# Grand Canyon National Park

# Resource Management Plan

Part One—Narrative

January 1997

# Grand Canyon National Park

## Resource Management Plan

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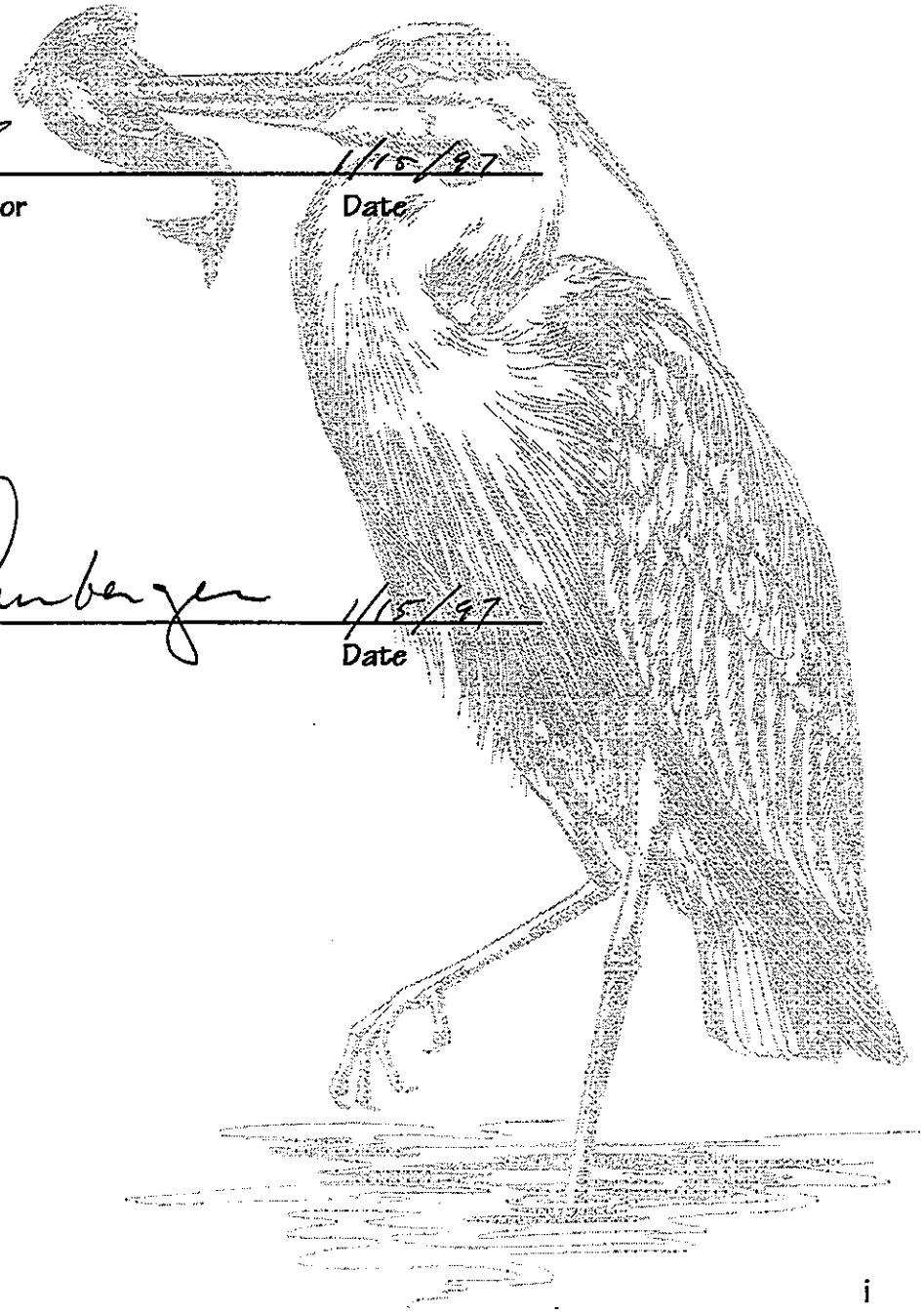

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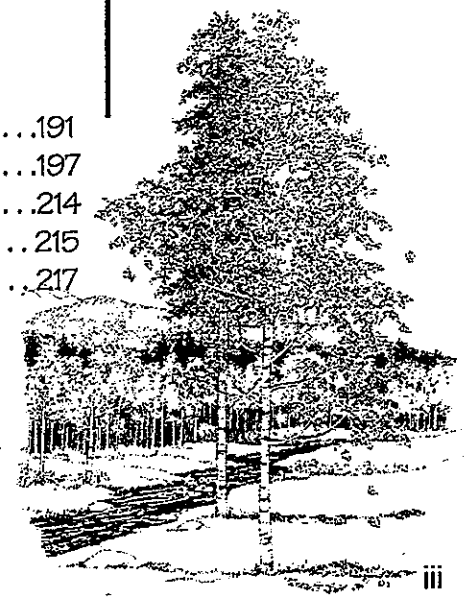

# PREFACE

## Plan Purpose

The purpose of the Resource Management Plan (RMP) is to provide long-term guidance and direction for the stewardship of the natural, cultural and recreational resources of Grand Canyon National Park. Primary stewardship functions include management, interpretation, education, research, inventory, monitoring, mitigation, law enforcement, and maintenance. These functions are required to perpetuate natural processes, and natural and cultural resources in Grand Canyon National Park; to achieve Park purposes and management objectives; and to regulate Park use.

This Plan recognizes that the physical resource provides the basis for unique and valued visitor experiences. These experiences are vastly important; however, their management is beyond the scope of this Plan. Physical resources as they effect visitor experiences will be mentioned in this Plan, and frequent references will be made to other plans which address experience in greater detail.

This Plan draws upon appropriate legislation, National Park Service (NPS) policies and guidelines, goals and priorities established in the 1995 Grand Canyon National Park General Management Plan, as well as on a knowledge of Park resources and their special needs. This Plan provides a basis for setting goals and priorities, measuring resource accomplishments against documented needs, and making budget decisions.

This Plan is designed to be revised every four years; project statements will be added and deleted annually.

This RMP is the result of a three-year planning process beginning in 1993 that defined what actions need to be taken to provide for the protection and management of these resources. The initial RMP scoping session, held in 1993, was attended by over 60 participants. Resource managers from the United States Forest Service (USFS), Arizona Game and Fish, United States Fish and Wildlife Service (USFWS), Northern Arizona University (NAU) Department of Forestry and Research, the Colorado Plateau Research Station of the U.S. Geological Survey's Biological Resource Division, the Aldo Leopold Wilderness Research Institute, NPS central offices and neighboring parks all contributed significantly to the process.

The RMP is divided into a narrative section and a section containing project statements derived from the RMP computer database. It includes the actions and contributions of all Park operational units and partners in achieving our shared resource-stewardship goals. Although the preparation and implementation of the Plan is the responsibility of the Grand Canyon National Park Science Center, resource management projects routinely involve shared responsibilities and interdivisional cooperation for successful development and implementation. Resource management issues often transcend Park boundaries requiring the coordination of other State, Federal and local agencies as well as American Indian groups, private interests and landowners.

### Relationship to Other Plans

The Park's General Management Plan provides the overall objectives for Park management; the RMP is the primary resource-stewardship action plan. There is another group of plans referred to as visitor-use action plans that focus on the management of visitor activities and recreational resources in the Park. Examples include the Wilderness Management Plan, Colorado River Management Plan, and the Aircraft Management Plan.

It must be stressed, however, that there is an obvious connection between the management of visitor use, experiential resources, and the protection of natural and cultural and recreational resources.

In other cases, resource issues are so complex and/or controversial that they cannot be adequately dealt with in this document. These require their own individual resource action plans. The need for these plans is identified in this document, and their relevance to current management objectives and issues will be described. Some of these plans will require public and peer review; examples include the Fire Management Plan, Cultural Landscape Management Plan, and the Cave Management Plan.

## Regional Planning and Coordination

Grand Canyon National Park is located within the Colorado Plateau physiographic region. The resources stewardship actions described in this document are guided by the fundamental tenet of maintaining and perpetuating ecosystem processes and cultural affiliation integrity. It is recognized that the natural and cultural aspects of the Park ecosystem are part of a greater ecosystem of the Colorado Plateau.

This is, and must remain, a distinguishing aspect of Park resources management. It is essential that the National Park Service work effectively with neighboring agencies, tribes and communities in order to assure that the Park remains a place where natural forces continue to shape the landscape and cultures.

The primary mechanism for recognizing issues and planning actions that extend beyond park boundaries is the Grand Canyon Science Center Partnership. A complete description of this partnership is found in Chapter Three of this document.

## Definition of Resource Stewardship (Management)

The function referred to as natural resource stewardship or management is defined in the NPS Natural Resource Guidelines (NPS-77):

*Natural resource management is the process by which the NPS strives to understand natural processes and human induced effects; mitigates potential and realized effects; monitors for ongoing or future trends; protects existing natural organisms, species, populations, communities, systems, and processes; and interprets these organisms, systems, and processes to the park visitor. This function is broken down into six sub-functions: Research, mitigation, monitoring, protection, interpretation and administration.*

Cultural Resource Management is defined in the NPS Cultural Resource Management Guidelines, NPS-28:

*Cultural resource management involves Research, to identify, evaluate, document, register, and establish other basic information about cultural resources; Planning, to ensure that this information is well integrated into management processes for making decisions and setting priorities; and Stewardship, under which planning decisions are carried out and resources are preserved, protected and interpreted to the public.*

# CHAPTER ONE Background Information

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## Park Location

Grand Canyon National Park lies on the Colorado Plateau in northwestern Arizona. The area is a vast, semiarid land of raised plateaus and structural basins typical of the southwestern United States. Drainage systems are deeply cut, forming numerous steep-walled canyons. The higher elevations of the Plateau are forested; the lower elevations are a series of desert basins.

Fifty-five percent of the Colorado Plateau is Federally owned, including 27 units administered by the National Park Service, 17 national forests administered by the United States Forest Service, 26 designated wilderness areas, 32 million acres administered by the Bureau of Land Management, numerous state parks and countless roadless and remote areas. American Indian reservations occupy 24% of the land and state governments control 6%, leaving 15% of the region's lands in private ownership. (Hecox and Ack. 1996. *Charting the Colorado Plateau: An Economic and Demographic Exploration*)

Grand Canyon National Park, encompassing 1,218,376 acres, is the largest single protected area within the Colorado Plateau region. The Park is bounded on the north by the Kaibab National Forest and the Arizona Strip District of the BLM, on the east by the Navajo Reservation, on the south by Kaibab National Forest and Hualapai and Havasupai reservations, and on the west by the upper reaches of Lake Mead National Recreation Area.

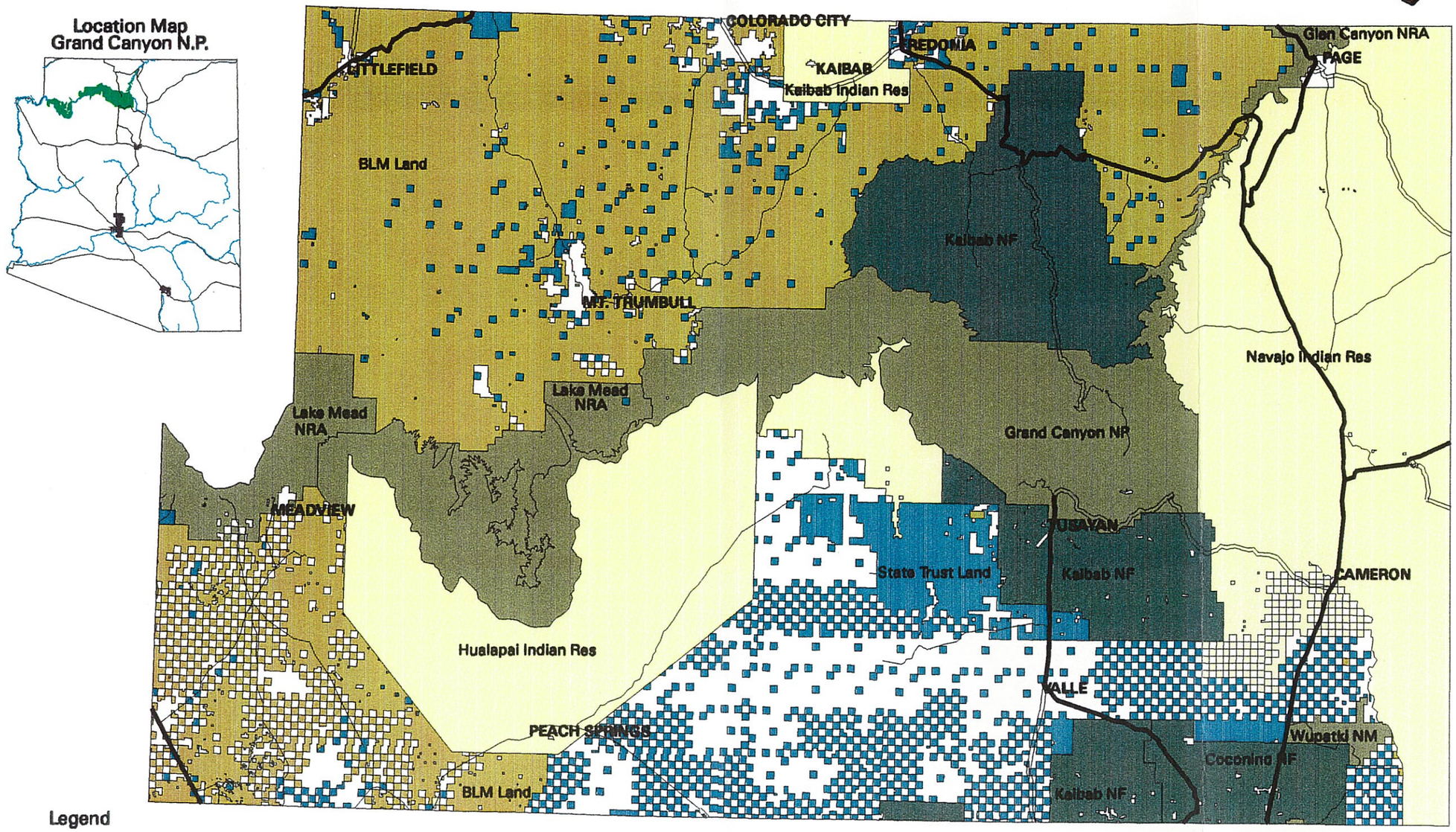
The Park is located entirely within Arizona, in Mohave and Coconino Counties, and is in Congressional District Number Three.

### Colorado Plateau Eco-Region

As with most distinctive areas of the world, the landscapes, ecological communities and cultures of the Colorado Plateau eco-region evolved together. However, unlike many regions, the forces of nature and the strengths of early cultures on the Plateau continue to dominate, creating a unique sense of place. This provides a rare opportunity to preserve one of the few places in North America where culture and wilderness successfully coexist.

The following purposes and significance statements were formed during the general management planning process, and are included in the final 1995 Grand Canyon National Park General Management Plan (GMP).

# Land Ownership surrounding Grand Canyon National Park




Legend

- Private Land
- State Trust Land
- BLM Land
- National Forest
- Indian Reservation
- National Park Service
- AZ Game and Fish
- Primary Highway
- Secondary Road
- Road

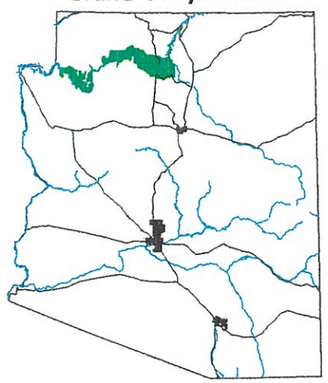
SCALE 1:1000000

10 0 10 20 30 40 50

MILES

N W E S

# Grand Canyon National Park
# Proposed Wilderness and other existing Wilderness Areas




COLORADO CITY
FREDONIA
KAIBAB
LITTLEFIELD
PAGE
MT. TRUMBULL
Grand Canyon N.P.
MEADVIEW
TUSAYAN
CAMERON
VALLE
PEACH SPRINGS

Legend

- BLM Wilderness Areas
- NFS Wilderness Areas
- GRCA Proposed Wilderness
- Developed Areas and Roads
- Natural Areas
- Primary Highway
- Secondary Road
- Road

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N W E S

# Park Purpose and Significance

## Park Purposes

- *Preserve and protect the natural and cultural resources and ecological processes of Grand Canyon, and its scenic, aesthetic, and scientific values, as a place of national and worldwide importance.*

- *Provide opportunities for visitors to experience and understand the environmental interrelationships, resources, and values of Grand Canyon without impairing the resources.*

## Park Significance

### *World Heritage Site*

As a World Heritage Site, the Grand Canyon is recognized as a place of universal value, containing superlative natural and cultural features that should be preserved as part of the heritage of all the world's peoples. The Grand Canyon is unusual in meeting both natural and cultural resource criteria for World Heritage Site designation.

### *Natural Resources and Natural Ecosystem Processes*

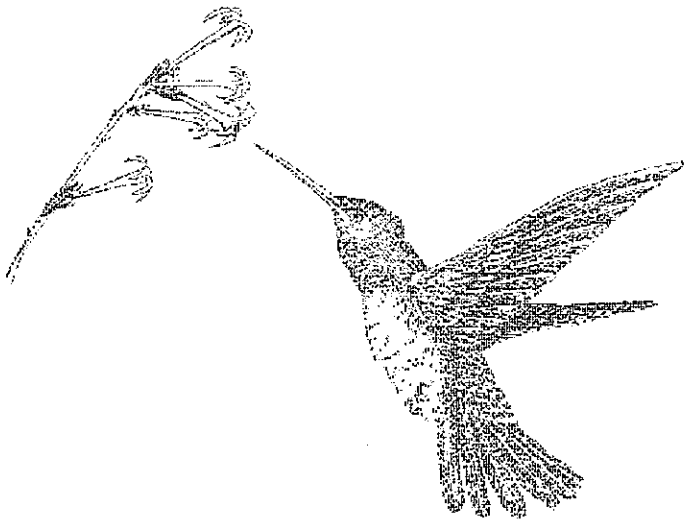
Well known for its geologic significance, the Grand Canyon is one of the most studied geologic landscapes anywhere in the world. It offers an excellent record of three of the four eras of geological time, a rich and diverse fossil record, a great diversity of geologic features and rock types, and numerous caves containing extensive and significant geological, paleontological, archeological and biological resources. As stated in the establishing legislation, the Grand Canyon is the "greatest eroded canyon in the United States."

It is considered one of the finest examples in the world of arid-land erosion. The Grand Canyon is neither the world's longest nor deepest canyon, but its volume is immense, averaging 4,000 feet deep for its entire 277 miles; 6,000 feet deep at its deepest point, and 15 miles at its widest. The significance of the Canyon, however, is not limited to geology.

The Park's great biological diversity includes five of the seven life zones and three of the four deserts in North America; from rim to river one encounters the—Lower Sonoran, Upper Sonoran, Transition, Canadian, Hudsonian life zones—equivalent to traveling from Mexico to Canada.

The Park serves as an ecological refuge, with relatively undisturbed remnants of dwindling ecosystems (such as boreal forest and desert riparian communities), and numerous rare, endemic or specially protected (threatened/endangered) plant and animal species.

Over 1,500 plant species, 287 bird species, 88 mammalian species, 58 reptile and amphibian species, and 26 native fish species are found in the Park.



*Research, Study and Education*

The Park is a scientific Mecca for geologists, geographers, ecologists and other scientists from around the world. The Park contains six Research Natural Aeas totaling 3,580 hectares that provide opportunities for research in ecosystems that remain relatively pristine. The Kaibab Squirrel National Natural Landmark occurs partially within the Park, protecting the ponderosa pine habitat of the endemic Kaibab Squirrel. The Park contains remote caves that preserve exceptionally important fossil records of extinct species and human habitation, providing a window into the mysteries of past cultural and ecosystem changes. The Park and surrounding adjacent protected areas represent one of the largest regions of Wilderness and protected landscapes in North America. When managed properly, this area provides an unequalled research laboratory, a classroom for young scientists, and an incredible resource for all to study and enjoy.

*Cultural Resources*

At least 4,000 years of human occupation have resulted in a rich and dynamic cultural history which is still evident. Today, eight separate Indian Tribes have identified close cultural and sacred ties to the Grand Canyon, with some considering the Canyon their original homeland and place of origin. Grand Canyon contains more than 3,500 known archeological sites with artifacts indicating 3,000 to 4,000 years of human habitation. A recent finding suggests human use of the Canyon as much as 10,000 years ago. Approximately two percent of the Park has been systematically surveyed.

Euro-American habitation brought western frontier heritage and tourism. The Park's historic properties include 124 buildings listed as National Historic Landmarks, 336 properties listed on the National Register of Historic Places, 44 buildings and structures determined eligible for listing on the National register, and 884 buildings and structures on the List of Classified Structures. In addition, the South Rim Historic Village is being nominated as a National Historic Landmark thematic area.

*Scenic Qualities and Values*

The Grand Canyon has internationally recognized scenic vistas, qualities and values. With ever-changing and colorful scenery of enormous proportions, it is widely considered one of the world's most spectacular landscapes. The great diversity of scenery includes forests, deserts, canyons, plains, plateaus, volcanic features, streams and waterfalls. The Grand Canyon's air quality greatly effects the clarity and color of the visual scene.

*Opportunities for Recreation, Re-creation, and Solitude*

A diversity of resource-based recreational opportunities are available: the vast majority of the Park provides opportunities for wilderness experiences; hundreds of miles of trails and routes provide access; three inner-canyon trails are designated National Recreation Trails as part of the National Trails system; and the Colorado River within the Grand Canyon provides one of the world's premier primitive river experiences, including the longest stretches of white water in the continental United States.

The Grand Canyon is a place of tremendous natural, scenic and historic interest. For all who visit, it is a place of beauty. For those who seek solitude, it is a place of profound mystery, peace and tranquility. For those who know the Canyon best, these are the most precious and fragile of values. From the native peoples that have called these canyons home, to early European explorers such as Major John W. Powell, to modern-day outdoor enthusiasts, philosophers, artists, poets, musicians and photographers, the Grand Canyon of the Colorado River is spoken of as a sublime place of wonder, inspiration and spiritual power.

To Powell it was,

> *the most sublime spectacle in nature...It is a land of music. The river thunders in perpetual roar, swelling in floods of music when the storm Gods play upon the rock and fading away in soft and low murmurs when the infinite blue of heaven is unveiled. With the melody of the great tide rising and falling, swelling and vanishing forever, other melodies are heard in the gorges of the lateral canyons....Thus the Grand Canyon is a land of song.*

In his journal, Powell attempts to sum up his feelings,

> *The glories and the beauties of form, color and sound unite in the Grand Canyon—forms unrivaled even by the mountains, colors that vie with the sunsets and sounds that span the diapason from tempest to tinkling raindrop, from cataract to bubbling fountain.*

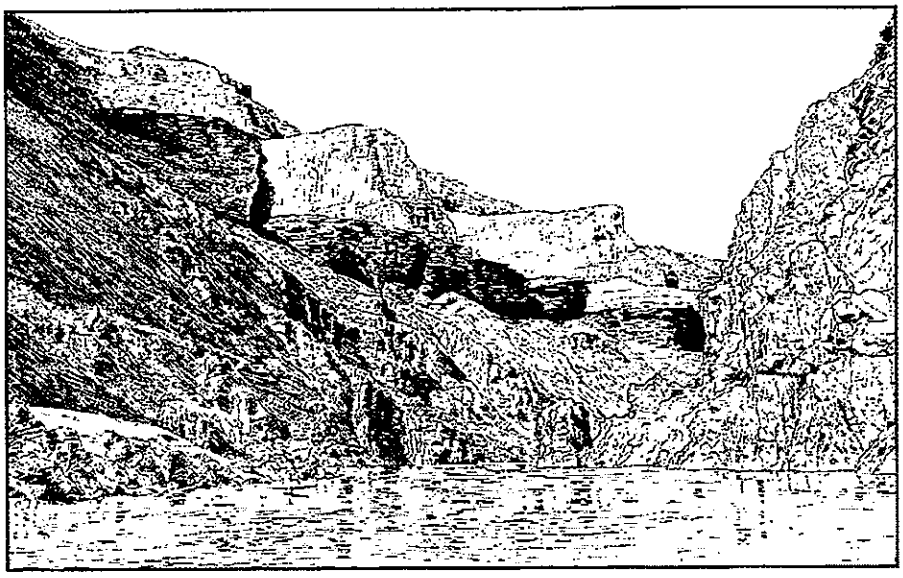
*The Natural Soundscape*

Precious human values and emotions are often the most difficult to preserve. As Powell so eloquently states, the power of the Grand Canyon rests in its unique combination of form, color and sound. To most visitors the importance of form and color are readily evident. The contributions of natural sounds to the environment and human experience is more subtle yet no less important.

*Potential Designations*

Over one million Park acres meet the criteria for Wilderness designation as part of the National Wilderness Preservation System. If combined with over 400,000 additional acres of proposed or designated Wilderness contiguous to Park boundaries, this area could become one of the largest, primarily desert, wilderness areas in the United States.

The Colorado River and most of its tributaries in the Park meet the criteria for Wild River designation as part of the National Wild and Scenic Rivers System.



## Legislation Affecting Grand Canyon

There is a large body of legislation that directs the activities of the National Park Service in general, and the management of Grand Canyon National Park specifically. A summary of all such legislation can be found in Appendix A.

Grand Canyon National Park was first set aside as a "Public park for the benefit and enjoyment of the people" on February 26, 1919 (40 Stat 1175, Grand Canyon National Park Establishment Act).

Major changes were made in the Park boundary in 1975 by Public Law 93-620, the Grand Canyon Enlargement Act. This Act summarizes the Park's significance, stating that Grand Canyon National Park is a "natural feature of national and international significance." The Act established the 1,215,735-acre Grand Canyon National Park from a mixture of State and Federal lands which included the former Grand Canyon National Park, Grand Canyon and Marble Canyon national monuments, portions of Lake Mead National Recreation Area, USFS, BLM, and Bureau of Indian Affairs (BIA) lands.

Public Law 93-620 also authorizes the Secretary of the Interior to submit to the Federal Aviation Administration (FAA), the Environmental Protection Agency (EPA), or other responsible agencies recommendations for regulations concerning the use of aircraft in Grand Canyon National Park, if aircraft are threatening public safety, visitor experience, or natural quiet.

The National Park Service Overflights Act, Public Law 91-100 (1987), address the issue of aircraft overflights at the Grand Canyon, requiring the FAA and the NPS to work together to "substantially restore natural quiet to the Grand Canyon."

Grand Canyon's international significance was recognized in October, 1979, with the Park's designation as a World Heritage Site. The high percentage of foreign visitation clearly demonstrates the Park's international popularity.

The Grand Canyon Protection Act of 1992 charged the Secretary of the Interior to manage the operations of Glen Canyon Dam to "protect the natural, cultural and recreational values of Glen Canyon National Recreation Area and Grand Canyon National Park." This legislation called for adaptive management of Glen Canyon Dam operations by the Bureau of Reclamation (BOR), supported by a long-term research and monitoring program, to assure that the resources and values of concern were protected.

# Land Management Zones

Management of natural and cultural environments in a national park system unit is based on management zones identified by the Park's General Management Plan and Statement for Management, but is derived from the following classifications in *NPS Management Policies* (1988, p.4:1-2):

## Natural Zones

"The primary objective in natural zones is the protection of natural resources.... Natural resources will be managed with a concern for fundamental ecological processes as well as for individual species and features.... Managers and scientists...will try to maintain all the components and processes of natural evolving park ecosystems, including the natural abundance, diversity and ecological integrity of the plants and animals" (Ibid.p.4:1). At Grand Canyon a Wilderness Subzone includes lands currently designated as potential Wilderness. Although not listed as subzones, other areas have special designations such as Research Natural Areas and Special Habitat Areas.

