used, a proven method for eliciting response from nearby resident willow flycatchers (Seutin 1987, Craig et al. 1992, Sogge and Tibbitts 1994, Sferra et al. 1995, Sogge et al. 1997a). At each site, surveyors will broadcast recorded willow flycatcher songs, and look and listen for responses. The Tape-playback method maximizes the likelihood of detecting nearby flycatchers, allowing for positive identification by comparison to the "known" willow flycatcher tape.

Documenting Presence/Absence

Surveys will begin as soon as there is enough light to safely walk (about one hour before sunrise) and end by about 0900 - 1000 hrs, depending on the temperature, wind, background noise, and other environmental factors.

Surveys will be conducted within the sites if it is possible to do so without breaking vegetation or damaging the habitat. Flycatchers often respond most strongly if the tape is played from within the habitat and territory, rather than from the periphery. It can be difficult to hear singing willow flycatchers that are a short distance away amidst the noise generated by many other singing and calling birds. Therefore, it will be preferable to survey from within the habitat, but surveyors will move carefully to avoid disturbing habitat or nests. Surveying will be done from the periphery where terrain, extremely dense vegetation, or deep water prohibit walking through the habitat.

At each site surveyors will stand quietly for 1 - 2 minutes or longer, listening for spontaneously singing flycatchers. If flycatcher are not heard during the initial listening period, the broadcast willow flycatcher song tape will be played for 15 - 30 seconds, then surveyors will listen for approximately 1 - 2 minutes for a response. This procedure will be repeated (including a 10 - 20 second quiet pre-broadcast listening period) every 20 - 30 m throughout each survey site. The tape will be played at about the volume of natural bird calls, and not so loud as to cause distortion of the broadcast. Tapes will include a series of fitz-bews interspersed with several whitts.

Determining Breeding Status

To determine if the flycatchers found at a particular site are migrants or territorial, surveyors will find out if they are still present during the "non-migrant" period, from about 15 June - 20 July; Unitt 1987). A willow flycatcher found during this time is probably a resident bird on a territory (although there is a small chance it could be a non-territorial "floater"; Sogge and Tibbitts 1994, Sogge et al. 1997b). Surveyors will determine whether a pair is present and breeding by moving a short distance away from where the bird was sighted, find a good vantage point, and sit or lie quietly to watch for signs of breeding activity.

Timing and Number of Visits

This survey protocol will require a minimum of five surveys at each site, one during each period outlined below, to document absence of willow flycatchers. Successive surveys must be at least 5 days apart, surveys conducted more closely are not considered to be in separate survey periods.

Survey 1: 15 - 31 May (1 visit)

The timing of this survey is intended to coincide with the period of high singing rates in newly arrived males, which tends to begin in early to mid-May. This is one of the most reliable times to detect flycatchers that have established their territories. However, not all territorial males may have arrived by this time, and migrants (of all subspecies) may still be present and singing during this period.

Survey 2: 1 - 21 June (1 visit)

During this period, the earliest arriving males may already be paired and singing less, but later arriving males should still be singing frequently. This survey will provide information to determine the status of flycatchers detected during survey 1 (e.g., if detected during survey 1 but not survey 2, the first detection may have been a migrant). Detecting a flycatcher at the same site on surveys 1 and 2 increases the likelihood that the bird is not a migrant (but does not necessarily confirm it). During survey period 2 we should detect nesting activity by resident birds.

Survey 3: 22 June - 17 July (3 visits)

Southwestern willow flycatchers should have arrived on their territories by this time. Flycatcher singing rates may have lessened, and most paired flycatchers will have initiated nesting activity. Migrant willow flycatchers should no longer be passing through. Therefore, any flycatchers detected are probably resident breeders or nonbreeding floaters. Surveyors will determine if flycatchers detected during surveys 1 and/or 2 are still present, and watch for nesting activity. The two additional visits during the period will help determine if any late flycatchers arrived and if these birds are breeding.

Southwestern willow flycatchers may not arrive and/or initiate breeding activities at higher elevation sites (above 2000 m) until early June, possibly later in some years due to weather or migration patterns. Therefore, flycatcher breeding chronology may be "set back" one or two weeks at such sites and surveys will be conducted in the latter part of each period.

Documenting Presence of Cowbirds

Brown-headed cowbirds significantly impact many southwestern willow flycatcher populations by decreasing or eliminating flycatcher productivity, nesting success, and juvenile survival (Unitt 1987, Brown 1988, Whitfield 1990, USFWS 1993, Whitfield and Strong 1995, Sferra et al. 1997, Sogge et al. 1997b). It will be important to document if cowbirds occur at a flycatcher breeding site to determine if those flycatchers are at risk from cowbird brood parasitism.

Methods Western Yellow-billed Cuckoo

We will survey all potential yellow-billed cuckoo habitat within the survey areas. A total survey, rather than sub-sampling of potential habitat, is the preferred approach when searching for a potentially rare, widely distributed species such as the western yellow-billed cuckoo. Surveys will be conducted between 0530 to 1100 hrs daily, following the protocol recommended in Laymon (1998). The hottest part of the day (>100 F) will be avoided since activity of cuckoos declines sharply. Song playback of the paired cuckoos' contact call *AKowlp@* is the most effective method to locate this species (Johnson et al. 1981). Surveyors will tape-broadcast the *AKowlp@* calls of the yellow-billed cuckoo every 100 m while walking through, or adjacent to, potential cuckoo habitat. All locations of singing or calling yellow-billed cuckoos will be considered as potential territories, and will be mapped (with GPS coordinates taken) for follow-up evaluation. When yellow-billed cuckoos are detected, data will be collected regarding their response to broadcast playbacks, breeding

status, habitat utilization and nest site characteristics. Nesting status will be verified by nest inspection, and clutch size, number and age of young. After fledging has taken place (or a nesting attempt fails), nests will be examined and nesting habitat measurements made.

Timing and Number of Visits

This survey protocol will require a minimum of three surveys at each site, one during each period outlined below, to document absence of yellow-billed cuckoos. Cuckoo surveys will be conducted at the same time willow flycatcher surveys are being conducted. Successive surveys must be at least 5 days apart, surveys conducted more closely are not considered to be in separate survey periods.

15 June – 27 June (1 visit)

The timing of this survey is intended to coincide with the period of high singing rates in newly arrived males, which tends to begin in early to mid-June. This is one of the most reliable times to detect cuckoos that have established their territories.

28 June 7 July (1 visit)

During this period, the earliest arriving males may already be paired and singing less, but later arriving males should still be singing strongly. This survey can provide insight about the status of cuckoos detected during survey 1.

8 July – 20 July (1 visit)

Western yellow-billed cuckoos should have arrived on their territories by this time. Cuckoo singing rates may have lessened, and most paired cuckoos will have initiated nesting activity.

In addition to recording detections of willow flycatchers and yellow-billed cuckoos, the surveyors will also record all bird species encountered during the surveys. We will also use Global Positioning System equipment to geo-reference all survey sites, and will record these sites and location data on all data sheets

PARTNERSHIP:

Additional funding will be dependent on state, federal or private lands that are administered adjacent to each park. Potential partners may include; Bureau of Land Management, Bureau of Reclamation, U. S. Forest Service, State of Utah and any other agency or organization that is responsible for the management of these lands.

SCHEDULE:

Field efforts will be conducted by contracted personnel under the direction of the Northern Colorado Plateau inventory coordinator. The network will provide logistical and other support when possible. Field activities will occur over two field seasons (2001 – 2002) in order to provide adequate time for surveys and to allow for annual environmental variability which may affect sampling conditions and population/distribution parameters.

PRODUCTS:

- Final project report outlining the results of the willow flycatcher and yellow-billed cuckoo surveys.
- Species lists of all birds detected throughout the survey area(s).

- Geographic coordinates (ULM or LAT/LONG) of all sites surveyed, and locations where willow flycatchers and yellow-billed cuckoos were detected

Progress reports will be submitted on an annual basis throughout the duration of this study. These reports will include: (a) a summary of overall progress during each year; (b) indications of any problems encountered during that reporting period; (c) synopsis of work to be undertaken during the following year; and (d) other information pertinent to future needs of the study. These annual reports will be provided at the end of each calendar year and will summarize all progress made during the year of the study.

An initial pre-study meeting will be held following notification of funding for FY2000. This report will entail discussion for the preliminary proposal, experimental design and proposed deliverables. Input will be solicited from Park staff and their suggestions considered for incorporation into the study following each annual oral presentation.

Delivery Schedule

Year 1 – 1 April 2001 – 31 December 2001

Year 2 – 1 April 2002 – 31 December 2002

Dates

Task

Year 1 - 1 April 2001 – 31 December 2001

1 April 2001 – 31 July 2001

Compile background material.
Orientation to the parks and establishment of transects in each habitat.

1 August 2001 – 31 December 2001

Conduct willow flycatcher and yellow-billed cuckoo surveys.
Compilation of data.
Prepare and finish annual report.
Oral presentation to parks.

Year 2 - 1 April 2001 – 31 December 2001

1 April 2002 – 31 July 2002

Continue to compile background material.
Orientation to the parks and establishment of transects in each habitat.

1 August 2002 – 31 December 2002

Conduct willow flycatcher and yellow-billed cuckoo surveys.
Compilation of data.
Prepare and finish annual report.

IMPLEMENTATION:

We will explore options to conduct this work cooperatively with the U.S. Geological Survey, Biological Resources Division in Flagstaff (Colorado Plateau Field Station), principal investigator Matthew Johnson. Other alternatives include contracting or hiring seasonal staff. Working with staff of the Colorado Field Station would allow for closer collaboration with bird work in the Southern Colorado Plateau Network and help ensure a coordinated effort.

FUNDING:**Budget (Priority 3 Parks)**

Willow Flycatcher and Yellow-billed Cuckoo Surveys: BLCA,CURE,DINO,HOVE CO/ CARE,ZION UT		
Item	FY2003	FY2004
Personnel Costs		
Project Leader		
12 weeks @ \$350 per week (half time)	\$4,200	\$4,200
Fringe Benefits @ 9.31 (workman comp. etc)	\$391	\$391
Field Technicians		
2 technicians x 12 weeks @ \$400 per week	\$4,800	\$4,800
Fringe Benefits @ 9.31% (workman comp. etc.)	\$447	\$447
Personnel costs total	\$9,838	\$9,838
Travel		
Vehicle and Mileage costs		
Vehicles		
1 vehicle @ \$150 per week x 12 weeks	\$1,800	\$1,800
Mileage: 1358 mi x 5 trips between 6 parks, 7000 miles x 0.18)	\$1,260	\$1,260
Per Diem \$20 per person x 3 (60 days)	\$2,400	\$2,400
Travel costs total	\$5,460	\$5,460
Miscellaneous Costs		
Binoculars: 1pair @ \$350 per pair	\$350	0
Tape players: 3 @ \$25 each	\$ 75	\$60
Global Positioning System 1 @ \$150 each	\$150	0
Camping Supplies (Tents, coolers etc.)	\$100	0
Film, Batteries, clip boards, data books etc.	\$200	\$200
Xeroxing, report reproduction, etc.	\$200	\$200
Total Equipment Costs	\$1,075	\$400
Total Direct Costs	\$16,373	\$15,698
Indirect Costs (Northern Arizona University @ 15% total	\$2,456	\$2,355
Total Costs	\$18,829	\$18,053

REFERENCES CITED:

- Aldrich, J. W. 1951. A review of the races of the Traill's flycatcher. *Wilson Bulletin* 63:192-197.
- Arizona Game and Fish Department. In prep. Wildlife species of concern in Arizona. Arizona Game and Fish Department. Phoenix, Arizona.
- Behle, W. H. and H. G. Higgins. 1959. The birds of Glen Canyon. Pp. 107-133 in *Ecological studies of flora and fauna in Glen Canyon* (A. M. Woodbury, ed.). University of Utah Anthropological Paper 40 (Glen Canyon Series No. 7).
- Brown, B. T. 1988. Breeding ecology of a willow flycatcher population in Grand Canyon, Arizona. *Western Birds* 19 (1):253-33.
- Craig, D., R. Schlorff, B. Valentine and C. Pelles. 1992. Draft survey protocol for Willow Flycatchers (*Empidonax traillii*) on National Forest Service Lands in the Pacific Southwest region. USDA Forest Service. 13 pp.
- Browning, M. R. 1993. Comments on the taxonomy of *Empidonax traillii* (Willow Flycatcher). *Western Birds* 24:241-257.
- Franzreb, K. 1987. Perspective on managing riparian ecosystems for endangered bird species. *Western Birds* 18:10-13.
- Gains, D.A. 1974. Review of the status of the Yellow-billed Cuckoo in California: Sacramento Valley Populations. *Condor* 76:204-209.
- Harris, J. H. 1991. Effects of brood parasitism by Brown headed Cowbirds on Willow Flycatcher nesting success along the Kern River, California. *Western Birds* 22(1):132-6.
- Harris, J. H., S. D. Sanders, and M. A. Flett. 1988. The status and distribution of the Willow Flycatcher (*Empidonax traillii*) in the Sierra Nevada. California Department of Fish and Game, Wildlife Management Branch Administrative Report 88-1.
- Hubbard, J. P. 1987. The status of the willow flycatcher in New Mexico. Endangered Species Program, New Mexico Department of Game and Fish, Santa Fe, New Mexico. 29 pp.
- Johnson, R.R., B.T. Brown, L. T. Haight, and J. M. Simpson. 1981. Playback recordings as a special avian censusing technique. *Estimating Numbers of Terrestrial Birds: Studies in Avian Biology*. All Press, Inc. Lawrence, KS. Pp.
- Laymon, S.A. 1998. Yellow-billed Cuckoo survey and Monitoring protocol for California. Unpublished Report. p 4.
- Milhous, R. T. 1994. Instream flows and cottonwood establishment in the Bosque del Apache reach of the Rio Grand River. Pp 535-544 in R.A. Marston and V.R. Hasfurther eds. *Effects of human-induced changes on hydrologic systems*. Proc. Ann. Summer Symp. of American Water Resources Assoc. 1182 pp.
- Monson, G. and A. R. Phillips. 1981. Annotated checklist of the birds of Arizona. University of Arizona Press, Tucson, Arizona. 240 pp.
- New Mexico Department of Game and Fish. 1996. List of threatened and endangered. Amendment No. 1, NMAC 33.1;31 January 1996. New Mexico Department of Game and Fish, Santa Fe, New Mexico.
- Oberholser, H. C. 1974. *The bird life of Texas*. University of Texas Press, Austin, Texas. 1069 pp.
- Phillips, A. R. 1948. Geographic variation in *Empidonax traillii*. *Auk* 65:507-514.

- Schlorff, R. W. 1990. Status review of the willow flycatcher (*Empidonax traillii*) in California. Report to the California Department of Fish and Game, Department Candidate Species Status Report 901. 23 pp.
- Seutin, G. 1987. Female song in Willow Flycatchers (*Empidonax traillii*). *Auk* 104: 329330.
- Sferra, S.J., R.A. Meyer and T.E. Corman. 1995. Arizona Partners in Flight 1994 southwestern willow flycatcher survey. Final technical report 69. Arizona Game and Fish Department, Nongame and Endangered Wildlife Program. Phoenix, Arizona. 46 pp.
- Sferra, S.J., T.E. Corman, C.E. Paradzick, J.W. Rourke, J.A. Spencer and M.W. Sumner. 1997. Arizona Partners in Flight southwestern willow flycatcher survey: 1993-1996 summary report. Technical Report 113. Arizona Game and Fish Department, Nongame and Endangered Wildlife Program. Phoenix, Arizona. 46 pp.
- Sogge, M.K. and T.J. Tibbitts. 1994. Distribution and status of the southwestern willow flycatcher along the Colorado River in the Grand Canyon--1994. Summary report. National Biological Service Colorado Plateau Research Station/Northern Arizona University and U.S. Fish and Wildlife Service, Phoenix. 37 pp.
- Sogge, M.K., R.M. Marshall, S.J. Sferra and T.J. Tibbitts. 1997a. A Southwestern Willow Flycatcher Natural History Summary and Survey Protocol. Technical Report NPS/NAUCPRS/TR-97/12.
- Sogge, M.K., T.J. Tibbitts and J.R. Petterson. 1997b. Status and ecology of the Southwestern Willow Flycatcher in the Grand Canyon. *Western Birds* 28(3):142-157.
- Unitt, P. 1987. *Empidonax traillii* extimus: an endangered subspecies. *Western Birds* 18(3):137-162.
- U.S. Fish and Wildlife Service. 1991. Notice of review: animal candidate review for listing as endangered or threatened species. November 21, 1991, Federal Register 56:5880458836.
- U.S. Fish and Wildlife Service. 1992. Notice of 90day finding on petition to list the southwestern willow flycatcher as an endangered species. September 1, 1992, Federal Register 57:3966439668.
- U.S. Fish and Wildlife Service. 1993. Proposal to list the southwestern willow flycatcher as an endangered species and to designate critical habitat. July 23, 1993, Federal Register 58:3949539522.
- U.S. Fish and Wildlife Service. 1995. Final Rule Determining Endangered Status for the Southwestern Willow Flycatcher. Federal Register 60: 10694 (February 27, 1995).
- Utah Division of Wildlife Resources. 1997. Utah Sensitive Species List--March 1997. Utah Division of Wildlife Resources, Salt Lake City, Utah. 28 pp.
- Whitfield, M. J. 1990. Willow flycatcher reproductive response to brownheaded cowbird parasitism. Masters Thesis, California State University, Chico, California. 25 pp.
- Whitfield, M.J. and C.M. Strong. 1995. A brown-headed cowbird control program and monitoring for the southwestern willow flycatcher, South Fork Kern River, California. California Department of Fish and Game, Bird and Mammal Conservation Program Report 95-4, Sacramento, California. 17 pp.

PROJECT TITLE: Baseline inventories for selected NCP Parks (BLCA, CURE, CEBR, FOBU, HOVE, GOSP, PISP, and TICA)

TAXONOMIC GROUP: MAMMALS - 01

FUNDING STATUS: IM

PROBLEM STATEMENT:

In the Northern Colorado Plateau network there are eight parks in need of baseline surveys. In general, very little previous mammal work has been conducted on these eight parks (see Appendix C for background information on each park) and none has been the subject of a baseline inventory. Five of the eight parks are relatively small [Table 2] (FOBU, HOVE, GOSP, PISP, and TICA) and should be relatively cost-effective to survey, although logistical access to parts of TICA are problematic. The three remaining parks (BLCA, CURE, and CEBR) are of moderate size, are relatively complex, and have several different strata that require sampling. Information is not sufficient to assess if there are selected species of local concern, although bats as a group are of concern, shrews are under-represented in most park work, and information on large mammals is frequently fragmentary and not well documented. Where specific concerns have been raised about sensitive species (e.g., big-eared bats), the baseline inventories will be designed to address these information needs.

OBJECTIVES:

1. Acquire all available historical data on status and occurrence of mammals at five parks, including copies of theses, dissertations, publications, reports, museum records of voucher specimens, and incorporate these data into a centralized database managed by the network;
2. Assess occurrence for all mammals at these parks with the goal of documenting 90% of the potential species occurring at each park, retaining vouchers as necessary or appropriate;
3. Conduct field studies using a combination of random and stratified-random plots, complete inventories (for small parks), focal area surveys for areas of special importance (identified by park staff as possible), historic sites as needed, and intuitive sampling of areas deemed to be of high mammal species richness; Methods for these inventories are described in Section VII of this study plan.
4. Evaluate all sites for their potential for long-term monitoring;
5. Provide a final report detailing the investigations at each park, accompanied by distribution maps (in ARCINFO format) of species occurrence at the parks, management recommendations as appropriate, and comments on status of sensitive species.

STUDY DESIGN AND METHODS:

1. Objective 1: The PI and staff will review available information at each park, request lists of voucher specimens from appropriate museums, review a master list of potential species at each park, and enter these data into a master file for each park.
2. Objective 2: Using the master list approach, as refined by the PI, species will be documented through field inventories; photographs of animals, tracks, or scat; reliable reports of species observed by knowledgeable personnel; and species reported by other agencies (e.g., state fish and game departments).
3. Objective 3: Depending upon the size of the park, availability of data upon which park area can be stratified, and possibility of conducting mammal inventories at some of the same sites used by other vertebrate studies, we will use one or more of the following repeatable approaches at each park:

complete inventories (small parks of a homogeneous nature), randomly-selected study areas based on stratification of the park by elevation, aspect, etc., unequal sampling at selected points of high management interest or potential high species richness, and intuitive sampling based on experience with mammals on the Colorado Plateau.

4. Objective 4: All sites will be evaluated during field studies and subsequent analyses for their potential to serve as long-term monitoring sites because of their uniqueness in terms of species composition, endemism, or presence of sensitive species.
5. Objective 5: The final report, one per park, will be produced in a mutually-agreed to format with all information (species captures/site, voucher specimens, georeferenced localities, distribution maps, etc.) attached as appendices to the final report.

PARTNERSHIPS:

This work will be conducted under an Interagency Agreement with the U.S. Geological Survey, Mid-continent Ecological Science Center, who will serve as a partner and contribute salaries of selected permanent staff, selected equipment, and some museum services as a cost share to the project. In addition, the University of New Mexico and other agencies and entities will be approached about their interest in contributing to the work. In addition, other cooperators who have appropriate expertise and are known to individual parks may be contracted to work at some parks. In all cases, known or potential partners will be asked to contribute either funds or in-kind services that lead to the successful completion of this project.

SCHEDULE:

Survey work for mammals will be conducted primarily from May to September, depending in part upon elevation and climate at the park. Planning assumes a four-person crew at each park. Some parks may lend themselves to some “off-season” sampling of rodents, carnivores, and ungulates; for the most part, bats will be sampled during the summer months. Known, significant wintering aggregations of bats will be censused in the winter months as appropriate. Additional data collection from other sources (agency reports, etc.) will occur in the off-season. Smaller parks will require fewer person-days of work, larger more complex parks will require more time; times are estimates in all cases. Two parks (BLCA and CURE) will be surveyed as a single unit to reduce costs. Years denote when surveys start and end at each park.

Park	Complexity	Person-days/yr	FY-01	FY-02	FY-03	FY-04	Other Comments
BLCA-CURE	High	112	X	X			Strata needed, remote
CEBR	Mod. high	84	X	X			Strata needed
FOBU	Moderate	56	X	X			Previous inventory
GOSP	Low	28	X	X			Complete census
HOVE	Moderate	56	X	X			Dispersed units
PISP	Low	28	X	X			Complete census
TICA	Moderate	28	X	X			Logistical access?

PRODUCTS:

This project will generate documented occurrence of mammals on national parks with a goal of documenting up to 90% of mammal species on each park. Annual reports in a mutually-agreed-to format, including databases, progress, and problems will be provided by the end of each calendar year. Final reports will be provided at mutually-agreed-to dates that allows NPS to use results in continued efforts. In addition, Arcview GIS themes and MS Excel or Access databases of all mutually-agreed-to information will be provided as appendices to the final report. The NCP I&M Coordinator will oversee that project findings and data are placed or updated in the servicewide biological databases as appropriate. Metadata, following FGDC data standards, will be provided by the Principal Investigator.

IMPLEMENTATION:

We plan on conducting this work in a cost-share arrangement with the U.S. Geological Survey Biological Resources Division in Albuquerque. Dr. Mike Bogan, who has done extensive mammal work on the Colorado Plateau will serve as Principal Investigator for these studies.

FUNDING:

Budget Item	FY 2001	FY 2002	FY 2003	FY 2004	Total
Salaries	25,100	25,100			50,200
Equipment (nets, traps, expend.)	2,000	2,000			4,000
Travel:					
Vehicles	5,000	5,000			10,000
Per Diem (camping rate of \$15)	6,000	6,000			12,000
Motel (1/wk)	3,200	3,200			6,400
Curation and Data Management	2,500	2,500			5,000
Direct support costs	6,200	6,200			12,400
NPS Total	\$50,000*	\$50,000*			\$100,000*
Contributed /matching funds (USGS)	\$20,000	\$20,000	\$40,000		\$80,000

* = includes USGS costs for data analysis and report writing

* approximately 15% of this total will be applied to overhead

PROJECT TITLE: Focused inventories for selected parks -- ARCH, CANY, CARE, COLO, ZION

TAXONOMIC GROUP: MAMMALS - 02

FUNDING STATUS: IM

PROBLEM STATEMENT:

In the Northern Colorado Plateau network there are five parks that have had some level of previous survey and that now require completion of those surveys or focused surveys on particular groups of mammals, as decided by participants at the May meeting in Moab. These parks have varying levels of previous surveys: CARE has good coverage but lacks details in some habitats and groups; CANY has good rodent coverage but needs details on bats and carnivores, ARCH needs additional data on bats and carnivores and some rodent work, COLO has a previous survey and recent data on bats, and ZION needs work on bats, lagomorphs, and in some additional habitats (see Appendix ? for background information on each park). Three of the parks are relatively large and complex; ARCH and COLO are less so [need area figures here or reference to table with such] and should be more cost-effective to survey; in places at each park, logistical access will be problematic. Information is not sufficient to assess if there are selected species of local concern, although bats as a group are of concern, shrews are under-represented in most park work, and information on large mammals is frequently fragmentary and not well documented. Where specific needs on sensitive species have been raised (e.g., some bat species), those concerns will be addressed as a part of the focused inventories.

OBJECTIVES:

1. Acquire all available historical data on status and occurrence of mammals at eight parks, including copies of theses, dissertations, publications, reports, museum records of voucher specimens, and incorporate these data into centralized databases maintained by the network;
2. Assess occurrence for all mammals at these parks with the goal of documenting 90% of the potential species occurring at each park, retaining vouchers as necessary or appropriate;
3. Conduct field studies using a combination of random and stratified-random plots, complete censuses (for small parks), focal area surveys for areas of special importance (identified by park staff as possible), historic sites as needed, and intuitive sampling of areas deemed to be of high mammal species richness; Methods for these inventories are described in Section VII of the study plan;
4. Evaluate all sites for their potential for long-term monitoring;
5. Provide a final report detailing the investigations at each park, accompanied by distribution maps (in ARCINFO format) of species occurrence at the parks, management recommendations as appropriate, and comments on status of sensitive species.

STUDY DESIGN AND METHODS:

1. Objective 1: The PI and staff will review available information at each park, request lists of voucher specimens from appropriate museums, review a master list of potential species at each park, and enter these data into a master file for each park.
2. Objective 2: Using the master list approach, as refined by the PI, species will be documented through field inventories; photographs of animals, tracks, or scat; reliable reports of species observed by knowledgeable personnel; and species reported by other agencies (e.g., state fish and game departments).
3. Objective 3: Depending upon the size of the park, availability of data upon which park area can be stratified, and possibility of conducting mammal inventories at some of the same sites used by other

vertebrate studies, we will use one or more of the following repeatable approaches at each park: complete inventories (small parks of a homogeneous nature), randomly-selected study areas based on stratification of the park by elevation, aspect, etc., unequal sampling at selected points of high management interest or potential high species richness, and intuitive sampling based on experience with mammals on the Colorado Plateau.

4. Objective 4: All sites will be evaluated during field studies and subsequent analyses for their potential to serve as long-term monitoring sites because of their uniqueness in terms of species composition, endemism, or presence of sensitive species.
5. Objective 5: The final report, one per park, will be produced in a mutually-agreed to format with all information (species captures/site, voucher specimens, georeferenced localities, distribution maps, etc.) attached as appendices to the final report.

PARTNERSHIPS:

This work will be conducted under an Interagency Agreement with the U.S. Geological Survey, Mid-continent Ecological Science Center, who will serve as a partner and contribute salaries of selected permanent staff, selected equipment, and some museum services as a cost share to the project. In addition, the University of New Mexico and other agencies and entities will be approached about their interest in contributing to the work. In addition, other cooperators who have appropriate expertise and are known to individual parks may be contracted to work at some parks. In all cases, known or potential partners will be asked to contribute either funds or in-kind services that lead to the successful completion of this project.

SCHEDULE:

Survey work for mammals will be conducted primarily from May to September, depending in part upon elevation and climate at the park. Planning assumes a four-person crew at each park. Some parks may lend themselves to some “off-season” sampling of rodents, carnivores, and ungulates; for the most part, bats will be sampled during the summer months. Known, significant wintering aggregations of bats will be censused in the winter months as appropriate. Additional data collection from other sources (agency reports, etc.) will occur in the off-season. Smaller parks will require fewer person-days of work, larger more complex parks will require more time; times are estimates in all cases. Three parks (COLO, ARCH, CANY) are relatively close and will be surveyed sequentially to reduce costs. Years denote when surveys start and end at each park. Some work at ZION can be done in the off-season. Comments on remoteness refer to logistical access problems.

Park	Complexity	Person-days/yr	FY-01	FY-02	FY-03	FY-04	Other Comments
ARCH	Moderate	56			X	X	Stratif. Needed
CANY	High	112			X	X	Stratif. Needed, remote
COLO	Moderate	56			X	X	Stratif. Needed
CARE	Mod. High	84	X	X			Stratif. Needed, remote
ZION	Mod. High	84			X	X	Stratif. Needed, mod. Remote

PRODUCTS:

This project will generate documented occurrence of mammals on national parks with a goal of documenting up to 90% of mammal species on each park. Annual reports in a mutually-agreed-to format, including databases, progress, and problems will be provided within four months of ending of field work. Final reports will be provided at mutually-agreed-to dates on a schedule that allows NPS to use results in continued efforts. In addition, Arcview GIS themes and MS Excel or Access databases of all mutually-agreed-to information will be provided as appendices to the final report. The NCP I&M Coordinator will oversee that

project findings and data are placed or updated in the servicewide biological databases as appropriate. Metadata will be provided by the Principal Investigator.

IMPLEMENTATION:

We plan on conducting this work in a cost-share arrangement with the U.S. Geological Survey Biological Resources Division in Albuquerque. Dr. Mike Bogan, who has done extensive mammal work on the Colorado Plateau will serve as Principal Investigator for these studies.

FUNDING:

Budget Item	FY 2001	FY 2002	FY 2003	FY 2004	Total
Salaries	3514	3514	21586	21586	\$50,200
Equipment (nets, traps, etc.)	280	280	1720	1720	\$4,000
Travel:					
Vehicles	700	700	4300	4300	\$10,000
Per Diem (camping rate of \$15)	840	840	5160	5160	\$12,000
Motel (1/wk)	448	448	2752	2752	\$6,400
Curation and Data Management	350	350	2150	2150	\$5,000
Direct support costs	868	868	5332	5332	\$12,400
NPS Total	\$7,000*	\$7,000*	\$43,000*	\$43,000*	\$100,000*
Contributed/matching funds (USGS)	\$5,000	\$5,000	\$20,000	\$20,000	\$90,000*

* + includes USGS costs in FY05 for data analysis and report writing

* approximately 15% of this total will be applied to overhead

PROJECT TITLE: General Amphibian and Reptile Inventory for NCPN Parks**TAXONOMIC GROUP:** HERPS - 01**FUNDING STATUS:** IM**PROBLEM STATEMENT:**

There is very little information available on the herpetofauna inhabiting parks in the Northern Colorado Plateau network (NCPN). Even for the most basic information on what species occur in each park, there are significant gaps between what has been documented and what species are suspected to occur. This is true for all parks in the NCP, although some parks have better documentation than others. No park has a working knowledge of distribution and abundance of their reptile or amphibian faunas. Policies for managing herpetofauna in these parks cannot be developed until an inventory of species is completed, and it is known which species policies must address. There may be particularly sensitive species present in these parks that require special attention and/or management, but without inventories, there is no way to know if these parks have special herpetofauna.

OBJECTIVES:

1. To compile data of all existing records of occurrence for reptile and amphibian species at all parks in the NCPN.
2. To conduct field surveys at all parks, designed to detect species suspected to occur within a park but currently undocumented, bringing the number of documented species up to at least 90% of the expected species for each park.
3. To incorporate into field surveys efforts to increase documentation of species identified as sensitive by each park.
4. To identify reptile and amphibian species that warrant special management considerations for each park, whether because of known population declines, specific threats to critical habitats, or because the species represent particularly effective monitoring opportunities as part of a "vital signs" monitoring program.
5. To begin to document distribution of reptile and amphibian species in each park, especially those identified as sensitive by the parks.
6. To work with park staff, other NPS, and other experts to develop an effective monitoring program for each park that will enable park Resource Management staff to assess population status of amphibian and reptile species over time in their parks, and detect significant changes in population trends early in these shifts.

STUDY DESIGN AND METHODS:

For the general inventory of all NPS units in the NCPN, we will adopt 'a *think like a lizard*' strategy. The first step will be to compile two lists of species for both reptiles and amphibians. The first will be of all species that are expected to occur in a park, based on range maps, discussions with experts, and records in the parks, etc. The second list will consist of all species known to occur in each park. Species on the former list but not on the latter list will be targeted at that particular park.

After the lists have been developed, searches will be conducted in the specific habitats used by each species, targeting specific activity periods, microhabitats, etc. to maximize the likelihood that each species will be detected. Search methods are described in detail in the general study design for the NCPN.

The parks will be divided into two groups (see Table 1), each group will be surveyed in two of the four years of this project. One group will be surveyed in years 1 and 3, the other group in years 2 and 4. Years 1 and 2 will represent the major efforts to complete the species lists, and years 3 and 4 will be used to target more intensely those species that are still predicted in a particular park but have not been detected yet.

Reptile and amphibian activity patterns vary temporally between species, and even with a specie there are often seasonal shifts in activity that affect detectability (e.g., diurnal to nocturnal shifts, road basking increasing in cooler weather, etc.). To account for these differences, three visits per year are proposed for each park: late spring, summer, and late summer/early fall. Because of the large elevational and latitudinal ranges encompassed by the NCPN, the same season is not experienced in the same calendar period by all parks. Thus, as indicated in the general methods, parks will be surveyed sequentially from south to north and from low elevation to high elevation in spring and summer. The order will be reversed for the late summer/fall survey period (see Schedule below).

Table 1. Designation of parks as low latitude/elevation or high latitude/elevation and assignment to groups.

	Group 1	Group 2
low elevation/latitude parks	PISP, ZION, CARE	CANY, ARCH, NABR, HOVE, COLM
high elevation/latitude parks	BRCA, CEBR, DINO, GOSP, TICA	BLCA, CURE, FOBU

PARTNERSHIPS:

Canyonlands NP (CANY) received funding in 2000 from the Department of Interior's Amphibian Research and Monitoring Initiative (ARMI) to conduct an amphibian inventory of the park. The USGS will continue with efforts in CANY that will include working to develop survey methods for both inventory and monitoring of arid amphibian populations. There are opportunities for collaboration with the crew conducting this work, and to test methods being used in Canyonlands in other environments. The USGS, Canyonlands NP, and Earthwatch Institute have begun a study in Salt Creek in CANY to evaluate the response of amphibians and invertebrates to the closure of the 4WD road in Salt Creek. This study is collecting data on amphibians along three segments of Salt Creek: a) where vehicles are still allowed to drive; b) in the former road section, now closed; and c) in a segment where motor vehicles have not driven for at least 35 years. Data include species present, sizes of individuals, and estimates of abundance based on captures in pitfall traps and transect encounters of all stages of amphibians. These data will provide a basis for understanding distribution patterns and relative abundance of amphibians in different parts of the creek system, and these methods can be exported to other parts of CANY as well as to other park units in the Northern Colorado Plateau Network.

IMPLEMENTATION:

This project will be accomplished through a cooperative agreement with the U.S. Geological Survey, Biological Resources Division offices in Moab and Flagstaff. Dr. Tim Graham, with the Canyonlands Field Station will serve as the Principal Investigator along with Erika Nowak and Trevor Persons from the Colorado Plateau Field Station. Through the joint nature of this project between BRD in Moab and Flagstaff, herptofauna inventories within the Northern and Southern Colorado Plateau Networks will be closely coordinated.

SCHEDULE:

2001:

- March: Hire, train and orient crews, begin surveying low elevations of ZION and PISP.
 April: Continue surveying ZION, conduct full survey of PISP, survey CARE.
 May: Complete surveys at higher elevations of ZION and CARE, begin surveys at BRCA and CEBR, survey TICA, GOSP, begin surveys at DINO
 June: Complete surveys at DINO, BRCA, CEBR. Begin summer surveys at low elevations of ZION, CARE; complete survey of PISP.
 July: Complete surveys at higher elevations of ZION and CARE, begin surveys at BRCA and CEBR, survey TICA and GOSP.
 August: Complete surveys at BRCA, survey DINO. Begin fall surveys at TICA, GOSP, CEBR.
 September: Fall surveys of BRCA, DINO. Survey PISP, ZION, CARE.
 October: Complete surveys of ZION and CARE as needed. Data analysis, annual report preparation (project manager only).
 November: Completion of annual report (project manager only).

2002:

- March (last half): Hire, train and orient crews as needed
 April: Survey CANY, ARCH, NABR, HOVE, COLM (in that order, from low/south to high elevation/north).
 May: Complete spring surveys at HOVE, NABR, COLM. Survey BLCA, CURE, FOBU.
 June: Survey CANY, ARCH, NABR, HOVE, COLM.
 July: Complete surveys at NABR, HOVE, COLM. Survey BLCA, CURE, FOBU.
 August: Begin fall surveys at BLCA, CURE, FOBU.
 September: Fall surveys of COLM, HOVE, NABR, ARCH, CANY.
 October: Complete surveys of CANY and ARCH as needed. Data analysis, annual report preparation (project manager only).
 November: Completion of annual report (project manager only).

2003 and 2004:

April-September, visit parks to survey any special habitats requiring additional attention or survey at different time, based on results of 2001 surveys.

PRODUCTS:

A list of reptile and amphibian species documented to be in each park, based on field surveys associated with this study will be compiled and provided to each park and to the NCP coordinator. In addition, a list of species documented from previous work (based on museum searches, contacts with local herpetologists, etc.) will be provided, along with an assessment of the correspondence between the two lists (e.g., whether differences between the 2 lists can be attributed to changes in environmental conditions or to incomplete surveys in the past or from the current effort). The principal investigator will provide annual reports, a final report, and MS Access databases of all information collected during the project, stored on CD media. The NCP coordinator will ensure that project findings are updated in the servicewide biological databases including NPSpecies, ANCS+, Natural Resource Bibliography, and the Dataset Catalog. Metadata in accordance with FGDC and USGS NBII standards will be provided by the principal investigator. Principal investigator will work with NCP coordinator and NPS GIS specialists to incorporate survey results into GIS ArcView themes.

FUNDING:

Budget Item	FY 2001	FY 2002	FY 2003	FY 2004
Salaries	35190	35190	23577	23577
Benefits	11613	11613	7781	7781
Travel :				
Vehicles	4097	4097	2745	2745
Per Diem	5520	5520	3698	3698
Park Housing/Motel/Camp	2415	2415	1618	1618
Curation and Data Management	1784	1784	1195	1195
Total	60619*	60619*	40614*	40614*

* Approximately 15% of this total will be applied to overhead costs.

PROJECT TITLE: National Park and Regional Herbaria Searches**TAXONOMIC GROUP:** PLANTS - 01**FUNDING STATUS:** partial IM, need other sources**PROBLEM STATEMENT:**

The National Park Service has initiated an effort to catalog the presence of all vascular plant taxa occurring within parks in the national National Park Species (NPSpecies) database. Voucher specimens residing in a variety of institutional herbaria represent a significant information resource on the occurrence and distribution of plant species within individual National Parks. Specimen information from these herbaria is not readily accessible or useable for a variety of reasons including misidentification of specimens, uncertain location information, outdated nomenclature and inaccessibility of data.

Herbaria are located at individual National Parks as well as regional and national universities and museums. 14 of the 16 NCPN parks have herbaria (Table 1). Although individual national parks maintain an automated database (ANCS+) for biological and cultural collections, this data is not always complete. There is a need to update this information.

Table 1. Number of Specimens in National Park Herbaria within the Northern Colorado Plateau.

ARCH	762	DINO	2300
BLCA	497	FOBU	750
BRCA	1135	GOSP	no herbarium
CANY	1630	HOVE	148
CARE	1800	NABR	842
CEBR	684	PISP	no herbarium
COLM	400	TICA	142
CURE	146	ZION	2855

Due to restrictive NPS collections management policies many regional institutions (e.g. universities) have declined to actively curate collections from the parks. As a result communication between regional (and national) herbaria and national parks within the network has been poor. We suspect that collections at these regional institutions contain many plant specimens from network parks and we propose to conduct electronic and manual herbarium searches at these institutions. Searches of regional collections would be coordinated and cost-shared with adjacent networks such as the Southern Colorado Plateau Network.

We propose to do a variety of herbaria searches to obtain voucher information, as well as verifying identifications in collections held by individual parks in the network. This information will be used to update ANCS+ and NPSpecies databases. In addition, location data will be added to network inventory databases used to map species locations.

OBJECTIVES:

1. Conduct an expert review and annotation of all National Park herbaria within the NCPN.
2. Complete an electronic data search of important regional and national herbaria for specimens occurring within NCPN parks.
3. Conduct selected manual herbaria searches to complete gaps in knowledge.

METHODS AND APPROACH:

To meet objective 1 we plan on contracting expert botanical expertise to conduct on-site studies of material in herbarium collections of 13 parks, in order to verify identifications. A review of material in the Fossil Butte NM herbarium was completed this summer by Walt Fertig, botanist with the Wyoming Natural Diversity Database. We anticipate a National Park Service employee working side by side with the expert(s) recording annotation information as the collections are reviewed. To ensure that these corrections are incorporated into the ANCS+ database, we will work directly from a print-out of current ANCS+ plant data. Corrections will be manually entered into ANCS+ and NPSpecies databases. We intend to initiate a portion of the herbarium review work in the first year of this project.

Regional and national herbaria are a potential significant source of plant voucher information for the network. Among these larger herbaria are: Brigham Young University (BRY); University of Utah (Garrett); Northern Arizona University (Deaver); University of Wyoming (Rocky Mountain); San Juan College; Utah State University (Intermountain); University of Colorado (Boulder); University of New Mexico; Southern Utah State University; Mesa College; and Ft. Lewis College. National herbaria include California Academy, Missouri Botanic Gardens, and New York Botanic Gardens.