The bulk of Grand Canyon National Park (1,117,718 acres) is classified as a natural zone. Over one million acres is included in the proposed Wilderness area.

## Cultural Zones

The primary objective in cultural zones is to preserve and foster appreciation of cultural resources. Where compatible with cultural resource objectives, the policies for natural zones will be followed. Subzones include: Archeological District(s) Subzone; Historical District(s) Subzone; and Native American Traditional Access Subzone.

The historic zone is comprised of four National Register districts on the North and South Rims. There are three districts on the North Rim: the Bright Angel Lodge District (73.1 acres), National Park Service Headquarters District (2.2 acres), and the North Rim Inn District (77 acres). The South Rim Village Historic District (73.5 acres) extends along the rim from the Bright Angel Lodge to Verkamps Curios. The Grandview Historic District (91 acres) is located just below the Grandview overlook on Horseshoe Mesa. No formal archaeological districts or American Indian traditional access subzones have been defined.

## Development Zones

These zones are managed for intensive visitor use. Visitor faculties such as walkways, buildings and other management faculties occupy much of the zone. The natural aspects of the land within these zones is altered.

At Grand Canyon the development zone is comprised of four distinct areas within the Park: South Rim Village Area (2,200 acres), Desert View (50 acres), North Rim Developed Area (150 acres), and Phantom Ranch (18 acres).

## Special Use Zones

Special Use Zones are defined as where another public/private entity has jurisdiction within the Park. At Grand Canyon, the special use zone includes the 95,300-acre Havasupai Use Land.

Figure 1-1 summarizes Grand Canyon National Park management zones.

Figure 1-1

*Grand Canyon National Park Management Zones*

| Acreage | Percent of park |
|---|---|
| **Development Zone** | |
| 2,418 | 0.2 |
| **Historic Zone** | |
| 298 | |
| **Special Use Zone** | |
| 95,300 | 7.8 |
| **Natural Zone** | |
| 1,117,718 | 92.0 |
| **Total** | |
| 1,215,735 | 100.0 |

## Land Use and Trends

### Adjacent Land Uses

Grand Canyon National Park is entirely surrounded by other Federal and Tribal lands managed by a variety of agencies and governments. To the west, the Park is bounded by the Hualapai and Havasupai reservations, and portions of Lake Mead National Recreation Area. To the east, the Park is bounded by the Navajo Reservation and Glen Canyon National Recreation Area. On the North and South rims, USFS lands abut the Park, and along the northwest boundary, lands administered by the BLM adjoin the Park. Since these areas are managed for a greater variety of recreational, traditional, and multiuse activities than Park lands, uses along contiguous areas are not always compatible.

The major area of cooperation with **Glen Canyon National Recreation Area** is at Lees Ferry, where the confluence of the Paria and Colorado rivers marks the boundary between the two NPS areas. At Lees Ferry, Grand Canyon river trips launch downstream while numerous fishing trips launch and travel upstream into Glen Canyon NRA. The Lees Ferry site is within the boundaries of Glen Canyon NRA, but both NPS areas have on-site personnel. Glen Canyon NRA is actively involved in the management of a trophy trout fishery above Lees Ferry, and works with the Arizona Department of Fish and Game to stock 50,000 exotic rainbow trout annually. These fish have populated most sections of the post-dam altered aquatic environment of the Colorado River within the Grand Canyon National Park.

The major area of cooperation between Grand Canyon National Park and **Lake Mead National Recreation Area** is Pearce Ferry and the Grand Wash Cliffs. Pearce Ferry is a major takeout point for Colorado River trips.

North of the Park is the **Kaibab National Forest** and the **BLM's Arizona Strip District.** Both of these areas are managed under a multiple-use concept. Within the Kaibab National Forest, the major use is timber production; thinning, slash burning, pest control and other forestry management techniques are regularly practiced. Grazing is also permitted on forest lands. These and other management practices require that Grand Canyon National Park work with national forest personnel to provide boundary protection from fire. The Kaibab National Forest is also designated as a Game Preserve, and is set aside for the protection of game animals and birds (16 USC 684-687).

On the Arizona Strip, use had been restricted to scattered grazing leases and limited recreation until about 1980, when rich deposits of uranium ore began to be mined. There is currently one active mine in the Park's vicinity, and two others under development. The closest mine is 3.5 miles from the Park boundary. Potential impacts from the Arizona Strip include introduction of radioactive wastes and/or mine water into Park watersheds, and increased visitor use resulting from improved access created by other agencies.

Trespass-cattle grazing has occurred on Grand Canyon National Park land, and the National Park Service has constructed fencing to ameliorate this problem. The inexact boundary location, inaccessibility, and need for rock-drilling to set fence posts all make fencing very expensive.

Approximately 400,000 acres of the BLM Arizona Strip District, including several units immediately adjacent to the Park, have recently received Wilderness designation. This designation is compatible with Grand Canyon land use.

To the south, the Park is bordered by the **Kaibab National Forest,** and the **Hualapai and Havasupai Indian reservations.** Issues of concern between the National Forest and the Park are similar to issues on the North Rim, with the exception of a pending land exchange between a private developer and the forest service.

A number of small inholdings within the USFS Tusayan Ranger District are being purchased by a developer to exchange for a more commercially viable parcel of land near the Park's south entrance community of Tusayan. The developers propose lodging, retail, local resident housing, and visitor attractions for the site. The development could significantly increase the number of employees living in the immediate area, impacting schools, law enforcement and other infrastructure elements. It is proposed that this development will be accommodated by drilling a deep well. The Forest Service is also proposing additional campgrounds in the Tusayan Ranger District, and a visitor facility in conjunction with the land exchange, both of which could have Park impacts.

Eastern boundary issues are exclusively related to the Navajo Nation, and are discussed below.

## American Indian Neighbors

Grand Canyon's American Indian neighbors called this area home long before the first European arrived. The relationship between the various American Indian groups and the National Park Service is evolving.

Today, as a result of recent focus on developing an understanding and appreciation for cultural differences, there is an strong effort to promote partnerships between these groups and the NPS.

The GMP actively sought participation and input from each tribe, travelling to each reservation and meeting with representatives. There is good communication between these groups and Grand Canyon National Park as a result of these efforts. The ethnography program described in the GMP outlines important issues expressed at these meetings.

Interaction with the **Havasupai** continues to increase due to the overlap in activities between the Tribe and NPS. The Tribe and Grand Canyon are linked through the 1975 Grand Canyon Enlargement Act, along with numerous other laws and executive orders related to government-to-government relations and access to sacred sites. Traditional use continues within those lands identified as Havasupai Traditional Use Lands, including limited grazing, hunting and collecting.

The Park and Tribe have executed many agreements which form the foundation for on-going relationships. The Park and the BIA have executed a cooperative agreement on fire management along the common boundary. Memoranda of Understanding (MOU) have been in effect regarding Great Thumb and Supai Camp. Although both have expired, the Tribe and the Park plan to enter into agreements for these and other areas of mutual concern.

To the east, the Park is bounded by the **Navajo Reservation.** The administrative boundary for Grand Canyon National Park, as established in the 1975 Enlargement Act, included lands in Marble Canyon which were also included within Navajo Nation lands. When the Enlargement Act was passed, the boundary was to meet with Navajo Nation concurrence.

*Tribes with Identified Affiliations with the Grand Canyon:*

- *Havasupai Tribe*
- *Hopi Tribe*
- *Hualapai Tribe*
- *Navajo Nation*
- *San Juan Southern Paiute*
- *Paiute Indian Tribe of Utah*
- *Kaibab Paiute Tribe*
- *The Pueblo of Zuni*

No concurrence was ever received, hence a debate continues over the boundary location. A Solicitor's Opinion supports the NPS contention that the boundary is one-quarter mile east of the Colorado River in certain sections, and the Canyon rim in others.

Interaction with the Navajo Nation and local chapters continues (primarily Cameron and Gap-Bodaway), with emphasis on regional tourism and backcountry access.

The Department of the Interior, through a Solicitor's Opinion, believes the boundary between the Park and the **Hualapai Reservation** to be the old Colorado River high-water line from Mile 166 to Lake Mead on the south side. The Hualapai Tribe believes that the boundary is the center of the Colorado River. Although the debate continues, the Park and Tribe do continue to coordinate on projects related to the General Management Plan, and impacts due to the operations of Glen Canyon Dam.

Although Grand Canyon has on-going relationships with five additional Tribes, none share a boundary with the Park. The Hopi Tribe, the Pueblo of Zuni, the Kaibab Paiute Tribe, the Paiute Indian Tribe of Utah, and the San Juan Southern Paiute Tribe all have ancestral interests in the Grand Canyon. Consultation continues with all Tribes related to all compliance projects and planning projects which could affect areas of ancestral interest to all tribes.

## Within-Park Land Use

Lands in State or private ownership are undeveloped, and not currently used for non-park purposes. Navajo Nation lands however, are currently used for grazing and other non-park subsistence uses. See Figure 1-2. One tract is State-owned land—the Colorado River bottom. There is virtually no potential for development of this land. Public Law 93-620 declares that State lands can only be acquired by donation or exchange.

Figure 1-2
*Ownership of Lands within Grand Canyon National Park*

*Virtually all lands within the Park are Federally owned.*

| Owner | Acreage | Percent |
|---|---|---|
| Navajo Nation* | 24,288 | 2.0 |
| State of Arizona | 11,860 | 1.0 |
| Private | 392 | 0.0 |
| Federal (NPS) | 1,179,194 | 97.0 |
| Total | 1,215,734.64 | 100.0 |

**Please note that these lands are indicated to be within the Park's administrative boundary, and concurrence has not been received from the Navajo Nation.*

The highest priority acquisitions are the Hearst, Curtis, and Lee privately owned tracts. The Hearst property is the largest tract, consisting of 16 potential mining claims on 325.87 acres below the Grandview overlook and on the north bank of the Colorado River. The Lee property consists of 66.67 acres located on the north side of the Colorado River in the Toroweap Valley.

Lands on the Colorado River's east side in the former Marble Canyon National Monument are included in the Navajo Reservation. Although these lands are currently used for non-park purposes, acquisition by NPS in the near future is unlikely. Section 5(2) of Public Law 93-620 allows only for the transfer of lands held in trust for Indian Tribes to the United States upon approval of the Indian governing body.

# Visitor Use Analysis

In 1919, the year Grand Canyon became a national park, 44,173 people visited. Since that time, visitation has steadily increased. By 1956, over one million people visited annually. In 1969, the two million mark was topped. In 1976, the Bicentennial year, the Park received 3,026,235 visitors, and hit four million in 1991. In 1996, visitation reached 4.877 million.

Reasons for increased visitation have never been carefully studied. However, population growth, increased mobility, expanded communication/media networks, a growth in discretionary income and time, and an increase in the number of available lodging units/campground spaces have all been contributing factors.

Visitation fluctuates seasonally: 22 percent of visitation occurs during spring, 48 percent during summer, 22 percent in fall, and eight percent in winter. Visitation surges during Easter week, Christmas week, and the first two weeks in August. As with all parks, spring and fall seasons are experiencing rapid growth.

In 1991, 4,222,397 visitors entered Grand Canyon National Park (a 12 percent increase over 1990); backcountry users spent 87,384 nights in the backcountry (although an exact figure is not known, the park estimates that approximately 800,000 visitors per year hike below the rims); river runners spent 163,262 user days on the Colorado River. Approximately 20,801 visitors rode mules into the Canyon, while the air-tour industry estimates that 650,000 visitors participated in air tours.

A thorough analysis of existing data, as well as new data-collection efforts, are needed to develop comprehensive visitor profiles, visitor-use patterns, and data gaps for Grand Canyon National Park.

A yearlong visitor survey was conducted in 1991 for the *General Management Plan*. This survey revealed:

- Almost 20 percent of the Park's visitors venture below the rim
- A large percentage of the Park's visitors (about 40 percent) come from other countries
- A majority of Park visitors spend the night in lodges, motels, and campgrounds in, and adjacent to, the Park.
- Most visitors are not traveling as a part of an organized tour group, but rather, are traveling with two or three other people, usually members of the same family, and arrive via privately owned vehicles
- Most Park visitors are well educated with a median annual income of over $40,000*

*Further information is available in: *A Study of The Perceptions, Expectations, and Satisfaction Levels of Visitors To Grand Canyon National Park—A Final Report Prepared for Western Regional Office, National Park Service,* by Don E. Albrecht, Department of Rural Sociology and Recreation, Parks and Tourism Sciences, Texas A&M University, College Station, Texas.

*A vast majority of Park visitors ranked the following as extremely important*

- *viewing the Canyon from Park overlooks*
- *knowing that Park resources and values are being protected*
- *experiencing natural quiet*

# National Environmental Policy Act and National Historic Preservation Act Compliance

## National Environmental Policy Act Compliance

Occasionally management and development activities at Grand Canyon National Park have the potential to adversely affect the environment. These include road, trail, and visitor-facility construction; forest-fire suppression; and changes in regulations governing visitor-use levels. Compliance with the National Environmental Policy Act (NEPA) and other environmental legislation is the legal responsibility of the NPS.

Preparation of environmental compliance documentation is detailed in the *Project and Environmental Compliance Guide,* (January 1991), available from Grand Canyon National Park. Such documentation is completed prior to initiating new projects.

Projects involving any of the following elements need environmental clearance:

- ground or vegetation disturbance
- historic sites, structures or districts
- sites with potential archeological resources
- floodplains or wetlands
- threatened, endangered or sensitive species
- wildlife disturbance or population impacts
- changes in carrying capacities or user numbers
- planning and development proposals
- areas designated for Wild and Scenic River status
- prescribed burns
- sites within significant scenic vistas or viewsheds

Several parties involved with environmental compliance determine the appropriate clearance process and whether the proposed project requires a Categorical Exclusion (CA), Environmental Assessment (EA), or Environmental Impact Statement (EIS). In most cases the process includes the project initiator, the primary Park program manager, Park Compliance Coordinator, staff specialists within the Grand Canyon National Park Science Center, and the Superintendent. When working with EAs and EISs, the Public Information Officer directs the public involvement process.

Generally the Resource Management Plan is not the document through which environmental compliance is accomplished. Compliance (including requirements relating to the National Environmental Protection Act (NEPA), threatened and endangered species, floodplains and wetlands, air quality, etc.) is usually accomplished on a case-by-case basis as funding for a resource management activity becomes likely. Each action called for in a RMP project statement must be categorized as follows: environmental compliance has already been accomplished; is not required; or is required but has not been done and will be done before any irreversible and irretrievable actions have been taken.

Some actions called for in the Resource Management Plan are continuations of existing programs in which compliance has been completed. If not implemented under previous plans, actions called for in this Plan are only proposals and thus not subject at this time to environmental compliance actions under the NEPA. However, before any new actions proposed in this Plan can be implemented, specific environmental compliance actions will be completed.

NEPA requires Federal agencies to 1) consider every significant aspect of a proposed action's environmental impact and, 2) inform the public that environmental concerns were considered in the decision-making process. Thus, NEPA invokes a process of thinking ahead, of determining a cause-and-effect scenario for the proposed actions, and describing those relationships to the public.

The Council on Environmental Quality establishes documentation procedures for implementation of the NEPA process. Three basic routes of NEPA documentation are used to meet legal responsibilities. They are the EIS, EA, and Categorical Exclusion (CA), listed in descending order of complexity. Only the CA does not need public review.

NEPA requirements ensure that any proposal to implement a previously non-operative portion of this Plan will include public comment and input.

## National Historic Preservation Act (NHPA) Compliance for Sections 110 and 106

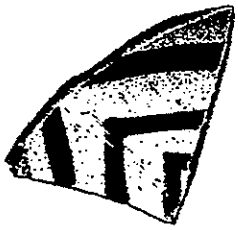
The purpose of NHPA is to preserve historic properties in addition to those of national significance, and establish frameworks to provide needed protection. Sections 106 and 110 of the Act have the greatest influence on Park operations. Section 110 calls for stewardship of resources owned or controlled by a Federal agency.

Stewardship includes identifying and evaluating all resources, and nominating to the National Register of Historic Places those resources thought to have local, State, regional, or national significance.

Until a resource is determined not to have historic significance, it must be protected as a historic property. Section 106 requires a Federal agency to take into account the outcome a proposed action might have on a property that is included in, or eligible for, inclusion in the National Register. It also provides that the Advisory Council on Historic Preservation be provided opportunity to comment on the proposed action. Actions proposed within this Plan will be reviewed for compliance with Section 106.

The cultural resources aspects of this Plan were reviewed and approved in consultation with the Arizona State Historic Preservation Officer (SHPO) and the Advisory Council on Historic Preservation prior to the finalization of this document.

Developing and implementing a comprehensive, integrated resource-management program at Grand Canyon National Park requires the active participation of all Park divisions. The components of an integrated resource management program include: management direction; planning and compliance; consultation and coordination; education and interpretation; research and study; inventory and monitoring; restoration and rehabilitation; maintenance; law enforcement; and mitigation.



# Roles in Resource Management

## Park Staff Roles and Relationships to Resource Management

*Grand Canyon National Park Science Center*

The resource management program is coordinated by the Science Center, but all Park staff has responsibility for protecting Park resources or supporting those that do.

The Science Center is responsible for resource planning, program coordination, research, long-term monitoring, and the implementation of actions requiring expertise in natural science, social science and cultural resource management.

*Division of Visitor Services and Interpretation*

This Division is responsible for providing a comprehensive interpretive and educational program that includes complex resource issues. Public education is a key element in a proactive resource stewardship program. This program is being expanded to meet the informational and educational needs of Park neighbors, other government agencies, and those involved in the political process.

*Division of Visitor and Resource Protection*

This Division is responsible for protecting resources through public education by providing information regarding regulations and proper behavior; enforcing regulations; issuing backcountry permits and monitoring use; and through implementing the Park's wildland and structural fire management programs. This preventative role is essential to resource management program success.

*Division of Maintenance and Engineering*

This Division is responsible for site and structure maintenance; restoration and rehabilitation of historic structures; resource impact mitigation of recreational use and facility development; and trail maintenance.

*Division of Administration*

This Division provides support for Park operations including resource management. This is a critical and essential function that has a substantial bearing on resource management program effectiveness.

*Division of Concessions Management*

This Division assures that all concession operations contribute as true stewardship partners, in all aspects of the resource management program. Areas where concession operations can be most effective include visitor education, recycling, water conservation, and the effective maintenance of historic structures.

*Office of Public Affairs*

The Office of Public Affairs has the responsibility for developing and maintaining a proactive public relations strategy focused on gaining public support for NPS and Interior positions, Park programs and projects.

*Office of the General Management Plan Implementation Team (I-Team)*

The I-Team was established in 1996 to implement the Park's new General Management Plan. The primary focus of this work group is to oversee major changes in developed area facilities and roads, establish a transportation system, and provide leadership in the development of strategies to increase external funding sources to support the GMP.

*Superintendent's Office*

The Superintendent's Office is responsible for resource stewardship program leadership and oversight by establishing goals; formulating strategies; approving priorities; allocating personnel and funding needed to successfully implement projects and programs; and evaluating resource program effectiveness and efficiency. This office represents the National Park Service and Grand Canyon National Park when dealing with issues that are politically sensitive. A goal of this Plan is to provide scientifically valid information to Park management for making informed decisions that protect, restore and preserve the Park's natural and cultural resources and associated values.

## Partner Organization Roles in Resource Management

*Federal, Tribal, State and Local Government Roles*

Government agencies and American Indian tribes that manage lands adjacent to the Park boundary or share regulatory authority for the preservation and use of Park resources are essential resource management program partners. In some cases the role of these organizations are incorporated in law, others are documented in formal agreements, while some are informal working relationships. The science program components of these relationships are documented more fully in Chapter Three—***Grand Canyon National Park Science Center Partnership.*** In general, an objective of this Plan is to improve the effectiveness of working relationships with partner organizations.

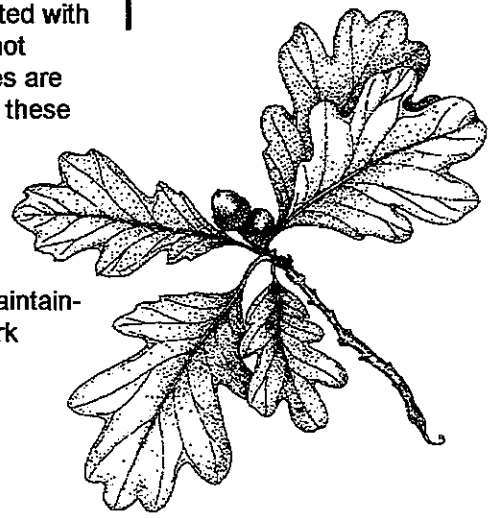
*Cooperating Association and Non-Government Partners*

***Grand Canyon Association*** (GCA) is a not-for-profit organization which fosters, supports and enhances NPS educational and scientific operations. The Association is as a retailer of interpretive and educational material for Grand Canyon National Park. Materials produced and sold include various types of books, educational videos, music, and artwork. The Association strives to educate the public on subjects dealing with natural and cultural history, and issues facing the environment. They offer classes through the ***Grand Canyon Field Institute*** as a way to further the public's knowledge, understanding and appreciation of the Grand Canyon.

The ***Grand Canyon Fund*** (GCF) was established as a not-for-profit organization in 1995 to raise monies in support of implementing high priority actions needed to improve Park facilities, and protect resources. Many of these needed actions are defined in the *General Management Plan* and this Plan.

*Non-government Conservation Organizations*

Numerous conservation and advocacy organizations are actively engaged in insuring that public values associated with Grand Canyon National Park are not diminished, and that park resources are effectively protected. The role that these organizations play in articulating public interests, views, and needs, and being engaged in creating effective solutions to management issues, is essential to the preservation of this Park and to maintaining the integrity of the National Park System.



# CHAPTER TWO

## Present Resource Description and Status

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## Natural Resources

### Natural Quiet

Since the time of John Wesley Powell, the first Euro-American to record an exploration of the Grand Canyon, this area has been known for its unique combination of immensity and quiet. The clear skies, desert light, dry air, limited vegetation, geologic grandeur and starkness all contribute to creating an area that has long been revered and sought for its quietness and solitude. Indeed, archaeological and ethnographic information suggests prehistoric and historic American Indian groups sought and revered the Canyon for many of these same reasons, just as contemporary American Indians continue to do. The present-day importance of these characteristics can be observed at least twice daily in the large number of visitors who flock to rim overlooks, and watch in silence and awe as the sun sets or rises. For visitors to the inner canyon who actively seek out opportunities for solitude and natural quiet, the meaning, importance, and value of quiet and natural sound is greatly magnified.

Just as natural quiet is important to visitor experience and Park appreciation, it is also critically important to other protected Park resources. "Non-natural sounds" (i.e., introduced, human-caused or mechanically produced sounds) may, depending on location, volume, and timing, produce direct and indirect negative physiological and behavioral responses in wildlife. Non-natural sounds also may have negative impacts on cultural and historic resources including possible damage to fragile archaeological and historic structures from vibration and acoustic impacts. Similarly, non-natural sounds may negatively impact areas used as ceremonial, sacred, or traditional-use sites.

Grand Canyon's quiet is not the absence of sound—it is not silence. It is the presence of the sounds of nature in the absence of human-caused or mechanically produced sounds. It is the sound of wind in the trees, the sound of animals, and of water flowing. These conditions of natural quiet typically vary from moment to moment and place to place with changes in vegetation, terrain, meteorological conditions, and the presence of animals. The changes in natural sound levels combined with the ability to discern natural sounds from discrete sources make the impact of natural sound conditions and natural quiet all the more valued and significant to the listener. The presence of natural quiet tends to heighten the stimuli and impact received through other senses.

Natural sounds and natural quiet have long been regarded as Park resources. They are among the conditions and resources the National Park Service is mandated to protect and "leave unimpaired for the enjoyment of future generations." This mandate, under the Organic Act, was strengthened under the Redwood Act of 1978 which specified that resource preservation is the primary responsibility of the National Park Service. Thus, under law, policy, and visitor expectation, natural quiet is a resource to be protected.

## Geologic Resources

The Grand Canyon of the Colorado River is a world-renowned showplace of geology. Geologic studies in the Park began with the work of Newberry in 1858, and continue today. The Grand Canyon's excellent display of layered rock is invaluable in unraveling the region's geologic history. Extensive carving of the plateaus allows detailed study of Earth movements. Processes of stream erosion and vulcanism are easily seen and studied.

The Colorado River has carved the Grand Canyon into four plateaus of the Colorado Plateau Province. The Province is a large area in the Southwest characterized by nearly-horizontal sedimentary rocks lifted 5,000 to 13,000 feet above sea level. The Plateau's arid climate produced many striking erosional forms, culminating in the Grand Canyon. The Canyon's mile-high walls display a largely undisturbed cross section of the Earth's crust extending back some two billion years.

Three "Granite Gorges" expose crystalline rocks formed during the early-to-middle Proterozoic Era (late Precambrian). Originally deposited as sediments and lava flows, these rocks were intensely metamorphosed about 1,750 million years ago. Magma rose into the rocks, cooling and crystallizing into granite, and welding the region to the North American continent.

Beginning about 1,200 million years ago (late Proterozoic), 13,000 feet of sediment and lava were deposited in coastal and shallow marine environments. Mountain building about 725 million years ago lifted and tilted these rocks. Subsequent erosion removed these tilted layers from most areas leaving only the wedge-shaped remnants seen in the eastern Canyon.

Rock layers formed during the Paleozoic Era are the most conspicuous in the Grand Canyon's walls. Coastal environments and several marine incursions from the west between 550 and 250 million years ago deposited sandstone, shale and limestone layers totaling 2,400 to 5,000 feet thick. Layers from the Cambrian, Devonian, Mississippian, Pennsylvanian and Permian periods are present.

Erosion has removed most Mesozoic Era evidence from the Park, although small remnants can be found, particularly in the western Grand Canyon. Nearby rock outcrops suggest 4,000 to 8,000 feet of sedimentary layers from the "Age of Dinosaurs" once covered the Grand Canyon area. Cenozoic Era (the "Age of Mammals") layers are limited to the western Grand Canyon and terraces near the River itself. A few sedimentary deposits formed in lake beds, but the most spectacular recent deposits are the lava flows and cinder cones on the Shivwits and Uinkaret plateaus. Volcanic activity began about six million years ago and has continued to within the last several thousand years. Spectacular lava cascades down the Canyon walls have helped date the Grand Canyon's carving.

The Grand Canyon itself is a late Cenozoic feature, characteristic of renewed erosion during this time. Vigorous cutting by the snow-fed Colorado River carved the Canyon's depth. Canyon widening is held in check by the region's dry climate. The asymmetry between rapid downcutting and slow widening results in the Grand Canyon rather than a more typical broad (and nondescript) river valley. Although violent storms may send flash floods gouging down narrow side canyons, the lack of steady moisture has created a stark landscape of mostly naked rock.

Harder, erosion-resistant rocks such as the Coconino Sandstone and the Redwall Limestone have eroded into bold cliffs. Softer layers melt into slopes like the Tonto Platform (Bright Angel Shale) and the Esplanade (Hermit Shale). The oldest, crystalline rocks are chiseled into the craggy cliffs of the Granite Gorges.

Nearly 40 identified rock layers form the Grand Canyon's walls. They have attracted students of earth history since 1858. Because most layers are exposed through the Canyon's 277-mile length, they afford the opportunity for detailed studies of environmental changes from place to place (within a layer) in the geologic past. Geologic evolution through time can be studied through the changes between different layers.

It was the work of geologists that began changing the public's opinion of the Grand Canyon region from that of "a worthless locale" to "the most sublime of earthly spectacles." After nearly 150 years, geologists are still not finished studying the Grand Canyon. In the mid-1970s, a new rock layer was identified in the Canyon walls. Scientists continue investigating how environment affects rock formation. Perhaps the biggest question of all, how the Colorado River chose this course and begin carving the Canyon, still awaits a clear answer.

*Soils*

Geology and slope strongly influence most Grand Canyon soils. Currently, soils throughout the Canyon are categorized as poorly developed. Soils are highly variable, ranging from moist forest soils of the North Rim to shallow, dry mineral soils and bedrock exposures of the inner canyon. Inner canyon soil textures are sandy loam, sands, or loamy sands. It is likely that there are a few silt loams or clay loams in the Hermit and Bright Angel shales and in the Toroweap Valley.

Most soil types erode very easily and regenerate slowly. Their sandy nature allows water to be absorbed immediately, leaving the ground dry shortly after rain showers. The soils are typically fragile and require little disturbance to create erosional problems.

Large Park areas show essentially no human impacts to soils. Other areas were used for farming, grazing and mineral extraction. Developed areas have heavily impacted soils. Soil ("cryptogamic") crusts are very sensitive soil systems, specific to arid lands. These crusts cover a significant portion of inner canyon soil. Cyanobacteria form the crust, while other bacteria, algae, fungi, lichens, and mosses are often present. These crusts play important roles in reducing soil erosion, increasing water conservation and in promoting nitrogen fixation. They create a more favorable environment for vascular plants to germinate under arid conditions. These crusts are highly susceptible to trampling and air pollution.

Soil surveys exist for about 23% of the Park (188,000 acres on the Sanup Plateau and 93,500 acres on the Havasupai Traditional Use Lands). These areas were surveyed as part of grazing allotment analysis. Extensive soil surveys, however, have not been conducted for much of the Canyon.

The soils along the Colorado River are known in more detail. Land areas along the River are characterized by fine-grained beaches, coarse-grained cobble bars, and tributary fan deposits. The fine-grained deposits found on river terraces may be classified according their age (pre- or post-Glen Canyon Dam), how they were deposited (floods, wind action, or underwater reworking below present high water) and soil grain size (cohesive silts, and sands with negligible silt).

*Cave Resources*

Hidden within the Grand Canyon are hundreds of caves. Most are dissolved into the limestones in the Redwall and Muav formations, although caves occur in other formations. The caving community is well aware of these caves; hikers frequently visit Cave of the Domes on Horseshoe Mesa. Caves throughout the Park contain unique cave formations or "speleothems"; mummified remains of extinct Ice Age fauna; archeological remains (including split-twig figurines); and unique biological systems. Many caves also play a major role in regional hydrology. Substantial underground streams emerge from Vaseys Paradise, Cheyava Falls, and Roaring, Thunder, and Tapeats springs.

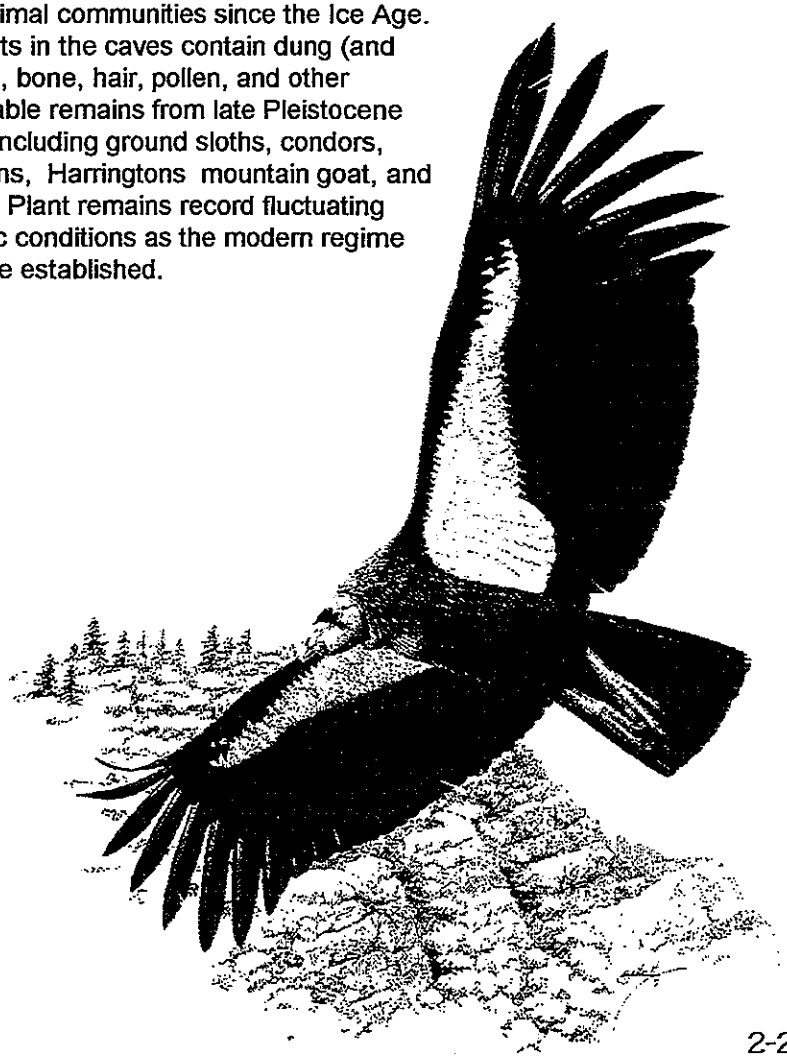
*Paleontological Resources*

Fossils found within the Grand Canyon encompass virtually the entire spectra of type and preservation. They include algal mats and bacterial spores over a billion years old, mummified dung and hair 11,000 years old, and a multitude of body and trace fossils from the Paleozoic Era, 550-250 million years ago. Fossils tell a great deal about the origin of their host rocks, including the rock's age and its depositional environment. Nineteenth-century geologists responsible for the earliest geologic mapping at Grand Canyon relied heavily on fossils to determine rock age and their equivalence to known strata.

The older Proterozoic rocks in the inner gorge (schist, gneiss, and granite) are not fossil-bearing. Younger Proterozoic rocks of the Grand Canyon Supergroup (specifically the Bass limestone) contain the oldest fossils in the region (1.2 billion years old). These are "stromatolites," primitive algal remains very similar to modern algal domes found in marine environments. The 750 million-year-old Kwagunt Formation contains abundant bacterial cysts and spores.

The paleontological record is richer for Paleozoic rocks, including all of the horizontal layers visible from the Canyon rim. Most of these fossils are remains of marine invertebrates. Along the rim, the Kaibab Limestone contains many fossil localities easily accessible to the public, and easily destroyed by development. Evidence of ancient life can be found in the non-marine rocks as well; windblown Coconino Sandstone contains footprints left by ancient reptiles and amphibians. The Supai Group and the Hermit Shale also contain footprints, as well as plant and invertebrate fossils.

Dry caves in the Park contain a wealth of information regarding Grand Canyon's plant and animal communities since the Ice Age. Deposits in the caves contain dung (and guano), bone, hair, pollen, and other perishable remains from late Pleistocene fauna including ground sloths, condors, teratorns, Harringtons mountain goat, and others. Plant remains record fluctuating climatic conditions as the modern regime became established.



## Water Resources

Most of the water flowing in the Colorado River through the Grand Canyon originates in the high mountain areas that rim the upper Colorado drainage basin. The estimated runoff in the Colorado River at Lees Ferry, Arizona (the head of the Grand Canyon), has ranged from 5.6 to 24.0 million acre-feet per year. Ten-year averages ranged from 11.6 to 18.8 million acre-feet. The significance of this variability is acute in modern River management. A 25-year period (1906-1930) of predominantly above-average runoff was used to allocate water in the Colorado River to seven western states and Mexico (the 1922 Colorado River Compact and 1944 Mexican Water Treaty). The following 40 years (1931-1970) had predominantly below-average runoff. Current allocation accounts for nearly complete use of the Colorado River's flow. Springs and tributaries entering the Colorado in Grand Canyon contribute about 0.5 million acre-feet of water to the River annually.

### *Historic Water Use*

Despite the tremendous quantity of water flowing through the mile-deep Canyon, the water supply history at Grand Canyon has been one of scarcity. As the River cut a canyon through the rock layers, ground water drained into the Canyon. Precipitation is quickly absorbed by the porous rock on the rims, making surface water rare and temporary.

Before 1900, mules carried some water to the South Rim developments from the springs at Indian Garden, 3,200 feet below Grand Canyon Village. Water was also collected in natural or dug "tanks" and cistern catchments. After completion of the railroad to Grand Canyon in 1901, water was hauled to the South Rim in tank cars.

A sewage disposal plant was completed on May 28, 1926, making reclaimed effluent available for non-potable uses. On August 26, 1932, the Santa Fe Railroad completed a pipeline to Indian Garden. Pumps were installed with a capacity of 278,000 gallons per day.

The water lifted from Indian Garden proved sufficient to meet the needs of the large influx of Park visitors following World War II. Additional reservoirs on the South Rim provided storage for water pumped during the slack winter season. Water storage capacity grew from about four million gallons in 1958 to thirteen million gallons in 1968. Water consumption in that year reached 96 million gallons, virtually the entire flow from the springs at Indian Garden.

The earliest developments on the North Rim obtained water from a small spring on Bright Angel Point. A pipeline from Roaring Springs, 3,000 feet below the North Rim, began delivering water in 1928. A dam and hydropower plant on Bright Angel Creek supplied power.

In August 1970, a 13-mile-long transcanyon pipeline was completed, connecting Roaring Springs below the North Rim with the pumping facilities at Indian Garden below the South. The pipeline operates continuously, delivering approximately 720 gallons per minute (378.4 million gallons per year) to the Indian Garden pumping station. Two new pumps at Indian Garden were also installed in 1970. The system could deliver 420 gallons per minute from Indian Garden to the South Rim, through the 1932 pipeline installed by the Santa Fe Railroad. The springs at Indian Garden now flow freely into Garden Creek, but are supplemented by surges of excess water from the transcanyon pipeline. These surges have very different water quality from the natural flow from Indian Garden springs.

Between 1985 and 1988 major improvements were made to the transcanyon pipeline and pumping facilities at Indian Garden. A new eight-inch-diameter steel pipeline was installed from the South Rim to Indian Garden inside a directional drill hole. A new, 750-horsepower pumping system replaced the original pumps in the renovated 1932 pump house. A section of the transcanyon waterline from Plateau Point to the Colorado River was replaced with steel pipe and rerouted to avoid rock slides. A pipeline from Grand Canyon Village to Desert View, initiated in the 1960s, was completed. A new million-gallon reservoir replaced the 325,000-gallon tank to serve higher elevation facilities in Grand Canyon Village. These improvements allow up to 680 gallons of water per minute to be pumped from Indian Garden, provide additional water storage on the South Rim, and allow water to be pumped the twenty-eight miles to Desert View instead of being hauled by tanker truck.

By the early 1990s, the transcanyon pipeline had exceeded its material lifetime. As the pipeline continues to age, repairs are needed more frequently, and become more costly. It will cost approximately $40 million to upgrade the pipeline and extend its life. This project's environmental consequences will be determined through the National Environmental Protection Act and the National Historic Preservation Act compliance processes.

*Water Rights*

Water is a vital natural resource, especially in the arid southwestern United States, where legal and institutional systems are organized to control water use. In the Grand Canyon region, water use is subject to treaty obligations, Federal and State laws, and interstate compacts and agreements. Water rights are generally based on the appropriation doctrine in which first-in-time is first-in-right. Most surface water has already been assigned to specific applicants or users. The remaining supply is desired, and actively pursued, by many State and interstate groups, as well as private individuals.

The Federal government has asserted, and the courts have affirmed, that it has the right to enough water to develop Federal "reserved" land, provided the water is used for purposes of the reservation. National Parks are examples of such reservations. The right is effective as of the date of the reservation action. The Federal government thus has the right to use all waters originating in, or flowing through, Grand Canyon National Park for Park purposes that was not already claimed before the reserve's establishment. Federal reserved water rights for Park purposes have been asserted, and must be quantified for Park areas in the Little Colorado River Basin.

The complex nature of water development projects makes cooperation among water users essential in making projects possible. In 1922 the Colorado River states drafted the Colorado River Compact to apportion the River's waters. Congress approved the Compact in the Boulder Canyon Project Act of December 21, 1928, and President Hoover declared it in effect on June 25, 1929. The Compact divided the Colorado River into two drainage basins, Upper and Lower, with Lees Ferry, Arizona, the dividing line between them.

## Air Resources

Grand Canyon National Park enjoys some of the cleanest air left in the United States. This clean air is a fragile resource, and existing levels of human-caused pollution create clearly visible hazes. Many studies have been conducted to characterize this haze, its composition and origin. In addition to visibility studies, monitoring programs in the Park measure acid deposition (both wet and dry), ozone concentrations, ultraviolet radiation, and meteorological data. Special studies have supplemented this information with other data.

### *Class I Area*

Grand Canyon National Park was designated a Class I area by the Clean Air Act as amended in 1977 (Public Law 95-217). The Act limits deterioration in air quality and gives added protection to uniquely scenic areas. Amendments to the Act in 1990 called for the creation of the Grand Canyon Visibility Transport Commission to study the interstate transport of air pollutants into the Grand Canyon area. The Commission made its recommendations to the Environmental Protection Agency June 10, 1996. The recommendations address reducing air pollution emissions from industry and vehicles. They also address smoke from forest and agricultural burning and other visibility-related issues. A successor to the Commission will continue its regional coordination role, and monitor recommendation implementation.

### *Monitoring*

Air quality monitoring at Grand Canyon began in 1958. Since then, many techniques have been used to measure visibility, aerosols, gases and acid deposition. The monitoring program is designed to identify existing air quality and trends, measure sensitivity of Park resources to air quality, establish local and synoptic weather patterns affecting air quality, and identify sources and the nature of existing and potential pollutants.

Air quality at Grand Canyon is generally good, but is increasingly threatened by human sources, including metropolitan areas in Arizona, Nevada and California, and also development in northern Mexico. The net effect is a measurable impact on the visibility that is of paramount importance for visitors to appreciate the Grand Canyon. Visibility is often impaired in Grand Canyon National Park by haze even though pollutant levels do not exceed National Ambient Air Quality Standards (NAAQS). Very small amounts of light-scattering pollutants can significantly reduce visibility under such clean conditions. Haze results in a reduction in clarity and brilliance in the Park and can eliminate distant views. Visibility at the Grand Canyon averages 80 miles, and can exceed 155 miles on the clearest days. Haze can reduce visibility to less than 50 miles, but visibility is still superior to many sections of the country, and should remain so for the future.

## Vegetation Resources

More than 1,500 known vascular plant species within an elevation difference of almost 8,000 feet have been documented within the Park. Additional species are to be expected with future botanical inventory, especially within remote and rugged areas of the inner canyon and western Grand Canyon. Approximately eight percent of the Park's flora is exotic. Grand Canyon has over a dozen endemic plants known only from localities within the Park's boundaries. An additional 23 regional endemics are known which have ranges crossing Park boundaries. Also, over 167 species of fungi, 64 moss species and 195 lichen species have been reported. Species composition and distribution are influenced by climate, geomorpology and geology.

The Park contains 129 vegetation communities or formations: riparian woodland and scrub, desertscrub, grassland, woodland, and forest. Sixty-three vegetation associations within these formations have been classified and mapped in Grand Canyon (see: Warren, Reichhardt, Mouat, Brown, and Johnson. 1982. *Vegetation of Grand Canyon National Park*). A riparian community exists along the Colorado River and its perennial tributaries, characterized by the exotic saltcedar (tamarisk), coyote willow, arrowweed, seep willow, western honey mesquite and catclaw acacia. The Colorado River riparian corridor has been disturbed due to the building and operation of Glen Canyon Dam in 1963. Hanging gardens, seeps and springs contain many rare and unique plant species.

Next to the River corridor is a desertscrub community composed of plant species with affinities to the four North American desert floras. A Mohavean desertscrub extends from the Grand Wash Cliffs in extreme western Grand Canyon to near the Colorado River's confluence with the Little Colorado River. It is typified by warm desert species such as creosote bush and white bursage. Frost-sensitive species more characteristic of the Sonoran Desert such as brittle bush, catclaw acacia, and ocotillo can also be found. Chihuahuan species such as mariola, western honey mesquite, and four-wing saltbush also occur. Upstream of the Little Colorado River in Marble Canyon and on the Tonto Platform, species more characteristic of the Great Basin Desert predominate, such as big sagebrush, blackbrush, and rubber rabbitbrush.

Grassland communities in Grand Canyon are rare and few. Mountain meadows on the North Rim are of two types: montane meadows and upland subalpine grasslands. Both are typified by many grass species, with sedges in the wettest areas and forbs and grasses along the dry margins. Semi-desert shrub-grasslands occur at Toroweap Valley and above the Grand Wash Cliffs. These areas are characterized by big galleta, blue and black grama, Indian ricegrass, and three-awns.

Above the desertscrub and up to 6,200 feet is a woodland consisting of pinyon pine and one seed and Utah junipers. Other species include big sagebrush, snakeweed, Mormon tea, Utah agave, narrowleaf and banana yucca, snakeweed, winterfat, Indian ricegrass, dropseed, and needlegrass.

Above the woodland between elevations of 6,500 and 8,200 feet on both the North and South rims is a forest characterized by ponderosa pine. Typical plants in this community are Gambel oak, New Mexico locust, mountain mahogany, elderberry, creeping mahonia, and fescue.
Another forest type is found on the North Rim above 8,200 feet. This spruce-fir forest is characterized by Englemann spruce, blue spruce, Douglas fir, white fir, aspen and mountain ash. Typical plants include several species of perennial grasses, groundsels, yarrow, cinquefoil, lupines, sedges and asters.

*Fire Effects*

Natural fire presence or absence influences the number and distribution of plants and animals in an ecosystem. Fire suppression in the Grand Canyon region during the 55 years before 1978 (when a prescribed fire program was instituted at Grand Canyon) has changed the structure and vegetation composition of the pre-settlement forest and shrub communities. Many communities are fire-dependent for the perpetuation of natural processes. Research conducted on both the North and South rims shows that these forests are adapted to frequent, low-intensity fire. However, the spruce-fir forest of the North Rim, above 8,200 feet, is characterized by both low-intensity and infrequent, high-intensity fires.

In fire's absence, thick stands of young pine, spruce, and fir have closed in upon the once open parklike North Rim forest. Lack of natural burning allows tree crowns to close in and shade many forage plants that support forest animal populations. Dense stands of trees allow the rapid spread of forest infestations such as dwarf mistletoe. The deep accumulation of forest litter improves the habitat for some nuisance insects. Tree crowding contributes to the general slowing of growth rates and lowered resistance to disease and insect infestations. The large quantities of forest fuels accumulated due to previous fire suppression activities. There is a decrease in herbaceous and shrub production, disruption of nutrient cycling, and ecosystem simplification with decreased species and landscape diversity.

The Park's forested areas are now susceptible to holocaust, stand replacing fires. Unburned fuels due to fire suppression have accumulated to unsafe levels so that wildfire threatens entire forest stands and endangers Park developed areas. Since 1978, the Park has accomplished less than 13% of the projected area to be treated by prescribed fire. The remaining 87% involves significant complexity, much of it without precedent to the National Park Service.

Expanding the prescribed fire zone into some of the wilderness zone on North Rim is important to return to a natural fire regime. Achievement may take decades since several large and complex management ignited prescribed fires must be executed near these areas.

*Endangered/Protected Species*

Currently there is one Federally listed endangered plant in Grand Canyon: the sentry milk-vetch (*Astragalus cremnophylax* var. *cremnophylax* ). In addition, there are seven "species of concern," formally termed Category 2 plants by the U.S. Fish and Wildlife Service under the Endangered Species Act (ESA). There is not enough evidence at this time to support listing these seven species; but should additional information on threats to their populations become available, they may become candidates for listing. (See: U.S. Fish and Wildlife Service. 1996. "Endangered and Threatened Species, Plant and Animal Taxa; Proposed Rule." February 28, 1996, *Federal Register*, Part III).

Outside Park boundaries are three Federally listed plants: the Brady pincushion cactus is endangered, and the Welsh milkweed and Jones cycladenia are threatened. There are three proposed candidate plants and nine "species of concern." No populations of these species are presently known within the Park. But in some cases suitable habitat does exist, and populations may be discovered in the future.

Additional protection is afforded many native plants by the Native Plant Law developed by the Arizona Commission of Agriculture and Horticulture. Unauthorized collection of these plants is illegal without a permit. Also, Federal agencies with lands next to the Park have assigned special status designations to many species.

## Wildlife and Fisheries

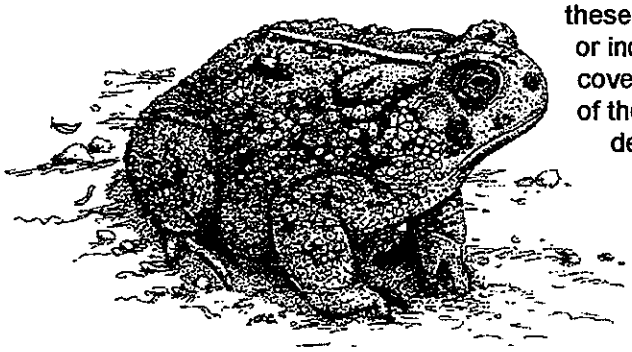
Its large size, relatively unfragmented and diverse habitat, and range of elevations and associated climates have made Grand Canyon National Park a valuable wildlife preserve. The current Park wildlife species database includes 315 birds, 88 mammals, 50 reptiles, 8 amphibians, 21 fishes (including five native species), and thousands of aquatic and terrestrial invertebrate species.

The Park spans nearly 8,000 ft. in elevation, from the Mohave desertscrub regions along the Colorado River in the Park's western end of the Kaibab Plateau's subalpine conifer forests on the North Rim. Three broad habitat types will be used to group Park wildlife: the River corridor and inner canyon riparian areas, inner canyon desert uplands, and the coniferous forests.

### *River Corridor and Inner Canyon Riparian Areas*

The riparian habitat along the Colorado River corridor has developed since 1963 in response to controlled releases from Glen Canyon Dam, making Grand Canyon the only place in the Southwest where large riparian habitats have been created rather than degraded or destroyed.

Patchily distributed, naturalized riparian habitat along the main Colorado River channel and tributaries supports diverse and abundant wildlife assemblages, and provides critical habitat for riparian-dependent species. Most animal species that inhabit the inner canyon depend on these riparian areas directly or indirectly for food and cover during at least part of their annual cycles. The densities of some lizards and birds along the River have been found to be the highest recorded anywhere.



Until Glen Canyon Dam was completed in 1963, the Colorado River's aquatic system was dominated by **native fish.** These native species were specifically adapted to highly variable seasonal fluctuations in sediment load, flow, and temperature, and were severely impacted by dramatic changes resulting from the dam. The introduction of nonnative fish contributed to competition and direct mortality. Of the eight native species found in the River before 1963, three species are now extirpated in the Grand Canyon (the Colorado squawfish, and the bonytail and roundtail chubs), two are barely holding on (humpback chub and razorback sucker), and three are still considered common (speckled dace, flannelmouth and bluehead suckers).

Programs to introduce **nonnative species** for sport and food began at the turn of the century. Most releases were warm-water fish from the eastern U.S., although carp and brown trout were also stocked. Several trout species were introduced for sport purposes by the NPS, Arizona Game and Fish Department (AGFD), and the USFS in the 1920s. While the NPS ceased stocking in 1964, AGFD continues to plant rainbow trout near Lees Ferry. At least 16 species of nonnative fish can now be found in the Grand Canyon stretch of the Colorado. This number may increase, as fish stocked in lakes Mead and Powell could move into the Canyon.

Due to previous fish-stocking programs, a popular sport fishery now exists in Grand Canyon. The stretch below Glen Canyon Dam is the most favored, but some tributaries also receive moderate to heavy fishing pressure. The presence of rainbow trout spawning in tributaries also provides a food source for overwintering bald eagles. Some concern has been expressed about potential eagle disturbance by anglers at Nankoweap Creek.

Another impact of recreational fishing in the Grand Canyon is the accidental catch of endangered native species. This is of particular concern outside the no-fishing zone (within one-half mile of the Little Colorado River confluence) since the remaining humpback chub population exists ten miles above and below the Little Colorado confluence.

Plant species' diversity and lush growth along the newly created riparian zone provides many **bird** habitats in a relatively small area. River corridor bird use illustrates this habitats' importance. Of the 315 bird species recorded in the greater Grand Canyon region, 250 (79%) were found in the River corridor. Only 48 bird species regularly nest along the River; others use the River as a corridor through the desert or as overwintering habitat.

Vegetation occurs in discrete patches rather than continuously along the River. Patch size is an important factor in determining its suitability for a bird species. Patches that may sustain some species for breeding may be too small for other species. Some species avoid nesting in small vegetation patches, presumably due to a lack of suitable nest sites or food, or vulnerability to predators.

Fire, disease, and erosion due to river processes or human use affect these vegetation patches and their use as wildlife habitat. Any changes in the flow regime of Glen Canyon Dam will modify the distribution and species composition of riparian vegetation. These changes will in turn effect the bird communities along the corridor, benefiting some species and thwarting others.

Under post-Dam conditions, large numbers of waterfowl have begun using the stretch below Glen Canyon Dam during winter, peaking in late December and early January. Nineteen species have been regularly reported between Lees Ferry and Soap Creek, at a density of 136 ducks per mile. The diversity and number of waterfowl using this area attests to the abundant food resources in the productive clear, cold aquatic ecosystem. This ecosystem is based on the trophic relationships that exist between filamentous green algae, diatoms, amphipods, and larval insects.

Of the 34 **mammal** species found along the Colorado River corridor, 15 are rodents and eight are bats. While river otters and muskrats are extremely rare, beavers and other rodents have probably benefited from the Dam's presence, increasing their distribution. By cutting willows, cottonwoods, and shrubs for food, beaver can significantly affect riparian vegetation. Other rodents are mostly omnivorous, using many different vegetation types. While bats typically roost and inhabit desert uplands, the insect abundance along the River and tributaries attracts foraging bats from throughout the inner canyon and conifer forests on both rims.

Coyotes, ringtails and spotted skunks, which are the most numerous riparian predators, prey on invertebrates, rodents and reptiles. Raccoon, weasel, bobcat, gray fox, and mountain lion are also present, but much rarer.

Mule deer and desert bighorn sheep are the ungulates which frequent the River corridor. Observational evidence suggests that since the removal of 500 burros by 1981, the number of bighorn sheep has increased. Mule deer are generally not permanent residents along the River, but travel from the rim when food and water resources become scarce there.

There are 27 known **amphibian and reptile** species that reside in the River corridor. The three most common amphibians (canyon treefrog, red-spotted toad, Woodhouse's toad) need the River corridor, or tributary riparian areas with perennial water, for breeding. However, these species are more tolerant of desiccation than most amphibians, and red-spotted toads have been found as far as one-half mile from a known water source. Leopard frogs are also very rare in the corridor, and are known to exist at only two sites.

Of the remaining 23 reptile species, ten are considered common along the corridor. Reptiles use both upland desert and riparian sites, but higher densities are supported in riparian areas due to the rich invertebrate food source and vegetation, and the per site abundance near water.

Lizard density tends to increase from the upland desert to the water's edge. Within the zone between water's edge and open tamarisk sites, lizard densities are equal to or higher than other Southwestern sites. Gila monsters and chuckwallas are the two largest lizards in the Canyon, with chuckwallas much more common.