For objective 2 we need to identify which institutional herbaria have specimen data in electronic formats. In year one we plan on initiating some level of data acquisition from these institutions. We are uncertain of the costs associated with obtaining this electronic data. We plan on coordinating and cost-sharing this work with the Southern Colorado Plateau Network vegetation group.

Objective 3 will require site visits to regional herbaria to manually obtain voucher specimen information where electronic data is not available, or there is a need to view the specimens directly. This work would be conducted by trained botanical NPS staff or expert botanical contractors.

PARTNERSHIP:

Portions of this project targeting acquisition of voucher data from regional and national institutions will be conducted jointly with the Southern Colorado Plateau Network vegetation group. It is possible that other adjacent networks may be interested in a combined effort. Our intention is to cost-share this work where possible.

PRODUCTS:

This project will generate updated presence/absence lists and distribution maps for plant species within Northern Colorado Plateau parks. The identification of all park herbarium collections will be verified and annotated accordingly. These corrections and updates will be incorporated into ANCS+ and NPSpecies databases.

IMPLEMENTATION:

This project will be coordinated by the NCPN Inventory and Monitoring Program Manager. The work will be conducted through a combination of contract and in-house work. We will seek the best expert botanical assistance available for the verification of park plant collections.

FUNDING:

At this time we do not have enough funding to complete all of the work associated with this project. We plan on seeking additional funding through other NPS regional and national competitions. The current inventory funding will be used to complete as many of the herbaria reviews as searches as possible.

Budget Item	FY 2001	FY 2002	FY 2003	FY 2004
Salaries	7,000	8000		
Travel	2,700	2000		
Supplies	300			
Contributed/Matching Funds	TBD	TBD		
TOTAL	10,000*	10,000*		

*Approximately 15% of this total will be applied to overhead.

PROJECT TITLE: General Floristic Survey of Hovenweep National Monument

TAXONOMIC GROUP: PLANTS - 02

FUNDING STATUS: IM

PROBLEM STATEMENT:

A comprehensive floristic inventory of Hovenweep National Monument (HOVE) has not been completed. The most current tally of vascular plants for HOVE is 275 species, and this list is estimated to be approximately 75% complete. The National Park Service herbarium for HOVE contains 137 specimens, primarily from the collections of Dale Schmidt in 1973. Additional inventory work has been conducted over the years by park service biological technician, Marilyn Colyer (1990-1995) and the Colorado Native Plant Society (1998). Although these efforts have contributed to the knowledge of the HOVE flora, a comprehensive understanding is still lacking. Colyer (1996) conducted studies of plant species of special concern during the first half of the 1990s.

The Monument is comprised of six separate units in southeastern Utah and southwestern Colorado. Total acreage of the Monument is 784 acres. Given the small size of the individual units we will not apply a randomized sampling design and we plan on conducting a complete inventory of all units. Where species of special concern are encountered additional effort will emphasize collecting more detailed distribution and abundance data.

OBJECTIVES:

1. Conduct systematic inventory to document vascular plant presence/absence to achieve a 90% complete inventory.
2. For plant species of special concern (rare and exotics) collect detailed distribution and abundance information.

STUDY DESIGN AND METHODS:

A complete floristic survey of all 6 units of Hovenweep National Monument will be conducted over a three-year period. To account for phenological variation in the flora, field visits are planned for four different times within a given field season (March, May, August and October).

Prior to field work all previous botanical work and specimens in the Hovenweep NM herbarium (located at SEUG Headquarters) will be evaluated. Location information from collections will be mapped to determine where most of the botanical work has been performed. Based on an evaluation of this information, locations and habitats within the park in need of further work will be identified.

Voucher specimens will be collected for all unknown plants encountered, as well as those presently unrepresented in the herbarium. All plants collected will be processed by SEUG biologist Charles Schelz and stored in the herbarium at the SEUG Headquarters. All data will be entered into ANCS+ by our curator, Vicki Webster, and into NPSpecies databases by Charles Schelz.

SCHEDULE:

Surveys will be performed 4 times a year, in March, May, August and October for 3 years.

- 2001: Preparation work in January and February of 2001. Map known collection sites in Arc-Info, obtain aerial photos and general collecting equipment. 3 days

Surveys in March, May, August and October. Three days each month for a total of 12 days

November and December: Identify unknown specimens, list and map all plants collected. List all plants found. Write annual report.

2002: Continue surveys in March, May, August and October.

November and December: Identify unknown specimens, list and map all plants collected. List all plants found. Write annual report.

2003: Continue surveys in March, May, August and October

November and December: Identify unknown specimens, list and map all plants collected. List all plants found. Write annual report.

Write Final Report and Species list, submit for publication.

PRODUCTS:

Annual reports for 2001 and 2002. Final report in December, 2003. Final report will include a species list with maps and aerial photos of population locations of species of concern and exotic species. This information will be used to update the suite of inventory and monitoring and ANSC+ databases with more complete presence/absence, distribution and abundance information.

IMPLEMENTATION:

This project will be completed by the SEUG Biologist Charles Schelz and NCPN Network Inventory and Monitoring Project Manager, Angela Evenden.

FUNDING:

It is estimated that the surveys will involve approximately 12 days per year for the botanists with 3-5 days of office work and preparation. Yearly and final reports and voucher preparation will take an additional 5 days per year.

Budget Item	FY 2001	FY 2002	FY 2003	FY 2004
Salaries	4,166	4,166	4,166	
Travel	300	300	300	
Supplies	300			
TOTAL	4,766	4,466	4,466	

REFERENCES CITED:

Colorado Native Plant Society. 1998. Hovenweep National Monument Plant List. On file in Biologist Office at the Southeast Utah Group Headquarters, Moab, UT. 3p.

Colyer, Marilyn. 1996. Data sheets for 18 Threatened and Endangered Plant Species Inventory Relays established from 1993-1996. On file in Biologist Office at the Southeast Utah Group Headquarters, Moab.

PROJECT TITLE: General Vegetation Inventory of Timpanogos Cave National Monument

TAXONOMIC GROUP: PLANTS – 03

FUNDING STATUS: IM

PROBLEM STATEMENT:

The flora of Timpanogos Cave NM (TICA) has not been specifically studied and documented. However, studies in the vicinity of the Monument in the American Fork Canyon and Mt. Timpanogos area provide information on the vascular plant species likely to occur within the Monument boundaries. Kelly Allred conducted a floristic study of Mt. Timpanogos as part of a graduate study through Brigham Young University in the early 1970s (Allred 1974). As part of this effort he compiled a comprehensive vascular plant list for Mt. Timpanogos. This list has been variously labeled as the list for Mt. Timpanogos NM (Allred 1974), however, a conversation with Dr. Allred during July of 2000 confirmed that this list was for the entire area of Mt. Timpanogos (Allred 2000).

The Monument encompasses 250 acres and occupies an extremely steep side-slope of the American Fork Canyon. Given the small size of the Monument a complete floristic inventory will be conducted.

One plant species of special concern is known from within the Monument, *Draba brachystylis*. It is not presently known whether this population has been mapped. If necessary, distribution of this and other species of special concern encountered in this study will be documented with more detailed distribution and abundance information.

OBJECTIVES:

1. Conduct systematic inventory to document vascular plant presence/absence to achieve a 90% complete inventory.
2. For plant species of special concern (rare and exotic) collect detailed distribution and abundance information.

STUDY DESIGN AND METHODS:

A complete floristic walk-through survey will be completed on all 250 acres of the Monument over a two-year period. A trail that extends to a high point in the Monument will be used for access to the range of elevations within the monument. Some areas may be inaccessible since side-slopes are extremely steep with avalanche chutes. To account for phenological variation in the flora, field visits are planned for three to four different periods within a field season (March, May, August and/or October).

Prior to field work all previous botanical work in the Monument vicinity and specimen data from the Timpanogos Cave NM herbarium (142 specimens) will be examined to familiarize the investigator(s) with the local flora and the status of the herbarium collections.

Voucher specimens will be collected for all unknown plants encountered, as well as those presently unrepresented in the herbarium. All plants collected will be processed by the project botanist or contractor and stored in the herbarium at Timpanogos.

PARTNERSHIP: A possible partner in this study would be the botany department at nearby Brigham Young University. Staff and students associated with the herbarium at BYU could assist in collection of field data.

IMPLEMENTATION: Work associated with the project will either be contracted out and/or completed by the NCPN Inventory and Monitoring Program Manager. We will also explore possibilities of involving students and faculty from BYU.

SCHEDULE:

Surveys will be performed 4 times a year, in March, May, August and October for 2 years.

2001: Preparation work in January and February of 2001.

Surveys in March, May, August and October.

November and December: Identify unknown specimens, list and map all plants collected. List all plants found. Write annual report.

2002: Continue surveys in March, May, August and October.

November and December: Identify unknown specimens, list and map all plants collected. List all plants found. Write annual report.

Write Final Report and Species list, submit for publication.

PRODUCTS:

This project will generate presence/absence and distribution data for vascular plants found within Timpanogos Cave NM. This data will be incorporated into tabular and spatial datasets to be developed by the network data management team.

FUNDING:

Budget Item	FY 2001	FY2002	FY 2003	Total
Salaries	3,900	4,000		
Travel	1,000	1,000		
Equipment	100			
TOTAL	5,000*	5,000*		

*Approximately 15% of this total will be applied to overhead

REFERENCES CITED:

Allred, K. 1974. Timpanogos Cave National Monument Vascular Plant List. Unpublished Data. (List is for entire Mt. Timpanogos area, not just the Monument).

Allred, Kelly W. 1975. Timpanogos Flora. Master's Thesis. Brigham Young University, Provo, UT 178p.

Allred, K. 2000. Personal communication with A. Evenden. July 2000.

PROJECT TITLE: General Floristic Inventory of Black Canyon of the Gunnison National Park and Curecanti National Recreation Area

TAXONOMIC GROUP: PLANTS – 04

FUNDING STATUS: IM

PROBLEM STATEMENT:

Floristic inventories of Black Canyon of the Gunnison NP and Curecanti NRA are thought to be incomplete. It is estimated that only 60% of the known flora in each area has been documented. However, a more thorough investigation into past floristic work and an evaluation of existing data is needed to determine how accurate these estimates are and the extent of inventory work actually needed.

Black Canyon of the Gunnison National Park has been the subject of some previous floristic work. In 1969, a professor at Colorado College compiled a plant checklist (Beidelman 1969) substantiated by vouchers which are presumably located in the college collection. In 1983, a more comprehensive checklist was compiled by Dr. William Weber of the Univ. of Colorado in Boulder. This checklist summarizes all previous botanical work by Beidelman and his students, and others. It is presently unknown how complete this species list is. According to Colorado Natural Heritage Program botanists conducting work in the area this field season, new species are still being added to the list. A new location of a regional endemic plant *Thelypodopsis juniperorum* was located within park boundaries during 1999. The park is of moderate size encompassing 31,282 acres. Approximately 10,000 of these acres were added to the park in 1999 and have not been subject to previous inventory work.

In contrast to the natural habitats within Black Canyon of the Gunnison NP, Curecanti NRA is largely comprised of a series of three reservoirs along the Gunnison River. Lands immediately adjacent to these reservoirs have been subject to various degrees of past disturbance including irrigated agriculture and livestock grazing, and now support many exotic plant species. Past floristic inventory work has included a park checklist by Einwalter (1968) and various other investigators. A seasonal park employee, Teresa Ritz (1998) compiled a park checklist based on all existing collections known at that time.

An examination of existing collections will be an important part of establishing an inventory baseline. The herbaria at Black Canyon and Curecanti contain 497 and 146 specimens, respectively. Existing floristic inventory information will be evaluated to determine target habitats and geographical areas of the parks in need of further study.

OBJECTIVES:

1. Conduct systematic inventory to document vascular plant presence/absence to achieve a 90% complete inventory.
2. For plant species of special concern (rare and exotic) collect detailed distribution and abundance information.

STUDY DESIGN AND METHODS:

Floristic inventories in these two parks will be conducted using a targeted, stratified random design. Field methods will include time area searches and/or plots detailed in the general methods section of this study plan. To account for phenological and year-to-year variation in the flora, surveys will be conducted over a two-year period and at several times during the field season.

Prior to field work and final study design development, all previous botanical work and specimen data for collections in the Black Canyon and Curecanti herbaria will be evaluated. Location information from collections will be mapped to determine where most of the botanical work has been performed. Based on an evaluation of this information, locations and habitats within the park in need of further work will be identified.

Voucher specimens will be collected for all unknown plants encountered, as well as those presently unrepresented in the herbarium.

SCHEDULE:

Surveys will be performed 4 times a year, in March, May, August and October for 2 years.

2001: Preparation work in January and February of 2001.

Surveys in March, May, August and October.

November and December: Identify unknown specimens, list and map all plants collected. List all plants found. Write annual report.

2002: Continue surveys in March, May, August and October.

November and December: Identify unknown specimens, list and map all plants collected. List all plants found. Write annual report.

Write Final Report and Species list, submit for publication.

PRODUCTS:

This project will generate presence/absence and distribution data for vascular plants found within Black Canyon and Curecanti. Voucher specimens will be collected and curated. This data will be incorporated into tabular and spatial datasets managed by the network data management team.

IMPLEMENTATION:

It has been suggested that this project be proposed as a graduate student study, possibly with the Univ. of Wyoming at Laramie. Other options for implementation include contracting the work.

FUNDING:

Budget Item	FY 2001	FY 2002	FY 2003	FY 2004
Graduate Student Study		20,000*	20,000*	

*Approximately 15% of this total will be applied to overhead costs.

REFERENCES CITED:

Beidleman, R.G. 1969. Checklist of Black Canyon National Monument Plants. Colorado College. 6 p.

Einwalter, Dean C. 1968. List of Vascular Plants of Curecanti Recreation Area. Unpublished list on file with park headquarters. 13 p.

Ritz, Teresa. 1998. Preliminary list of vascular plant taxa of Curecanti National Recreation Area. Unpublished list on file at park headquarters. 16 p.

Weber, William A. 1983. Checklist of Vascular Plants Black Canyon of the Gunnison National Monument. Unpublished report on file at University of Colorado Museum, Boulder, CO. July 1983. 27 p.

PROJECT TITLE: Inventory of General Flora, Sensitive Plant Species and Invasive Non-native Plants in the Green River District, Dinosaur National Monument

TAXONOMIC GROUP: PLANTS - 05

FUNDING STATUS: IM

PROBLEM STATEMENT:

A systematic botanical survey of Dinosaur National Monument was conducted by the Colorado Natural Areas program under contract with the NPS in 1987-1989 (Naumann 1990). Drought conditions in 1989 hampered efforts to complete fieldwork for the Green River District (Utah Portion of the monument):

“Precipitation collected for the water year beginning October 1988 and ending September 1989 in Dinosaur National Monument (Monument Headquarters, Dinosaur, Colorado) was a record low (155 millimeters/6.09 inches). The 25-year average (1964-1989) was 295 millimeters/11.61 inches (Petersburg, personal communication). The previous record low was 157 millimeters/6.19 inches recorded in 1977. Drought conditions in 1989 had a noticeable effect on plant growth and reproduction. Many taxa remained dormant or failed to reproduce during the growing season in 1989. This reduced the number of sensitive taxa documented, and probably reduced the total number of taxa recorded during the course of the study.”

Historic collections from the Green River District were partially compiled during the 1987-89 study (see references cited in Naumann 1990). Those records, coupled with the complexity of geologic substrates in the area, led to the following recommendation in the final report:

“The unusual concentration of endemic and sensitive plant species in the Green River District is of national significance. Designation of the Green River District as a Special Botanical Interest Area is recommended.”

The monument has been interested in completing detailed inventory and mapping of sensitive species in the Green River District since the 1987-89 project was completed. This work will require specialized searches of rare habitats/species. Documentation of the general flora of this area will likely bring the complete checklist much closer to the 90% target.

Since 1995, the monument has also been very concerned about threats from invasive plants. A combined survey of TES, invasive species and the general flora will maximize efficiency in both fieldwork and herbarium research components of botanical inventory work proposed under the NPS Natural Resource Challenge initiative. We propose to conduct botanical survey work in the Green River District of Dinosaur National Monument (= 56,387 acres) in a manner that is complementary to and consistent with work completed in the 1987-89 surveys completed for the Colorado portions of the monument (=154,456 acres).

GOAL:

Improve NEPA compliance and resource stewardship with respect to botanical resources in Dinosaur National Monument. Document the flora of Dinosaur National Monument to within 90% completion, focusing on the Green River District (Utah portion of the monument). Provide abundance, geographic distribution and conservation status information on species of special concern; provide abundance, geographic distribution and resource threat information on invasive non-native plant species

OBJECTIVES:

1. Conduct a systematic botanical inventory of the Green River District (Utah portion—56,387 acres) in Dinosaur National Monument, focusing primarily on documentation of threatened, endangered, special concern, and invasive plant species.
2. Complement similar surveys that have been completed for the Yampa River District (Colorado portion of the monument) and for adjacent Piceance Basin and western Moffat County, Colorado and Uinta Basin, Utah.
3. Provide a more complete checklist of the flora of Dinosaur National Monument, compiled from fieldwork, literature, and museum sources, complemented by a relatively complete set of verified plant specimens for inclusion in the monument herbarium.
4. Provide baseline data for use in natural resource conservation, management and research within the monument and within a broader regional context.
5. Provide data on sensitive plant resources and invasive plant species to assist managers in implementation of the Dinosaur National Monument Management Plan, especially in areas that are the focus of resource management activities, public education, and facilities planning/development and/or ongoing maintenance.
6. Provide recommendations for areas suitable for long-term monitoring studies, and/or other site-specific special management, based on preliminary assessment of identified threats and/or resource management issues.

STUDY DESIGN AND METHODS:

Objective 1 & 5: Contract botanist(s) will be provided with 1) a print-out of specimen records for the Green River District and adjacent areas, 2) a list of known or expected plant species of special concern for the area, 3) a list of known or expected invasive plants for the study area, 4) geologic and topographic maps of the study area at a scale of 1:24,000, 5) access to aerial photographs of the study area, 6) copies of maps and relevant information that were compiled for the study area during the 1987-89 surveys.

The study area contains extremely rugged and inaccessible terrain, in addition to areas that are proximate to (and influenced by) developed facilities (roads, campgrounds, trails, visitor center and fossil quarry, historic sites, etc.). Sampling strategy will include heavier sampling in areas known or likely to experience impacts from visitor activities or facilities development/maintenance; lighter sampling will occur in inaccessible backcountry areas. Sampling strategy will include stratification by geologic substrate, based on results and recommendations described in Naumann (1990). Known, or high probability habitats will be sampled preferentially for rare and invasive plants.

During the course of searching for special status plants, contract personnel will refer to the specimen print-out and will collect voucher specimens of species encountered that are 1) not represented on the checklist, 2) have no voucher specimens listed for the Utah portions of the monument, 3) appear to be underrepresented in the collections, or 4) are unrecognized taxa. No effort will be made to conduct separate searches for undocumented taxa, except at the direction of the monument botanist or NCP inventory coordinator. Walking search routes will be documented on 1:24,000 topographic maps in a manner consistent with the 1987-89 surveys.

Objective 2: Work will be completed in a manner that is sensitive to and informed by prior work in the local area. Contractor(s) must become familiar with work completed in the Uinta and Piceance Basins and in western Moffat County, Colorado. This work will be used along with the monument list to produce a master list of expected taxa, in consultation with the monument botanist.

Objective 3: Specimens will be collected as described in #1, above. The first sheet of duplicates will be deposited at DINO; any second sheets will go to RM. More complete herbarium research will be conducted at DINO, BRY, COLO, UTC, RM and CS, especially to look for taxa not included on the checklist. If funding permits, the monument botanist will visit the Carnegie Museum to examine and verify Graham's collections from the 1930s.

Objectives 4: Voucher specimens data, maps and associated occurrence data will be collected in a manner consistent with Natural Heritage Program methodologies. Data on species of special concern will be supplied to the Utah or Colorado Natural Heritage Programs, as appropriate. Invasive plant data will be collected in a manner consistent with the State of Montana's *Noxious Weed Survey and Mapping System*.

Objective 6: Recommendations for appropriate long-term monitoring sites will be made based on a comprehensive analysis of new and existing data, taking into account specific park threats and resource issues.

PARTNERSHIP:

Inventory efforts will complement work completed by the Colorado Natural Areas Program in 1987-1989, and will provide follow-up on recommendations originating with that work (Naumann 1990). The monument will seek cooperative funding through the Utah Native Plant Society, Dinosaur Nature Association and the National Fish and Wildlife Foundation's Native Plant Conservation Initiative.

SCHEDULE:

Fieldwork will be conducted by contracted personnel under direction of the monument botanist and the Northern Colorado Plateau inventory coordinator. The monument will support activities by providing logistical support such as boat transportation and use of backcountry facilities, as available. Field activities will occur over two field seasons (2002 - 2003) to provide adequate time for survey efforts and to allow for some annual environmental variability which may affect sampling conditions and population distribution parameters. Museum and literature research will be conducted during the study period at times chosen by the contractor.