Many snake species, which are not directly dependent on surface water, may be found both within the inner gorge and the River corridor. Since many snakes feed on lizards, higher prey densities along the River probably result in higher snake densities as well. Five rattlesnake species have been recorded in the Park. Two are distinct species rarely encountered, the Southwestern speckled Rattlesnake and the Northern black-tailed rattlesnake. The other three snakes are subspecies of the Western diamondback rattlesnake complex: the Grand Canyon rattlesnake, Great Basin rattlesnake, and the Hopi rattlesnake. Of these, the grand Canyon Rattlesnake is most commonly encountered in the inner canyon, the Hopi on the South Rim, and the Great Basin on the North Rim.

As the demand for reptiles in the pet trade increases and collectors seek new sources of supply, many national parks are having problems with illegal reptile collection, especially rattlesnakes.

The highest abundance of Park **invertebrates** is found in the River corridor. Invertebrates play a major role in food pyramids that link the aquatic and terrestrial systems, and also serve as the basis for the vertebrates in the Canyon.

Kanab Ambersnails (*Oxyloma haydeni kanabensis*), discovered in 1991 at Vaseys Paradise, are known to exist at only one other site in southern Utah. The Vaseys population size is not known definitively, but was estimated in fall 1995 to be ca. 106,000 individuals. Searches at more than seventy other springs and seeps along the Colorado River have failed to locate any other Kanab Ambersnail populations.

*Inner Canyon Desert Uplands*

The biotic communities of the desertscrub uplands are influenced by the four North American deserts from which they are derived (further described in the *Vegetation Resource* Section). Moving upriver, as the elevation becomes higher and the climate cooler, there are fewer cacti, creosote, and brittlebush, and more widely spaced shrubs such as white bursage and blackbrush. Widespread erosion and rock weathering has created numerous scree slopes and talus fields that provide numerous animal hiding places. The arid conditions of the desertscrub uplands favor a fauna comprised chiefly of reptiles and desert-adapted rodents, although birds also breed in the uplands and cliff areas.

Approximately 30 **bird** species breed primarily in the desert uplands and cliffs of the inner canyon. There are no endemic birds; virtually all species present breed in other suitable habitats throughout the Sonoran and Mohave deserts. It is estimated that at least 100 pairs of peregrine falcons nest along the cliffs of the inner canyon. The abundance of bats, swifts, and riparian birds provides ample food for peregrines, and suitable aerie sites are plentiful along the steep canyons. Unless overwintering survival is a limiting factor in population regulation, the peregrine population is likely to continue to increase.

The **mammalian** fauna includes 50 species, mostly rodents and bats. Three of the five Park woodrat species occur in desertscrub. Many generations of woodrats inhabit the same middens, which can serve as valuable indicators of past climatic conditions and associated vegetation. Numerous caves in the inner canyon provide roost sites for migratory and resident bats. Maternity colonies are especially prone to disturbance from human exploration, and greater efforts are needed to inventory Park caves for bats, and establish protective measures where necessary.

**Amphibians** are generally absent from upland areas that are more than one mile from water. Except for the desert banded gecko, which seems to be distributed only near water along the Colorado River, all **reptiles** known to inhabit the River corridor also appear in the uplands, albeit in lower densities.

*Coniferous Forests*

The three forest types are piñon-juniper between 4,000 and 6,200 feet; ponderosa pine with Douglas fir, white fir, and aspen up to 8,200 feet; and subalpine spruce-fir above 8,200 feet. The higher elevation conifer forests of the Kaibab Plateau, and to a lesser extent the Coconino Plateau, provide habitat patches for species usually found much further north. These "sky-islands" result in disjunct distributions of many species in the western U.S.

The conifer forests of the Grand Canyon region have been extensively altered by past practices of cutting, fire suppression, and overgrazing. As mentioned in the Vegetation Section, fire suppression has transformed the forests from an open parklike setting into a thick, dense forest choked with many young trees. These changes have presumably impacted wildlife species that prefer open canopy forests, such as Kaibab squirrels and goshawks. But more species of mammals and breeding birds are found in the conifer forests than either the inner canyon or River corridor habitats.

Of the approximately 90 **bird** species that breed in the coniferous forests, 51 are summer residents and at least 15 of these are known to be neotropical migrants. Impacts to bird populations from Park prescribed-fire activities are poorly known at present, but have the potential to drastically alter species distributions and population levels. Goshawks and spotted owls are threatened elsewhere in the Southwest from logging activities. Goshawks in particular, and to a lesser extent spotted owls, find refuge in the Park primarily in the conifer forests and upper side canyons along the North Rim.

The conifer forests provide habitat for 52 **mammal** species. On the Kaibab Plateau are found small mammal species more typical of northern latitudes, including porcupines, shrews, red squirrels, and several bat species.

Human activity during the last century has left its mark on the mammal fauna. Three species are reported to have been hunted to extirpation: the wolf, jaguar, and the grizzly bear. Predators were targeted for removal on the Kaibab from 1906 to 1939, resulting in the destruction of 816 mountain lions, 30 wolves, 7,388 coyotes, and 863 bobcats. Lion densities remain low to this day, attesting to the long-term impacts of these programs.

The 1920s Kaibab mule deer explosion resulting from overambitious predator control and hunting elimination, was classic wildlife mismanagement. The mule deer population increased from 4,000 in 1906 to 100,000 in 1924. The subsequent inevitable starvation left 10,000 deer by 1936. Although livestock grazing was discontinued in 1920 on the Kaibab Plateau, the habitat degradation that resulted from the presence of so many deer is still evident. Timber cutting on Kaibab National Forest lands since 1944 has benefited deer by increasing the early successional stage forest, which contains optimal forage. This is in sharp contrast to fire suppression, which reduces available deer forage. From 1969 to 1984, deer population levels fluctuated between 4,700 and 25,000 animals.

Mule deer on the Kaibab Plateau migrate from lower elevation piñon-juniper forests in the winter to higher elevation mixed-conifer forests in the summer. Included within Park boundaries is five percent of their available overwintering habitat and 25% of their summering habitat.

Arizona's native elk, *Cervus merriami*, were hunted to extinction by the early 1900s. Rocky Mountain elk were subsequently transplanted in Arizona, and populations have become established as far north as the South Rim and as far west as Havasu Canyon. In the Park's vicinity, these elk have so increased in number and size during the last 20 years that they are now considered a trophy population, and managed accordingly by the Arizona Game and Fish Department.

Bear have always been uncommon in this region, and reports remain rare. The last bear known to frequent the Park on the North Rim was killed outside the Park in 1991 after it became a nuisance, feeding on trash. However, bears could disperse into the Park from adjacent Forest Service land, where hunting is now prohibited.

The tiger salamander and the spadefoot toad, two **amphibians** not usually found in the other two habitats, occur in spruce-fir forests. Most **reptiles** are found in the piñon-juniper and ponderosa pine regions, especially the mountain short-horned lizard, which is found chiefly in piñon-juniper forests on the Canyon's rims.

*Endangered/Protected Species*

Park animals are on the official list of endangered or threatened wildlife that is maintained by the U.S. Fish and Wildlife Service are listed in Figure 2-1. The Park also provides habitat for 12 Federal Candidate Category 2 species.

Due to recovery-plan goals being met, plans in 1996 call for the bald eagle to be downlisted to threatened status, and the American peregrine falcon to be removed entirely from the Endangered Species list.

Monitoring efforts are underway for most remaining Park threatened and endangered species. The *List of Threatened Native Wildlife in Arizona,* developed by the Arizona Game and Fish Commission, includes 21 Park species.

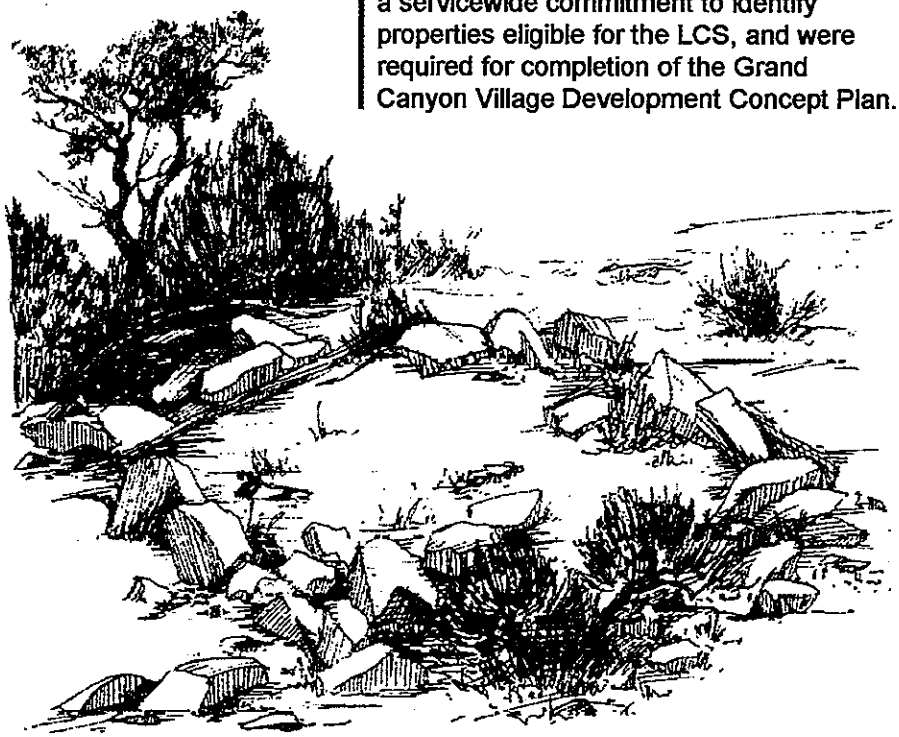
Figure 2-1
*Grand Canyon National Park's Endangered and Threatened Wildlife*

| | | |
|---|---|---|
| Bald Eagle | *Haliaeetus leucocephalus* | Endangered |
| American Peregrine Falcon | *Falco peregrinus anatum* | Endangered |
| Mexican Spotted Owl | *Strix occidentalis lucida* | Threatened |
| Southwestern Willow Flycatcher | *Empidonax traillii extimus* | Endangered |
| Humpback Chub | *Gila cypha* | Endangered |
| Razorback Sucker | *Xyrauchen texanus* | Endangered |
| Kanab Ambersnail | *Oxyloma haydeni kanabensis* | Endangered |

# Cultural Resources

Grand Canyon National Park is rich in cultural resources; over 3,500 prehistoric and historic sites have been recorded. This inventory is based on a two percent survey of the entire Park.

Knowledge about Grand Canyon's cultural resources has come from research and reporting begun in 1540 AD during a trip by Spaniards to the Canyon rim. However, most knowledge has been acquired in the last few decades. Extensive inventories and mapping of archeological resources have been accomplished over the last 15 years. Preliminary evaluations of architectural and historic resources were made in 1974 and 1976 by architects, historians and architectural historians from the former NPS Western Regional Office and Denver Service Center. These studies were part of a servicewide commitment to identify properties eligible for the LCS, and were required for completion of the Grand Canyon Village Development Concept Plan.



Ruin of type found at Grand Canyon showing Masonry of an early Pueblo period.

## Archaeological Resources

Archaeological resources are the remains of past human activity and the records documenting scientific analysis of those remains (NPS-28,1:8). Grand Canyon's archaeological resources encompass a wide variety of cultural remains indicating Canyon use by people over the last 4,000 years. With approximately two percent of Park lands systematically surveyed recording 3500 archaeological sites, resources may total over 50,000. A single fragment of a Paleo-Indian projectile point suggests the possibility of use by big-game hunters at the end of the Pleistocene, nearly 10,000 years ago.

Archaic hunters, possibly of the Pinto Basin Desert culture, placed willow or cottonwood split-twig figurines in caches in caves presumably for the purpose of imitative magic. Radiocarbon analyses of some figurines indicate manufacture between 3000 and 4000 years ago. At this time, no diagnostic artifacts have been found in direct association with the figurines, although Pinto Basin projectile points have been found in their vicinity. Small campsites, projectile points and rock art provide further evidence of the Archaic tradition at Grand Canyon National Park.

Additional information has been obtained in recent years indicating an expanded Archaic occupation. Test excavations conducted at five selected sites in the inner canyon in 1984, and limited sampling of additional sites along the Colorado River in 1989/90 have produced radiocarbon dates well into the late Archaic/early Basketmaker period (2100 BC to 500 AD). In addition, Archaic-style rock art has been documented in the Park's Tuweep district, along with diagnostic projectile points from various locations. With the added information of probable Archaic and Basketmaker occupations, the time period from the Archaic to the later pueblo is no longer a mystery.

People moved in and out of Grand Canyon, leaving behind evidence of their lives here. Thousands of dwellings, shelters, and agricultural terraces have been located, providing evidence of ancestral Pueblo farmers living on both rims and in the inner canyon. Pottery, chipped stone, ground stone, and other artifacts remain to help tell the story of these people and their passage through the Canyon between 800 and 1200 years ago.

The evidence of human occupation increases after around 500 AD. Remains of early pueblo period sites have been found throughout the Park. Diagnostic Basketmaker projectile points have been found eroding from a few middens, and information from excavation of a cluster of pithouses in the Tuweep district attest to this presence. Slab structures and circular pithouse-like dwellings along with early Puebloan ceramics and lithics are found in rock shelters and occasionally in the open.

Peak prehistoric population and maximum Canyon use appear to have occurred roughly between 1000 AD and 1150 AD. Sites are found in almost every possible type of location from the River to both rims. Riverine sites consist mainly of masonry pueblos of one to several rooms with occasional water/soil control features. The high Pleistocene terraces and other River terraces are also characterized by open masonry pueblos. Granaries and small habitation sites are found on talus tops throughout the inner canyon. The remains of single-room sites and mescal pits dot the River corridor and the Tonto Platform.

The Esplanade (topographically a higher platform) has revealed a number of open masonry pueblos, rock shelter sites and mescal pits. Other trailside sites, usually granaries, caches and small habitation sites, are found throughout the Supai Formation. A few hundred meters higher, small cliff dwellings are found, and at the rims, small open masonry sites from one to a dozen rooms are located, many accompanied by check dams and terraces. Single and multi-room dwellings, kivas, and granaries were built of jacal and masonry, dry and wetlaid, coursed and uncoursed. These types of sites as well as caches, water/soil control systems and more ephemeral sites such as artifact scatters and low masonry walls in rock shelters attest to full use of the Canyon's seasonal abundance. The majority of these sites were occupied by ancestral pueblo peoples, the Anasazi, or, as the Hopi call them, Hisatsinom.

At about the same time, members of another ancestral puebloan group from the Virgin River vicinity were occupying the western Park north of the Colorado River. In addition, intensive use was made by the Cohonina of the South Rim, the Esplanade and Havasu Canyon. This group's activities include similar intense use of various Canyon microenvironments. However, there is more variability in structure type, and less emphasis on agriculture with a consequent increase in gathering. Hundreds of mescal roasting pits in protecting rock shelters, and abundant lithics are scattered over the Esplanade.

Climatic shifts apparently dictated the abandonment of Grand Canyon shortly after 1175 AD. Tree-ring analysis indicates that Tusayan Ruin on the South Rim was one of the last sites occupied, with abandonment by around 1225 AD. By 1300 AD, and possibly earlier, Southern Paiute Indians moved into the area north of the Canyon, and made occasional use of resources below the rim. Rock shelters and other limited-activity campsites are found on the North Rim, where dense forest and alpine meadows created good habitat for wildlife such as deer, and below the rims, where water and edible plants would have been more plentiful. Occasional Paiute ceramics found south of the River indicate contact with the population there. More research needs to be done to determine this contact's nature and extent as well as that which existed between North and South rim peoples prior to 1150 AD.

During the same time period, Indians of the Cerbat Branch moved from the Lower Colorado River Valley into abandoned Cohonina territory. Cerbat sites resemble those of the Paiute with the exception of ceramic types and the more intense exploitation of the abundant mescal growing on the Esplanade. Also, agriculture played a fairly important part in the economy, as shown by ethnographic analogy. Little change seems to have occurred in the subsistence patterns and cultural traits from 1300 AD, with the arrival of the Cerbat, until the nineteenth century and the intrusion of the Anglo-American culture into the Havasupai and Hualapai ways of life.

The Hopi, Zuni, Southern Paiute and Navajo all left remains that have become part of the archaeological record. These same people continue to use the Canyon today for traditional and religious reasons.

In addition to the prehistoric and historic American Indian archaeological legacy, Euro-American history, from the time of contact in 1540 through development of the NPS is represented in the archaeological record. The majority of the historic archaeological record comprises evidence of early exploration (John Wesley Powell and Robert Brewster Stanton), exploitation (early mining sites from Ralph Cameron, Pete Berry, William Wallace Bass, and John Hance), and tourism (Grandview and Buggeln Hotel sites, Hance Ranch, and Bass Camp).

## Ethnographic Resources

An ethnographic resource is defined as any natural or cultural resource linked to the traditional practices, values, beliefs, history and/or ethnic identity of a cultural group or groups.

Grand Canyon has been home to various groups of people for thousands of years. These people, both American Indian and more recent Euro-Americans, have used the Canyon as both a home and a place linked to traditional practices, values and beliefs. To the **Hopi** and **Zuni**, the Grand Canyon represents their place of origin into this world. For Hopi, it also represents the place where their spirits come to rest after death. Although the Anasazi (Hisatsinom) migrated from the Canyon area, their descendants, the Hopi, continue periodic visits. Trips are made to gather ceremonial salt from the deposits along the eastern Colorado River, and to the Sipapuni, a mineral spring located just outside the Park on the Little Colorado River which is believed by the Hopi to be their place of origin.

For the **Pueblo** (Hopi and Zuni) people, archaeological remains in the Canyon provide evidence of their migration from their place of origin to their present homes. For the **Pai** (Hualapai and Havasupai) people, the Canyon and the River are the lands they have been entrusted to care for; the River represents the backbone. For the **Southern Paiute**, the Canyon represents a place given to them from the Creator to protect and manage, including its water and natural resources. To the **Navajo** people, the Colorado River in Grand Canyon forms a protective boundary on the western border of Navajo land. The Navajo can trace certain ancestry to specific locations in the Canyon.

**Euro-Americans** recognized the Canyon's spiritual values in the establishment of the national park in 1919. World Heritage designation told the world that the Grand Canyon had value beyond just the American people. The 1975 Grand Canyon Enlargement Act specified natural quiet and scenic resources as important, yet intangible, qualities that must be protected. These, too, are ethnographic resources.

### *Traditional Uses*

Many tribes who claim ancestral ties to the Grand Canyon continue to use the Park. Salt and hematite are collected from the locations along the River by all tribes, and certain plants are collected for traditional and medicinal purposes throughout the Park. Pine nuts are still collected by Indians and non-Indians. One small group of Havasupai continue to live approximately one mile west of Grand Canyon Village in Supai Camp. The 1975 Grand Canyon Enlargement Act enlarged the Havasupai Reservation by 185,000 acres, at which time the Tribe relinquished any further rights within the Park. The Act also allotted 95,300 acres of NPS land, termed Havasupai Use Lands (HUL), for "grazing and other traditional purposes."

## Historic Resources

Historic resources are cultural resources which have been determined to have significance within some historic context or theme of Park lands. The significance has been achieved during the historic period, as opposed to the prehistoric time period. Resources include districts, sites, landscapes, buildings, structures and objects. Their significance is determined through research.

The following description of Euro-Americans and their development of Grand Canyon offers a background to the Park's historic districts, landscapes, buildings, structures, features and objects.

### *Period of Exploration*

Evidence of European interaction with the Canyon is another Park cultural development phase. The historic period begins with Don Garcia Lopez de Cardenas' exploration in 1540 AD of the South Rim and possible routes to the River. In three unfruitful days, he reached neither the River nor the Havasupai of whom he had been told by local Indians. European contact with both Havasupai and Southern Paiute in their homelands occurred in 1776 with visits by the Franciscan priests, Francisco Garces and Silvestre Velez de Escalante. Both accounts of the Indians, although relatively brief, are the first descriptions within the Park. For Europeans, the immense chasm was a barrier from the beginning. Grand Canyon's discovery by a United States explorer, a fur trapper named James Ohio Pattie, reportedly occurred in 1826. The Grand Canyon became United States territory officially in 1850, and exploration began in earnest. The daring scientific expeditions down the Colorado River led by Major John Wesley Powell in 1869 and 1871 were the most significant in terms of mapping and exploration.

*Pioneer Settlement*

The pioneer settlement of the Grand Canyon area began with the establishment of a ferry across the Colorado River by John Doyle Lee in 1871 at the mouth of the Paria River. Settlement by ranchers and miners did not really progress until the railroads reached towns bordering the Grand Canyon (such as Flagstaff and Williams in the 1880s). Prospectors also began to explore Grand Canyon in the second half of the 19th century, and established numerous mining claims. Mining was limited until the railroad's arrival. In the latter part of the nineteenth century, gold fever was spreading throughout the West. The exposure of so many rock formations and fault zones in the Canyon led some to believe that precious metals could be easily found. In reality, high grade asbestos, copper, silver, lead, and more recently, uranium ores and bat guano were located, but the logistical problems of building and stocking mining camps and of transporting the ore to the rim made mining attempts economically unfeasible. By the Park's inception in 1919, all mining, except at private inholdings and the Orphan Mine near Grand Canyon Village, had ceased.

Evidence of these ventures is still very visible in the Park. Examples are found in Asbestos Canyon, Copper Canyon, Shinumo Canyon, Point Sublime, Hakatai Canyon, Horseshoe Mesa and Red Canyon. Evidence consists of trail and masonry work along access routes, mine adits and tailings, masonry and wooden cabins, tent floors, grinders, sawed-off shovels and other tools and human refuse. The roads and trails these early miners and settlers established formed the backbone of today's circulation systems at Grand Canyon.

Most notable amongst the early mining ventures are those of Peter Berry and Ralph and Niles Cameron. These individuals were responsible for improving the Bright Angel (and later making it into a toll road) and Grandview trails. Their purpose was mineral exploitation and water development. Ore from the Last Chance Mine on Horseshoe Mesa received an award for purity at the Columbian Exposition.

Many prospectors turned to tourism as a more effective way to make money. John Hance's cabin near Grandview became the nucleus of a tent-camp hotel, the first tourist facility at the Grand Canyon. It was located at the terminus of the Flagstaff—Grand Canyon stage line. The Grandview Hotel, the first hotel constructed on the rim, was built in 1897, and replaced a cabin used by miners from Horseshoe Mesa. In 1906, Martin Buggeln constructed a large frame hotel beside the old Hance tent hotel. These structures were razed over a span of several decades, from the late 1920s through the 1960s, when the NPS removed the few remaining structures. For a time, these hotels and the Grandview Trail down to Horseshoe Mesa and the River were the center of Park tourist activity.

A more remote, but no less interesting area, was Bass Camp established by W.W. Bass in 1890. He built a trail to the River, and located several mineral claims, but his primary goal was to show the Canyon to as many people as possible. He built a road to the Canyon from Ash Fork and ran a stage, guiding tourists from both there and Williams. The building foundations, a tramway, and the camp's trash dumps are still visible.

Another of the early Canyon explorers was Louis Boucher. Boucher, known as "the Hermit," came to the Canyon around 1891. He was a quiet man who enjoyed the Canyon's solitude. More Canyon areas are named for Boucher than for any other individual: Hermit Creek, Hermit Canyon, Hermit Trail, Hermit Rapid, Boucher Canyon, Boucher Creek and Boucher Rapid all bear his name. He made his homes both within Hermit and Boucher canyons, developing trails, water sources, farming areas, tourist accommodations and mining claims. Although he left the Canyon sometime before 1912, his contributions to early Park development are still significant.

*Railroad Development*

To increase ridership on its cross-country trains, the nation's major railroad companies began to promote the great natural wonders and national parks of the American West for tourism. The arrival of the Santa Fe Railroad in 1901 shifted the primary tourist focus to the area of the South Rim near the Bright Angel Trailhead. The Santa Fe Railroad Station (Grand Canyon Depot) was unique among railroad stations in its log construction and rustic design. The Bright Angel Hotel was begun as a tent camp by J.W. Thurber, a stage operator who extended the stage route from Hance's Motel to Bright Angel Canyon in 1895. Probably the first person to build in this area was "Bucky" O'Neill, a journalist, mayor, sheriff, soldier and promoter who was also fond of the Canyon. His log cabin is the oldest surviving structure on the rim. Ralph Cameron, another early Canyon entrepreneur, moved a cabin to the area and added a porch and second story in 1902, naming it the Cameron Hotel. Development of tourist facilities by the Fred Harvey Company in conjunction with the Santa Fe Railway began during this time. El Tovar Hotel and Hopi House curio shop, both examples of this early partnership, were both completed in 1905.

Entrepreneurs such as the Kolb Brothers and John G. Verkamp constructed what are now the few remaining examples of pioneer/vernacular style structures. The Fred Harvey Company and Santa Fe Railroad used Rustic, Swiss Rustic and Ethno-Historic Styles of architectures to evoke romantic images of pioneer construction and the rustic character of the western frontier.

Mary Elizabeth Jane Colter designed the Hopi House as a replica of structures indigenous to the Hopi mesas east of the Canyon. She then designed both Lookout Studio and the Hermits Rest concession buildings to blend with natural rock formations in the true spirit of rustic architecture. As a true expression of the politics and competition of the time, Lookout Studio was intentionally placed by the Fred Harvey Company to obscure the visitor's view of Kolb Studio from El Tovar.

*Federal Administration*

From 1905 until 1916, the United States Forest Service administered the Grand Canyon area. Even though the USFS developed a townsite plan, very little development was completed until after the area became Grand Canyon National Park in 1919. The National Park Service Landscape Engineering Department developed its own townsite plan, and working closely with the Santa Fe Railway and Fred Harvey Company, expanded Park visitor and administration facilities over the next two decades. Grand Canyon Village is one of the earliest, most ambitious and most significant examples of 1920s American Town Planning, and a very significant cultural landscape. The landscape is in process of nomination for landmark status as part of the NPS thematic nomination of landscape architecture in the national parks.

During the early 1900s, administration, housing, and maintenance facilities were constructed by both the NPS and the concessioner. Stephen Mather addressed the issue of development in national parks as follows:

> *...In the construction of roads, trails, buildings and other improvements, particular attention must be devoted always to the harmonizing of these improvements with the landscape....*

Most buildings constructed during this development period are still standing, and many are used for their originally designed purpose. They were constructed in what is now referred to as *NPS Rustic* style, although many were designed by concession architects. The Grand Canyon Village Historic District includes many of these structures, although the District has more structures built by the Fred Harvey Company during these years than by the NPS.

Park development changed from a tourist trade based on railroad transportation to one based on the automobile in the late 1920s. Even though the Depression caused a decline in visitation, it was short-lived, and the need for facilities development continued. In 1935, the Bright Angel Lodge complex, designed by Mary Colter, was completed.

By this time the Fred Harvey Company had developed tourist facilities in the bottom of the Canyon at Phantom Ranch. Colter designed not only the structures but carefully planned the siting and location of the buildings in relation to each other. These buildings inspired other architects working at the Park.

The Union Pacific Railway, at the urging of the National Park Service, had developed facilities on the North Rim at Bright Angel Point. These buildings, the North Rim Inn, and the NPS Headquarters area, their architectural style and the way in which they were sited on the landscape followed the same rustic tradition.

The Ranger Station Complex at Tuweep provided not only a functional home in a remote location, but also continued the rustic architectural standard as a romantic welcome to adventurous visitors who arrived there.

*Civilian Conservation Corps (CCC)*

In the mid-1930s the NPS used assistance from the Civilian Conservation Corps to maintain and expand visitor-related facilities. Projects involving the CCC were integrated within the Canyon at places like Indian Garden and Phantom Ranch, as well as in the developed areas on both the North and South rims. Four CCC camps focusing on projects such as road and trail building, erosion control, fire protection and building construction. Most development in Grand Canyon National Park between 1933 and 1941 was the direct result of the Civilian Conservation Corps labor. The oral history of this significant time in the Park's development is a significant resource which needs further attention.

Trails, Canyon overlooks, roads, retaining walls, monuments and structures established a design pattern and language throughout the Park. CCC programs influenced the NPS and further refined and institutionalized the concepts of NPS Rustic Architecture.

In 1935, NPS architect Albert H. Good defined the style as follows:

> *...Successfully handled, it is a style which, through the avoidance of rigid, straight lines, and over-sophistication, gives the feeling of having been executed by pioneer craftsmen with limited hand tools. It thus achieves sympathy with natural surroundings and with the past....*

Arno B. Cammerer, Director of the National Park Service in 1935, stated a similar design philosophy during this period:

> *...In any area in which the preservation of the beauty of nature is a primary purpose, every modification of the natural landscape, whether it be by construction of a road or erection of a shelter, is an intrusion. A basic objective of those who are entrusted with development of these areas for the human uses for which they are established, is, it seems to me, to hold these intrusions to a minimum and so to design them that, besides being attractive to look upon, they appear to belong to and be part of their settings....*

### *Historic Properties*

At present, six historic districts, two prehistoric sites and one individual structure are listed on the National Register of Historic Places. The Park's historic properties include 124 buildings listed as National Historic Landmarks, 336 listed on the National Register of Historic Places and an additional 44 determined to be eligible. The List of Classified Structures contains 884 properties. In 1980 the entire Park was determined eligible by the State Historic Preservation Officer as an archeological multiple resource area; this nomination is still pending.

Many of the Park's historic properties are worthy of preservation. In most cases, the significance of an individual building is based on architectural style, association with master designers, technical (engineering) qualities, or associations with broad patterns of history. As a whole, the historic properties at Grand Canyon National Park may have national significance for their use as a model of Park development. Site and building integrity makes the area useful in interpreting land use and history which is of local, regional and national significance.

### *Historic Structures*

These resources have been described somewhat in the previous section on historic resources. Over 450 historic structures, most representative of NPS Rustic architecture, were designed and built between 1900 and 1940. These varied cultural resources illustrate the general historic development of the American West. More than that, they represent human exploitation, adaptation, and finally, recreation in an extremely rugged and diverse environment.

### *Cultural Landscapes*

Cultural landscapes are setting we have created in the natural world (NPS-28, 1:8). They not static, nor have they ever been. Landscapes evolve sometimes rapidly to accommodate new technologies, use patterns and lifestyles. The key to cultural landscape preservation is to understand them–what is significant about them and which character-defining features to preserve. Sometimes these features may be small and relatively easy to preserve, such as a vegetation type or certain landscape features. However, sometimes what defines a landscape's character is the way a building relates to other buildings, to site features, roads and work areas. For example, the Power House on the South Rim historically related very strongly to the railroad tracks, hence its location and orientation in the village.

A change in this strong relationship may disrupt this character-defining feature. Cultural landscapes define the context and setting for historic structures. These developments have been described somewhat in the previous section on historic resources.

Like historic buildings and districts, cultural landscapes reveal aspects of our country's origins and development through their form and the ways they were used. They tell us about our evolving relationship with the natural world. At Grand Canyon, most of the developments began to take form during the height of rustic architecture and town planning.

Grand Canyon Village on the South Rim is under consideration for National Landmark status. Overlooks, trails and roads constructed by the CCC illustrate excellent examples of development for recreational purposes at Grand Canyon during the 1930s, and are significant cultural landscapes. Sixteen cultural landscape areas have been identified.

### *Museum Collection*

Museum objects are manifestations and records of behavior and ideas that span the breadth of human experience and depth of natural history (NPS-28, 1:8). Museum collection goals are to preserve, and provide for research and educational purposes, materials which are representative of Park natural and cultural resources. The collection is comprised of over 250,000 cultural and natural history objects. It is divided into six major subcategories: biology, paleontology, geology, history, archeology, and ethnology. Over 1000 people use the collection each year including staff, researchers, and publishing companies.

The collection is an important record of the natural history and changing Park environment. For example, the Park has one of the largest paleontology collections in the National Park Service including specimens unavailable elsewhere. The quaternary collection documents changes in the Canyon's environment approximately 10,000 years ago, when animals such as ground sloths were using caves. The collection also maintains geologic, insect, herbarium, study skin, bone, and wet specimen collections.

Large collections of natural history specimens exist at facilities such as the Museum of Northern Arizona (insects), and Northern Arizona University (paleontological and herbarium collections). These collections have yet to be catalogued into the Park's collection, although knowledge of them is important to staff and researchers. All collections removed from Federal lands are the property of the land managing agency, and these collections, although housed outside the Park, are part of the Park collection.

The cultural history collection contains materials which document the Park's human history. The ethnography collection contains a small collection of material documenting the crafts of American Indians around the Grand Canyon area. The archeology collection protects over 100,000 artifacts documenting the presence of humans in the Canyon for the last 10,000 years. The history collection contains artifacts and archives documenting recent human activities in the Park including early exploration, mining, the development of tourism, and government management.

Throughout the 1920s and 1930s, Park employees collected materials which form the basis of the current collection. The intent was to preserve representative specimens of all Park areas, to serve as a learning tool for employees, and for exhibit purposes. Heavy emphasis was placed on natural history specimens, though cultural material, specifically archaeology materials for exhibit needs, was also collected. With the nature of the Park's small museums and limited exhibit space, the collection has become research-oriented rather than exhibit-oriented.

Once the orientation toward research began, collections with specific interests were conducted. Some of these collections have become part of the Park research collections; others are housed with the research institution, and these have not been cataloged into the Automated National Catalog System in use at the Park. At the time some of the research was conducted, collection permits were not required. The research institutions in some cases may be unaware of the NPS ownership. Collections also increased due to the need to preserve artifacts and specimens which might have been destroyed due to various construction or other destructive events.

While all collections have inherent value due to the objects they contain, the collections at Grand Canyon National Park have an intangible value due to the national prominence of some of the collectors and donors. A partial list of these donors includes Marian Albright, Bruce Babbitt, Stephen Booth, Ferdinand Burgdorff, J. Harvey Butchart, Mary E. Jane Colter, Barry Goldwater, Marguerite Henry, Francois Mathes, John H. Maxson, Nicholas Roosevelt, Clyde Searl, John Wetherill, and David White.

## Recreational and Experiential Resources

Grand Canyon's natural and cultural resources in addition to its clean air, temperate climate, solitude, generally unspoiled environment, and opportunities for outdoor experiences, all combine to make the Park a major national, and increasingly international, visitor attraction. The Grand Canyon has internationally recognized scenic vistas, experiential qualities, and recreational values. With the Canyon's enormous proportions and the ever-changing play of sunlight and shadow on its geologic formations, it is widely considered one of the world's most beautiful natural areas. Its great scenic variety includes forests, deserts, canyons, grasslands, plateaus, volcanic features, streams and waterfalls.

The Canyon's Class I air quality is extremely important for enjoying its scenic qualities (i.e. visibility, colors and details) for both daytime and night-sky viewing. The Canyon also allows for direct access to numerous opportunities for solitude and contemplation. With these rare qualities, the Grand Canyon is recognized and sought out as a place of unusual and noticeable natural quiet. Grand Canyon's natural, cultural and scenic qualities, coupled with its vast size, give rise to inspirational and spiritual values and a sense of timelessness.

The Grand Canyon is the largest and possibly the most diverse wilderness on the Colorado Plateau, ranging from the Kaibab boreal forests to the Joshua tree forest of the Mohave Desert. Grand Canyon National Park forms the core of a 1.5-million-acre wilderness consisting of proposed National Park Service units and designated Forest Service and Bureau of Land Management wildernesses.

A great diversity of resource-based recreational opportunities and support services help visitors experience, enjoy, and appreciate the wide range of recreational opportunities that are available in the Park's developed and wilderness zones.

### Developed Frontcountry Areas

Within the developed rim areas, visitors have easy access to trails and overlooks, as well as opportunities for solitude and contemplation. The developed areas also contain commercial services including developed campgrounds, hotels, restaurants, cafeterias, curio shops, grocery stores, filling stations, post offices, and medical services.

#### *South Rim*

The South Rim presents opportunities different from those available in other Park areas. Of utmost importance is direct access to the rim where panoramas provide the Park's aesthetic, inspirational, and emotional appeal—one of the main reasons people visit. The South Rim remains the focus for most Park visitors, with diverse opportunities for Canyon viewing, from Desert View to Hermits Rest. The South Rim accommodates large numbers of visitors, but the experience may include dense crowds and related conflicts and resource impacts.

Visitors can experience solitude in a natural setting as well as social exchange in developed areas.

#### *North Rim*

The serene and beautiful natural environment, sweeping Canyon views, and a relaxed, uncrowded feeling are the prime qualities of the North Rim developed area.

The North Rim and the adjacent national forest offer a low-key and uncrowded atmosphere that offers opportunities to be intimately involved with the environment.

*Tuweep*

Tuweep is unique at Grand Canyon since it is remote yet accessible by car. This area is known for its spectacular views of the Colorado River, especially Lava Falls, a major rapid. Excellent examples of volcanic activity include dramatic views of Vulcan's Throne, a cinder cone precariously perched on the inner gorge, as well as the Uinkaret Mountains extending northward into the Mt. Logan and Mt. Trumbull wildernesses.

Visitor facilities are minimal, consisting of uncrowded, semi-primitive campgrounds and a ranger station.

*Lees Ferry*

Human occupation at Lees Ferry extends back hundreds, perhaps thousands, of years. Petroglyphs and other artifacts indicate prehistoric occupation by Pueblo and hunting and gathering societies well before European arrival. The Lees Ferry Historic District contains a variety of stone structures that date back to the late nineteenth century. A short stroll up the Paria ends at Lonely Dell; the ranch first occupied by, and the ferry crossing first operated by, the infamous John Doyle Lee.

Lees Ferry provides direct vehicular access to the Colorado River. Visitors can enjoy excellent trout fishing from shore or by boating upriver. Lees Ferry is the launch site for over 800 white-water river trips each year. River trip length ranges between three days and three weeks.

*Cross-Canyon Corridor*

The most intense use of the inner canyon occurs in the non-wilderness cross-canyon "Corridor," which consists of developed trails and campgrounds along the Bright Angel, South Kaibab and North Kaibab trails. This area is a semi-primitive developed zone that receives high levels of day and overnight use. Ranger stations and medical assistance are available at Indian Garden, Bright Angel and Cottonwood campgrounds.

Lodging and dining facilities are available at Phantom Ranch, a small rustic historic lodge where visitors can experience the inner canyon. Day-use hiking, mule rides, fishing and overnight use account for the high use-levels in this area.

Additional rustic facilities have historically been provided along the trails to meet visitor needs. For over a hundred years, mules have carried visitors into the Canyon, hauled supplies, and helped with trail maintenance.

The corridor trails are the main transportation routes for most visitors into the inner canyon. Services, such as drinking water and toilets, are provided at critical locations for visitor safety and to reduce environmental impacts.

## Proposed Grand Canyon Wilderness

Grand Canyon National Park consists of over one million acres of primitive lands and proposed wilderness, approximately 240 free-flowing miles of the Colorado River, and the developed inner-canyon Corridor areas including Indian Garden, Phantom Ranch and Cottonwood. Over 23,000 visitors float the River annually. Approximately 800,000 visitors day-hike in the Canyon each year. Over 15,000 people hike and camp in the proposed wilderness, and 25,000 use Corridor campgrounds. The total annual corridor and wilderness use including the River is 275,000 user-nights. Over 90% of the Park, including the River, is proposed for wilderness designation.

In addition to being characterized by an absence of human-produced structures and roads, wilderness is also characterized by the lack of human-produced sounds. While efforts are being made to reduce noise levels throughout the Park, noise levels within the inner canyon are particularly troublesome due to the lower ambient (background) sound conditions present there (thus a reduced muffling effect), the expectation of solitude and quiet held by visitors, the expanding air-tour overflight industry, and a legislative mandate to "substantially restore conditions of natural quiet." Conditions of natural quiet (i.e., conditions where the only sounds audible are those produced by nature) are critical to both the definition of wilderness and human perceptions of a wilderness experience.

Thus, wilderness is defined by its visual, aural, and social characteristics. The importance of solitude, natural quiet, and wilderness experience is attested by the large number of visitors willing to travel long distances and expend great physical effort to reach the often remote areas where these qualities may be experienced.

The proposed wilderness contains hundreds of miles of trails and routes which provide diverse recreational opportunities and experiences. Most of these trails have received little or no maintenance for decades, and many contain sections of serious resource damage.

### *Wilderness Opportunity Spectrum (WOS)*

This approach offers a spectrum of wilderness conditions including finer gradations of naturalness and solitude, i.e., primitive conditions. The WOS is a zoning strategy which delineates particular areas where different management prescriptions apply. While the WOS permits a range of naturalness and solitude based upon different levels of recreational use, all opportunity classes must lie within the range of wilderness criteria regarding natural conditions and visitor experience. The Grand Canyon proposed wilderness is divided into three zonal opportunity classes: threshold, primitive, and wild, with a total of 84 distinct management areas.

***Threshold Opportunity Class*** areas are the most intensively used within Grand Canyon's proposed wilderness. Threshold areas have designated campsites and limited facilities such as toilets. These areas are managed for the highest use levels consistent with visitors' expectations regarding wilderness verified thorough research and monitoring. Of the 84 total areas at Grand Canyon, 24 are in the Threshold Class.

Visitors in threshold classes are likely to have contacts with other campers, day hikers and river runners.

***Primitive Opportunity Class*** areas provide a greater opportunity than threshold zones for an isolated and remote experience. Camping is primarily at-large, except in areas that require special management actions for resource protection. Of the 84 total areas at Grand Canyon, 39 are Primitive Class

Opportunities for solitude are likely, although contacts with other overnight users and river runners may occur.

***Wild Opportunity Class*** areas provide the greatest opportunity for an unconfined, solitary experience. Of the 84 areas at Grand Canyon, 21 are Wild Class.

Contacts with other hikers are unlikely and contacts with river runners are less frequent than in other areas.

*Colorado River Corridor*

The Colorado River, as it flows through the Park, provides opportunities for one of the world's premier river experiences, including one of the world's longest stretches of navigable white water. The River corridor is proposed for wilderness designation, and the GMP calls for a wilderness river experience on the Colorado River. Relatively high levels of use (motorized and non-motorized) occur during the primary season (May to September), moderate levels in the shoulder months (October and April), and low levels in the winter months (November through March). Camping is concentrated on beaches, and high use levels occur at attraction sites. Visitors are likely to have many contacts while traveling on the River and at attraction sites during the primary season. Contacts are less frequent during the shoulder months. Opportunities for solitude exist year-round but are more likely during the shoulder and winter months.

## Regional Recreation Opportunity Spectrum

Grand Canyon National Park is bounded by the Kaibab National Forest, Bureau of Land Management areas, Lake Mead and Glen Canyon national recreation areas, and tribal lands administered by the Navajo Nation, Havasupai, and Hualapai tribes. Opportunities for off-road mechanized use (all-terrain vehicles and mountain biking, for example) as well as fishing, river running, hunting, horseback riding, camping and motorized-boat use are available outside the Park.

# CHAPTER THREE

## Resource Management Programs

### Chapter Topics

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## Grand Canyon National Park Science Center Partnership

The Grand Canyon National Park Science Center (GCNPSC) was created in April, 1995. The Science Center is a new concept that responds in a proactive way to initiatives within the Department of the Interior, the National Park Service, and from external sources on a regional or ecosystem scale to improve agency efficiency, public service and resource protection. Central to this effort is the need to work more closely with associated State and Federal agencies, American Indian tribes, conservation groups and other organizations that share an interest in resource stewardship on public lands.

The Science Center is made up of an internal NPS operational function and a partnership program. The NPS staff includes natural resource scientists, historians, curators, sociologists, archaeologists, physical scientists, and other professional subject-matter experts; technicians who assist in carrying out field operations; and technical and administrative-support staff.

Together these people, in consultation with Partnership members, provide the scientific knowledge about Park resources necessary to make knowledgeable and informed management decisions. This staff also formulates and prepares resource management plan, and provides the leadership to carry out key portions of the Park's resource stewardship program.

The new Science Center organization is engaged in many of the same operations as the previous Park resource management division with the addition or expansion of social science capability, a proactive research program which will be carried out primarily by partnership agencies and contract research scientists, and the development of a comprehensive long-term monitoring program for both natural and cultural resources. The purpose of expanding the later two operations is to greatly improve our knowledge and understanding of Park resource conditions. Periodically evaluating the status and trends of resource condition is a fundamental agency responsibility that provides the necessary information to develop proactive management actions that reduce threats to resource health and visitor enjoyment before they become serious problems.

The Science Center Partnership Program includes the regular involvement and participation of six recognized categories of science program partners; cooperating associations, American Indian tribes, academic and agency partners, citizen conservation association partners, and other Park operational units.

The purpose of this partnership is to integrate the efforts of State and Federal land-managing agencies, American Indian tribes, educational institutions, and science advocates to achieve the shared mission of protecting and managing natural and cultural resources within Grand Canyon National Park, and on adjacent lands. Primary activities include the identification of resource issues, the development of stewardship strategies, and the facilitation of joint field-science programs.

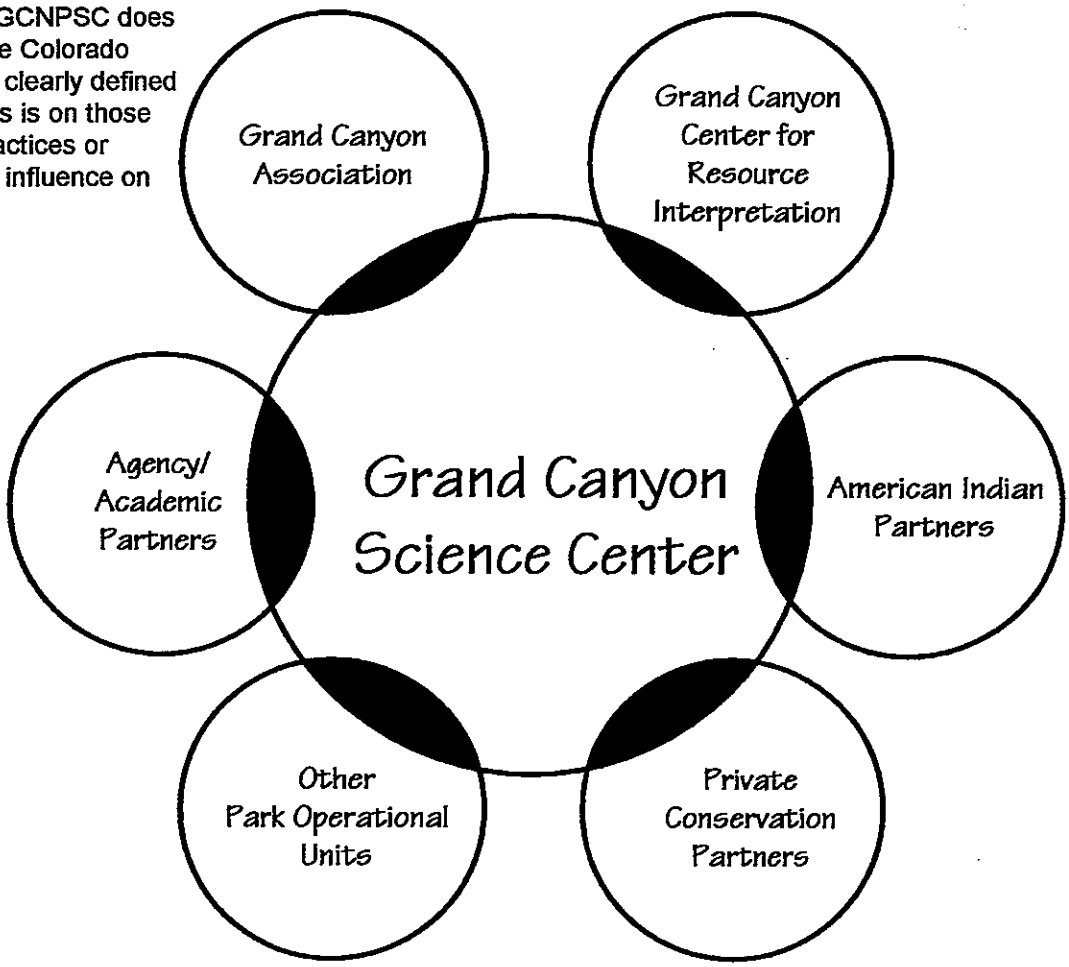
Actions of regional scope or that require multi-agency or stakeholder involvement include: management-objective development for the proposed Glen Canyon Dam Adaptive Management Program, water resource protection, Threatened and Endangered species and habitat protection strategies, wildlife management, fire management, and the control of exotic plant species.

A primary role of the Grand Canyon National Park Science Center Partnership is to facilitate the implementation of the concept of ecosystem management, regional science and management actions.

At this time the scope of the GCNPSC does not extent to include the entire Colorado Plateau. Although there is no clearly defined zone of cooperation, the focus is on those lands where management practices or human activities can have an influence on the Park.

Figure 3-1
*Grand Canyon Science Center Relationship with Partners*

A primary role of the Grand Canyon National Park Science Center Partnership is to facilitate the implementation of the ecosystem management concept.



## The Resource Stewardship Strategy

The Resource Stewardship Strategy includes four elements:

- **The Vision**
  The capabilities and programs that should be in place by the year 2000.
- **Objectives**
  What needs to be achieved in specific program areas within the next four years.
- **Key Actions**
  What needs to be done administratively to fulfill the Vision and meet the Objectives.
- **Project Statements**
  The individual projects that should be accomplished within this planning period. Included in Chapter Three are titles of the highest priority natural, cultural, and integrated project statements. For a complete listing, consult the Project Statement section of this Plan.

### Resource Management Program Vision

By the end of this planning cycle (2000), Grand Canyon National Park's resource stewardship program will include a wide array of partnerships that enhance program effectiveness. Park neighbors, the general public, stakeholder groups, cooperating agencies and adjacent American Indian tribes will understand, appreciate, and support Park resource-stewardship objectives and programs. The combined efforts of all stewardship partners, together with a fully engaged public, will result in a level of protection and effective management that will preserve, *unimpaired,* the resources and public values associated with Grand Canyon National Park.

Park staff engaged in resource-stewardship programs and support activities will be highly educated, trained and skilled professionals working in positions that are properly organized into a proactive and highly effective work force. Critical positions will have been filled and/or the functions will be accomplished through partnerships or other means.

### Resource Management Program Objectives

These objectives are established to provide program guidance on how the National Park Service and partners will achieve the resource-stewardship mission at Grand Canyon National Park. The objectives provide the foundation for the stewardship strategy, and serve to focus NPS staff and partners on critical issues and projects. They represent the best balance of effort to protect resources, educate stakeholders, and provide a wide variety of experiences that are consistent with law and NPS policy.

The objectives are broken down into natural, cultural, and integrated categories. Sociological and visitor-based concerns are listed under integrated resource objectives.

*Natural Resource Objectives*

1. Restore natural areas damaged by visitor use, and implement protective actions needed to prevent future damage.

2. Through the development and operation of a science-based comprehensive natural resource inventory and monitoring program, develop and maintain an understanding of the status and trends of populations, communities and ecosystems, and the phenology of the resource.

3. Restore, enhance, and protect populations of threatened or endangered species.

4. Preserve the natural genetic integrity and species composition within the Park, consistent with ecosystem processes, including the elimination of nonnative plant and animal species wherever possible.

5. Protect natural quiet as a critical Park resource. Reduce or eliminate excessive or unnecessary noise in, over and adjacent to the Park which detracts from visitors' enjoyment of natural Park values or which adversely affects Park resources.

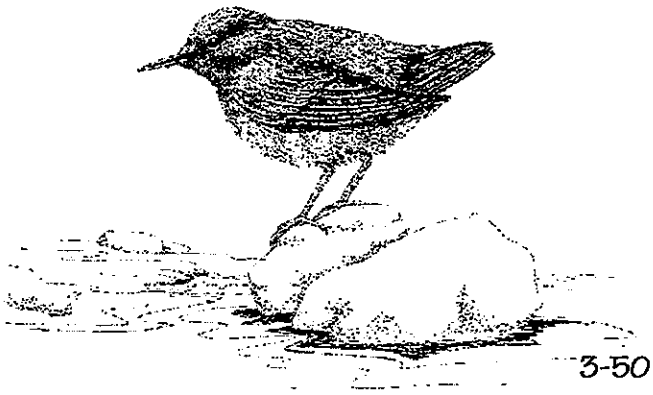
6. Manage the Colorado River to restore or "mimic," to the degree feasible, pre-dam natural and physical processes, including fish, wildlife and plant populations, and ecological relationships.

7. Protect and conserve sources and quality of natural water resources. Develop a comprehensive database on surface and ground water sources, and monitor key sources.

9. Preserve air quality, and protect it from within-Park, as well as, external degradation. Work toward continued protection of Grand Canyon's Class I airshed.

10. Reintroduce and maintain fire's natural role in Park ecosystems to the maximum extent possible.

11. Perpetuate the natural, geological, and ecological conditions and historic associations of the Park's cave resources.



*Cultural Resource Objectives*

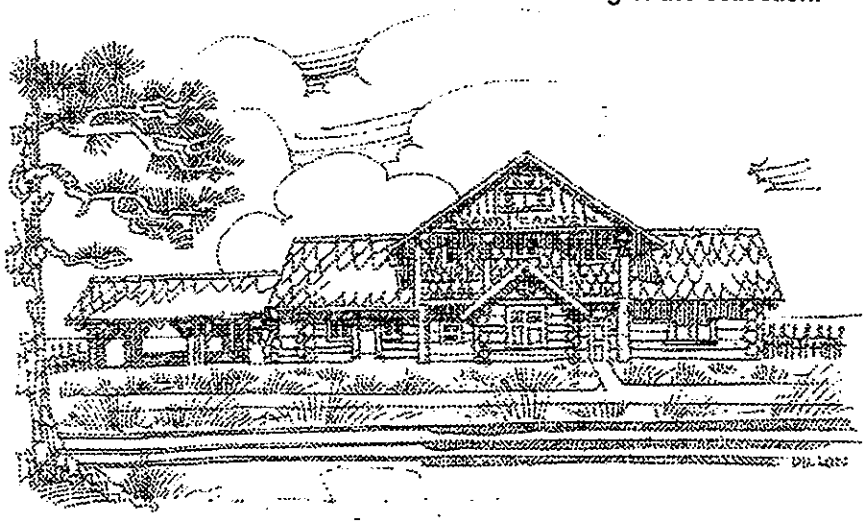
1. Develop a professionally staffed historic preservation program. Protect the character and fabric of historic buildings and other structures through preservation, restoration, register listing, adaptive use, and other appropriate means.

2. Perpetuate unimpaired the Park's prehistoric cultural resources, protecting them from vandalism or unauthorized excavation, collection, appropriation, or visitor use.

3. Obtain and maintain appropriate inventories of cultural resources including a survey of archaeological sites.

4. Collect ethnographic data and develop an ethnohistory for the Havasupai, Hopi, Hualapai, Navajo, Southern Paiute, and Zuni in association with the Grand Canyon, as appropriate, to preserve, protect and interpret Park resources and values important to diverse American Indian cultures, including sacred, significant and traditional use areas.

5. Facilitate the achievement of an effective museum-collection program that is up-to-date, reflects current preservation policies, meets most information and research needs, and provides for the effective housing of the collection.



*Integrated Resource Objectives*

1. Develop and maintain a comprehensive multi-disciplinary research and monitoring program focused on improving our collective knowledge of natural and cultural resources, visitors, visitor-based impacts, and ecological process, with an emphasis on obtaining specific knowledge needed to define and resolve management issues.