PRODUCTS:

1. Annual Progress Report, paper copy.
2. Final Report in paper copy and electronic copy, Microsoft Word format.
3. Paper copy field maps and data forms for TES and invasive non-native species.
4. Digital GPS/GIS data in a format to be specified by the Servicewide I & M Program.
5. Voucher specimens will be provided to Rocky Mountain Herbarium, Laramie, WY for verification and curation.
6. Voucher specimen data in Microsoft Access format, compatible with NPSpecies database.
7. Other electronic databases, as required and specified by the Servicewide I & M Program.

IMPLEMENTATION:

This work will be contracted out.

FUNDING:

Prospective contractors will be required to submit a detailed budget for completing the required work.

Budget Item	FY 2001	FY 2002	FY 2003	FY 2004
Dinosaur National Monument Botanical Inventory Contract Project		25,000*	25,000*	

*Approximately 15% of this total will be applied to overhead costs

REFERENCES CITED:

Naumann, T.S. 1990. Inventory of plant species of special concern and the general flora of Dinosaur National Monument 1987-1989. U.S.D.I. National Park Service Report, Rocky Mountain Region, Denver, CO. 116 pp. + appendices.

PROJECT TITLE: Fossil Butte National Monument Sensitive Plant Inventory

TAXONOMIC GROUP: PLANTS – 06

FUNDING STATUS: IM

PROBLEM STATEMENT:

Fossil Butte National Monument lies in southwestern Wyoming and is the only protected area in this portion of the state. Within the Monument are occurrences of four endemic or rare plant species of special concern: tufted twinpod (*Physaria condensata*), Dorn’s twinpod (*P. dornii*), starveling milkvetch (*Astragalus jejunus*) and *Lepidium integrifolium* var. *integrifolium*. Seasonal botanist, Clayton Kyte at Fossil Butte has completed some work on locating these species within the Monument, however, specific population data has not yet been documented. A more in-depth inventory of these plant populations is proposed.

OBJECTIVES:

1. Document existing populations of plant species of special concern with more detailed distribution and abundance information, as well as GPS locations.

STUDY DESIGN AND METHODS:

Targeted field investigations will be conducted in special habitats for the four plant species of special concern at Fossil Butte National Monument. When populations are encountered they will be mapped and detailed distribution and abundance information will be collected.

PARTNERSHIP:

The Wyoming Natural Diversity Database manages rare plant data within the state of Wyoming and would an appropriate partner in this project.

SCHEDULE:

Field investigations for these species will be scheduled to coincide with flowering periods for these species.

PRODUCTS:

This project will generate presence/absence and distribution data for these species of special concern at Fossil Butte. This data will be incorporated into tabular and spatial datasets managed by the network data management team.

IMPLEMENTATION:

This project could be conducted as a cooperative project with the Wyoming Natural Diversity Database or by use of existing park service staff.

FUNDING:

Budget Item	FY 2001	FY 2002	FY 2003	Total
Salaries	1,100			
Travel	300			
Equipment	100			
Total	1,500*			

*Approximately 15% of this total will be applied to overhead costs

APPENDIX F. Project Statements for Unfunded Inventory Projects.

Western Burrowing Owl Surveys	\$12,000 per year	BIRDS-04
Golden Eagle Surveys	\$15,000 per year	BIRDS-05
Northern Goshawk Surveys	\$15,000 per year	BIRDS-06
Sage Grouse Surveys	\$12000 per year	BIRDS-07
Northern River Otter Inventory	\$35,000	MAMMALS-04
Inventory of Selected Mammal Species of Special Concern	\$50,000	MAMMALS-05
Large Carnivore Workshop	\$6,000	MAMMALS-06
Chuckwalla Survey at Capitol Reef NP	\$6,000 per year	HERPS-02
Field Survey for Roundtail Chub (<i>Gila robusta</i>)	\$10,500	FISH-01
Colorado Cutthroat Trout Survey at CURE	\$10,000	FISH-02
Black Canyon Fish Inventory	\$10,000	FISH-03
Special Status Plant Species Inventory at parks of the Southeast Utah Group	\$15,000	PLANTS-06
General Sensitive Plant Inventory – BRCA, ZION, CEBR	\$ 75,000	PLANTS-07
General Invasive Plant Inventory – Multipark Team	\$110,000	EXOTICS-01

PROJECT TITLE: Western Burrowing Owl Surveys**TAXONOMIC GROUP:** BIRDS - 04**FUNDING STATUS:** Unfunded**PROBLEM STATEMENT:**

Proposed are targeted inventories for burrowing owl in three parks: Arches NP, Canyonlands NP, Curecanti NRA and Dinosaur NM. One to two year inventories would be conducted depending upon how much work is needed at each park.

The breeding range of the burrowing owl *Speotyto cunicularia* throughout the Colorado Plateau ranges from well-drained grasslands, steppes, desert prairies and agricultural lands (Haug et al. 1993). Main breeding habitat characteristics are mainly in dry open shortgrass, treeless plains that are often associated with burrowing mammals. Burrowing owls can be found in golf courses, cemeteries, airports, and vacant lots in residential areas and university campuses. Presence of a nest burrow is a critical requirement for western burrowing owls (Thomsen 1971, Martin 1973, Zarn 1974, Wedgewood, 1978, Haug 1985).

Burrowing owls numbers have declined, mainly due to intensive cultivation of grasslands and native prairies (Bent 1938). Factors that have contributed to these declines include; shooting and trapping, pesticides and degradation of breeding and wintering habitat. Prairie dog control has also been very harmful, destroying owl nesting habitat throughout the western United States (Butts 1973). Evidence of population declines due to habitat destruction, pesticides and predators have been noted in New Mexico, Texas Arizona and Utah. Burrowing owls are listed as species of special concern in Utah (James in press).

OBJECTIVES:

1. Determine and map existing burrowing owl habitat in each National Park.
2. Document the number of burrowing owls in the study area during the breeding season, and determine if the owls are territorial and/or breeding.
3. If breeding burrowing owls are found, determine breeding habitat and territory characteristics, nesting status and nest placement characteristics
4. Develop recommendations for future burrowing owl monitoring and management alternatives

STUDY DESIGN AND METHODS:***Tape broadcast Method***

Burrowing owls produce a variety of calls (Martin 1973). The primary song is considered the mate attraction and territorial call. Given only by the male, this song will be used for these burrowing owl surveys. The call is a "coo coo" two notes of equal frequency with the second note longer than the first. Other calls include distress, warning and copulation calls (Haug and Didiuk 1993).

The survey procedure will be divided into two phases. The initial 10-min. will involve scanning the observation site with binoculars or a spotting scope. At the end of the 10-min. period surveyors will then play a cassette tape of the primary song for 1 min. The broadcast will be repeated after 5 minutes. During and after each broadcast the observation area will be scanned for owl activity and behavioral responses. From the elapsed time to the onset of the broadcast call all owl behavioral response will be recorded. Censuses will not be conducted when winds exceed 20 km/h or during heavy rain. Light winds and drizzle does not seem to depress the behavioral response for the owls to the broadcast calls. Each week the study sites will be checked on foot to determine the number of nesting pairs present.

PARTNERSHIP:

Additional funding will be dependent on state, federal or private lands that are administered adjacent to each park. Potential partners may include; Bureau of Land Management, U. S. Forest Service, State of Utah and Colorado and any other agency or organization that is responsible for the management of these lands.

SCHEDULE:

Field efforts will be conducted by contracted personnel under the direction of the Northern Colorado Plateau inventory coordinator. The network will provide logistical and other support when possible. Field activities will occur over two field seasons in order to provide adequate time for surveys efforts and to allow for annual environmental variability which may affect sampling conditions and population/distribution parameters.

PRODUCTS:

Progress reports will be submitted on an annual basis throughout the duration of this study. These reports will include: (a) a summary of overall progress during each year; (b) indications of any problems encountered during that reporting period; (c) synopsis of work to be undertaken during the following year; and (d) other information pertinent to future needs of the study. These annual reports will be provided at the end of each calendar year and will summarize all progress made during the year of the study.

An initial pre-study meeting will be held following notification of funding. This report will entail discussion for the preliminary proposal, experimental design and proposed deliverables. Input will be solicited from Park staff and their suggestions considered for incorporation into the study following each annual oral presentation. The final oral report will be given following conclusion of the study, and will focus on the results of the study and management recommendations.

A final project report outlining the results of the burrowing owl surveys along with geographic coordinates (ULM or LAT/LONG) of all sites surveyed, and locations where burrowing owls were detected will be presented at the end of the project. A species lists of all birds detected throughout the survey area will also be included in this report

FUNDING:

\$12,000 per year.

REFERENCES CITED:

- Boyce B. 1981. Bird Checklist of Golden Spike National Historical Site.
- Bent, A.C. 1938. Life Histories of North American Birds of prey. U.S. Natl. Mus. Bull. No. 170.
- Butts, K.O. 1973. Life history and habitat requirements of Burrowing Owls in western Oklahoma. M.Sc. thesis, Oklahoma State Univ., Stillwater.
- Haug, E.A. 1985. Observations on the breeding ecology of Burrowing Owls in Saskatchewan. M.Sc. thesis, Univ. Saskatchewan, Saskatoon.
- Haug, E. A. and A. B. Didiuk. 1993. Use of recorded calls to detect Burrowing Owls. J. Field Ornithol. 64:188-194.
- James, P. C., T. J. Ethier, and M. K. Toutloff. (In press). Parameters of a declining Burrowing Owl Population in Saskatchewan. J. Raptor Res.
- Martin, D. J. 1973a. Selected aspects of Burrowing Owl ecology and behavior in central New Mexico. Condor 75:446-456.
- Martin, D.J. 1973b. A spectrographic analysis of Burrowing Owl vocalization. Auk 90:564-578.

Thomsen, L. 1971. Behavior and ecology of Burrowing Owls on the Oakland Municipal Airport. Condor 73:177-192.

Wedgewood, J. A. 1978. The status of the Burrowing Owl in Canada. A report prepared for the committee on the Status of Endangered Wildlife in Canada. Can Wildl. Serv., Ottawa.

Zarn, M. 1974. Burrowing Owl, Report No. 11. Habitat management series for unique or endangered species. Bureau Land Manage., Denver, CO.

PROJECT TITLE: Golden Eagle Surveys – All Parks in Northern Colorado Plateau Network**TAXONOMIC GROUP:** BIRDS - 05**FUNDING STATUS:** Unfunded**PROBLEM STATEMENT:**

Native Americans recently have requested permits to increase the number of golden eagles harvested for religious purposes and to expand the area from which eagles are harvested. To determine potential effects of harvest scenarios, the National Park Service needs information on golden eagle population size and population dynamics. The need for more information about the status of the species and information about its population biology has also been requested from the U.S. Fish and Wildlife Service (USFWS) and the Office of Migratory Bird Management. These agencies in collaboration with the National Park Service will develop a strategy for monitoring golden eagle population status and assessing the potential effects of removal of eagles from the population.

This study will investigate the status of golden eagle (*Aquila chrysaetos*) to determine presence/absence and breeding status in all 16 parks within the Northern Colorado Plateau Network. Most of these parks have little information on golden eagle presence/absence, distribution and abundance and breeding information, but may have potential breeding habitat. One to two-year inventories will be conducted at each park depending on the amount of work needed to complete these inventories within each park.

OBJECTIVES:

1. Review the literature for information relevant to the current status of golden eagles in the study area.
2. Correspond with federal, state, Native American, and non-government biologists to solicit information about golden eagle population biology and opinion about the status of the species.
3. Conduct aerial surveys of potential habitat.
4. Estimate the status of the golden eagle in the study area.

STUDY DESIGN AND METHODS:

Information derived from the literature will include delineation of the distribution (the range) of the golden eagle in the study area during the breeding, migration, and winter seasons; seasonal "habitat" associations; sites at which the eagle has been inventoried, surveyed, studied, or monitored; and population biology information (e.g., density of adults, proportion that attempt nesting, number of young produced, proportion of young that survive to adulthood, and adult survival rates).

Aerial surveys will concentrate on parks where golden eagle habitat exists. Surveys will "target" periods and "types" of birds; 1st the breeding age birds associated with nests, territory holders, during the breeding season, and 2nd, birds, of all ages, associated non-breeding range during the period between breeding and migration.

A total of two aerial surveys will be conducted in National Parks that have adequate habitat or that have had historical sightings. Surveys will occur during the breeding season, beginning in April and ending at end of July and beginning of November and ending at the end of February.

PARTNERSHIP:

Due the concern of this issue, funding has already been established through U.S. Fish and Wildlife Service and USGS-Biological Resource Division.

SCHEDULE:

Field efforts will be conducted by contracted personnel under the direction of the Northern Colorado Plateau inventory coordinator. Field activities will occur over two field seasons in order to provide adequate time for surveys efforts and to allow for annual environmental variability which may affect sampling conditions and population/distribution parameters.

PRODUCTS:

Progress reports will be submitted on an annual basis throughout the duration of this study. These reports will include: (a) a summary of overall progress during each year; (b) indications of any problems encountered during that reporting period; (c) synopsis of work to be undertaken during the following year; and (d) other information pertinent to future needs of the study. These annual reports will be provided at the end of each calendar year and will summarize all progress made during the year of the study.

An initial pre-study meeting will be held following notification of funding. This report will entail discussion for the preliminary proposal, experimental design and proposed deliverables. Input will be solicited from Park staff and their suggestions considered for incorporation into the study following each annual oral presentation. The final oral report will be given following conclusion of the study, and will focus on the results of the study and management recommendations.

A final project report outlining the results of the golden eagle surveys and geographic coordinates (UTM or LAT/LONG) of all sites surveyed, and locations where golden eagles were detected will be presented at the end of the project.

FUNDING:

\$15,000 per year

PROJECT TITLE: Northern Goshawk Surveys**TAXONOMIC GROUP:** BIRDS-06**FUNDING STATUS:** Unfunded**PROBLEM STATEMENT:**

This proposed project will focus on northern goshawk (*Accipiter gentilis*) surveys to determine presence/absence and determine if these species are breeding in Zion National Park, Cedar Breaks National Monument, Colorado National Monument, and Dinosaur National Monument. These parks have little information on Northern Goshawk presence/absence, distribution and abundance and breeding information, but may have potential breeding habitat. One to two-year inventories will be conducted at each park depending on the amount of work needed to complete these inventories of each park.

Northern goshawk breeding range throughout western North America is from western and central Alaska, south to central California, southern Arizona, through the eastern foothills of the Rockies (Squires and Reynolds 1997, AOU 1998).

Goshawks nest in a wide variety of forest types including deciduous, coniferous, and mixed forests. Typically nests in mature or old-growth forests (Reynolds et al. 1982, Speiser and Bosakowski 1987, Detrich and Woodbridge 1994). western U.S., in hardwood-hemlock (*Tsuga canadensis*) forests, where black birch (*Betula lenta*) and American beech (*Fagus grandifolia*) are preferred nest characteristically nests in coniferous forests including those dominated by ponderosa pine (*Pinus ponderosa*; Bright-Smith and Mannan 1994, Reynolds et al. 1992) or lodgepole pine (*Pinus contorta*; Squires and Ruggiero 1996), or in mixed forests dominated by various coniferous species including fir (*Abies* spp), Douglas-fir (*Pseudotsuga menziesii*), cedar (*Thuja* spp), hemlock, spruce (*Picea* spp), and larch (*Larix* spp; Hayward and Escano 1989, Reynolds et al. 1982). Western birds also nest in deciduous forests dominated by aspen (*Populus tremuloides*), paper birch (*Betula papyrifera*), or willow (*Salix* sp.; McGowan 1975, cited in Squires and Reynolds 1997; Swem and Adams 1992, Younk and Bechard 1994).

Goshawks nest generally in the largest trees of dense, mature stands with high canopy closure (60-95 percent) and sparse groundcover, near the bottom of moderate slopes, and near water (Reynolds et al. 1982, Siders and Kennedy 1994). Occasionally will nest in relatively open stands (10 percent canopy coverage; Reynolds et al. 1982).

Goshawks generally forage in both heavily forested and relatively open habitats. In ponderosa pine forest of Arizona, habitat on sites selected for foraging had higher canopy coverage, greater tree density, and greater density of large trees, but lower prey abundance than non-foraging sites (Beier and Drennan 1997).

Threats:

Timber harvest is the principal threat to goshawk breeding populations (Squires and Reynolds 1997). In addition to the relatively long-term impacts of removing nest trees and degrading habitat by reducing stand density and canopy cover, logging activities conducted near nests during the incubation and nestling periods can have an immediate impact resulting in nest failure due to abandonment (Boal and Mannan 1994, Squires and Reynolds 1997). Following canopy reduction by logging, goshawks are often replaced by other raptors including red-tailed hawk (*Buteo jamaicensis*), great horned owl (*Bubo virginianus*), and long-eared owl (*Asio otis*; Crocker-Bedford 1990, Erdman et al. 1998). Fire suppression, grazing, and insect and tree disease outbreaks can result in the deterioration or loss of nesting habitat (Graham et al. 1999).

Predation by great horned owls is especially significant as they prey on both adult and nestling goshawks (Boal and Mannan 1994, Erdman et al. 1998, Rohner and Doyle 1992). Other known or suspected predators include martens (*Martes americana*), fishers (*Martes pennanti*), and wolverines (*Gulo gulo*); Erdman et al. 1998, Graham et al. 1999).

Goshawks were often persecuted in the past (Bent 1937), intentional shooting or trapping is no longer considered a significant source of mortality. The impact of falconry is generally unknown; however, in northern Wisconsin falconers removed an estimated 5 percent of young annually from monitored nests during a 21-year period (Erdman et al. 1998).

STUDY DESIGN AND METHODS:

Playing taped goshawk vocalizations along transects during the nesting season is an effective means of detecting breeding birds (Joy et al. 1994; Kennedy and Stahlecker 1993). Responses by adults are highest when vocalizations are broadcast during the nestling and fledgling-dependency periods. In New Mexico, the alarm call elicited the greatest response during the nestling period, whereas the wail and food-begging calls resulted in a greater response during the fledgling stage (Kennedy and Stahlecker 1993). In Arizona, adults responded at similar rates to the alarm and food-begging calls during the fledgling stage. However, when combining both nesting stages, adults approached more often to the alarm call than to the begging call (Joy et al. 1994). Both sexes respond to broadcast calls, although males are more likely to approach silently than females (Joy et al. 1994). In steep, rugged terrain, where transects are difficult to follow, broadcasting calls from a vehicle on roads can be a labor-efficient and equally effective method of detecting breeding birds, depending on road density and distribution (Bosakowski and Vaughn 1996). Relying on responses to broadcasted calls must be mindful of vocal mimicry by Steller's jays (*Cyanocitta stelleri*; Kennedy and Stahlecker 1993). Listening for spontaneous vocalizations of breeding pairs in the three months preceding egg laying, from 0.5 hour before dawn to approximately 3.25 hours after dawn, resulted in a 100 percent detection rate. However, this technique may have limited usefulness since it requires prior knowledge of territory and nest locations (Reynolds, pers. comm.). Because not all nest sites are used every year, multiple-year surveys may be necessary to determine site use (DeStefano et al. 1994).

FUNDING:

\$ 15,000 per year

REFERENCES CITED:

- American Ornithologists' Union (AOU). 1998. Check-list of North American birds. Seventh edition. American Ornithologists' Union, Washington, DC. 829 pp.
- Beier, P., and J.E. Drennan. 1997. Forest structure and prey abundance in foraging areas of northern goshawks. *Ecological Applications* 7:564-571.
- Bent, A.C. 1937. Life histories of North American birds of prey. Part 1. *Bull. U.S. Natl. Mus.* 137. 409 pp.
- Boal, C. W., and R. W. Mannan. 1994. Northern goshawk diets in ponderosa pine forests on the Kaibab Plateau. *Studies in Avian Biology* 16:97-102.
- Bosakowski, T., and M. E. Vaughn. 1996. Developing a practical method for surveying northern goshawks in managed forests of the western Cascades. *Western Journal of Applied Forestry* 11:109-113.
- Bright-Smith, D. J., and R. W. Mannan. 1994. Habitat use by breeding male northern goshawks in northern Arizona. *Studies in Avian Biology* 16:58-65.
- Crocker-Bedford, D. C. 1990. Goshawk reproduction and forest management. *Wildl. Soc. Bull.* 18:262-269.
- DeStefano, S., S. K. Daw, S. M. Desimone, and E. C. Meslow. 1994. Density and productivity of northern goshawks: implications for monitoring and management. *Studies in Avian Biology* 16:88-91.
- Detrich, P. J. and B. Woodbridge. 1994. Territory fidelity, mate fidelity, and movements of color-marked northern goshawks in the southern Cascades of California. *Studies in Avian Biology* 16:130-132.
- Erdman, T. C., D. F. Brinker, J. P. Jacobs, J. Wilde, and T. O. Meyer. 1998. Productivity, population trend, and status of northern goshawks, *ACCIPITER GENTILIS ATRICAPILLUS*, in northeastern Wisconsin. *Canadian Field-Naturalist* 112:17-27.

- Graham, R.T., R.L. Rodriguez, K.M. Paulin, R.L. Player, A.P. Heap, and R. Williams. 1999. The Northern Goshawk in Utah: habitat assessment and management recommendations. USDA Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-22. 48 pp.
- Hayward, G. D., and R. E. Escano. 1989. Goshawk nest-site characteristics in western Montana and northern Idaho. *Condor* 91:476-479.
- Joy, S. M., R. T. Reynolds, and D. G. Leslie. 1994. Northern goshawk broadcast surveys: hawk response variables and survey costs. *Studies in Avian Biology* 16:24-30.
- Kennedy, P.L., and D.W. Stahlecker. 1993. Responsiveness of nesting northern goshawks to taped broadcasts of 3 conspecific calls. *Journal of Wildlife Management* 57(2):249-257.
- McGowan, J.D. 1975. Distribution, density and productivity of goshawks in interior Alaska. Final report. Federal aid in wildlife restoration. Projects W-17-3, W-17-4, W-17-5, and W-17-6. Job 10.6R. Alaska Dept. of Fish and Game, Juneau, AK. 31 p.
- Reynolds, R. T., E. C. Meslow, and H. M. Wight. 1982. Nesting habits of coexisting Accipiter in Oregon. *Journal of Wildlife Management* 46:124-31.
- Rohner, C. and F. I. Doyle. 1992. Food-stressed great horned owl kills adult goshawk: exceptional observation or community process? *Journal of Raptor Research* 26:261-263.
- Siders, M. S. and P. L. Kennedy. 1994. Nesting habitat of ACCIPITER hawks: is body size a consistent predictor of nest habitat characteristics? *Studies in Avian Biology* 16:92-96.
- Speiser, R., and T. Bosakowski. 1987. Nest site selection by northern goshawks in northern New Jersey and southeastern New York. *Condor* 89:387-394.
- Squires, J. R. and L. F. Ruggiero. 1996. Nest-site preference of northern goshawks in south-central Wyoming. *Journal of Wildlife Management* 60:170-177.
- Squires, J.R., and R.T. Reynolds. 1997. Northern Goshawk (ACCIPITER GENTILIS). In A. Poole and F. Gill, editors, *The Birds of North America*, No. 298. Academy of Natural Sciences, Philadelphia, and American Ornithologists' Union, Washington, DC. 32 pp.
- Swem, T. and M. Adams. 1992. A northern goshawk nest in the tundra biome. *Journal of Raptor Research* 26:102.
- Younk, J. V. and M. J. Bechard. 1994. Breeding ecology of the northern goshawk in high-elevation aspen forests of northern Nevada. *Studies in Avian Biology* 16:119-121.

PROJECT TITLE: Sage Grouse Surveys – DINO, HOVE, GOSP and FOBU

TAXONOMIC GROUP: BIRDS – 07

FUNDING STATUS: Unfunded

PROBLEM STATEMENT:

Greater sage grouse (*Centrocercus urophasianus*) and Gunnison sage grouse (*Centrocercus minimus*) were recently recognized as two species (AOU 2000), both of which occur in or near National Parks on the Northern Colorado Plateau. Gunnison sage grouse currently inhabit southwestern Colorado and southeastern Utah in several small isolated populations. Sage grouse are closely associated with sagebrush ecosystems of western North America. Sagebrush habitat types have tremendous amount of natural variation in vegetation composition, habitat fragmentation, topography and frequency of fire (Braun 1987). Consequently, sage grouse are adapted to a mosaic of sagebrush habitats throughout their range.

Threats

Range reduction since the 1950's have largely been attributed to conversion of sagebrush dominated habitats to agriculture, pasture, and housing developments, while livestock grazing and increased deer and elk populations reduce available grasses for food and nesting cover (Schroeder et al. 1999). The Gunnison sage grouse is federally list Candidate 1 species. Greater sage grouse inhabit a much broader geographic range, including northern Utah and northwestern Colorado, Wyoming, Nevada, eastern California and Oregon, and central Montana. However population declines across this area have documented extirpation from 5 states and 1 province since the early 1900's. These reductions are caused by many of the same factors as for Gunnison sage grouse. While most of these threats do not currently effect most National Park Service (NPS) lands, population changes caused outside NPS holdings certainly may effect local populations within parks. We propose to survey sage grouse and map sage grouse habitat and lekking grounds on NPS lands in Dinosaur NM, Hovenweep NM, Golden Spike NHS, and Fossil Butte NM.

STUDY DESIGN AND METHODS:

Visual counts of sage grouse will be made at each lek throughout the months of April and May. Observations will occur at a distance of 400 m with spottijng scopes and binoculars during repeated daily sessions. Both males and females will be counted, but overall abundance estimates will be based on counts of males because female attendance at leks is irregular. The presence of yearling males will be noted when possible. Peak male attendance at a lek will be taken as the estimate of cock abundance at the site for that season. Peak counts will be combined to derive an overall cock population estimate each year (Emmons and Braun 1984, Braun and Beck 1996).

FUNDING: \$12,000/year

REFERENCES:

- Braun, C.E. Current issues in Sage Grouse Management. Proc. West. Assoc. State Fish and Wildl. Agencies 67:134-144.
- Braun, C.D. and T.D. Beck. 1996. Effects of research on Sage Grouse Management. Transaction of the North American Wildlife and Natural Resources Conference 61:429-436.
- Emmons, S.R. and C.D. Braun. 1984. Lek attendance of male Sage Grouse. Journal of Wildlife Management 48:1023-1028.
- Schroeder, M.A., J.R. Young, and C.E. Braun. 1999. Sage Grouse (*Centrocercus urophasianus*). The Birds of North America, No. 425 (A. Poole and F. Gill, eds.) The Birds of North America. Philadelphia, PA.

PROJECT TITLE: Status of river otters (*Lutra canadensis*) on the Colorado Plateau

TAXONOMIC GROUP: MAMMALS - 04

BACKGROUND AND APPROACH:

Several parks (e.g., ARCH, CANY, DINO) have expressed interest in or concern for the status of river otters in or near the parks. Most concern about otters in the Southwest are with the original endemic subspecies, *L. canadensis sonora*, which originally occupied portions of Utah, Colorado, New Mexico, Arizona, and Nevada. In northern Utah and northwestern Colorado, the original subspecies was *L. c. pacifica*, while in the eastern portion of Colorado *L. c. lataxina* occurred. Records from Hall (1981) suggest that *L. c. sonora* occurred in that part of the Colorado River Basin south of Grand Junction and this would have been the subspecies that historically occurred at ARCH and CANY, as well as parks to the south. Durrant (1952) examined no specimens otters from southern Utah and his only comment on otters from this area was in reference to observations of otters in Glen Canyon by Gregory in 1927(?). In adjacent Arizona, Hoffmeister (1986) refers to the range of river otters as "formerly along the Colorado River, from the Utah line to the Mexican boundary . . ." He believes that they were never present in large numbers. He cites observations of otters in the Colorado River, mostly in the Grand Canyon, from 1909, 1912, and 1916 and says since 1945 otters have been seen at several places but no more recently than 1958. Reports of their presence persist in this area as of 2000, but no specimens that might allow allocation to subspecies seem to be available. In Colorado, Fitzgerald et al. (1994) state that the river otter once occurred in most of the major river drainages of that state and was subsequently extirpated. They further note that in 1976, Colorado initiated restoration efforts in several drainages, including the Colorado River and that stock for these efforts came from six different states or Canadian provinces. These otters represent different subspecies and considerable genetic mixing has occurred. This is a complicating factor in assessing the status of otters elsewhere in the Colorado River Basin. Indeed, concern about otters in southern Utah, however well-intentioned, may apply to descendants of otters originally re-introduced into Colorado. Prior to engaging in recovery efforts in the lower Colorado River, some attempt should be made to determine origin and parentage of otters occurring there.

FUNDING: \$35,000

REFERENCES CITED:

- Durrant, S.D. 1952. Mammals of Utah: taxonomy and distribution. Univ. Kansas Publ., Mus. Nat. Hist., 6:1-549.
- Fitzgerald, J.P., C.A. Meaney, and D.M. Armstrong. 1994. Mammals of Colorado. Denver Museum of natural History and Univ. Press of Colorado, Boulder.
- Hall, E.R. 1981. The mammals of North America. Second ed., 2 vols., John Wiley and Sons, New York.
- Hoffmeister, D.F. Mammals of Arizona. Univ. Arizona Press, Tucson.

PROJECT TITLE: Inventories for selected potential Species of Concern on the Northern Colorado Plateau.

TAXONOMIC GROUP: MAMMALS – 05

FUNDING STATUS: Unfunded

PROBLEM STATEMENT:

In the Northern Colorado Plateau network there are a variety of species that are of potential concern. Reasons for this concern stem from: 1) lack of knowledge about status or population levels of these species; 2) perceptions that these groups are declining even though definitive evidence for the Northern Colorado Plateau is lacking; or the fact that individual parks have expressed concern about these species on their lands. In some cases, some of these species and concerns are incorporated into the broader or focused baseline inventories (Appendix E). However, most work on the species or groups included in this statement will require funding beyond that specified in Appendix E. Many of these species are endemic to the Colorado Plateau, at least at the subspecific level, and thus they represent considerable portions of the endemic mammalian diversity of the Colorado Plateau (Hall 1981). Species included are: shrews of the genera *Sorex* and *Notiosorex* which are widely underrepresented in faunal surveys; selected lagomorphs (*S. nuttallii*, *L. americanus*, *L. townsendii*) which have been reported as extirpated on some parks; several endemic or peripheral ground squirrels (e.g., *Eutamias rufus/hopiensis*, *Ammospermophilus leucurus ssp.*, *Spermophilus tridecemlineatus parvus*, *S. variegatus utah*, *S. spilosoma cryptospilotus*) and two species of tree squirrels (*Tamiasciurus hudsonicus*, *Glaucomys sabrinus*); and several poorly known heteromyids with endemic subspecies on the plateau (e.g., *Perognathus fasciatus*, *P. flavescens*, *P. flavus*, *P. parvus*, *P. longimembris*, *P. formosus*, *Choetodipus intermedius*, *Dipodomys ordii*, *D. microps*, and *D. merriami*).

OBJECTIVES:

1. Acquire all available historical data on status and occurrence of these species, including copies of theses, dissertations, publications, reports, museum records of voucher specimens, and incorporate these data into a centralized database (Excel or Access);
2. Assess occurrence for these species at each park, retaining vouchers as necessary or appropriate;
3. Conduct field studies at likely sites of occurrence of these species, primarily at historic sites, as needed, and intuitive sampling of areas deemed to contain these species;
4. Evaluate sites where these species are found for their potential for long-term monitoring;
5. Provide a final report detailing the investigations at each park, accompanied by distribution maps (in ARCINFO format) of species occurrence at the parks, management recommendations as appropriate, and comments on status of sensitive species.

STUDY DESIGN AND METHODS:

1. Objective 1: The PI and staff will review available information at each park, request lists of voucher specimens from appropriate museums, review a master list of potential species at each park, and enter these data into a master file for each park.
2. Objective 2: Species will be documented through field inventories; photographs of animals, tracks, or scat; reliable reports of species observed by knowledgeable personnel; and species reported by other agencies (e.g., state fish and game departments).
3. Objective 3: Depending upon the size of the park, availability of data upon which park area can be stratified, and possibility of conducting mammal inventories at some of the same sites used by other vertebrate studies, conduct sampling in areas believed to represent appropriate habitat for these species.
4. Objective 4: All sites will be evaluated during field studies and subsequent analyses for their potential to serve as long-term monitoring sites because of their uniqueness in terms of species composition, endemism, or presence of sensitive species.

5. Objective 5: The final report, one per park, will be produced in a mutually-agreed to format with all information (species captures/site, voucher specimens, georeferenced localities, distribution maps, etc.) attached as appendices to the final report.

PARTNERSHIPS:

Suitable partners for these surveys should be sought among faculty and graduate students at universities, federal and state agencies (e.g., BLM, FWS, state game agencies), and non-governmental organizations (e.g., TNC), who can serve as partners and contribute funding and personnel.

PRODUCTS:

Presence and absence data in suitable databases, specimen vouchers as appropriate, and final reports documenting areas searched, level of effort, and results.

FUNDING: \$50,000

REFERENCES CITED:

Hall, E.R. 1981. The mammals of North America. Second ed., 2 vols., John Wiley and Sons, New York.

PROJECT TITLE: Proposed workshop on large carnivores

TAXONOMIC GROUP: MAMMALS – 06

FUNDING STATUS: Unfunded

BACKGROUND AND APPROACH:

During the May 2000 meeting of the two Colorado Plateau networks there was concern expressed by several parks about human safety and aggressive wildlife (primarily black bears and mountain lions).

Large carnivores are a focus of management concern in many of the NPS units on the Colorado Plateau. Cougars (*Felis concolor*) and black bears (*Ursus americanus*) were identified as species of special interest in 11 and 5 parks, respectively, in a survey of the 36 Colorado Plateau NPS units. Of all mammals, cougars were mentioned most often. Although there is general interest in the status and life history of cougars and black bears, the impetus for special interest arose primarily from concerns for human safety. Cougars and black bears can frighten, injure, and kill humans (Herrero 1985, Herrero & Fleck 1990, Beiers 1991). A number of incidents have occurred in National Parks, including several on the Colorado Plateau. There is speculation that incidents may escalate especially with increases in cougar populations.

While there has been significant research on cougars of the Colorado Plateau and other ecologically-similar regions (e.g., Robinette et al. 1959; Ackerman et al. 1984; Hemker et al. 1984; Lindzey et al. 1988, 1994; Anderson et al. 1992; Logan et al. 1996), little of this research has occurred in NPS units. Moreover, much research on cougars has focused on hunter harvest and livestock depredation – issues of little concern on most NPS lands. Research on black bears in or near NPS units on the Colorado Plateau has been limited to a survey in Mesa Verde NP (LeCount & Mollohan 1984) and studies in mountains to the east and south (Ogborn 1990, LeCount 1990, Beck 1991). General principles have been developed for management to minimize conflicts between humans and large carnivores (Herrero 1985, Logan & Sweanor 2000), but application of these principles requires site-specific information as well as compilation and full elucidation of the principles themselves. The need for information predictably increases in instances where managers try to harmonize potentially conflicting objectives, as in NPS units where there is regulatory requirement not only to protect humans, but also to preserve and protect native species such as cougars and black bears.

The extensive movements of large carnivores pose special problems for land managers. Cougars and black bears exist at comparatively low densities and occupy ranges of potentially large size. Most NPS units on the Colorado Plateau are smaller than the average life range of a cougar or black bear in this region (70-700 km² and 20-200 km², respectively). Only a few (GRCA, GLCA, ZION, CANY, and CARE) are probably large enough to contain an appreciable number of cougars. Under these circumstances, management of cougar and bear populations on adjoining lands has major effects on these large carnivores and their interactions with humans in most parks. Managers increasingly recognize that interagency coordination is needed to adequately address a host of management issues. There is little doubt that a high level of such coordination will be required to deal with research and management issues related to large carnivores in NPS units on the Colorado Plateau.

Workshop

A 2-day workshop is planned for late Spring, 2001, to address management and research-needs pertaining to large carnivores on the Colorado Plateau. The location is yet to be determined, but will be chosen to facilitate travel by participants. The existence of suitable facilities also will be taken into consideration. The U.S.G.S. Colorado Plateau Field Station and Resource Management, Grand Canyon NP, will collaborate on planning and conducting the workshop.

Workshop goals & outcomes

1. Compile and present existing information on cougars and black bears in or near Colorado Plateau NPS units.
2. Compile and present information on relevant state and federal regulations, as well as local socio-political considerations relevant to the management of large carnivores.
3. Present existing strategies and other information pertaining to management of humans and large carnivores in park settings.
4. Articulate goals for large carnivore management as defined by existing federal and state regulations, as well as areas of potential common ground among those goals.
5. Formulate potential interagency strategies for managing cougars and black bears in and near Colorado Plateau parks to achieve common and jurisdiction-specific goals.
6. Identify research needs pertaining to large carnivores in and near NPS units and formulate a strategy for meeting these needs.

Workshop participants

Participants will include invited presenters and all interested NPS personnel, land managers from adjoining jurisdictions, state game managers with jurisdiction over wildlife in or near parks, and large carnivore scientists. Presenters will include those with experience in successfully managing cougars and bears in park settings as well as scientists expert in the life histories of cougars and black bears.

Workshop structure

The first day will be devoted to presenting background information relevant to formulating management and research strategies, as per goals 1-3. The second day will be devoted to formulating those strategies, as per goals 4-6.

FUNDING:

A total of \$12,000 will be allocated to conducting this workshop: \$1,000 for refreshments, supplies, and rental of facilities; \$11,000 to cover travel expenses. Of the \$12,000, half (\$6,000) will come from inventory money budgeted for the Northern Colorado Plateau Network of parks and half (\$6,000) from money budgeted for the Southern Colorado Plateau Network. Most travel money will be used to defray the expenses of invited presenters. The remainder will be used to defray the expenses of NPS personnel unable to pay for travel out of other budgets. Priority will be given to personnel directly involved with management of wildlife in their respective parks.

REFERENCES:

- Ackerman, B.B., Lindzey, F.G. and Hemker, T.P. 1984. Cougar food habits in southern Utah. *Journal of Wildlife Management* 48: 147–155.
- Anderson, A.E., Bowden, D.C., Kattner, D.M. 1992. The puma on the Uncompahgre Plateau, Colorado. Colorado Division of Wildlife, Technical Publication No. 40.
- Beck, T.D.I. 1991. Black bears of west-central Colorado. Colorado Division of Wildlife, Technical Publication No. 39.
- Beier, P. 1991. Cougar attacks on humans in the United States and Canada. *Wildlife Society Bulletin* 19: 403–412.
- Hemker, T.P., Lindzey, F.G. and Ackerman, B.B. 1984. Population characteristics and movement patterns of cougars in southern Utah. *Journal of Wildlife Management* 48: 1275–1284.
- Herrero, S. 1985. Bear attacks: their causes and avoidance. Nick Lyons Books, New York, NY.
- Herrero, S. and Fleck, S. 1990. Injury to people inflicted by black, grizzly or polar bears: recent trends and new insights. *International Conference on Bear Research and Management* 8: 25–32.

- LeCount, A.L. 1990. Characteristics of an east-central Arizona black bear population. Arizona Game and Fish Department, Research Branch Technical Report No. 2.
- LeCount, A. and Mollohan, C. 1984. Mesa Verde National Park bear reconnaissance. Unpublished report. 15pp.
- Lindzey, F.G., Ackerman, B.B., Barnhurst, D. and Hemker, T.P. 1988. Survival rates of mountain lions in southern Utah. *Journal of Wildlife Management* 52: 664–667.
- Lindzey, F.G., Van Sickle, W.D., Ackerman, B.B., Barnhurst, D., Hemker, T.P. and Laing, S.P. 1994. Cougar population dynamics in southern Utah. *Journal of Wildlife Management* 58: 619–624.
- Logan, K.A. and Sweanor, L.L. 2000. Puma. Pages 347–377 in S. Demarais and P.R. Krausman, editors. *Ecology and management of large mammals in North America*. Prentice Hall, Upper Saddle River, NJ.
- Logan, K.A., Sweanor, L.L., Ruth, T.K. and Hornocker, M.G. 1996. Cougars of the San Andreas Mountains, New Mexico. Final report, Federal Aid in Wildlife Restoration Project W-128-R, New Mexico Department of Fish & Game, Santa Fe.
- Ogborn, G.L. 1990. Ants (Formicidae) in the diet of American black bears (*Ursus americanus*) in southeastern Utah. M.S. Thesis, Brigham Young University, Provo, UT.
- Robinette, W.L., Gashwiler, J.S. and Morris, O.W. 1959. Food habits of the cougar in Utah and Nevada. *Journal of Wildlife Management* 23: 261–273.

PROJECT TITLE: Chuckwalla Distribution and Abundance Surveys - Capitol Reef National Park**TAXONOMIC GROUP:** HERPS - 02**FUNDING STATUS:** Unfunded**PROBLEM STATEMENT:**

There are several old records of chuckwalla, *Sauromalus ater*, from Glen Canyon National Recreation Area just south and east of Capitol Reef National Park (Tanner 1958, Hayward et al. 1958, Woodbury 1959, Tanner and Avery 1964, Atwood et al. 1980, Hollingworth 1998). The closest record to the park is 21 kilometers (13 miles) but habitat is present in Halls Creek. Hoddenback (1977) stated that the species had been observed in the southern end of the park, but no documentation exists for the species in Capitol Reef other than his reference. The species is ranked as an S2 by the state of Utah. What makes this population very interesting is that this area is the northeastern most limit of the species range. In discussing the chuckwalla in this region, Tanner (1958) states: "...are known from only a few specimens that exhibit interesting variation when contrasted with better known populations outside the Basin." Since that time, Glen Canyon dam has been built and this remote population has been further isolated from its main distribution in the Mojave Desert.

The southern portion of the park has been featured in several national magazines recently and is receiving increased visitor use. The chuckwalla is an NPS sensitive species that may occur in this area of increasing use. Information is needed about presence/absence and, if present, about distribution and habitat utilization. This will help the park protect this interesting species at the periphery of its range.