2. Continue to develop and maintain an innovative and proactive interpretation and education program focused on enhancing public understanding of the values and resource stewardship issues associated with the protection of Grand Canyon National Park and related ecosystems and cultural associations.

3. Define and execute a stewardship-advocacy program, consistent with NPS policy and law, that integrates information gained through science with Park education and public relations programs with the goal of strengthening the Grand Canyon National Park protection constituency.

4. Clearly delineate and maintain the Park boundary to protect natural and cultural resources.

5. Maintain and enhance government-to-government relationships with neighboring American Indian tribes, and those throughout the region who have ancestral interests in Grand Canyon.

6. Manage Park resources as part of the greater Colorado Plateau, recognizing both the shared natural and cultural heritage of neighboring governments and peoples, and the alternative recreational opportunities available within the region.

7. Manage Park areas included in the Grand Canyon National Park Wilderness Recommendation as Wilderness. Actively pursue designation of these lands as part of the National Wilderness Preservation System.

8. Maintain facilities, roads, and trails to prevent resource damage.

9. Protect natural resources from direct damage or removal by human activities by maintaining an effective law-enforcement function focused on prevention of illegal resource-damaging activities.

## Key Actions

*Calendar Year 1997*

1. Through effective recruitment, leadership, supervision, and training, set high professional standards for staff carrying out the resource stewardship mission.

2. Undertake organizational and personnel management to identify, and fill if possible, positions needed to achieve high priority needs and meet the most advanced concepts of position management and professionalization.

3. Complete the Science Center Partnership, including all official agreements.

4. Develop a Colorado River Management Forum with the goal of meeting resource and recreation management challenges that face National Park Service units.

5. Improve resource protection and visitor experience quality in the Colorado River corridor by being a leader in the Colorado River Adaptive Management Program, and by actively participating in the Long-term Resource Monitoring Program to achieve goals consistent with the National Park Service mission and applicable statutes.

6. Seek ways to meet the most critical Science Center infrastructure needs including offices and museum storage.

7. Complete the draft Wilderness Management Plan, and submit for agency and public review.

8. Begin revision of the Colorado River Management Plan.

9. Work with the FAA to complete an Aircraft Management Plan, including developing a comprehensive task analysis, plan objectives, schedule of deliverables, and public involvement process.

10. Provide funding for an on-going comprehensive research program through cooperative efforts with Grand Canyon Association and other partners.

11. Improve knowledge base on sociological factors affecting management issues.

*Calendar Year 1998*

1. Implement the Park stewardship-advocacy program by integrating comprehensive education, outreach, and media programs to effectively convey the full range of public values being provided to the public through the protection and management of Grand Canyon National Park.

2. Seek funding to support the new comprehensive research program with assistance from the Grand Canyon Association and other partner sources.

3. Continue to resolve the most critical Science Center infrastructure needs including museum storage and staff office space.

4. Continue implementation of effective organizational and position management plans to achieve the most advanced concepts of position management and professionalization.

5. Continue to provide leadership in the Colorado River Management Forum so as to achieve increased levels of regional coordination on Colorado River issues.

6. Submit a nomination to classify the Colorado River within Grand Canyon as Wild and Scenic under National Wild and Scenic Rivers Act.

7. Make significant progress on the Aircraft Management Plan as defined by the articulated objectives and timeline identified in 1997.

8. Complete the final Wilderness Management Plan, and implement needed actions.

9. Complete the draft Colorado River Management Plan, and accomplish agency and public review consistent with the schedule developed in 1997.

10. Continue funding on-going comprehensive research program through cooperative efforts with Grand Canyon Association and other partners.

11. Improve knowledge base on sociological factors affecting management issues.

*Calendar Year 1999*

1. Design long-term resource monitoring programs, and implement as many elements as funds will allow.

2. Produce the first of a periodic Status of the Park Resource Report.

3. Continue to meet the most critical Science Center infrastructure needs including museum storage and staff office space.

4. Complete a draft Aircraft Noise Management Plan, and submit for agency and public review.

5. Complete the Colorado River Management Plan.

6. Continue funding on-going comprehensive research program through cooperative efforts with Grand Canyon Association and other partners.

7. Improve knowledge base on sociological factors affecting management issues.

*Calendar Year 2000*

1. Complete the final Aircraft Noise Management Plan.

2. Implement actions called for the in Colorado River Management Plan.

3. Begin process to review and revise this Resource Management Plan.

4. Continue funding on-going comprehensive research program through cooperative efforts with Grand Canyon Association and other partners.

5. Improve knowledge base on sociological factors affecting management issues.

## Top Ten Project Statements

*Natural*

1. Aquifer Monitoring at Selected South Rim Spring Gaging Stations (GRCA-N-330.502)
2. Evaluate Impacts of Ground Water Withdrawals on Adjacent Lands (GRCA-N-330.500)
3. Develop Basic Data for Geographical Information System Program (GRCA-N-900.102)
4. Develop Air Quality Management Program (GRCA-N-710.001)
5. Develop Prescribed Fire Biological Monitoring Protocol (GRCA-N-200.000)
6. Develop and Implement Integrated Pest Management Program (GRCA-N-240.100)
7. Inventory Spring, Seep, and Riparian Vegetation (GRCA-N-112.000)
8. Monitor Peregrine Falcon (GRCA-N-220.105)
9. Survey and Status Report for Special Status Plants (GRCA-N-130.000)
10. Inventory and Monitor Threatened and Endangered Species (GRCA-N-220.100)

*Cultural*

1. Complete Museum Research and Storage Facility (GRCA-C-230.001)
2. Maintain Government to Government Relationship with Indian Tribes (GRCA-C-100.040)
3. Develop Research Design for Archaeology Investigations (GRCA-C-400.001)
4. Preserve Park Museum Collections (GRCA-C-200.002)
5. Establish Historic Structures Preservation Program (GRCA-C-340.001)
6. Implement Program for Archaeology Site Monitoring (GRCA-C-410.000)
7. Mitigate Impacts to Archaeology Sites (GRCA-C-420.000)
8. Prepare Historic Structures Report (HSR) for North Rim Entrance Station Residence (GRCA-C-350.003)
9. Develop Cultural Landscape Report (CLR) for Backcountry Historic Trails (GRCA-C-330.017)
10. Prepare Ethnographic Overview for Grand Canyon (GRCA-C-700.002)

*Integrated*

1. Manage Aircraft Overflights (GRCA-N-810.006)
2. Rehabilitation of Wilderness Resource Impacts (GRCA-N-810.002)
3. Develop Travel Simulation Model for Colorado River (GRCA-N-800.003)
4. Mitigate Road Impacts to the Basin Meadow (GRCA-N-810.005)
5. Research and Monitor Natural Quiet (GRCA-N-800.005)
6. Revise Colorado River Management Plan (GRCA-N-820.002)
7. Research and Monitor Day Use in the Backcountry (GRCA-N-800.006)
8. Colorado River Visitor Use Impact Monitoring (GRCA-N-800.002)
9. Backcountry Research and Monitoring (GRCA-N-800.001)
10. Stabilization and Rehabilitation of Historic Trails (GRCA-N-810.001)

*Research*

1. Archaeological Research Design
2. Ethnographic and Tribal Use Studies
3. Archaeological Site Inventories
4. Fire Effects Monitoring: Archaeological and Biological
5. Fire History/Ecology Studies
6. Fire Management Alternatives Studies
7. Visitor Characteristics and Use Studies
8. Ground Water Resource Studies
9. Cave Resource Inventories
10. Spring/Seep Invertebrate Surveys

*Overarching issues are broad-spectrum issues that affect more than one resource.*

## Overarching Issues

### Information Acquisition and Management

Information is essential in identifying resource threats and developing effective resource management strategies. At Grand Canyon National Park even the most basic information is nonexistent or incomplete. Available information is often difficult to access due to the absence of a comprehensive data and information management system. The only exception is the Park's Geographic Information System (GIS). Although the GIS is not yet complete, a process is in place to make continued improvements.

Since the Park was established, a collection of information, artifacts, archives, inventories, photographs, etc., have been accumulating in the Park's Museum Collection. Together with the Park's Research Library, these data systems contain a wealth of information about resource management alternatives. However, much of this information is unavailable to staff and researchers due to insufficient cataloging and data input/database; lack of interagency and university networking and data sharing capabilities; lack of a GIS system capable of organizing, analyzing and presenting large inter-relational databases in spatially referenced format for easy use; and lack of staff. Due to the lack of data and information sharing throughout the Colorado Plateau, archaeological and historical information is unavailable. Relational databases of consistent design must be developed for both natural and cultural resources and incorporated into GIS.

The Museum Collection are threatened by inadequate storage facilities. A fire, theft, or vandalism could easily destroy the Museum Collection eliminating years of research as well as irreplaceable natural and cultural artifacts.

### Increased Visitation

Ever-increasing visitation has repercussions throughout the Park. Planning for upgraded facilities (both inside and outside Park boundaries), potable water supplies, visitor trampling of vegetation, vehicle impacts, and rapid changes in visitor use patterns have taxed Park resources and personnel. In 1995, annual visitation rose to nearly five million, and is expected to nearly double in the next decade.

Overnight backcountry use and rapidly increasing inner canyon day use are having severe effects on resources and on the Park's ability to handle emergency operations in these remote areas. Over 15,000 people hike and camp in the proposed wilderness each year. Visitor experience throughout the inner canyon is not always consistent with the management objectives and standards established in the 1988 Backcountry Management Plan. Visitors are crowded at camping areas and attraction sites. Over-visitation at sensitive sites such as springs and archaeological sites is damaging these resources.

## Regional and Ecosystem Planning

It is increasingly evident that the NPS can not meet it's resource stewardship goals without the support and cooperation of agencies, tribes and landowners that manage adjacent lands. In addition, regional cultural and social needs and expectations have a major bearing on what resource management strategies will be most successful. As an example, major Park watersheds originate far beyond Park boundaries (Little Colorado, Colorado, Paria, Havasu and Kanab watersheds). Land-use practices within these watersheds will have a larger bearing on water quality and quantity than anything the NPS can do within the boundary.

Other external threats and issues that need cooperative planning and partnerships are air quality, data management, prescribed fire, river recreation management, aircraft overflights and protecting ethnic and tribal heritage. It is essential that the NPS continue developing a wide variety of partnerships with cooperating agencies, tribes and the public sector that will enhance the implementation of truly effective stewardship programs.

## Lack of Park Funding and Staff

Although not well definable in specific resource impacts, lack of adequate funding seriously affects all Park programs. NPS base-operating funds available for resource stewardship programs are substantially less than what is needed for even a basic scientifically credible program. A recent Servicewide survey conducted by the NPS determined that Grand Canyon staffing levels were only 25 percent of what is needed to support a comprehensive program. This is not a problem that is unique to this Park. Other large parks with complex resources and sensitive issues are in a similar situation. See Figure 3-2 and 3-3.

## Glen Canyon Dam Operations

The operation of Glen Canyon Dam by the Bureau of Reclamation has a substantial effect on natural and cultural resources and recreation within the Colorado River corridor in Grand Canyon. The Grand Canyon Protection Act (1992) requires the Secretary of the Interior to manage Glen Canyon Dam to protect the natural, cultural and recreational resources of Grand Canyon National Park and Glen Canyon National Recreation Area. The Record of Decision for the Operations of Glen Canyon Dam Final Environmental Impact Statement, signed on October 9, 1996, includes an adaptive-management program supported by long-term research and monitoring. The NPS must take a leadership role in assuring that the future adaptive-management program is successful in meeting NPS river corridor stewardship needs.

## Need For Ongoing Tribal Partnerships

Grand Canyon is significant in the spiritual lives of regional American Indian tribes. In recognition of the special relationship the Grand Canyon has for these people, Grand Canyon National Park actively pursues cooperation with tribal governments.

The various American Indian tribes in and around Grand Canyon National Park have an interest in protecting this sacred place. To some, the Canyon is their place of worship; to others, it is both their place of origin and their final resting place. Canyon stewardship takes many forms, from assistance on illegal or resource-damaging activities, to political activism on behalf of Park resources. For example, both the Hopi and Hualapai tribes made strong presentations in Washington, D.C., in support of moderating flows from Glen Canyon Dam. Their message was so powerful that it influenced the Secretary of the Interior in favor of protecting Park resources and values.

Traditionally, there has been limited dialog between the NPS and the various American Indian tribes who have ancestral claims to the Grand Canyon. To improve this situation, the Cultural Resource Program Manager and/or Superintendent periodically meet with the tribal governments of the Hopi, Havasupai, Hualapai, Navajo, Kaibab Paiute, San Juan Southern Paiute, Paiute Indian Tribes of Utah, and Zuni. These meetings revealed a great many issues and concerns which were addressed in the General Management Plan and in the proposed Ethnography Program. The tribal governments felt, for example, that the NPS should be helping tribes to develop an environmentally sound economy which better meets Park management objectives. They also felt that the Park should actively seek input from Tribal Chapter Elders, medicine men, and others not only as a matter of respect, but also because it will bring the Park to a more holistic and comprehensive understanding of all values associated with Grand Canyon.

The Park maintains a unique relationship with the Havasupai Tribe due to the Grand Canyon National Park Enlargement Act of 1975. The Act intrinsically links the Park's and the Tribe's futures by establishing Havasupai Use Lands within Grand Canyon National Park. These lands require special management inclusive of Havasupai traditional uses. A Memorandum of Understanding is under review for management of Havasupai Use Lands.

Memoranda of Understanding are in preparation between Grand Canyon National Park and tribes under the Native American Graves Protection and Repatriation Act (NAGPRA). A more focused Federal government to tribal government partnership is proposed under the Ethnographic Program.

## The Protection of Natural Quiet

Grand Canyon National Park exceeds all other parks in air-tour flights. The air-tour industry is comprised of 43 companies from five states. This multimillion dollar industry carries approximately 800,000 passengers averaging over 100,000 flights per year. In the summer months, flights are estimated at 10,000 per month. Projections are that flights will double in number by the year 2010. NPS efforts to restore natural quiet to the Grand Canyon continues to be a difficult and politically sensitive issue. The NPS must provide leadership in assuring that the FAA works effectively in meeting the intent of the 1987 NPS Aircraft Overflights Act (Public Law 91-100), within Grand Canyon National Park.

## Wilderness Management

In September, 1980, the National Park Service recommended that 980,088 acres of Grand Canyon lands be designated as wilderness immediately, and an additional 131,814 acres be considered for potential wilderness designation. If adopted over 1,111,902 acres would be established as wilderness. Although the EIS and Wilderness Recommendation were submitted to Congress, designation was never finalized.

In 1993, the National Park Service revised the original Wilderness Recommendation, now calling for 1,109,257 acres to be designated immediately, and 29,820 acres recommended for potential wilderness, for a total of 1,139,077 acres. The issue of various nonconforming uses still requires resolution. Grand Canyon Wilderness affects the management of most programs discussed in Chapter 3, but will be further discussed under the recreational resource management section.

## Restoration of a Natural Fire Regime

Fire suppression over the last 70 years has resulted in denser, more uniform plant communities. This has reduced habitat diversity, suppressing many plant and animal populations, and contributed to their decline. Fuels have accumulated to the point where fires rage out of control, damaging natural and cultural resources. Although there is an active fire program at Grand Canyon, there is need to further develop compliance, survey and research programs associated with prescribed burns.

## The Need For Enhanced Parkwide Programs To Protect Resources

### *Interpretation and Education*

*...the problem with looting is not here in the Four Corners area. It is in the drawing rooms of Washington D.C., on the mantles of Boston fireplaces and on the walls of Los Angeles condominiums...Until the reaction to the private display of such artifacts is one of scorn rather than approval, those artifacts will continue to find a market....*

—David B. Madsen
*Preserving Traces of the Past*

The role of interpreters is powerful and exciting. The potential impact that interpretation can make in the preservation of Park resources, both natural and cultural, is more far-reaching than many other resource management programs. An expanded Interpretative Program will lead to better conservation of Grand Canyon's resources.

### *Protection Strategies and Enforcement of Regulations*

A proactive enforcement program focused on the resource damage prevention and visitor education is essential to meet the Parks's stewardship mission. This includes actions such as: developing proactive protection strategies and plans; developing special regulations to protect resources; patrolling to deter poaching, theft of archaeological artifacts, improper recreation use, livestock trespass, and timber and mining violations; regulating public use through permit systems and education; and instructing the public in ways to reduce their impacts on Park resources.

## Social Science Program Development

Park resource-stewardship program success depends greatly on our ability to understand the needs and expectations of various user groups and other stakeholders that do not directly visit the Park. This understanding is necessary to develop and implement successful strategies that mitigate user conflicts, reduce impacts to resources, and improve visitor experiences. This program has just begun with the addition of a Social Scientist to Park staff.

**Figure 3-2**

*The 1996 FTE allocation devoted to resource management.*

| Type of NPS Employee | FTE* of Resource Work | | |
|---|---|---|---|
| | Natural | Cultural | Total |
| Research Scientists<br>Research Grade Evaluation and Research Grant Administration Programs | 1.0 | 0.0 | 1.0 |
| Resource Specialists<br>Series 170, 190, 193, 401, 404, 430, 808, 1015, 1016, 1060, 1215, etc. | 13.0 | 9.3 | 22.3 |
| Park Rangers<br>Series 0025, Resource Management | 7.5 | 1.0 | 8.5 |
| Park Rangers<br>Series 0025, Resource Protection | 1.0 | 0.7 | 1.7 |
| Park Rangers<br>Series 0025, Resource Interpretation | 0.5 | 1.5 | 2.0 |
| Maintenance Personnel | 1.0 | 1.0 | 2.0 |
| Other (Management/Clerical) | 1.0 | 1.0 | 2.0 |
| Total of All Resource Personnel | 25.0 | 14.5 | 39.5 |
| Total Park FTE (All Personnel)<br>325 | Percent of Park FTE Devoted to Resources<br>7.6% | 4.4% | 12% |

*FTE—Full Time Equivalent

| Type of NPS Employee | FTE* of Resource Work | | |
|---|---|---|---|
| | Natural | Cultural | Total |
| **Research Scientists**<br>Research Grade Evaluation and Research Grant Administration Programs | 1.0 | 0.0 | 1.0 |
| **Resource Specialists**<br>Series 170, 190, 193, 401, 404, 430, 808, 1015, 1016, 1060, 1215, etc. | 57.50 | 40.21 | 97.71 |
| **Park Rangers**<br>Series 0025, Resource Management | 10.0 | 10.0 | 20.0 |
| **Park Rangers**<br>Series 0025, Resource Protection | 6.0 | 6.0 | 12.0 |
| **Park Rangers**<br>Series 0025, Resource Interpretation | 3.0 | 3.0 | 6.0 |
| **Maintenance Personnel** | 10.0 | 6.0 | 16.0 |
| **Other (Management/Clerical)** | 1.5 | 1.5 | 3.0 |
| Total of All Resource Personnel | 89.0 | 66.71 | 145.71 |

**Figure 3-3**

The FTE allocation required to fully staff a Resource Management Program which would address most of the issues and threats described in this Plan.

The Resource Management Assessment Program (R-MAP) is a servicewide accessment of the staff required to meet NPS resource management standards.

This computerized database is derived from the extent and complexity of each park's natural and cultural resources and visitation patterns.

*The Natural Resource Management Program follows a simple and logical process:*

## Natural Resource Management Program

### Know Resource
*and Identify Threats*

- INVENTORY: Acquire basic resource knowledge
- MONITOR: Determine trends in resource condition
- RESEARCH: Determine cause and effect relationships

### Manage Resource According to Management Objectives

- EDUCATE: Foster understanding and appreciation for resource stewardship
- PROTECT: Prevent resource deterioration
- MITIGATE: Reduce resource damage
- RESTORE: Replace or repair damaged resources

### Maintain Resources at Desired Integrity

- Partnerships
- Stewardship

# Natural Resource Management Program

## Program Overview

The Natural Resource Management Program for Grand Canyon National Park consists of activities performed by Park Science Center staff, other Park operational divisions, governmental and non-governmental agencies, and organizations working on behalf of the American people to preserve and protect Grand Canyon's natural resources.

The NPS Natural Resource staff is a dynamic workforce that is responsive to changing needs and developing issues. A core staff of resource specialists is focused on maintaining a long-term program while addressing short-term critical issues that arise, sometimes unexpectedly, from year to year. Expertise will be maintained in the physical sciences such as air and water quality as well as the biological sciences, data management, and GIS. Expertise will also be maintained in the Divisions of Resource and Visitor Protection, Interpretation and Visitor Services, and Maintenance and Engineering that are essential to carrying out the enforcement, education and restoration activities described in this Plan.

## Program Goal and Objectives

The primary goal of the Natural Resource program is clearly defined within the 1916 Organic Act and amendments, and further clarified in *NPS Management Policies.* The goal is to "...conserve the scenery and the natural and historic objects and the wild life therein... by such means as will leave them unimpaired...." The agency emphasis is not only on preserving species and habitat but also on maintaining natural processes and dynamics that are essential to long-term ecosystem perpetuation. Specific objectives to natural resource management were presented earlier in this chapter.

### *Maintain Resource at Desired Integrity*

The Park Natural Resource Management Program Manager and staff will seek to develop and maintain effective working relationships and partnerships with other government agencies that have a defined authority or interest in working to achieve the Park's stewardship objectives. For example, the Park has formed cooperative efforts to conduct animal management activities including integrating management practices to reduce conflicts; coordinating research; sharing data and expertise; exchanging resources through transplants; establishing native wildlife corridors; and maintaining essential habitats adjacent to the Park. In addition, the Park will seek the cooperation of others in minimizing the impacts of outside influences, controlling noise, maintaining water quality and quantity, eliminating toxic substances, preserving scenic views, improving air quality, preserving wetlands, protecting threatened or endangered species, eliminating alien species, managing use of pesticides, and managing fires. The Park will also seek other means of preserving and protecting park resources.

## Issues

*Lack of resource status and trends knowledge*

The Park's information data bases are missing or lacking considerable information in many areas needed for sound resource management. Lack of such information severely handicaps managers in protecting resources since many management decisions or responses to external threats must be based on intuitive rather than qualitative data. Intuitive or incomplete data provides a very weak, and at times, incorrect position for managers to take and hold against strong political forces advocating actions which may be harmful to the Park.

*Natural processes within the Park have been disrupted*

Disruption or alteration of natural processes and conditions at Grand Canyon began, in some cases, prior to the Park's designation. Overgrazing of Park lands was significant prior to 1919, and caused losses of topsoil and changes in vegetation composition which, in some areas, exist today. Fire suppression, beginning in the 1920s, allowed tree densities to increase, fire intolerant species to expand their range, and the buildup of dead and down materials. The damming of the Colorado River represents another major disruption of natural processes.

*Lack of adequate Park staff expertise and funding support*

While the natural resource professionalization initiative significantly increased the natural resource staff by three, resource management staffing and project funding remains at very inadequate levels. Resource protection and management needs at such a complex Park are vast. The Park covers 1.2 million acres, and includes a wide variety of extensive resources such as: an estimated 1,000 caves, over 500 water sources, and many biotic communities. Current staffing consists of thirteen Full-time Equivalents (FTEs), while the Natural Resource Management Assessment Program (NR-MAP), a computerized system which calculates staffing needs by park resource management work factors, indicates that a park of this size and complexity should have a total staff of 30 FTEs.

*Need to improve partnerships*

It is recognized that if the Park is to managed effectively, there is a need to be more involved with those entities, such as adjacent land management agencies, American Indian Tribes, and concerned private groups, who share interests in management of adjacent lands. Such partnerships in many cases can allow common goal achievement through poling of scarce resources and expertise while providing early input into proposed actions which may affect the Park.

*Increased visitation is creating additional resource impacts*

Increased visitation has resulted in many forms of impacts such as: larger areas of soil compaction and vegetation loss at backcountry campsites, and increased noise and light pollution.

*Human activities outside Park boundaries threaten Park resources*

Activities on adjacent lands such as road construction, timber harvesting, hunting, mining, and cattle grazing threaten Park resources by altering the natural habitat for wildlife, increasing access to remote areas adjacent to the Park, and increasing the potential for water diversions and pollutants.

## Current Funded Program

Resource management activities are a part of general Park operations, and include such things as hunting patrols, hazard tree removals, fence repairs, integrated pest management, public fire management, education, and resource management interpretation of problems and solutions.

The Park's full-time resource management staff devoted to natural resource issues consists of 7.0 FTE. NR-MAP, indicates that a park of this size and complexity should have a total staff of 30 FTEs.

The major Natural Resource Program areas are:

- Geologic Resource Management
- Paleontological Resource Management
- Cave Resource Management
- Water Resource Management
- Air Quality Management
- Vegetation Management
- Revegetation Program
- Forest Ecosystem Restoration
- Wildlife and Fisheries Monitoring and Management
- Geographic Information Systems

Two areas, Geology and Paleontology, are currently unfunded; however, because they are important Park resources, and are frequently supported by research funding from the academic community, they have been included. Forest ecosystem restoration, a major part of the Vegetation Management Program, is identified as a separate area due to it's size, funding source, and focus on fire as the primary tool for achieving program objectives.

# Geologic Resource Management

## Program Overview

Grand Canyon is world-renowned as a geological showcase. Geologic studies in the Park began with the work of Newberry in 1858, and continue today. The Grand Canyon's excellent display of stratified rock is invaluable in unraveling the region's geologic history, while the extensive plateau dissection allows detailed study of tectonic movements. Stream erosion processes and vulcanism are easily seen and studied. While considerable work has been done, there is much that remains to understand and protect Grand Canyon's geologic features, perpetuate natural geologic processes, and provide for visitor health and safety.

All too often, geology is thought of as a timeless process operating so slowly as to be imperceptible in a human time scale. This misconception leads to limited understanding and management of geologic resources. In reality, major changes can occur in relatively brief time periods. These quick changes can be triggered by human actions, such as changes in the Colorado River's ability to erode and transport sediment caused by the closure of Hoover and Glen Canyon dams.

Rapid changes may also result from natural processes such as the debris flows creating Crystal Rapid, and destroying sections of the transcanyon water line overnight in 1966 and 1995. Understanding these processes must occur before the desirability of, and strategies for, mitigation and management can be developed.

## Program Objectives

According to policies addressed in NPS-77, geologic features will be protected and monitored to determine if threat mitigation is necessary for preservation. Geologic Program objectives include:

- Identify and inventory significant geologic features and processes
- More effectively integrate geologic resource management into overall Park management processes
- Support, coordinate, and assist with geologic research projects

Surficial geologic features are especially important for their scenic grandeur, structural foundation for recreational opportunities, and as a primary interface with most biota and cycling ecosystems. Therefore, directed management of geologic resources is fundamental to management for many other Park resources.

## Issues

Although repeatedly referred to as a place for scientific research and education throughout the Park's legislation and management objectives, geologic study is still lacking within Grand Canyon Science Center. The following issues were determined to be the most compelling and pertinent to managing geologic resources at Grand Canyon.

### *Geologic features are at risk*

Perhaps the most fragile of these features are associated with fossil, cave, and water resources, and are addressed under those program areas. Operation of reservoirs both up and down stream of the Grand Canyon have also placed features, such as beaches at risk, and require active management.

*Geologic processes have been disrupted*

The most notable disruptions result from operations of Glen Canyon Dam, but also include land-use practices and their effects on spring and stream flow.

*Geologic hazards pose environmental and human health/safety and property risks*

Numerous rockfalls, earthquake activity, and floods are all examples of geological processes active in the Grand Canyon that can pose a threat.

*Soil resources have been disrupted*

Soil resources have been disrupted over much of the Park by development and land-use practices, both past and present. In an arid climate like Grand Canyon's, the natural restoration of soils is an extremely slow process.

## Current Funded Program

Although the Grand Canyon is one of the world's outstanding geologic resources, there are currently no FTEs allotted to manage this Program.