OBJECTIVES:

1. Determine presence/absence for chuckwallas in Capitol Reef National Park.
2. Document and map the number of chuckwallas in the study area.
3. Determine habitat preference for chuckwallas in the study area.
4. Develop recommendations for future chuckwalla monitoring and management alternatives.

STUDY DESIGN AND METHODS:

Focused surveys for chuckwallas will be conducted in all potential habitat of the park. Potential habitat will be determined by visiting documented locations outside the park. Three visits when chuckwallas are active are proposed for the park each year, late spring, summer, and late summer/early fall. One visit will encompass a total of 10 days, including travel to and from the field crew's base. Because the survey area is so remote, it will take a day to hike in and another day to hike out during each trip.

PARTNERSHIP:

Additional funding will be dependent on state, federal or private lands that are administered adjacent to each park. Potential partners may include; Glen Canyon National Recreation Area and the Southern Colorado Plateau network, universities, and any other agencies or organizations that are responsible for managing lands that contain this species.

SCHEDULE:

Field efforts will be conducted by contracted personnel under the direction of the Northern Colorado Plateau inventory coordinator. Individual parks will support activities by providing logistical support. Field activities

will occur over 2 field seasons in order to provide adequate time for surveys efforts and to allow for annual environmental variability which may affect sampling conditions and population/distribution parameters.

PRODUCTS:

Progress reports will be submitted on an annual basis throughout the duration of this study. These reports will include: (a) a summary of overall progress during each year; (b) indications of any problems encountered during that reporting period; (c) synopsis of work to be undertaken during the following year; and (d) other information pertinent to future needs of the study. These annual reports will be provided at the end of each calendar year and will summarize all progress made during the year of the study.

An initial pre-study meeting will be held following notification of funding. This report will entail discussion for the preliminary proposal, experimental design and proposed deliverables. Input will be solicited from Park staff and their suggestions considered for incorporation into the study following each annual oral presentation. The final oral report will be given following conclusion of the study, and will focus on the results of the study and management recommendations.

A final project report outlining the results of the chuckwalla surveys along with geographic coordinates (UTM or LAT/LONG) of all sites surveyed, and locations where chuckwalla were detected will be presented at the end of the project. A species list of all reptiles detected throughout the survey area will also be included in this report

FUNDING:

\$6,000 per year.

REFERENCES CITED:

- Atwood, N. D., C. L. Pritchett, R. D. Porter, and B. W. Wood. 1980. Terrestrial vertebrate fauna of the Kaiparowits Basin. *Great Basin Naturalist* 40: 303-350.
- Hayward, C. L., D. E. Beck, and W. W. Tanner. 1958. Zoology of the Upper Colorado River Basin: I. The biotic communities. *BYU Science Bulletin, Biological Series* 1(3): 1-74.
- Hoddenbach, G. A. 1977. Preliminary Biological Evaluation of Halls Creek. Capitol Reef National Park, Resource Management Division, Unpublished manuscript. 17pp.
- Hollingsworth, B. D. 1998. The systematics of chuckwallas (*Sauromalus*) with a phylogenetic analysis of other iguanid lizards. *Herp. Monographs*, 12: 38-191.
- Tanner, W. W. 1958. Herpetology of Glen Canyon of the Upper Colorado River Basin. *Herpetologica* 14: 193-195.
- Tanner, and D. F. Avery. 1964. A new *Sauromalus obesus* from the upper Colorado basin of Utah. *Herpetologica* 20: 38-42.
- Woodbury, A. M. 1959. Amphibians and reptiles of Glen Canyon. In *Ecological Studies of Flora and Fauna in Glen Canyon*, Woodbury, A. M. (ed.). Anthropological Papers, No. 40, Department of Anthropology, University of Utah, Salt Lake City.

PROJECT TITLE: Field Survey for Roundtail Chub (*Gila robusta*) at CARE and vicinity

TAXONOMIC GROUP: FISH – 01

FUNDING STATUS: Unfunded

PROBLEM STATEMENT:

The roundtail chub (*Gila robusta*) is endemic to the Colorado River Basin. It is found primarily at middle elevations in large rivers and tributaries. Roundtail chub have declined in distribution and abundance throughout the Colorado River Basin, and are listed as a species of concern in the State of Utah.

Fisheries surveys conducted in Capitol Reef National Park and surrounding areas by Utah State University (Berry et al. 1975; Personal communication, Chuck McAda, U.S. Fish and Wildlife Service, Grand Junction, Colorado) reported roundtail chub in the upper reaches of the Fremont River. Subsequent surveys by the Smithsonian Institute (Personal communication, Wayne Starnes, Curator of Fishes, Smithsonian Institute, Washington, D.C.) failed to find this species. It is unclear if roundtail chub still occur in the Fremont and Dirty Devil rivers.

Occurrence of the roundtail chub in tributaries is important to know. The species has declined in many parts of the basin, and finding and protecting extant populations is important to conservation of the species.

OBJECTIVES:

1. Survey the Fremont, Dirty Devil, and San Rafael rivers, as well as Muddy Creek for the presence of roundtail chub,
2. Document habitats used, and
3. Identify limitations to distribution and abundance.

STUDY DESIGN AND METHODS:

A sampling trip will be conducted during the months of either July, August, or September, depending on weather conditions. Sampling is to be conducted in late summer because the low streamflow increases catch efficiency. Monsoonal rainstorms may cause floods during this time, and trips will be scheduled to avoid these events, when possible. The trip will be 7 days long, including travel to and from the sites. Sampling will be conducted at as many places as possible, with access by vehicle or afoot. Sampling will be conducted primarily with electrofishing equipment and with small seines. Mini-hoop nets and minnow traps will be set overnight. A backpack electroshocker will be used with a CPS system; the CPS system has been designed to minimize adverse effects of electrofishing on fish.

Data on fish will be collected and stored in a manner consistent with Park Service protocol. All fish captured will be identified, counted, measured and weighed, and released. Voucher samples will be taken and provided to the Park Service.

COORDINATION & LOGISTICS:

Sample areas will be accessed by vehicle or afoot. Two contract biologists will conduct the survey with assistance of one or more Park Service employees.

Sampling and handling of fish will require the following permits:

- Utah Division of Wildlife Resources scientific collecting permit, and
- National Park Service collecting permit and collection numbers to sample, capture, hold, and remove a species of wildlife from park boundaries.

SCHEDULE:

Field Trips: One 7-day trip during period of July, August, or September.
 Reports: December 15

PRODUCTS:

A report due December 15 (following field work) will provide a database of all fish captured, consistent with the data collection protocol of the Park Service.

FUNDING:**Budget (Cost Per Trip):**Labor

Scientist Salary & Benefits (70 hr @ \$85/hr)	\$ 5,950
Technician (70 hr @ \$50/hr)	<u>\$ 3,500</u>
	\$ 9,450

Equipment

1 backpack Electroshocker (7 days @ \$50/day)	<u>\$ 350</u>
	\$ 350

Travel and Food

Travel (1,000 miles @ \$0.35/mile)	\$ 350
Per Diem (2 people) (7 days @ \$50/day)	<u>\$ 350</u>
	\$ 700

TOTAL COST PER TRIP	\$10,500
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REFERENCES CITED:

Berry, C., C.W. McAda, and C. Phillips. 1975. Fish survey of southern Utah streams. Utah Cooperative Fishery Research Unit, Utah State University, Logan.

PROJECT TITLE: Colorado Cutthroat Trout Survey at CURE**TAXONOMIC GROUP:** FISH - 02**FUNDING STATUS:** Unfunded**PROBLEM STATEMENT:**

Historically, the Gunnison River, through the area now designated as Curecanti National Recreation Area, contained only four fish species, the flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker (*C. discobolus*), speckled dace (*Rhinichthys osculus*), and Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) (Behnke 1993a). Stocking of nonnative species including brook trout, rainbow trout, and brown trout began in the late 1800s. The continued stocking of nonnative species, along with completion of Blue Mesa dam in 1965, significantly altered the Gunnison River in the recreation area and led to the decline and near demise of the native Colorado River cutthroat trout in the area (Behnke 1993b). A number of tributaries that enter the recreation area, either directly or indirectly, have either historic populations of cutthroat trout or have been stocked with cutthroat trout at one time or another. Most of the populations are thought to be located off of recreation area lands but there is potential that some movement occurs into the recreation area. These waters include North and South Beaver Creeks and some of their tributaries, Big Blue Creek, Cebolla Creek and some of its tributaries, and the Lake Fork of the Gunnison River and some of its tributaries (CDOW, Brauch, pers. com., Aug. 24, 2000). The Colorado River cutthroat trout is listed by the State of Colorado as a State Special Concern Species. As no comprehensive inventory for Colorado Cutthroat trout has been conducted of tributaries to the recreation area, it is unclear if this State Special Concern species is still present in that environment.

OBJECTIVES:

1. Species of Concern – Document presence/absence of Colorado River cutthroat trout in tributaries to Curecanti National Recreation Area. If this species is found, determine distribution and abundance, and habitat characteristics.
2. Develop recommendations for future Colorado River cutthroat trout monitoring and management alternatives.

PRODUCTS:

A survey of Curecanti National Recreation Area tributaries will be conducted for the presence of Colorado River cutthroat trout. If these trout are found during the inventory, the distribution and abundance and habitat characteristics for this species will be determined.

Progress reports will be submitted on an annual basis throughout the duration of this study. These reports will include: (a) a summary of overall progress during each year; (b) indications of any problems encountered during that reporting period; (c) synopsis of work to be undertaken during the following year; and (d) other information pertinent to future needs of the study. These annual reports will be provided at the end of each calendar year and will summarize all progress made during the year of the study.

An initial pre-study meeting will be held following notification of funding. This report will entail discussion for the preliminary proposal, experimental design and proposed deliverables. Input will be solicited from Park staff and their suggestions considered for incorporation into the study following each annual oral presentation. The final oral report will be given following conclusion of the study, and will focus on the results of the study and management recommendations.

A final project report outlining the results of the fish surveys along with geographic coordinates (UTM or LAT/LONG) of all sites surveyed and locations where Colorado River cutthroat trout were detected will be presented at the end of the project. A species lists of all fish detected throughout the survey area will also be included in this report.

FUNDING: \$10,000

REFERENCES CITED:

Behnke, Robert J. 1993a. The Gunnison River drainage and its changing fish fauna part I; historical perspective. 9 pp.

Behnke, Robert J. 1993b. The Gunnison River drainage and its changing fish fauna part II; the native cutthroat trout of the Gunnison drainage and potential for restoration.

Colorado Division of Wildlife. 2000. Personal communication from Dan Brauch, Fishery Biologist, Gunnison, CO to M. Malick, National Park Service, Gunnison, August 24.

PROJECT TITLE: Black Canyon Fish Inventory**TAXONOMIC GROUP:** FISH - 03**FUNDING STATUS:** Unfunded**PROBLEM STATEMENT:**

Historically, the Gunnison River through the area now designated as Black Canyon of the Gunnison National Park, was considered a transition zone between cold water and warm water environments (Behnke 1993a). Native fish species consisted of roundtail chub (*Gila robusta*), flannelmouth sucker (*Catostomus latipinnis*), bluehead sucker (*C. discobolus*), speckled dace (*Rhinichthys osculus*), Paiute sculpin (*Cottus bairdi*), and Colorado River cutthroat trout (*Oncorhynchus clarki pleuriticus*) (Wiltzius 1978). The Gunnison River environment through the park was transformed from a transition zone into a coldwater environment with the construction of the Aspinall Unit of the Colorado River Storage Project (Behnke 1993a). The Aspinall Unit is comprised of Blue Mesa Dam, completed in 1965, Morrow Point Dam, completed in 1968, and Crystal Dam, completed in 1977. A 1966 inventory indicated that all of the above-listed native species were still found in the Gunnison River through the park, with the exception of the Colorado River cutthroat trout (Kinnear & Vincent 1967). The Colorado River cutthroat trout, flannelmouth sucker, bluehead sucker, and roundtail chub are listed by the State of Colorado as a State Special Concern Species. As no comprehensive inventory of the Gunnison River fishery has been conducted through the park since completion of the Aspinall Unit, it is unclear if these State Special Concern species are still present in that environment.

OBJECTIVES:

1. Systematic Fish Inventory – Document presence/absence of fish species in the Gunnison River through Black Canyon of the Gunnison National Park.
2. Species of Concern – Document presence/absence of fish of special management concern that are known or expected to occur in the park based on habitat or historic records.
3. Develop recommendations for future special management concern monitoring and management alternatives.

PRODUCTS:

A survey of the Gunnison River through Black Canyon of the Gunnison National Park will be conducted to determine presence/absence of historically present fish species. If species of management concern are found during the inventory, the distribution and abundance and habitat characteristics for these species will be determined.

Progress reports will be submitted on an annual basis throughout the duration of this study. These reports will include: (a) a summary of overall progress during each year; (b) indications of any problems encountered during that reporting period; (c) synopsis of work to be undertaken during the following year; and (d) other information pertinent to future needs of the study. These annual reports will be provided at the end of each calendar year and will summarize all progress made during the year of the study.

An initial pre-study meeting will be held following notification of funding. This report will entail discussion for the preliminary proposal, experimental design and proposed deliverables. Input will be solicited from Park staff and their suggestions considered for incorporation into the study following each annual oral presentation. The final oral report will be given following conclusion of the study, and will focus on the results of the study and management recommendations.

A final project report outlining the results of the fish surveys along with geographic coordinates (UTM or LAT/LONG) of all sites surveyed and locations where species of management concern were detected will be presented at the end of the project. A species lists of all fish detected throughout the survey area will also be included in this report.

FUNDING: \$10,000

REFERENCES CITED:

Behnke, Robert J. 1993a. The Gunnison River drainage and its changing fish fauna part I; historical perspective. 9 pp.

Kinnear, B. S. and R. E. Vincent. 1967. Fish and fish habitats in Black Canyon of the Gunnison National Monument. Colorado State University, 45 pp

Wiltzius, W. J. 1978. Some factors historically affecting the distribution and abundance of fishes of the Gunnison River. Final Report to Bur. Rec. Fishery Investigations of the lower Gunnison River Drainage. Colorado Division of Wildlife.

PROJECT TITLE: Special Status Plant Species Inventory at parks of the Southeast Utah Group**TAXONOMIC GROUP:** PLANTS - 06**FUNDING STATUS:** Unfunded**PROBLEM STATEMENT:**

Very little inventory work has been done on the sensitive plant species listed above for each park unit of the Southeast Utah Group.

ARCH: Sensitive Plant Inventory including *Lygodesmia entrada*, *Phacelia howelliana* and *Oreoxis trotteri*

CANY: Sensitive Plant Inventory including *Lygodesmia entrada*, *Eriogonum corymbosum* var. *smithii*, *Gilia latifolia* var. *imperialis*, and *Astragalus piscator*

NABR: Inventory of *Astragalus monumentalis*

HOVE: Sensitive Plant Inventory including *Phacelia howelliana*, *Asclepias cutleri*, *Astragalus cronquistii*, *Phacelia indecora*, and *Protriplex pleiantha*.

OBJECTIVES:

This project will locate and map all historic populations and survey and map any new sites.

STUDY DESIGN AND METHODS:

Each species will be evaluated for known locations, habitat requirements, and optimal time of year for surveys.

Aerial photos will be employed in the office and field for potential habitat analysis. All known and newly found population boundaries will be delineated using GPS, and these will be mapped on ortho-photo quads and 7.5 minute topography maps using GIS. These will also be entered into GIS Arc-Info. A permanent panoramic photo-point will also be established at every population site.

A number of these plants are annuals and simply do not show up during dry years, so this will be a multi-year project with a concentrated effort during the high moisture years.

Voucher specimens will be collected for all unknown plants encountered. Sensitive plants listed will only be collected if there is a need. All plants collected will be processed by Charles Schelz and stored in the herbarium at the SEUG Headquarters. All data will be entered into ANCS+ by our curator, Vicki Webster, and into NPSpecies databases by Charles Schelz.

The 90% inventory goal will be determined using the Utah Flora as a guide to what is expected in the area.

SCHEDULE:

Year 1: Preparation work in January and February of Year 1. Map known population sites in Arc-Info, obtain aerial photos and general collecting equipment. 3 days

Surveys in April-June for most species. 8-10 days.

November and December: Identify unknown specimens, list and map all populations. Write annual report.

Year 2: Continue surveys in May-June.

November and December: Identify unknown specimens, list and map all populations found.
Write annual report.

Year 3: Continue surveys in May-June.

November and December: Identify unknown specimens, list and map all populations found.
Write Final Report.

PRODUCTS:

Annual reports for Years 1 and 2. Final report in December, Year 3. Final report will include a species list with maps and aerial photos of all known population locations of species of concern.

FUNDING:

\$15,000 for personnel, equipment, vehicle, and travel expenses. This project may also entail the hiring of a GS-7 seasonal biological technician to assist with field work and data mapping. If a Bio-Tech is utilized, money allotted to the GS-12 position will be used. Some of the position money at the GS-12 level could also be divided with the SEUG as a cost sharing project.

Budget Item	Year 1	Year 2	Year 3	Total
Salaries	4,466	4,466	4,466	15,398
Benefits				
Equipment (herbarium mounting)	100	30	30	160
Travel	300	400	400	1,100
Vehicles				
Per Diem				
Park Housing/Motel/Camp				
Supplies	200	75	75	350
Curation and Data Management				
Contributed/Matching Funds				
TOTAL	5,066	4,971	4,941	15,008

PROJECT TITLE: General Sensitive Plant Inventory – BRCA, ZION, CEBR**TAXONOMIC GROUP:** PLANTS – 07**FUNDING STATUS:** Unfunded**BACKGROUND AND APPROACH:**

Many parks are lacking detailed distribution and abundance information for plant species of special concern, especially in more remote areas. Three parks in the same geographic vicinity are in need of more detailed rare plant surveys: Zion NP, Cedar Breaks NM and Zion NP. Proposed is a multi-park project aimed at filling in some of the inventory information gaps.

The first step in this project will be to identify target species of concern in each park that are in need of inventory. In addition, specific habitats or geographic portions to be inventoried will be identified. We may employ GIS modeling to identify potential habitat, and then conduct searches systematically in potential habitat. An emphasis will also be placed on conducting inventories in remote portions of these parks, which remain unstudied.

These inventories would be conducted over a 3-year period and at appropriate intervals throughout the growing season.

Zion NP: A partial survey of the Zion NP for threatened, endangered, and rare species was conducted in 1988 and 1989 by Dr. Stanley Welsh. At that time, Welsh identified 10 rare (endemic) plants known specifically to Zion and its vicinity. Additionally, 20 species were identified as occurring at the margins of their range. Complementing Welsh's work, in 1990, Joel Tuey of The Nature Conservancy elaborated upon seven of the most rare plants in the park. In 1995 Welsh surveyed for rare plants in Zion Canyon where shuttle system construction was proposed. Much of the west side of the park remains to be adequately surveyed, as well as remote areas. Opportunities to inventory hanging canyons and isolated mesa tops will require the use of a helicopter.

Although some extensive work has been conducted at ZION inventorying rare plants – this was only conducted in more accessible areas. The remote areas of the park remain unsurveyed.

Cedar Breaks NM: In a 1989 report entitled "Plant Community and Rare and Exotic Species Distribution and Dynamics at Cedar Breaks National Monument," Roberts and Jean list seven plant species that are described as "rare." The report further states that plant rarity does not necessarily imply endangerment or possible extinction, but may imply a restricted geographic range or distribution due to physical, biological or man-induced factors. These plant species at Cedar Breaks are associated with the unique geologic Claron limestone formation, which provides habitat for these endemic species. The nature of endemism with its narrowly restricted plant populations led the U.S. Fish and Wildlife Service to consider many of the endemic plants of Cedar Breaks National Monument for listing as threatened or endangered. These are plants that were formerly listed as "Category 3" or "candidate" species, but are now referred to as "Special Concern" species. They include: Navajo Lake milkvetch (*Astragalus limnocharis*); Least spring parsley (*Cymopterus minimus*); Red Canyon catchfly (*Silene petersonii*); Reveal's paintbrush (*Castilleja parvula* var. *revealii*); Cedar Breaks goldenbush (*Haplopappus zionis*); Cliff jamesia (*Jamesia americana* var. *zionis*); and Cliff daisy (*Erigeron proserlyticus*).

Bryce Canyon NP: Currently there are five plant taxa at Bryce Canyon listed in the Federal Register as candidates for threatened or endangered status (*Cryptantha ochroleuca*, *Silene petersonii*, *Castilleja parvula* var. *revealii*, and *Penstemon bracteatus*). Candidate taxa include those for which there is some evidence of vulnerability, but not enough data to support a listing proposal. Most of these plants occur in the unique environment of the "breaks" community. Populations of these plants have been monitored over time and

seem little affected by the current level of tourism activities. *Pediomelum bracteatus* occurs in ponderosa pine stands on the plateau and could be impacted by fuel and fire management activities.

FUNDING:

\$25,000/year for personnel, equipment, vehicle, and travel expenses, for three years. Personnel includes 1 GS-05 bio-tech for 4 months and 1 GS-0430-07 Botanist for 5 months each year. Personnel will be supervised by the Park Botanists at Zion NP and Bryce NP. Includes funds to contract a rock climber (some botanical training provided if necessary) to look at rock crevices at Zion National Park.

Budget Item	Year 1	Year 2	Year 3	Total
Salaries	19560	19560	19560	58680
Benefits				
Equipment	1000	1000	1000	3000
Travel				
Vehicles	2500	2500	2500	7500
Per Diem	1440	1440	1440	4320
Park Housing/Motel/Camp				
Supplies	500	500	500	1500
Curation and Data Management				
Contributed/Matching Funds				
Total	25,000	25,000	25,000	75,000

REFERENCES CITED:

Roberts, David W. and Jean, Catherine. 1989. Plant community and rare and exotic species distribution and dynamics in Cedar Breaks National Monument. Unpublished Report Contract Report No.PX-1200-9-C813 on file at Utah State University, Department of Forest Resources and Ecology Center. Logan, Utah. 185 p.

PROJECT TITLE: Northern Colorado Plateau Multi-Park Inventory of Critical Non-Native Plant Species**TAXONOMIC GROUP:** EXOTICS - 01**FUNDING STATUS:** Unfunded**PROBLEM STATEMENT:**

Invasive non-native plant management is a critical resource problem for parks in the Northern Colorado Plateau Network (NCPN). Aggressive weeds pose a significant threat to the unique and rare botanical resources for which the Colorado Plateau is renowned. Native plant communities, particularly riparian systems and grasslands, are being degraded as invasive weeds outcompete native plants, alter soil chemistry, and change natural fire frequencies.

Obtaining adequate funding to aggressively and proactively address this problem is a constant challenge. Formation of a multi-park team to inventory the abundance, geographic distribution and resource threat of targeted species will enable parks in the NCPN to achieve the common goal of prioritization, prevention and ultimate control of invasive weeds that threaten both natural and cultural resources.

This unified approach maximizes limited funds and resources through shared information, shared personnel and standard inventory protocols.

OBJECTIVES:

1. Integrate Efforts and Prioritize:

- ◆ Coordinate non-native plant management activities among the NCPN parks. Compile previous inventory efforts at all parks and identify data gaps.
- ◆ Prioritize target species and areas.

2. Inventory:

- ◆ Conduct distribution and abundance inventories on targeted non-native plant species at high priority areas.

3. Prepare for Monitoring:

- ◆ Provide recommendations for areas suitable for long-term monitoring studies and sites for monitoring control method efficacy.

STUDY DESIGN AND METHODS:

1. Integrate Efforts and Prioritize: Vegetation program managers from each park will work together to ensure standard inventory techniques. Existing information such as weed species lists, reports and previous inventory efforts will be gathered at each park. Species will be ranked using techniques developed by Hiebert and Stubbendieck (1993) based on degree of weediness and feasibility of control. This ranking will then be used to determine park and Plateau level inventory priorities.

Although nearly all parks in the NPCN have serious weed problems, capability to manage these infestations among the 16 parks varies. A few of the parks have significant efforts with comprehensive inventories, monitoring programs, and well developed treatment priorities. However, many parks have minimal inventories and are only capable of targeting the most critical areas or species. Through coordinated efforts, comprehensive inventories will be completed for all parks and Plateau-wide priorities will be set to coordinate monitoring and control efforts.

2. Inventory: Standardized inventories on high priority species and areas will be conducted at all parks. Data will be collected in a manner consistent with the State of Montana's *Noxious Weed Survey and*

Mapping System. Mapping protocol will also incorporate the Southwest Exotic Plant Mapping Program (SWEMP). Contract botanists will be provided with the following information from each park:

- ◆ geologic and topographic maps at a scale of 1:24,000
- ◆ aerial photographs/ digital ortho photo quads, if available
- ◆ list of known or expected invasive plants
- ◆ copies of maps and relevant information compiled from previous inventory work
- ◆ a prioritization of survey areas and species for inventory

3. Prepare for Monitoring: Recommendations for appropriate long-term monitoring sites and sites for monitoring control method efficacy will be made, taking into account specific park threats and resource issues.

PARTNERSHIP:

Sharing information and resources amongst parks in the NPCN will lead to more efficient inventory of invasive non-native species. This, in turn, will allow managers on the Plateau to better prioritize, monitor and control noxious weed problems.

SCHEDULE:

Fieldwork will be conducted by contracted personnel under the direction of the NCPN Inventory and Monitoring Coordinator. Parks will provide as much assistance as possible. This may include logistical support, housing (at cost to contractor), temporary office space, and personnel. Inventory work will occur over 2 years April through October. Develop two 2-person teams. The teams will travel from park to park, balancing each assignment with the time it takes to complete the work with the ability to identify species during specific months. Data gathering, compilation and management will be conducted during the study period at times chosen by the contractor.

PRODUCTS:

1. Annual Progress Report, paper and electronic copy
2. Final Report in paper and electronic copy, Microsoft Word format
3. Paper copy of field maps and data forms
4. Digital GPS/GIS data in a format specified by the Servicewide I&M Program
5. Data organized in Microsoft Access database
6. Voucher specimens and detailed photographs for new additions to park non-native species lists

FUNDING:

This work will be contracted out. Prospective contractors will be required to submit a detailed budget for completing required work.

Year 1	Year 2	Total
55,000	55,000	110,000

REFERENCES CITED:

Hiebert, R.D. and J. Stubbendiek. 1993. Handbook for Ranking Exotic Plants for Management and Control. Natural Resources Report NPS/NRMWRO/NRR-93/08.

APPENDIX G. Plants and Animals of Special Concern for Northern Colorado Plateau Network Parks

Arches National Park

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Empidonax traillii extimus</i>	southwestern willow flycatcher	G5T2	LE	potential
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4		likely
<i>Gymnogyps californianus</i>	California condor	G1	LE	present
<i>Haliaeetus leucocephalus</i>	bald eagle	G4	(PS)	potential
<i>Strix occidentalis lucida</i>	Mexican spotted owl	G3T3	LT	potential
Mammals				
<i>Mustela nigripes</i>	black-footed ferret	G1	(LE-XN)	potential
Fish				
<i>Catostomus latipinnis</i>	flannelmouth sucker	G3G4		likely
<i>Gila cypha</i>	humpback chub	G1	LE	present
<i>Gila elegans</i>	bonytail	G1	LE	potential
<i>Gila robusta</i>	roundtail chub	G2G3		likely
<i>Ptychocheilus lucius</i>	Colorado squawfish	G1	(LE-XN)	present
<i>Xyrauchen texanus</i>	razorback sucker	G1	LE	likely
Plants				
<i>Argyrochosma limitanea</i> ssp. <i>Limitanea</i>	southwestern cloak fern	G4G5T3T4		present
<i>Cystopteris utahensis</i>		G3?		present
<i>Asclepias cutleri</i>	cutler milkweed	G3		potential
<i>Asclepias macrosperma</i>	large-seeded milkweed	G4		present
<i>Atriplex welshii</i>	Welsh saltbush	G3?Q		likely
<i>Cirsium rydbergii</i>	Rydberg's thistle	G3G4		present
<i>Cryptantha osterhoutii</i>	Osterhout cat's-eye	G2G3		present
<i>Erigeron utahensis</i> var. <i>sparsifolius</i>	Utah fleabane	G4T3?		likely
<i>Eriogonum scabrellum</i>	Westwater buckwheat	G3		potential
<i>Ipomopsis roseata</i>	rosy standing-cypress	G4		present
<i>Lomatium latilobum</i>	Canyonlands lomatium	G1		present
<i>Lygodesmia doloresensis</i>	Dolores River skeleton-plant	G1Q		likely
<i>Lygodesmia entrada</i>	entrada skeleton-plant	G1Q		likely
<i>Mentzelia pterosperma</i>	wing-seed blazing-star	G3?		present
<i>Mimulus eastwoodiae</i>	Eastwood monkey-flower	G3		present
<i>Muhlenbergia thurberi</i>	Thurber's muhly	G3G4Q		present
<i>Oreoxis trotteri</i>	Trotter's oreoxis	G1		potential
<i>Perityle specuicola</i>	alcove rock-daisy	G1		likely
<i>Phacelia howelliana</i>	Howell phacelia	G2		likely
<i>Platanthera zothecina</i>	alcove bog-orchid	G2		present
<i>Xylorhiza glabriuscula</i> var. <i>linearifolia</i>		G4T1T2		present
<i>Zigadenus vaginatus</i>	sheathed death camas	G2		present

Black Canyon of the Gunnison National Park

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4T3		present
Plants				
<i>Cirsium perplexans</i>	Rocky Mountain thistle	G2		likely
<i>Cryptantha longiflora</i>	Long-flower cat's-eye	G3		likely
<i>Gilia penstemonoides</i>	beard-toungue gilia	G3		present
<i>Sullivantia hapemanii</i> var. <i>purpusii</i>	Purpus' sullivantia	G3T3		historic

Bryce Canyon National Park

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Empidonax traillii extimus</i>	southwestern willow flycatcher	G5T2	LE	present
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4		present
<i>Haliaeetus leucocephalus</i>	bald eagle	G4	(PS)	present
<i>Strix occidentalis lucida</i>	Mexican spotted owl	G3T3	LT	potential
Mammals				

<i>Cynomys parvidens</i>	Utah prairie dog	G1	LT	present
Plants				
<i>Astragalus wardii</i>	Ward milkvetch	G3		potential
<i>Castilleja revealii</i>	Reveal's indian paintbrush	G2		present
<i>Cryptantha ochroleuca</i>	yellow-white cat's-eye	G1?		present
<i>Cymopterus minimus</i>	Cedar Breaks biscuitroot	G1G2Q		present
<i>Ericameria zionis</i>	Cedar Breaks goldenbush	G2		present
<i>Erigeron abajoensis</i>	Abajo daisy	G1G2		present
<i>Eriogonum aretioides</i>	widtsoe wild buckwheat	G2		present
<i>Gentianella tortuosa</i>	Utah gentian	G3		present
<i>Heterotheca jonesii</i>	Jones golden-aster	G2		present
<i>Ivesia kingii</i>	King's ivesia	G3	(PS)	potential
<i>Ivesia sabulosa</i>	intermountain ivesia	G3G4		present
<i>Lesquerella rubicundula</i>	Bryce bladderpod	G3	(PS)	present
<i>Lomatium minimum</i>	little desert parsley	G3		present
<i>Oenothera howardii</i>		G3G4		present
<i>Oxytropis oreophila</i> var. <i>jonesii</i>	Jones' point-vetch	G4T3		present
<i>Pediomelum pariense</i>	Paria breadroot	G2G3		present
<i>Penstemon bracteatus</i>	Red Canyon beardtongue	G2		present
<i>Phlox gladiiformis</i>	Red Canyon phlox	G3?		potential
<i>Physaria lepidota</i> var. <i>lepidota</i>		G3T2?		present
<i>Physaria lepidota</i> var. <i>membranacea</i>		G3T2?		present
<i>Senecio malmstenii</i>		G1?		historic
<i>Silene petersonii</i>	Peterson catchfly	G2G3		present
<i>Sphaeromeria capitata</i>	rock-tansy	G3		present
<i>Tetranneuris depressa</i>	depressed bitterweed	G1G2Q		historic
<i>Townsendia alpigena</i> var. <i>minima</i>		G4?T3		present

Canyonlands National Park

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Empidonax traillii extimus</i>	southwestern willow flycatcher	G5T2	LE	potential
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4		likely
<i>Haliaeetus leucocephalus</i>	bald eagle	G4	(PS)	potential
<i>Strix occidentalis lucida</i>	Mexican spotted owl	G3T3	LT	present
Mammals				
<i>Canis lupus</i>	gray wolf	G4	(PS)	historic
<i>Mustela nigripes</i>	black-footed ferret	G1	(LE-XN)	potential
Fish				
<i>Catostomus latipinnis</i>	flannelmouth sucker	G3G4		present
<i>Gila cypha</i>	humpback chub	G1	LE	likely
<i>Gila elegans</i>	bonytail	G1	LE	likely
<i>Gila robusta</i>	roundtail chub	G2G3		likely
<i>Ptychocheilus lucius</i>	Colorado squawfish	G1	(LE-XN)	present
<i>Xyrauchen texanus</i>	razorback sucker	G1	LE	present
Plants				
<i>Argyrochosma limitanea</i> ssp. <i>limitanea</i>	southwestern cloak-fern	G4G5T3T4		present
<i>Cystopteris utahensis</i>		G3?		likely
<i>Argemone corymbosa</i> ssp. <i>arenicola</i>		G3G4T2T3		present
<i>Asclepias labriformis</i>	Utah milkweed	G3		likely
<i>Asclepias macrocarpa</i>	large-seeded milkweed	G4		present
<i>Astragalus missouriensis</i> var. <i>amphibolus</i>	Missouri milkvetch	G5T3T4		potential
<i>Astragalus nidularius</i>	birds-nest milkvetch	G3?		present
<i>Astragalus piscator</i>	Fisher milkvetch	G2G3		present
<i>Astragalus sesquiflorus</i>	sandstone milkvetch	G3?		present
<i>Ceanothus greggii</i> var. <i>franklinii</i>		G5T1T2		historic
<i>Cirsium rothrockii</i>	rose-colored thistle	G3?		likely
<i>Cirsium rydbergii</i>	Rydberg's thistle	G3G4		likely
<i>Cryptantha osterhoutii</i>	Osterhout cat's-eye	G2G3		present
<i>Cymopterus beckii</i>	pinnate spring-parsley	G1		potential
<i>Erigeron utahensis</i> var. <i>sparsifolius</i>	Utah fleabane	G4T3?		present
<i>Eriogonum smithii</i>	Smith wild buckwheat	G1		likely
<i>Gaillardia parryi</i>	Parry's blanket-flower	G3?		likely

<i>Gilia hutchinsifolia</i>	Hutchin's gilia	G3G4		present
<i>Gilia latifolia</i> var. <i>imperialis</i>		G4T2		present
<i>Ipomopsis roseata</i>	rosy standing cypress	G4		present
<i>Mentzelia pterosperma</i>	wing-seed blazing-star	G3?		present
<i>Mimulus eastwoodiae</i>	Eastwood monkey-flower	G3		present
<i>Muhlenbergia thurberi</i>	Thurber's muhly	G3G4Q		present
<i>Oreoxis trotteri</i>	Trotter's oreoxis	G1		likely
<i>Perityle specuicola</i>	alcove rock-daisy	G1		likely
<i>Phacelia howelliana</i>	Howell phacelia	G2		present
<i>Platanthera zothecina</i>	alcove bog-orchid	G2		historic
<i>Sphaeralcea janeae</i>	Jane's globemallow	G1		historic
<i>Vanclevea stylosa</i>	vanclevea	G3		present
<i>Xylorhiza glabriuscula</i> var. <i>linearifolia</i>		G4T1T2		present
<i>Yucca angustissima</i> var. <i>toftiae</i>		G5T2T3		present
<i>Zigadenus vaginatus</i>	sheathed death camas	G2		present

Capitol Reef National Park

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Empidonax traillii extimus</i>	southwestern willow flycatcher	G5T2	LE	present
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4		likely
<i>Haliaeetus leucocephalus</i>	bald eagle	G4	(PS)	potential
<i>Strix occidentalis lucida</i>	Mexican spotted owl	G3T3	LT	present
Mammals				
<i>Vulpes velox</i>	swift fox	G3	(PS)	present
Fish				
<i>Gila robusta</i>	roundtail chub	G2G3		present
Plants				
<i>Argyrochosma limitanea</i> ssp. <i>limitanea</i>	southwestern cloak-fern	G4G5T3T4		present
<i>Asclepias labriformis</i>	Utah milkweed	G3		present
<i>Asclepias macrosperma</i>	large-seeded milkweed	G4		present
<i>Asclepias uncialis</i> ssp. <i>ruthiae</i>	Ruth milkweed	G3?T3?		present
<i>Astragalus chamaeleuce</i> var. <i>laccoliticus</i>		G5T2?		present
<i>Astragalus coltonii</i> var. <i>coltonii</i>	Colton milkvetch	G4T3		present
<i>Astragalus consobrinus</i>	Bicknell milkvetch	G2G3		present
<i>Astragalus desperatus</i> var. <i>conspicuosus</i>	Barneby milkvetch	G5T3		historic
<i>Astragalus desperatus</i> var. <i>petrophilus</i>		G5T3		present
<i>Astragalus episcopus</i>	Bishop milkvetch	G3G4		present
<i>Astragalus harrisonii</i>	Harrison's milkvetch	G2G3		present
<i>Astragalus malacoides</i>	Kaiparowits milkvetch	G3		present
<i>Astragalus moencoppensis</i>	Moenkopi milkvetch	G3G4		present
<i>Astragalus musiniensis</i>	Ferron milkvetch	G2		present
<i>Astragalus pardalinus</i>	panther milkvetch	G3?		present
<i>Astragalus sesquiflorus</i>	sandstone milkvetch	G3?		present
<i>Astragalus wardii</i>	Ward milkvetch	G3		present
<i>Astragalus welshii</i>	Welsh milkvetch	G2G3		present
<i>Cryptantha abata</i>	dent-nut cat's-eye	G3		present
<i>Cryptantha johnstonii</i>	Johnston cat'-eye	G1G2		present
<i>Cryptantha mensana</i>	southwestern cat's-eye	G3		present
<i>Cryptantha setosissima</i>	bristly cat's-eye	G3?		present
<i>Cryptantha tenuis</i>	pretty cat's-eye	G3G4		present
<i>Cycladenia humilis</i> var. <i>jonesii</i>	Jones' cycladenia	G3G4T2	LT	present
<i>Cymopterus beckii</i>	pinnate spring-daisy	G1		present
<i>Erigeron abajoensis</i>	Abajo daisy	G1G2		present
<i>Erigeron awapensis</i>	Awapa daisy	G1Q		present
<i>Erigeron maguirei</i>	Maguire daisy	G2	LT	present
<i>Erigeron utahensis</i> var. <i>sparsifolius</i>	Utah fleabane	G4T3?		present
<i>Eriogonum corymbosum</i> var. <i>revelianum</i>	Reveal corymbed wild buckwheat	G5T3		present
<i>Eriogonum tumulosum</i>	woodside buckwheat	G3		present
<i>Euphorbia nephradenia</i>	Paria spurge	G2		present
<i>Gilia caespitosa</i>	Wonderland Alice-flower	G1	C	present
<i>Gilia tenuis</i>	Mussentuchit gilia	G1		present
<i>Ipomopsis roseata</i>	rosy standing-cypress	G4		present

<i>Lomatium junceum</i>	rush desert-parsley	G2G3		present
<i>Mentzelia marginata</i>		G2Q		present
<i>Mentzelia pterosperma</i>	wing-seed blazing-star	G3?		present
<i>Mimulus eastwoodiae</i>	Eastwood monkey-flower	G3		present
<i>Nama retrorsum</i>	Betatakin nama	G3		present
<i>Oenothera howardii</i>		G3G4		present
<i>Opuntia basilaris</i> var. <i>heilii</i>		G5T2?		present
<i>Pediocactus winkleri</i>	Winkler's pin-cushion cactus	G1	LT	present
<i>Penstemon moffattii</i>	Moffatt's beardtongue	G3?		present
<i>Penstemon ophianthus</i>	Arizona beardtongue	G3G4		present
<i>Phacelia rafaensis</i>	San Rafael phacelia	G3		present
<i>Physaria acutifolia</i> var. <i>purpurea</i>		G5T2		present
<i>Platanthera zothecina</i>	alcove bog-orchid	G2		present
<i>Schoenocrambe barnebyi</i>	Sye's Butte plainsmustard	G1	LE	present
<i>Sclerocactus wrightiae</i>	Wright fishhook cactus	G2	LE	present
<i>Sphaeralcea janeae</i>	Jane's globemallow	G1		historic
<i>Sphaeralcea psoraloides</i>	psoralea globemallow	G2		potential
<i>Spiranthes diluvialis</i>	Ute ladies' tresses	G2	LT	present
<i>Tetrandeum depressa</i>	depressed bitterweed	G1G2Q		present
<i>Thelesperma subnudum</i> var. <i>alpinum</i>		G5T1		present
<i>Townsendia aprica</i>	Last Chance townsendia	G1	LT	present
<i>Xylorhiza confertifolia</i>	Henrieville woody-aster	G2G3		present

Cedar Breaks National Monument Species

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4		likely
<i>Haliaeetus leucocephalus</i>	bald eagle	G4	(PS)	potential
<i>Strix occidentalis lucida</i>	Mexican spotted owl	G3T3	LT	potential
Plants				
<i>Aster wasatchensis</i>		G3?		present
<i>Astragalus limnocharis</i> var. <i>limnocharis</i>	Navajo Lake milkvetch	G2T1		present
<i>Castilleja revealii</i>	Reveal's indian paintbrush	G2		present
<i>Cymopterus minimus</i>	Cedar Breaks biscuitroot	G1G2Q		present
<i>Ericameria zionis</i>	Cedar Breaks goldenbush	G2		present
<i>Erigeron nematophyllus</i>	needle-leaf fleabane	G3		present
<i>Erigeron proselyticus</i>	professor daisy	G2		present
<i>Eriogonum pangucense</i> var. <i>alpestre</i>	Pangiutch wild buckwheat	G3T2T3Q		present
<i>Gentianella tortuosa</i>	Utah gentian	G3		present
<i>Ipomopsis spicata</i> ssp. <i>tridactyla</i>		G4?T2		present
<i>Ivesia sabulosa</i>	intermountain ivesia	G3G4		present
<i>Jamesia americana</i> var. <i>zionis</i>		G5T2		present
<i>Lesquerella rubicundula</i>	Bryce bladderpod	G3	(PS)	present
<i>Senecio malmstenii</i>		G1?		present
<i>Silene petersonii</i>	Peterson catchfly	G2G3		present
<i>Townsendia alpigena</i> var. <i>minima</i>		G4?T3		present