## Proposed Unfunded Program

Although all geologic resources are interrelated, the field has been subdivided for the purposes of this plan into six areas:

- geologic features
- geologic processes
- geologic hazards
- soils
- fossil resources (discussed in Paleontological Resource Section)
- cave resources (discussed in Cave Resource Section)

NR-MAP does not contain full-time equivalent projections directly applicable to the first three subdivisions listed above. However, it is evident that at least two FTEs would be required simply to coordinate the various programs. Many additional FTEs (NPS, contract, and outside researcher) are necessary to implement various called for actions. NR-MAP projections for Geological Resource Management can be found in Figure 3-4.

Initial establishment of a Park Geoscientist position could be used to begin management of all geologic, paleontologic and cave resources. After initial work is fully outlined, the staff could be augmented.

*Manage Geologic Features*

Since 1858 geologists have defined the Canyon's rock layers, grouping, subdividing and redefining them, until today over 95 different names have been applied to the (current) 28 major formations in the Canyon's walls. Thousands of references regarding the Grand Canyon's geology are contained in Spamer's *Bibliography of the Grand Canyon and the Lower Colorado River* (1990). The Grand Canyon is one of the most intensively studied geologic areas in the world, but management of geologic resources by the NPS in recent years has been limited to studies on the effects of Glen Canyon Dam, and to reviewing and issuing research permits. While it is true that some geologic resources tend to be rather inert, changing only slowly through time, this perspective is not appropriate for the management of individual geologic features. Some are quite fragile, and subject to rapid deterioration or destruction. The identification, monitoring and preservation of these features should be an important function of resource stewardship at Grand Canyon. To that end, a Geologic Feature Management Program must consist of the following programs:

**Inventory and document** Inventories and documentation should be pursued for the Park's geologic features. On a broad scale, this project has been accomplished with the geologic mapping of the entire Park at a 1:62500 scale. However, the maps are not yet completely digitized and available in computerized form. There is no comprehensive listing of smaller-scale geologic features of special interest.

Examples of such features would include caves and paleontological resources discussed elsewhere in this Plan; erosional, depositional, structural and mineralogical specimens; features of ethnographic importance to groups traditionally associated with the Canyon (Traditional Cultural Properties); sources for prehistoric raw materials; type sections of various strata; and measured sections (including well logs). Identification, geo-referenced documentation, and analysis of threats to these resources must precede preservation.

**Monitor** The monitoring of geologic features should concentrate on those features of greater scientific and cultural value and vulnerability. Monitoring features documents rates of change and the level of threats facing the feature's continued preservation. This program will indicate the need to initiate mitigation measures.

**Mitigate Threats and Protect** Mitigation of threats to geologic features will be based on the nature of the threat, the value of the feature, and overall management goals for an area. In cases of human-caused threats, the decision to take action will be more easily defined than in those cases where natural processes threaten a natural feature. Potential mitigation measures cover a broad spectrum of actions. For example, no action may be desirable if only natural processes threaten a feature of only moderate importance. Human threats may be mitigated through interpretation (on site or orientation), or through area closure. Collecting the feature and placing it in the Museum Collection may be desirable for smaller features of value. Installing monuments at type sections or important measured sections may guard against their "loss," but may not be appropriate in a wilderness area. Mitigating threats to geologic features must be accomplished on a case-by-case basis.

**Foster Research** Promoting geologic feature research is necessary for effective management. Geologic features are in constant flux, from formation, through change, and toward ultimate destruction. It is unreasonable to expect NPS staff to be fully aware of all changes occurring to all features. However, by fostering geologic research, outside expertise can identify features of interest, threats faced by those features, and propose mitigative measures. Such information may be the purpose of research or be incidental to research programs. The NPS can support research through direct contracting (for those studies of immediate management or interpretive concern), or indirectly through logistical support (provision of field laboratory facilities, supplementary funding from NPS or the cooperating association). A clear statement of Park research needs will help researchers obtain funding.

**Interpretation** Geologic feature interpretation is a major theme at Grand Canyon. While inadequate facilities, funding, and staffing prevent a full presentation, these limitations are addressed in other Park documents. Interpretation of geologic features should involve open dialogue between interpretation and the Science Center, so that new findings, information needs, and management concerns can be exchanged. Inclusion of interpretive questions and concerns in research proposals and permits will help interpreters present new findings and understandings to the public. Clear statements of management concerns can be communicated to the public as well.

| Geological Resource Management | NR-MAP* FTE Allocation | CURRENT FTE** Allocation |
|---|---|---|
| Geologic Resource Inventory, Mitigation and Monitoring | 1.0 | 0.0 |
| Geologic Resource Management, Planning and Interpretation | 1.0 | 0.0 |
| Geologic Research | 0.5 | 0.0 |
| Mining and Minerals Management | 0.25 | 0.0 |
| Soils | 0.56 | 0.0 |
| Geothermal | 0.23 | 0.0 |
| TOTAL | 3.54 | 0.0 |

**Figure 3-4**
The NR-MAP FTE allocation required to fully staff a Geologic Resource Management Program which would address most of the issues and threats described above.

*Perpetuate Natural Geologic Processes*

There is more to Grand Canyon's geologic resource than rocks. Geologic processes that carved the Canyon also represent a resource to be managed. "Management of geologic processes" may seem an oxymoron; many geologic processes, such as earthquakes or flash floods, are clearly beyond human control. While a geological process may not be amenable to control, the effects may be mitigated, and the process itself can be monitored. Many other geologic processes are influenced by human actions. Geologic processes can be broadly divided into four categories:

- tectonic processes (earthquakes and earth movement)
- weathering (*in situ* decomposition of rock)
- erosion (removal of weathered material)
- sediment transport (a subdivision of erosion, but here used to discuss the movement of sediment and debris in the Colorado River and its tributaries).

A management program for geologic processes in Grand Canyon is aimed at perpetuating these processes at their natural rates. Although the specific nature of the processes is described below, the management program for all consists of four basic steps:

- identification of the process
- monitoring the rate of change produced by the process
- determining human impacts on process initiation and rates
- implementation of appropriate mitigation measures.

Fostering research into these processes, and interpreting it to the public, have the same values as those identified under *Manage Geologic Features* (above).

**Natural Resource Management Assessment*
***Full Time Equivalent*

**Tectonic Processes** Tectonic processes are not controlled by human factors, although minor earthquakes have been triggered by human actions (i.e., the filling of lakes Mead and Powell). However, monitoring of the process is often possible. Detailed geologic mapping reveals faults, which helps to define areas of seismic potential. Detailed studies in areas prone to seismic activity can include mapping, instrumentation and trenching to reveal changes in elevation, stress fields, and other geophysical changes preceding or following seismic activity. This information is valuable to science. It may also be of value in mitigating damage to human health and safety (see safety section below).

**Weathering** Weathering is generally caused by natural factors; however, some human factors, such as atmospheric acidic deposition ("acid rain"), heavy human use, and chemically contaminated runoff from developed areas may alter weathering rates. All geologic features in the Park are affected to some extent by weathering, but monitoring of weathering effects should be confined to features of special interest. Control of acidic deposition is a regional program (see the *Air Quality* section of this Plan). Increased weathering due to heavy human use may be mitigated by surface treatments, diverting use to areas better able to withstand impact, or outright closure. Contaminated runoff should be captured and treated to mitigate impacts.

**Erosion** Erosion rates are definitely affected by human activity. Changes in vegetative cover, soil development, and runoff diversions can all increase erosion rates far above natural rates. Increased erosion impacts the area through soil removal, lowered local water tables, and damage to cultural resources. Downstream erosion impacts include decreased water quality, reduced channel capacity, burial of biologic and cultural resources, and biological changes.

Mitigation measures may include no action where natural pedogenic processes can repair the damage; better water collection and diversion engineering in developed areas; better control of use to avoid soil compaction; berm and other erosion control structure installation, and area closures. Selecting a mitigation measure depends on the problem's severity, area management goals, and the potential to restore a natural regime.

**Sediment Transport** Sediment transport is a natural consequence of weathering and erosion. From a management perspective, two aspects of sediment transport are of concern. The first is episodic debris flows in Grand Canyon's side canyons. These debris flows are composed of sediment ranging in size from microscopic clay particles to boulders many feet in diameter. Although water serves as a debris-flow lubricant, the majority of the material in transit is solid. Overall, the flows have the consistency of wet concrete. They reconfigure stream bottoms, and create rapids if they reach the Colorado River (such as the flow that created Crystal Rapid in its present form in 1966). There is the potential for such debris flows to create "unrunnable" rapids in the River. Studies of Grand Canyon debris flows have established chronologies for various tributaries which may be of value in predicting flow potential for the tributaries, and to plan desired mitigation actions for threatened resources (including cultural resources and recreational values at risk).

The second type of sediment transport of managerial concern occurs in the Colorado River. Sediment, particularly sand, transported by the River is placed in temporary storage on the River bed, along beaches and in terraces (particles finer than sand tend to pass through with little storage, while larger gravels and cobbles are transported only during major flood flows).

Depending on the location of storage, the sand forms riparian habitat, beaches for recreation, and river bars and eddies important for fish. Extensive studies of sand-transport dynamics have been accomplished as part of the Glen Canyon Environmental Studies, since transport is largely governed by water release rates from Glen Canyon Dam. Although the studies have amassed volumes of information about sediment transport, monitoring is needed to assess continuing impacts of Dam operations, and flood impacts from tributaries below the Dam. Based on monitoring data, further modifications to the operation of Glen Canyon Dam may be needed to mitigate adverse impacts.

A third concern are adjacent land-use practices that affect sediment transport including overgrazing, timber harvest, and road construction among others. These practices can increase sediment loads in Canyon watercourses. Partnerships and cooperative coordination with adjacent land owners and agencies is needed to help mitigate these effects.

*Manage Geologic Resource for Public Health, Safety and Property*

As in any natural environment, geologic features and processes in Grand Canyon pose threats to the health and safety of visitors and to property. Some of the hazards are not under human control (e.g., earthquakes), while others are the direct result of past human activity (e.g., abandoned mines). In addition, abandoned mines threaten other Park resources (e.g. mine drainage). An effective program to protect people and property from these threats consists of five basic steps:

- hazard identification and documentation
- monitoring threat levels
- threats and hazards mitigation
- research to identify previously unknown threats
- interpretation to inform the public of threats and safety measures.

**Inventory and Document** Hazard identification and documentation is an ongoing process. Some hazards, such as open mine shafts, have already been identified and documented. Other threats are known, but not documented (e.g., mine drainage into Lava Creek). Natural geologic processes of weathering and erosion constantly produce new rockfall hazards. A comprehensive program of hazard identification needs to be developed for the Park. Attention should focus on those hazards that pose a real threat to people or resources. For example, loose rock on the Canyon walls is a hazard, but may not be a threat in a remote area, while it may constitute an imminent danger above a heavily used trail.

Threat documentation should include the nature and location of the hazard, resources threatened, and immediacy of threat. The inventory should be designed to not only allow, but encourage, identification of new hazards.

**Monitor** A monitoring program should be used to observe the condition of hazards and the immediacy of threats such as unstable slopes to provide advance landslide warning. The program can also be used to monitor the effectiveness of mitigation measures.

**Mitigate Impacts and Protect** Threat mitigation can take a variety of forms based on the hazard's nature and immediacy. No action may be desirable in remote areas where hazards are natural phenomena, and threats are low. For example, a potential rockfall in wilderness may require no corrective action. In a more developed area, drainage diversion to slow undermining, or triggering the rockfall with explosives may be the desired mitigation. Other resource values may define mitigation measures. For example, mine shaft closure techniques may vary depending on cultural resource values, and use by threatened or endangered wildlife.

Some hazards, such as seismic risks, can not be controlled, and mitigation takes the form of preparedness.

**Foster Research** Research to identify and mitigate geologic hazards can strengthen the management program. Information may develop incidental to other research, or it may be the focus of a specific research effort. In some cases the hazard may be great enough and imminent enough, that research contracting may be desirable. In other cases, data collection added on to other projects may provide information in a timely manner.

**Develop Management Plan** Appropriate management plans for geologic hazards need to be developed. All planning should comply with all Federal and State laws and *NPS Management Policies*.

**Interpretation** Interpretation is vital to communicate hazards to the visiting public. It is not possible, nor even desirable, to eliminate all potential geologic hazards and threats. However, visitors and Park staff should be aware of methods to avoid danger, and be prepared for unexpected dangers. Such interpretation can be site and/or hazard specific (i.e., warning of cave-ins at abandoned mine shafts), or of a more general nature (i.e., the danger of Canyon rockfalls). The overall goal of such interpretation would be to promote safety in a hazardous environment.

*Manage Soil Resources*

Soils within Grand Canyon are highly variable, ranging from moist forest soils of the North Rim to shallow, dry mineral soils and bedrock exposures of the inner canyon. Human impacts on Park soils include large areas with essentially no impacts, areas formerly used for farming, grazing and mineral extraction, and the heavily impacted soils of developed areas. Management goals for Park soils are broadly stated as:

- maintain natural soil-forming processes
- control erosion triggered by human influences
- avoid soil contamination by nonnative chemical, physical or biologic agents
- make soil-suitability information available for planning.

To meet these needs, soil resource management for Grand Canyon should consist of the following, interrelated areas.

**Inventory and Document** Inventoring and documenting of Park soils has begun, with soils maps for the Havasupai Traditional Use Area and the Sanup Plateau. A digital soil map for the entire Park should be prepared. To work toward this goal, attention should first focus on those areas where impacts to soils are likely, the developed areas of the rims and cross-canyon corridor. Then, using the data from existing soil surveys, a preliminary Park soils map could be prepared by combining vegetation and geologic themes in the Park's geographic information system. Such a product would provide a first approximation for further study and verification.

**Monitor** Monitoring soil impacts (soil erosion, compaction and contamination) will reveal natural processes that should be perpetuated, and human-caused impacts that should be mitigated. Monitoring intensity will be governed by the extent of impacts, ranging from occasional checkups of remote areas to frequent analysis of developed areas.

**Mitigate Impacts and Protect** Human-impact mitigation can proceed after impacts have been identified and characterized. Pedogenesis (soil formation) is an ongoing natural process. In remote areas, natural pedogenesis may be sufficient to restore soils. In developed areas, active measures may be needed based on specific impacts (contamination, compaction, accelerated erosion). Avoidance measures include proper siting of developments, walkways, drainages; analysis of any soil material transported into the Park for contaminants (physical, biological or chemical); and proper waste disposal. Mitigation efforts will involve coordination between Science Center and Maintenance staffs.

**Foster Research** Soils research will improve Park soil protection. The wide range of soil types, and the Park's relatively undeveloped nature can serve as a baseline for other, more developed areas. Research into soil dynamics will provide management and the scientific community with a better understanding. Specific research problems may also be identified, including improved mitigation techniques, and microanalysis in areas of special concern (cultural resource sites, the River corridor, etc.).

**Interpretation** Soil resource interpretation offers an opportunity to inform the public about the importance and vulnerability of soils. Many cultural processes, from agriculture to recreation, are ultimately dependent on soils. Greater public awareness of these resources will enhance their protection.

# Paleontological Resource Management

## Program Overview

Paleontological resources in Grand Canyon's sediments encompass a wide diversity of types and preservation. The paleofauna and paleoflora include algal mats and bacterial spores over a billion years old, mummified dung and hair about 11,000 years old, and a multitude of additional body and trace fossils from the Paleozoic Era, 550-250 million years ago. Fossiliferous deposits occur within the marine and terrestrial sedimentary units exposed throughout the Canyon, and local associations of Pleistocene and Holocene remains are present within the Canyon's caves.

## Program Objectives

National Park Service policy recognizes the irreplaceable nature of paleontological resources, and establishes strategies for their preservation and study. Adequate management strategies outlined in NPS-77 include:

- Inventory all fossils in the Park and in other collections

  Identify fossils, consider strata, and complete field paleontological surveys. Thousands of prehistoric species have been identified in Grand Canyon, and a comprehensive, annotated bibliography has been prepared by Dr. Earle Spamer.

- Evaluate the significance of the Park's fossil resources

  Fossils may have value for interpretation, exhibits, historical studies, or science. Evaluation requires close coordination with the scientific community, whether through a Park Paleontologist or outside experts. At present, the scientific expertise needed for these determinations is not available at Grand Canyon.

- Preserve Park fossil resources

  As fossil resources are located, and their significance determined, they must be preserved. Depending on the particular fossil resource, management strategies include:

  - no action
  - monitoring
  - cyclic prospecting
  - stabilization and reburial
  - shelter construction
  - excavation
  - area closure
  - regular patrols (NPS-77)

  All eight strategies have been used in Grand Canyon, but without benefit of an overall plan.

Although a tremendous amount of scientific data have been recovered from the Canyon's paleontological resources, little is known about this resource from a managerial perspective.

## Issues

The following issues were determined to be the most compelling and pertinent to managing paleontological resources at Grand Canyon:

*The lack of knowledge concerning the extent and scope of paleontological resources puts these resources at risk*

Without systematic knowledge of the full extent and scope of the Park's paleontological resources, these resources cannot be managed effectively. Because the resource base is so diverse, and the Park so large, developing usable data bases is critical.

*The lack of a paleontological resources monitoring program puts these resources at risk for loss and destruction*

Losses may occur through human destruction or theft (both intentional and accidental). A monitoring program will allow intervention by the Park to preserve and protect these resource.

*A lack of paleontological research threatens the adequate preservation of these resources*

Management information needs cannot be satisfied without participation in paleontological research. While a tremendous amount of research has been done, not all the information gathered is used in publications and reports. Direct participation encourages the flow of information to Park staff.

*The lack of a comprehensive paleontological resource management plan puts these resources at risk*

A piecemeal approach to management virtually insures high priority issues will go unnoticed, and resources will be wasted.

*Paleontological resources have been impacted*

In addition to the destructive forces of weathering and erosion, the inflationary market values for fossils has elevated the incidence of theft and vandalism.

*Without a strong interpretive program, paleontological resources remain at risk*

Public education on the value and significance of paleontological resources, and the destructive nature of theft and vandalism, will help preserve these resources.

## Current Funded Program

Although Grand Canyon National Park contains an abundant and diverse paleontological resource, there are currently no FTE assigned to manage this program.

## Proposed Unfunded Program

The proposed program is directed toward developing a comprehensive management plan for the Park's paleontological resources. Six action areas have been established to address the issues and objectives presented. These action areas include:

- Inventory and Document Paleontological Resources
- Monitor Sensitive Paleontological Resources
- Foster Paleontological Research
- Develop Paleontological Resource Management Plan
- Mitigate Threats to Paleontological Resources
- Interpret Paleontological Resources

Based on the diverse paleontological resource at Grand Canyon, a preliminary assessment of staffing needs (NR-MAP) indicates a need for 3.5 FTEs to fully manage and implement the program. See Figure 3-5.

**Figure 3-5**
The NR-MAP FTE allocation required to fully staff a Paleontological Resource Management Program which would address most of the issues and threats described above.

| Paleontological Resource Management | NR-MAP* FTE Allocation | CURRENT FTE** Allocation |
|---|---|---|
| Inventory, Documentation, Monitoring and Mitigation of Paleo Resources | 1.5 | 0.0 |
| Paleontological Resource Management Planning and Interpretation | 1.0 | 0.0 |
| Paleontological Resource Research | 1.0 | 0.0 |
| TOTAL | 3.5 | 0.0 |

Initial establishment of a Park Geoscientist position could be used to begin management of all geologic, paleontologic and cave resources. After initial work is fully outlined, the staff can be augmented. It is likely that a portion of the 3.5 FTEs would be filled through research work, either contracted or invited. Currently, there are no FTEs devoted to paleontological resource management or research.

*Paleontological Resource Management*

**Inventory and document** Documenting fossil resources is the first step in devising a management strategy. The necessary and significant information is available from a number of sources, and may be explored concurrently on several fronts. Information developed should be entered into a geo-referenced database used to guide management actions. Potential information sources include:

- Physical specimens in the Park's collections provide an excellent starting point for documenting the diversity of fossil material present. Holdings in other institutions undoubtedly include types and localities not represented in the Park's collections.
- Scientific literature documents specimens in the Collection, and provides information on localities where no collections were made or whose specimens can not be located. The annotated bibliography compiled by Dr. Spamer probably will fulfill this need with minor updating.
- Creation of a paleontologic-locality database will help draw information on Park fossil resources into one, management-accessible location. The database package will be geo-referenced, and allow addition of monitoring data. As additional localities are discovered, they will be added to the database. The database package design will carry information from the documentation phase of a paleontological monitoring program into the rest of the program.

** Natural Resource Management Assessment*
***Full Time Equivalent*

**Monitor** Monitoring sensitive paleontological resources is vital to their preservation. For the monitoring program to respond to Park needs, fossil resources must be categorized by their vulnerability to theft, erosion, or other forms of degradation. The fossil's value (for interpretive, scientific, or other uses) must also be identified. This information can then be used to devise a monitoring program ensuring the fossils retain their value, and triggering necessary mitigation actions.

**Foster Research** Paleontological research in the Grand Canyon is the best way to learn about the resource. With the exception of the older Proterozoic strata and Quaternary lavas, most rock units are fossiliferous. A survey of the 1,215,735 Park acres for all fossil outcrops is clearly outside the ability of Park staff. However, by fostering research, and ensuring the results include useful management data (locality data, resource sensitivity and threats, etc.), the program's effectiveness will be greatly enhanced. Fostering research includes proposal review and permit processing, but also assistance in funding or providing field facilities and logistic support. Providing such support should be driven by priorities established in a Paleontological Resource Management Plan, but some flexibility will be necessary to meet the realities of the research community.

**Develop Management Plan** An overall management plan would guide paleontological resource management, defining and coordinating paleontologic monitoring, mitigation, research and other field projects. It would contain management guidelines necessary to evaluate the significance of individual fossils and fossil localities, devise appropriate monitoring programs, and identify research topics. It would also help to determine mitigation actions needed for preservation.

Research topics, especially those with important management implications, should be prioritized in the plan. The Park manages fossil resources and needs data, but it is primarily outside researchers who have expertise and access to funding. The paleontological program will evolve and grow as new fossils are discovered. Planning documents should also evolve to reflect the most recent resource understanding.

**Mitigation** Mitigating threats to paleontological resources is necessary if fossils resources are to be managed responsibly. The principle threats to fossils include the destructive forces of weathering and erosion. Once fossils become exposed, natural forces can quickly destroy them. Fossil resources are also threatened by development, construction and a variety of recreation activities. Impacts to fossils resources need to be evaluated to establish appropriate mitigation strategies. Paleontological resources are becoming increasingly threatened due to an escalating commercial market. The inflationary market values have elevated the incidence of theft and vandalism of paleontological resources on Federally protected lands, including national parks.

Various threats imposed on *in situ* paleontological resources can be mitigated through sound management strategies. These strategies can range from site security and stabilization to excavation. Proper collection will insure a specimen's scientific value is preserved.

**Interpretation and Education** Fossil resource interpretation is underway at Grand Canyon National Park. The Science Center and Division of Interpretation work together, insuring issues in paleontological resource management is included in interpretive programs. Open communication between the divisions will allow the public to learn about the life of the past and how fossil resources are discovered, studied and preserved.

# Cave Resource Management

## Program Overview

Hidden within the Grand Canyon are an estimated 1,000 caves. Of those, 380 have been located. Very few have been mapped or inventoried. Most have developed in the limestone of the Redwall and Muav formations, although some are known to exist in other formations. The existence of many caves is well known to the caving community; the Cave of the Domes, on Horseshoe Mesa, is frequently visited. Cave resources include unique cave formations or "speleothems," mummified remains of extinct Ice Age fauna, archeological remains (including split-twig figurines), and unique biological systems. Many caves also play a major role in regional hydrology, as evidenced by substantial streams emerging from Vaseys Paradise, Cheyava Falls, and Roaring, Thunder, and Tapeats springs.

## Program Objectives

In addition to the laws pertaining to other Park resources, caves and their resources are protected under the Federal Cave Resources Protection Act of 1988. National Park Service policy recognizes the sensitive nature of cave resources, and has established strategies for their preservation and study. Management strategies outlined in NPS-77 include:

- Protect and perpetuate the natural cave, karst, and hydrologic systems found within the Park including protection of all resources associated with Park caves, fissures and rock shelters.
- Inventory all Cave Resources to identify their significance. Cave resources must be evaluated in terms of scientific, interpretive and recreational values.
- Encourage scientific studies and research by qualified researchers.

## Issues

The following issues were determined the most compelling and pertinent to managing cave resources at Grand Canyon:

*The lack of baseline information concerning the extent, scope and significance of cave resources puts them at risk*

The Park has an estimated 1000 or more caves; of these only 82 have been inventoried and mapped. Lack of knowledge about cave locations and contents limits management actions, including protection.

*The lack of cave resource monitoring puts these resources at risk*

Based on documented cave resources and guidance contained in law, policy, and the Cave Management Plan, monitoring protocols and actions should be established for all caves.

## Current Funded Program

The Cave Management Plan and permitting system have been revised and updated. Protocol for inventorying caves and evaluating cave resources have been developed. While no funded cave survey work has been done, caves are mapped, and their resources inventoried as the opportunity arises primarily by the caving community.

## Proposed Unfunded Program

Work cooperatively with researchers and members of the National Speleological Society (NSS) to locate priority caves to begin systematically inventorying and mapping caves. Use this information to update resource inventory files and provide protection where needed.

Although it is estimated there are 1,000 caves in the Park, a detailed survey has not been conducted, and files are maintained on only 83 caves. Based on the estimated extent of cave resources at Grand Canyon, NR-MAP generated a need for 2.26 FTEs to fully manage and implement the cave program.

Establishment of a Park Geoscientist position could begin management of all geologic, paleontologic and cave resources. After initial work is fully outlined, the staff can be augmented. Currently, there are no FTEs devoted to cave resource management or research.

**Figure 3-6** shows the NR-MAP FTE allocation required to fully staff a Cave Resource Management Program at Grand Canyon which would address most of the issues and threats described above.

### *Cave Resource Management*

**Inventory and Document Cave Resources** A cave resource inventorying and monitoring program is necessary before any action can be taken. Documentation assesses information currently in Park files, information from cavers, and in-the-ground cave survey. Consultation with American Indian groups will be necessary to determine if a particular cave is a Traditional Cultural Property. Current files contain information on 83 Park caves, although individual file contents range from a cave identification number to complete surveyed maps, photo transects, resource evaluations, and monitoring protocols.

All available cave resource information must be consolidated into a database package that is:

- useful to management
- geo-referenced for integration into other Park resource themes
- capable of protecting the confidentiality of location and resource data
- containing information about cave geology, hydrology, ecology, cultural significance, and physical and biological hazards.

Cave maps may be integrated into the database or maintained separately. Documentation will begin with data already available in Park files, and expand to knowledge held by others. Full resource documentation will require a major exploration effort to discover, map and inventory caves (discussed below under *Research*).

Work cooperatively with the National Speleological Society and researchers in mapping caves and other cave inventory work.

**Monitor Sensitive Cave Resources** Monitoring sensitive cave resources documents their preservation or degradation. Sufficient information is currently available to resume monitoring some caves (e.g. Cave of the Domes). Based on documented cave resources, and guidance contained in law, policy, and a Park Cave Resource Management Plan, monitoring protocols should be established for all caves, and monitoring should be carried out. A monitoring program includes human recreation and research-use levels in the cave, radon monitoring, condition of known cave resources, and identification of new resources. Results from the monitoring program are used to adjust use levels or implement mitigation strategies needed to preserve cave values.