Colorado National Monument Species

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4T3		present
<i>Strix occidentalis lucida</i>	Mexican spotted owl	G3T3	LT	likely
Plants				
<i>Astragalus linifolius</i>	Grand Junction milkvetch	G3Q		present
<i>Astragalus musiniensis</i>	Ferron milkvetch	G2		likely
<i>Cryptantha longiflora</i>	long-flower cat's-eye	G3		historic
<i>Cryptantha osterhoutii</i>	Osterhout cat's-eye	G2G3		present
<i>Lomatium eastwoodiae</i>	Eastwood desert-parsley	G3G4		present
<i>Lomatium latilobum</i>	Canyonlands lomatium	G1		present
<i>Pediomelum aromaticum</i>	aromatic scurf pea	G3		present
<i>Platanthera sparsiflora</i> var. <i>ensifolia</i>	canyon bog-orchid	G4G5T3?		present

Curecanti National Recreation Area

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Centrocercus urophasianus</i>	Gunnison sage grouse	G1		likely
Plants				
<i>Astragalus anisus</i>		G2		present
<i>Astragalus wetherillii</i>	Wetherill's milkvetch	G3		likely
<i>Corydalis caseana</i> ssp. <i>brandegeei</i>	Sierra corydalis	G5T3T4		historic
<i>Gilia penstemonoides</i>	beardtongue gilia	G3		present
<i>Sullivantia hapemanii</i> var. <i>purpusii</i>	Purpus' sullivantia	G3T3		historic

Dinosaur National Monument

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Charadrius montanus</i>	mountain plover	G2	PT	likely
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4		likely
<i>Grus americana</i>	whooping crane	G1	(LE-XN)	potential
<i>Haliaeetus leucocephalus</i>	bald eagle	G4	(PS)	present
<i>Strix occidentalis lucida</i>	Mexican spotted owl	G3T3	LT	likely
Mammals				
<i>Mustela nigripes</i>	black-footed ferret	G1	(LE-XN)	potential
Fish				
<i>Catostomus latipinnis</i>	flannelmouth sucker	G3G4		present
<i>Gila cypha</i>	humpback chub	G1	LE	present
<i>Gila elegans</i>	bonytail	G1	LE	present
<i>Gila robusta</i>	roundtail chub	G2G3		present
<i>Ptychocheilus lucius</i>	Colorado squawfish	G1	(LE-XN)	present
<i>Xyrauchen texanus</i>	razorback sucker	G1	LE	present
Plants				
<i>Cystopteris utahensis</i>		G3?		present
<i>Arabis fernaldiana</i> var. <i>feraldiana</i>	rockcross	G3G4T3T4		present
<i>Astragalus chloodes</i>	grass milkvetch	G3		present
<i>Astragalus detritalis</i>	debris milkvetch	G3		likely
<i>Astragalus duchesnensis</i>	Duchesne milkvetch	G3		present
<i>Astragalus hamiltonii</i>	Hamilton milkvetch	G1		present
<i>Astragalus nelsonianus</i>	Nelson milkvetch	G2		likely
<i>Astragalus saurinus</i>	Dinosaur milkvetch	G3		present
<i>Carex curatorum</i>	Kaibab sedge	G2		present
<i>Cirsium ownbeyi</i>	Ownbey's thistle	G3		present
<i>Cymopterus duchesnensis</i>	Uinta Basin spring-parsley	G3		present
<i>Erigeron wilkenii</i>	Wilken fleabane	G1		potential
<i>Eriogonum lonchophyllum</i> var. <i>saurinum</i>	Dinosaur buckwheat	G4T3		present
<i>Eriogonum tumulosum</i>	woodside buckwheat	G3		present
<i>Hedysarum boreale</i> var. <i>gremiale</i>		G5T1		historic
<i>Hymenoxys lapidicola</i>	rock hymenoxys	G1Q		present
<i>Lepidium huberi</i>		G1G2		potential
<i>Muhlenbergia thurberi</i>	Thurber's muhly	G3G4Q		present
<i>Oenothera acutissima</i>	narrow-leaf evening primrose	G2		present
<i>Oxytropis besseyi</i> var. <i>obnapiformis</i>	Bessey locoweed	G5T2		present
<i>Penstemon angustifolius</i> var. <i>vernalensis</i>	Vernal narrow-leaf penstemon	G5T3		present
<i>Penstemon gibbensii</i>	Gibben's beardtongue	G1		likely
<i>Penstemon scariosus</i> var. <i>cyanomontanus</i>		G4T2		present
<i>Penstemon yampaensis</i>	Penland's beardtongue	G3Q		likely
<i>Platanthera zothecina</i>	alcove bog-orchid	G2		present
<i>Spiranthes diluvialis</i>	Ute ladies' tresses	G2	LT	present
<i>Trifolium andinum</i>	intermountain clover	G3		present
<i>Zigadenus vaginatus</i>	sheathed death camas	G2		present

Fossil Butte National Monument

Species	Common Name	G Rank	Federal Status	Site Status
Plants				
<i>Astragalus jejunus</i> var. <i>jejunus</i>	starveling milkvetch	G3T3		present
<i>Lepidium integrifolium</i> var. <i>integrifolium</i>		G2T1?		historic
<i>Penstemon paysoniorum</i>	Payson beardtongue	G3		present
<i>Physaria condensata</i>	dense twinpod	G2		present
<i>Townsendia nuttallii</i>	Nuttal Townsend-daisy	G3		present

Golden Spike National Historic Site

Species	Common Name	G Rank	Federal Status	Site Status
Plants				
<i>Allium passeyi</i>	Passey's onion	G1		present

Hovenweep National Monument

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4		potential
<i>Haliaeetus leucocephalus</i>	bald eagle	G4	(PS)	potential
<i>Strix occidentalis lucida</i>	Mexican spotted owl	G3T3	LT	potential
Plants				
<i>Astragalus cronquistii</i>	Cronquist's milkvetch	G2		potential
<i>Astragalus naturitensis</i>	Naturita milkvetch	G2G3		potential
<i>Grindelia laciniata</i>	cut-leaf gumweed	G2G3		potential

Natural Bridges National Monument

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4		potential
<i>Haliaeetus leucocephalus</i>	bald eagle	G4	(PS)	potential
<i>Strix occidentalis lucida</i>	Mexican spotted owl	G3T3	LT	potential
Plants				
<i>Aletes maddougali</i> ssp. <i>breviradiatus</i>	Mesa Verde aletes	G3T2T3		present
<i>Astragalus nidularius</i>	birds-nest milkvetch	G3?		likely
<i>Carex specuicola</i>	Navajo sedge	G2	LT	potential
<i>Cirsium rothrockii</i>	rose-color thistle	G3?		likely
<i>Cirsium rydbergii</i>	Rydberg's thistle	G3G4		present
<i>Erigeron kachinensis</i>	kachina daisy	G2		present
<i>Erigeron utahensis</i> var. <i>sparsifolius</i>	Utah fleabane	G4T3?		likely
<i>Gilia latifolia</i> var. <i>imperialis</i>		G4T2		potential
<i>Ipomopsis roseata</i>	rosy standing-cypress	G4		present
<i>Mimulus eastwoodiae</i>	Eastwood monkey-flower	G3		present
<i>Muhlenbergia thurberi</i>	Thurber's muhly	G3G4Q		present
<i>Platanthera zothecina</i>	alcove bog-orchid	G2		present
<i>Zigadenus vaginatus</i>	sheathed death camas	G2		present

Pipe Springs National Monument

Species	Common Name	G Rank	Federal Status	Site Status
Plants				
<i>Opuntia basilaris</i> var. <i>aurea</i>		G5T3		present

Timpanogos Cave National Monument

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4		likely
<i>Haliaeetus leucocephalus</i>	bald eagle	G4	(PS)	potential
Plants				
<i>Draba brachystylis</i>	Wasatch draba	G1G2		present

<i>Jamesia americana</i> var. <i>macrocalyx</i>		G5T2		present
<i>Penstemon platyphyllus</i>	broad-leaf beardtongue	G2G3		present

Zion National Park

Species	Common Name	G Rank	Federal Status	Site Status
Birds				
<i>Charadrius montanus</i>	mountain plover	G2	PT	likely
<i>Empidonax traillii extimus</i>	southwestern willow flycatcher	G5T2	LE	present
<i>Falco peregrinus anatum</i>	American peregrine falcon	G4		present
<i>Haliaeetus leucocephalus</i>	bald eagle	G4	(PS)	present
<i>Pelecanus erythrorhynchos</i>	American white pelican	G3		present
<i>Pipilo aberti</i>	Abert's towhee	G3G4		present
<i>Strix occidentalis lucida</i>	Mexican spotted owl	G3T3	LT	present
Mammals				
<i>Microtus montanus rivularis</i>	Virgin River montane vole	G5T2?Q		potential
Fish				
<i>Catostomus clarki</i>	desert sucker	G3G4		present
<i>Catostomus latipinnis</i>	flannelmouth sucker	G3G4		present
<i>Lepidomeda mollispinis</i>	Virgin spinedace	G1	(PS)	present
Plants				
<i>Cystopteris utahensis</i>		G3?		present
<i>Selaginella utahensis</i>	Utah spike-moss	G2G3		historic
<i>Aquilegia flavescens</i> var. <i>rubicunda</i>		G5T1		present
<i>Aster wasatchensis</i>		G3?		present
<i>Astragalus ensiformis</i>	pagumpa milkvetch	G3		present
<i>Astragalus episcopus</i> var. <i>lancearius</i>	lancer milkvetch	G3G4T2T3		present
<i>Astragalus striatiflorus</i>	escarpment milkvetch	G3		potential
<i>Astragalus subcinereus</i>	silver milkvetch	G3?		present
<i>Camissonia bairdii</i>	Baird's cammisonia	G1		present
<i>Camissonia multijuga</i>	frost-stem sun-cup	G3?		present
<i>Camissonia parryi</i>	Parry's evening primrose	G3?		present
<i>Carex haysii</i>		G1		present
<i>Cryptantha cinerea</i> var. <i>arenicola</i>		G5T3?		present
<i>Cryptantha decipiens</i>	gravel cat's-eye	G3G4		present
<i>Draba asprella</i> var. <i>zionensis</i>	Zion whitlow-grass	G4T3?		present
<i>Draba rectifruca</i>	mountain whitlow grass	G3?		present
<i>Epilobium nevadense</i>	Nevada willowherb	G2		present
<i>Erigeron proselyticus</i>	professor daisy	G2		present
<i>Erigeron religiosus</i>	religious daisy	G3?		present
<i>Erigeron sionis</i>	Zion daisy	G2G3		present
<i>Eriogonum jamesii</i> var. <i>rupicola</i>	sandstone wild buckwheat	G5T2T3		present
<i>Eriogonum panguicense</i>	Panguich buckwheat	G3		present
<i>Eriogonum thompsoniae</i> var. <i>albiflorum</i>	white-flow Thompson wild buckwheat	G4T2T3		present
<i>Eriogonum thompsoniae</i> var. <i>matthewsiae</i>	Mathew's wild buckwheat	G4T1?		present
<i>Eriogonum zionis</i> var. <i>zionis</i>	Zion wild buckwheat	G4QT2		present
<i>Hackelia patens</i> var. <i>harrisonii</i>		G5T2T3		present
<i>Heterotheca jonesii</i>	Jones golden-aster	G2		present
<i>Isocoma humilis</i>		GH		historic
<i>Ivesia sabulosa</i>	intermountain ivesia	G3G4		present
<i>Jamesia americana</i> var. <i>zionis</i>		G5T2		present
<i>Lesquerella intermedia</i>	Sante Fe bladder-pod	G3?		present
<i>Lomatium graveolens</i> var. <i>clarkii</i>		G5?T1		present
<i>Lupinus flavoculatus</i>	yellow-eye lupine	G3G4		present
<i>Lupinus latifolius</i> ssp. <i>leucanthus</i>		G5T2T3		present
<i>Muhlenbergia thurberi</i>	Thurber's muhly	G3G4Q		present
<i>Oenothera howardii</i>		G3G4		present
<i>Opuntia basilaris</i> var. <i>aurea</i>		G5T3		present
<i>Pediomelum mephiticum</i>	skunk-top scurf pea	G3?		present
<i>Pediomelum pariense</i>	Paria breadroot	G2G3		present
<i>Penstemon humilis</i> ssp. <i>obtusifolius</i>	lowly beardtongue	G5T2T3		present
<i>Penstemon leonardii</i> var. <i>higginsii</i>		G4G5T3?		present
<i>Perityle tenella</i>		G3?		present
<i>Phacelia rafaensis</i>		G3		present

<i>Physaria lepidota</i> var. <i>lepidota</i>		G3T2?	present
<i>Physaria lepidota</i> var. <i>membranacea</i>		G3T2?	present
<i>Ranunculus oreogenes</i>		G3?	present
<i>Sphaeromeria ruthiae</i>	Zion tansy	G2	present
<i>Viola charlestonensis</i>	Charleston violet	G3Q	present

APPENDIX H. Vegetation Types of Northern Colorado Plateau Parks																	
Community Type	Species	ARCH	BLCA	BRCA	CANY	CARE	CEBR	COLM	CURE	DINO	FOBU	GOSP	HOVE	NABR	PISP	TICA	ZION
Forest and Woodland																	
Subalpine Spruce-Fir	<i>Picea engelmannii-Abies bifolia</i>			X			X										
Limber Pine	<i>Pinus flexilis</i>			X			X										
Bristlecone Pine	<i>Pinus longaeva</i>			X		X	X										
Blue Spruce	<i>Picea pungens</i>		X	X		X	X										
Douglas Fir	<i>Pseudotsuga menziesii</i>		X	X	X	X	X	X	X	X				X		X	X
Douglas Fir-White Fir	<i>Pseudotsuga menziesii-Abies concolor</i>			X			X									X	X
Douglas Fir-Ponderosa Pine	<i>Pseudotsuga menziesii-Pinus ponderosa</i>									X							
Douglas Fir-LimberPine-Aspen	<i>Pseudotsuga menziesii-Pinus flexilis-Populus tremuloides</i>										X						
Aspen	<i>Populus tremuloides</i>		X	X	X	X	X	X	X	X	X						X
Ponderosa Pine	<i>Pinus ponderosa</i>		X	X		X	X	X	X	X							X
Gambel's Oak	<i>Quercus gambelii</i>		X	X	X	X	X	X	X				X	X			X
Rocky Mountain Maple-Gambel's Oak	<i>Acer glabrum-Quercus gambelii</i>							X									x
Bigtooth Maple-Gambel's Oak	<i>Acer grandidentatum-Quercus gambelii</i>			X	X											X	X
Live Oak	<i>Quercus turbinella</i>	X			X								X	X			X
Alligator Juniper	<i>Juniperus deppeana</i>																
Pinyon-Utah Juniper	<i>Pinus edulis-Juniperus osteosperma</i>	X	X	X	X	X		X	X	X		X	X	X	X		X
Pinyon-One-seed Juniper	<i>Pinus edulis-Juniperus monosperma</i>		X														
Curl-leaf Mountain Mahogany	<i>Cercocarpus ledifolius</i>									X							
Shrubland																	
Black Sagebrush	<i>Artemisia nova</i>	X	X	X	X			X	X	X		X	X	X			X
Big Sagebrush	<i>Artemisia tridentata</i>	X	X	X	X	X		X	X	X	X	X	X	X			X
Low Sagebrush	<i>Artemisia arbuscula</i>										X						
Rubber Rabbitbrush	<i>Chrysothamnus nauseosus</i>	X	X		X			X	X	X		X	X	X	X		X
Sticky-leaved Rabbitbrush	<i>Chrysothamnus viscidiflorus</i>	X		X	X	X		X		X					X		X
Blackbrush	<i>Coleogyne ramosissima</i>	X			X	X							X	X			X
Four-wing Saltbush	<i>Atriplex canescens</i>	X	X	X	X			X	X	X		X	X	X	X		X
Shadscale	<i>Atriplex confertifolia</i>	X			X	X		X		X			X	X			X
Desert Holly	<i>Atriplex hymenoletra</i>																
Goldenhead	<i>Acamptopappus sphaerocephalus</i>																X
Winterfat	<i>Eurotia lanata</i>	X			X					X							
Brittlebush	<i>Encelia farinosa</i>																
Creosote Bush	<i>Larrea tridentata</i>																X
Sand Shrub	<i>Ephedra viridis/cutleri-Artemisia filifolia</i>	X			X	X									X		X
Greaswood-Saltbush	<i>Sarcobatus vermiculatus-Atriplex canescens</i>									X							
Mixed Mountain Shrubland	<i>Artemisia tridentata-Purshia tridentata-Cercocarpus ledifolius</i>									X	X						

Community Type	Species	ARCH	BLCA	BRCA	CANY	CARE	CEBR	COLM	CURE	DINO	FOBU	GOSP	HOVE	NABR	PISP	TICA	ZION
Barren																	
Slickrock Barren	<i>various species-no dominants</i>	X			X	X		X		X				X			X
Rocky barrens	<i>various species-no dominants</i>		X	X	X		X		X	X	X						X
Other unclassified types																	
Talus communities	<i>various species-no dominants</i>	X	X		X	X	X	X	X	X				X			X
Dry streambeds	<i>various species-no dominants</i>	X	X	X	X	X		X	X	X				X			X
Saline	<i>various species-no dominants</i>										X						
Total Alliances (73)		34	24	24	42	36	16	26	21	40	11	9	22	26	14	4	39

APPENDIX I. Facilities and logistical support available by park.

PARK	HOUSING	OFFICE SPACE	VEHICLES	OTHER
ARCH	Housing: limited availability. Hotels and campgrounds available.	none	none	
BLCA/ CURE	Housing: variety of housing at CURE, limited at BLCA. Occassionally a dorm room available for short term stays.	Limited space available.	Limited availability – for short term periods, especially over weekends.	
BRCA	Most years housing is unavailable from May to September. Camps are available for crews working during the summer months.	Office space should be available upon completion of the headquarters building rehab. (August 2001). Computers and phone are available to be shared with seasonal staff. FAX and copy machine available.	Availability is difficult to predict. Most of the time logistics can be arranged for crews to borrow park vehicles for 2 to 4 week time periods.	Horse packing support can be arranged through private contractors available outside the park.
CANY	Housing: limited availability. Campgrounds available.	Office space possibly available.	Vehicles possibly available.	
CARE	Camping is available for up to 8 tents at a research site in the Fruita area.	Off-season office space only.	No vehicles are available.	Horse packing support into remote areas.
CEBR	Camping available.	none	none	
COLM	Housing: possible space. Campground in Monument.	Office possibly available.	May have vehicle available for limited and short-term use in Monument.	
DINO	Housing: limited availability of apartment space at established rental rate. Camping: limited availability of a trailer; several trailer pads with electric & sewer facilities are available; primitive camping in established campgrounds or backcountry.	Office space: available near the Headquarters area. Computer would only be available during the off-season, but facilities would accommodate lap-top computer. Phone, fax and copy facilities are available.	Limited availability of vehicle(s) in the off season, or for short-term use.	Limited raft support available for river-related work. DINO Resource Management staff will assist with logistics and field support where possible.
FOBU	Motels and rental units are available in Kemmerer. Temporary housing for 1-4 persons may be available. A	Limited space available. The VIP travel trailer is equipped with computer, modem and fax.	Limited availability – for short term periods, especially over weekends.	

	small travel trailer (2 persons) set up for V.I.P. housing is available on 1 st come 1 st serve basis. No campsites in park, however camping is available nearby.			
GOSP	Housing: 3 fully equipped RVs and three RV hookups. RVs in use part of year by archeological field crew.	Available w/ telephone, data jack, fax, etc.	One government vehicle.	
HOVE	Housing: limited availability. Camping available.	none	none	
NABR	Housing: limited availability. Camping available.	none	none	
PISP	Camping available.	None	none	
TICA	Housing: not available. Motels nearby in American Fork or Lehi for about \$60/night. Camping: none in the Monument, however 2 USFS campgrounds within 5 miles of Monument.			
ZION	Housing: only available Sept. through March. Research Camp: camping at Oak Creek w/tent platforms, port-a-john & picnic tables + shower facility – up to 10 people. Short-term campsites for no charge.	After 2002 may have some office space. In meantime Grotto house may be available w/no phone.	Case by case basis – depends on needs of other staff.	Zion staff will assist with logistics and extra staffing to I&M crews when possible.