Figure 3-6
NR-MAP FTE allocation required to fully staff a Cave Resource Management Program which would address most of the issues and threats described above.

| Cave Resource Management | NR-MAP* FTE Allocation | CURRENT FTE** Allocation |
|---|---|---|
| Inventory, Documentation, Monitoring and Mitigation of Cave Resource | 1.0 | 0.0 |
| Cave Resource Management Planning and Interpretation | 0.76 | 0.0 |
| Cave Resource Research | 0.5 | 0.0 |
| TOTAL | 2.26 | 0.0 |

**Foster Cave Research** Fostering and promoting cave research is an ideal strategy for meeting both Park and caver needs. Individual research projects may focus on specific topics, including cave or karst geology, hydrology, threatened and endangered species, or paleontology. By supporting research projects in Grand Canyon caves, private groups will be able to develop data not available to Park management. Data may include cave locations, resources, threats, or conditions. The NPS and the NSS have signed a memorandum of understanding that will improve cave research and exploration. In entering partnerships, Park data needs and accuracy requirements must be set forth clearly to derive maximum benefit from exploration and inventory work. Results can then be used to evaluate current management protocols and mitigation strategies, either through comparison with virgin caves or through assessment of inventoried impacts.

**Develop a Cave Resource Management Plan** The Cave Resource Management Plan supports the overall management process. It defines the permitting process for visiting Park caves. Park-specific criteria used in applying cave classifications (see NPS-77) are identified. Although impact-monitoring programs will be cave-specific, the management plan provides overall monitoring guidance, including human impacts mitigation.

Provide overall management strategies for cave resources. Work cooperatively with the National Speleological Society and researchers in mapping caves and other cave inventory work. Use data to update Cave Management Plan.

**Mitigate Threats to Cave Resources** Cave resource threat mitigation will ensure preservation of existing caves, and restore cave values. Mitigation measures include cave-etiquette interpretation, nondisclosure of cave locations and features, and limiting access to caves. Mitigation may also include seasonal cave closures based on cave inhabitant life cycles. In some cases mitigation may restore damaged cave resources.

** Natural Resource Management Assessment*
***Full Time Equivalent*

Mitigation can also include recovery of specimens collected from Park caves. While it will be impossible to restore such specimens to their caves, having the specimens in the Park Collection will make at least some of their information value available to researchers and the public.

Mitigate damage to cave resources caused by human factors. Educate the public on cave etiquette. Actively pursue policy of nondisclosure of cave locations and features, and limiting access to caves.

**Interpret Cave Resources** Cave resource interpretation is necessary to protect caves while still making information available to the public. Interpretive messages should be designed to meet the Park's needs for specific audiences. For example, backcountry users need to understand the need for, and process for obtaining, a cave permit before visiting caves. Readily accessible caves (Cave of the Domes) may need on-site interpretation. While interpretation should not promote cave use, it can encourage cave preservation, and present research results in a non-cave specific manner.

# Water Resource Management

## Program Overview

Managing Grand Canyon's freshwater resources includes a variety of subdisciplines. The specific water resources covered relate to those waters which occur naturally in the Park (rivers, springs, seeps and ponds), and the influences upon them (both physical and cultural). Not included are those issues dealing with the biota associated with those waters (covered in the Vegetation and Wildlife sections), and domestic water delivery systems. The ultimate goal of the water resource management program is to establish and preserve a natural regime in which the physical and biological components of the aquatic ecosystem function as they have evolved. The program, in addition to this goal, addresses public health issues, water-rights adjudication, long-term monitoring of Park waters, ground water withdrawal from adjacent lands, and water pollution issues.

## Program Objectives

Under NPS policy, the overall goals of water resource management are to *maintain, rehabilitate and perpetuate the inherent integrity of water resources and aquatic ecosystems* (NPS-77). Some Park watersheds originate far beyond Park boundaries (the Colorado, Little Colorado, Havasu, and Kanab watersheds). While the physical aspect of numerous drainages are contained entirely or largely within the Park (Nankoweap, Bright Angel, Shinumo, Tapeats, Spring, and Surprise are larger examples), their watersheds can be largely external, i.e., springs originate from regional aquifers. Thus, impacts on water resources from both outside and inside the Park are a concern.

Given water scarcity in the Grand Canyon's arid environment, it is not surprising that many water sources are Traditional Cultural Properties. Consultation with affected American Indian groups must be included in management of these resources. The ultimate goal of a water resource management program is to establish and preserve a natural regime in which the physical and biological components of the aquatic ecosystem function as they have evolved.

## Issues

The following issues are the most compelling and pertinent to managing the Park's water resources.

***The lack of a comprehensive water resource management program and updated plan puts this resource at risk***

A management document with current information to determine what data is needed, and how issues should be resolved in a prioritized manner does not exist. The Water Resources Management Plan was written in 1984, and needs extensive revision.

***The lack of adequate data to accurately characterize natural conditions puts this resource at risk***

A database is important to understand and achieve a natural water resource. Monitoring is necessary to define the spectrum of natural and human-influenced conditions of Park waters.

*Human health and safety are at risk*

Monitoring potential health and safety problems, chemical water quality, or water-borne pathogens is sporadic. Exceedances of standards have been documented, and probably continue. Life and property are at risk from floods; most inner canyon campsites, and sections of the South Rim developed areas are located in areas prone to flash floods.

*Human domestic water supply developments put the natural water regime at risk*

External water developments could impact springs in the inner canyon. Water diversions from Roaring Springs, via the transcanyon pipeline, affect NPS water and water-dependent resources. Alternatives to current potable water sources need to be evaluated. It is unknown if continued water sales to Tusayan is consistent with existing legislation and NPS policy.

*Park water rights must be established*

A court ruling has held that in states under the Appropriation Doctrine, such as Arizona, Federal agencies are required to file on water rights to establish ownership. This will require the Park to quantify all water resources. Information is needed to support NPS water rights claims. Adjudication is pending for the Little Colorado River.

*Wetlands are at risk*

The Colorado River, Kanab Creek, Havasu, Paria and Little Colorado River drainages originate outside the Park, and are exposed to a variety of pollutant sources including grazing, mining operations, urban sewage, and uranium milling facilities. All are suspected of transporting pollutants into Grand Canyon National Park. NPS actions may also result in loss of wetlands in the inner Canyon, due to reconstruction of the transcanyon pipeline, and on the North Rim due to road construction.

## Current Funded Program

In order to deal effectively with the varied and complex water-resource issues, Grand Canyon National Park operates under a Water Resource Management Plan. The plan was developed in 1984 and requires extensive updating. Currently, there is 1.0 FTE assigned to water resource management. Work involves stream/spring inventory and characterization of water quantity; location and chemical properties; water quality studies in the River corridor two to three times a year; floodplain analysis and indirect measurements of flood events; interagency monitoring of spring/ground water on selected sites below the South Rim; evaluation of impacts from ground water resource development outside the Park; development of stream monitoring protocols; establishment of channel reference sites for future instream-flow studies.

## Proposed Unfunded Program

Water resource management can be divided into six major arenas:

- overall program management
- natural condition characterization
- health and safety issues
- wetlands protection
- domestic supply development
- water rights establishment.

A preliminary assessment of staff needed to manage water resources in Grand Canyon National Park (NR-MAP) identified nearly five FTEs. These approximations may be modified upward as data becomes available, especially regarding impacts to springs and ground water from domestic water development south of the Park, and to management of Glen Canyon Dam and its effect on the Colorado River in Grand Canyon. Currently, there is one FTE available to achieve the goals and objectives outlined in this program. See Figure 3-7.

**Figure 3-7**
The NR-MAP FTE allocation required to fully staff a Water Resource Management Program which would address most of the issues and threats described above.

| Water Resource Management | NR-MAP* FTE Allocation | CURRENT FTE** Allocation |
|---|---|---|
| Estuarine | 0.0 | 0.0 |
| Marine | 0.0 | 0.0 |
| Palustrine | 1.24 | 0.0 |
| Natural Lakes/Ponds | 0.0 | 0.0 |
| Rivers | 1.47 | 0.05 |
| Reservoirs | 0.34 | 0.0 |
| Springs/Streams/Ground water | 1.36 | 0.95 |
| Water Rights Management | 0.4 | 0.0 |
| TOTAL | 4.81 | 1.0 |

** Natural Resource Management Assessment*
***Full Time Equivalent*

*Develop Overall Program Management*

Overall program management coordinates the various studies, projects and actions needed to meet the goal of naturally functioning aquatic systems. A timely management document insures that existing information is available, needed data are developed, and issues are resolved in a prioritized manner. The plan used for such work is the Park's Water Resource Management Plan. The Plan addresses three major categories, outlined in NPS-77:

- Background and authority are the legal and policy framework upon which the water resource management program is based. In addition to servicewide goals and objectives, specific guidance is found in the Law of the [Colorado] River, the Grand Canyon Protection Act, the Tusayan Water Sales guidance, NPS water rights policy, and State adjudications.
- The hydrologic environment describes what is currently known regarding the Park's water resources. Information on legal rights, the quantity and quality of Park waters, and outside factors influencing the resource are covered. Not only does this section identify the extent of current knowledge, but also points out gaps in existing data.
- Water resource issues and alternatives form the action portion of the plan. Grand Canyon faces a variety of issues, including incomplete characterization of natural conditions, threats to health and safety, preservation of Park wetlands, impacts of domestic water use, and undefined water rights.

The Water Resource Management Plan is a dynamic document requiring periodic revisions which may be internally driven, reflecting issue changes and/or new data, or externally driven by new laws or changes in surrounding land use.

*Characterize Natural Conditions*

Characterizing natural conditions is vital to managing any resource. A naturally functioning system is the ultimate goal of nearly all water management actions. To achieve this goal, those natural conditions must be quantitatively defined. In the course of condition definition, non-natural influences may also be identified. To characterize natural conditions, data must be developed on water quantity (including volume and seasonal variations), the water's chemical and biological components, and the geological processes determining the water's character and availability (ground water dynamics, regolith, geologic environment, etc.). Due to the highly variable nature of water flow and availability in the arid Canyon, long-term monitoring is needed to define the spectrum of natural (and human-influenced) conditions in Park waters.

**Inventory and Document** Characterize natural water resource conditions, and conduct a detailed hydrogeologic assessment of the South Rim. Delineate wetlands in vicinity of current and planned development areas. Identify and evaluate alternative sources of potable water, North and South rims.

**Monitor** Designing a water resource monitoring program is essential to gaining an understanding of the Park's diverse and dynamic fluvial systems. Monitor water resource conditions, and implement long-term monitoring program for water quality and quantity in the backcountry. Monitor wetland areas.

**Mitigate Impacts and Protect** Protect human health and safety from water-related threats, and mitigate those threats. Mitigate dangers to human health, safety and development from flood events.
Protect and preserve Park wetlands.
Ensure management activities do not degrade natural conditions, and evaluate potential impacts from water-supply developments outside the Park.

**Foster Research** Conduct and encourage research to characterize natural water resource conditions. Foster wetland-related research.

**Develop Management Plan** Update water resource management plan to more accurately reflect changing needs and priorities. Manage water resources to restore, preserve and protect natural systems.

**Interpret and Educate** Interpret human water supplies, use alternatives, and conservation.

*Protect Public Health and Safety*

In 1983, an investigation of bottom sediment samples along the length of the Colorado River within the Park indicated that high levels of fecal coliform bacteria were present in many locations. Glen Canyon Dam flow levels and release patterns agitates the river bottom and brings bacteria to the surface adjacent to river bank campsites. In these areas, contaminated water may be used by thousands of recreationists each year.

The protection of public health and safety assume great importance when water scarcity at Grand Canyon is considered. Where water is available, human use congregates. Some uses, such as inner canyon developments, are relatively permanent and susceptible to floods. Flood hazards are the water-related hazards most likely to take lives at Grand Canyon National Park. Other uses, such as recreational use of water throughout the Canyon, are more transient and seasonal. Aquatic chemical and biological hazards influence both uses. Microbial hazards are biological, but the techniques for identifying these hazards are more closely akin to chemical analyses. Consequently, microbial analysis is best carried out as an adjunct to chemical studies.

A complete analysis of health and safety issues allows Park management to develop options protecting permanent developments from danger, and educating recreational users on hazards and how to deal with them.

**Inventory and Document** Work cooperatively with the U. S. Geological Survey in conducting a detailed South Rim hydrogeologic assessment.

**Monitor** Implement long-term monitoring program of water quality and quantity including bacteria of the Colorado River and selected tributaries.

**Mitigate Impacts and Protect** Protect human health and safety from water-related threats. Conduct flood-hazard assessment on selected backcountry developed areas likely to be impacted by flood events. Mitigate dangers to human health, safety and developments from floods.

**Foster Research** Conduct and foster research to characterize natural water resource conditions.

**Develop Management Plan** Provide overall planning for health and safety protection from water-related threats. Develop a flood contingency plan for corridor developments, as part of the Water Resource Management Plan. This can include installation of a flood early warning system on Bright Angel Creek that will insure a timely response from Park staff.

**Interpretation** Interpret threats posed by water resources. The Park Hydrologist can train ranger and maintenance personnel to maintain an early warning system on Bright Angel Creek. Teach annual flood awareness classes to all personnel working and living in flood-prone areas. This course can include a flood warning protocol.

*Mitigate Threats of Human Domestic Water Supply*

**Development** Human domestic water supply development represents one of the greatest potential impacts to the natural water regime in the central Grand Canyon. NPS policy limits water withdrawals to the minimum necessary to support the use and management of the Park, and only if such use does not significantly alter natural systems. The impacts of existing water diversions from the Bright Angel watershed, and flow augmentation of the Pipe and Coconino watersheds need to be completely defined.

The impacts on ground water flow and availability from existing and proposed wells south of the Park could have long-lasting impacts on spring flow in the Canyon from the Little Colorado River west to the Havasu drainages, but insufficient data are available to assess these threats. Collection of comprehensive, detailed data are necessary to determine resource damage potential from ground water withdrawal.

**Inventory and Document** Identify and evaluate alternative sources of potable water for North and South rims. Develop information in support of an EIS for alternative water supplies.

**Monitor** Ensure that human water supply developments do not degrade natural conditions. Evaluate potential impacts from water-supply developments outside the Park.

**Mitigate Impacts and Protect** Ensure human water-supply developments do not degrade natural conditions, and that all future projects comply with Federal regulations. Evaluate potential impacts from in-Park water-supply developments, and insure that all future maintenance projects comply with Federal regulations.

**Foster Research** Conduct research cooperatively with the USGS and university personnel to characterize natural water conditions.

**Develop Management Plan** After the monitoring phase is complete, develop information for a revised *Tusayan Water Sales Environmental Assessment*. Incorporate this information into the revised Water Resource Management Plan.

**Interpretation** Submit all findings and alternatives to Management and Interpretive personnel.

*Establish Water Rights*

Establishing water rights preserves the Park's rights to water quantity and quality needed to maintain natural Park systems. These water rights must be developed in accordance with both State and Federal law. In adjudication proceedings (such as those for the Little Colorado River), the NPS (through the Justice Department) must quantify its needs for the preservation of Park values, which, if unmet, would defeat the Park's purpose. While the actual establishment of NPS water rights as discussed herein is a legal issue, it draws heavily on the results of monitoring programs carried on under characterization of natural conditions, and is augmented by findings of domestic-source impacts.

**Inventory and Document** Develop data bases on Park water resources needed for adjudication of Park water rights.

**Monitor** Establish long-term monitoring of significant water resources below the South Rim to determine impacts from water withdrawal outside the Park.

**Mitigate Impacts and Protect** Protect water rights through water adjudications. Pursue Wild and Scenic designation to provide additional layer of protection to assure minimum flows.

**Foster Research** Conduct studies, both in-house and cooperatively with other agencies to support NPS water right claims as part of the Little Colorado River adjudication. Examples of such studies could include channel maintenance parameters and fish habitat requirements.

**Interpretation** Other Park divisions can aid in the interpretation and education of water rights information.

*Protect Wetlands*

Wetlands provide some of the Park's most biologically productive areas. Biological productivity is best evaluated and perpetuated using the tools of science, and is discussed under the Vegetation and Wildlife sections of this Plan. Availability of free water makes this environment possible, and the water is subject to the same physical and legal characteristics that determine other water-resource values. Indeed, water supply to wetlands is inseparable from other water-supply issues, and cannot be treated independently without serious duplication of effort. Therefore, the physical aspects of wetlands (water supply and delineation) are discussed under water resources, with the former integrated into the characterization of natural conditions and the latter in its own section.

**Inventory and Document** Inventory flora and fauna of Park wetlands as well as spring discharges and water chemistry. Delineate wetlands in vicinity of current and planned developments.

**Monitor** Long-term monitoring of wetland areas is needed to establish baseline data, and monitor long-term trends.

**Mitigate Impacts and Protect** Identify wetlands that are at immediate risk, or have been impacted already from management activities. Develop strategies for mitigating these impacts.

**Foster Research** Conduct and/or foster independent wetland-related research.

**Develop Management Plan** Promulgate an overall wetland preservation Plan.

**Interpretation** Throughout all six "divisions" of the water resource management program, interpretation plays a key role. Interpreters are not limited to informing the public about specific water resources. Interpretation can also orient the public to special Park needs in managing its water resources to preserve natural conditions, and how such preservation will, in turn, play a pivotal role in maintaining the Grand Canyon as a dynamic system.

# Air Quality Management

## Program Overview

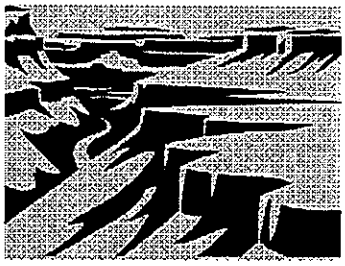
Grand Canyon enjoys some of the cleanest air left in the United States. This clean air is a fragile resource, and existing levels of human-caused pollution create a clearly visible haze. Many studies have been conducted to characterize this haze—its composition and origin. In addition to visibility studies, Park monitoring programs measure acid deposition (wet and dry), ozone concentrations, and meteorological conditions. Special studies have added substantially to this information.

Grand Canyon is a Mandatory Federal Class I area under the Clean Air Act as amended. This status does not reflect the present cleanliness of the air. Rather, it affords protection from increased concentrations of "criteria pollutants" (ozone, lead, nitrogen oxides, sulfur dioxide, carbon monoxide, and aerosols less than ten micrometers in diameter). National standards for criteria pollutant concentrations are set to guard human health and safety, but damage to other resources may occur at lower concentrations. The Clean Air Act also sets a goal of no human-caused visibility impairment in Class I areas (such as Grand Canyon), by preventing future hazes and eliminating existing ones. In working toward this goal, the EPA required the Navajo Generating Station (Page, Arizona) to reduce its sulfur dioxide emissions 90% by 1999, because of the emissions' visibility impact on Grand Canyon.

The value of air-quality studies extends beyond Park resource management. Most air-quality monitoring in the United States focuses on "problem areas" like urban centers and manufacturing complexes. Monitoring in rural areas like Grand Canyon develops a baseline to understand the characteristics of relatively pristine air, and to assess the pervasiveness of pollutants.

## Program Objectives

The air-quality program at Grand Canyon National Park is based upon National Park Service management guidelines established in NPS-77, *The goal of the NPS air resource management program is the preservation, protection, and enhancement of air quality and air quality related values of units of the National Park System by ensuring compliance with the requirements of the Clean Air Act and the NPS Organic Act.* Major program objectives include:



- Ensuring that facilities and activities within parks comply with Clean Air Act requirements, including State and local regulations

- Acquiring the information and tools to document air-quality conditions in parks, to evaluate trends, identify resources that may be or are affected by air pollutants, determine cause and effect relationships, and estimate changes that may result from changing pollution levels

- To remedy existing, and prevent future air-pollution effects on Park resources and values, by working with Federal, Tribal, and State governments in developing regulations and pollution-source permits, as required by the Clean Air Act.

## Issues

The following issues are pertinent to managing air quality at Grand Canyon:

*The lack of baseline data necessary to characterize existing air quality conditions puts air quality at risk*

There is a lack of baseline and effects information for air quality related values.

*The lack of documented information regarding the impact of air pollution on Park resources, visitor experience and public health puts those resources and values at risk*

Visitor enjoyment of the Park is hampered by traffic pollution, smoke, light and aircraft noise. Visibility impacts, acid deposition, and bio-effects are some of the potential impacts which require inventory, monitoring and mitigation. Presently, it is not known whether other Park resources, including biotic and cultural elements, are adversely affected by changes in air quality, or what levels of potential pollutants will cause significant resource damage.

*The lack of an air resource program and plan puts Park resources at risk*

Without a plan and program policy issues or pollution sources of greater significance may go unnoticed while others of lesser importance may receive unwarranted attention.

*External and internal sources pollute Park air quality*

There are regional as well as local sources which influence the air quality within the Park. These sources must be identified, monitored and documented. Sulfates from fossil fuel combustion, smelters and urban areas account for over 60 percent of the visibility reduction at Grand Canyon National Park. A major local source of sulfur dioxide is the Navajo Generating Station, the coal-fired generating plant at Page, Arizona. It was the focus of intensive studies from 1987 to 1991, and will reduce its sulfur dioxide emissions by 90 percent by 1999.

An EPA-sponsored study of the Mohave Power Project, a coal-fired generating station near the mouth of the Canyon, will determine its contribution to haze. Fugitive dust, smoke from wild and prescribed fires and natural organics also contribute to haze, but to a lesser extent. Ozone concentrations have been measured to be as high as 84 parts per billion (ppb) locally, well below NAAQS standards, yet above the threshold of damage to sensitive plants.

*Park resources have been impacted*

Visibility of integral vistas, and public health and air quality standards must be protected, and new Federal requirements for air toxins, hazardous air pollutants, operating permit programs, conformity, and regional haze must be met.

*There is a need to communicate air quality values and preservation to the public*

Since most pollutants affecting the Park originate outside Park boundaries, and other State, Tribal, and Federal agencies regulate air quality, an informed public is essential in shaping air quality management.

## Current Funded Program

Air quality monitoring at Grand Canyon began in 1959. Many techniques have been used to measure visibility, aerosols, gases, and acid deposition. Research is conducted to document existing air quality, to perceive trends, to measure sensitivity of Park resources to pollutants, to establish local and regional weather patterns affecting air quality, and to identify the sources and nature of existing and potential pollutants.

The clean, clear air of Grand Canyon is an excellent laboratory for monitoring and special studies to document, measure, and characterize the physical properties of haze. Sociological studies have investigated visitor reactions to haze. Tracer studies and computer modeling have sought sources of haze pollutants.
The Park monitors other air quality parameters as well. Current efforts include wet acidic deposition (National Atmospheric Deposition Program), dry acidic deposition and ozone concentrations (NPS Gaseous Pollutant Network), and meteorology.

Currently there is one FTE at Grand Canyon committed to oversee the air quality management program. Additional staff commitments interpret air quality issues.

## Proposed Unfunded Program

Protecting air quality and its related resources requires an extensive program of data collection and interpretation. Effective management requires:

- establishing existing air quality conditions
- identifying pollution sources affecting the Park
- characterizing effects of air pollution on Park resources
- mitigating identified pollution impacts
- communicating the importance of air quality values and preservation to the public.

Projections by the NR-MAP program identify a staff of almost four FTEs for air quality management, as shown in Figure 3-8. The sections below outline specific steps to manage air quality.

### *Establish Existing Air Quality Conditions*

Documenting existing air quality conditions is an ongoing job. Air quality varies under natural conditions, requiring a long baseline of information to make meaningful interpretations of "average conditions" and "trends." Improved monitoring techniques and new pollutants of concern may augment or replace existing monitoring procedures.

Our ability to define and measure air quality impacts on Park resources will improve in the future. Thus, to document existing air quality, three types of data collection and interpretation are needed.

**Monitoring of ambient air quality** This procedure documents what is in the air. A variety of instruments measure light transmission and scattering, sample aerosols and precipitation, gas concentrations, and record meteorological conditions. To provide a reliable data baseline, long-term measurements are needed. Short-term studies can identify particular pollutants or assess impacts for particular pollution sources. Data from special studies should be integrated into the long-term databases. Presently, nearly all ambient air quality monitoring is funded and/or contracted through the National Park Services' Washington Office Air Quality Division (AQD). AQD employs the technical expertise needed to produce scientifically defensible data and interpretations, and contracts for data analysis and technical support to field sites. This system has worked well. However, the Park must be prepared to assume at least partial funding of the program if necessary, to preserve a scientifically valuable baseline.

**Figure 3-8**
NR-MAP FTE allocation required to fully staff a Air Quality Management Program which would address most of the issues and threats described above.

| Air Quality Management | NR-MAP* FTE Allocation | CURRENT FTE** Allocation |
|---|---|---|
| Biological Effects, Planning, Regulatory and Interpretive Activities | 1.24 | 0.35 |
| Instrument Monitoring | 2.03 | 0.50 |
| Meteorological Monitoring | 0.56 | 0.10 |
| TOTAL | 3.83 | 1.0 |

**Establishing potential effects of air pollution on Park biota** The effects of various pollutants, in a range of concentrations, and on many plant and animal species, are documented in the literature. Comparing the biota of Grand Canyon with pollution-effects studies will begin to identify species at risk and symptoms to monitor. A monitoring program based on information developed by this comparison can alert the Park to resource degradation.

**Air quality related values in Grand Canyon were identified at various times in the past** Two such values are visibility and biotic health. However, many assessments are dated (e.g., "integral vistas"), and some values have not been studied (e.g., impacts on geologic features). Systematic analyses of Park resources and experiences, and the impact of air pollution on them, should be developed. The listing should be updated regularly, and used to set monitoring and mitigation priorities.

*Document Impacts on Park Resources*

Impacts on Park resources must be documented to develop options for dealing with air pollution effects. Although the mere presence of air pollutants may have legal significance, it is the impacts of those pollutants that drive legislative and administrative action to ensure clean air. By the same logic, documenting impacts on Park resources adds immediacy to the need for mitigation, and records the changing conditions of Park resources.
Three major resource impact categories are:

**Visibility** Many studies correlate the presence of air pollutants to reductions in visibility. Socioeconomic impacts of haze have also been studied. Continued monitoring of visibility will document physical changes. Aesthetic components of visibility require continuing studies to determine the socioeconomic values of current and future visibility conditions. Because Park visibility is sensitive to small increases in pollutants, visibility degradation can also serve as an early warning for other resource impacts.

** Natural Resource Management Assessment*
***Full Time Equivalent*

**Acid deposition** Precipitation chemistry has been measured in Grand Canyon since 1981, but impacts of acid deposition have not been studied in the Park. Current precipitation acidity is near normal, allowing baseline investigations of soils, biota, and cultural features to be made. With a baseline in place, current or future resource degradation can be identified.

**Bio-effects** Monitor air pollution effects on growth, reproduction and health of Park biota ("bio-effects") to help preserve ecosystem health. Current monitoring is limited to ozone effects on *Pinus ponderosa*, and lichen species have been inventoried. Pollutant-sensitive species growing in the Park, including *Rhus trilobata* and several species of lichens are monitoring candidates. Comprehensive monitoring should include the full range of Park environments. Ensuring the health of Park ecosystems is the primary goal of such a program. A secondary benefit is the identification of pollution problems in remote areas of the Park, where other monitoring efforts are not practical.

*Provide Air Resource Program Guidance*

Comprehensive air resource program guidance should be provided by a Park Air Quality Management Plan. Air-quality characteristics have been monitored in the Park since 1959, producing a solid foundation of information on which to build. A plan will ensure that Grand Canyon can coordinate and integrate all facets of air quality research and management into a comprehensive program. Air quality in the Park is dependent on actions hundreds of miles away, so flexibility is essential. The plan must respond to changing physical, chemical, and legal environments. The Park must be prepared to meet new Federal requirements for air toxins, hazardous air pollutants, operating permit programs, conformity, and regional haze.

**Identify Sources of Air Pollution**
Sources of air pollution affecting Park resources must be identified if their impacts are to be mitigated. Establishing some cause-and-effect relationships can be relatively straightforward, particularly for local sources. However, pollution comes into the Park from many distant sources as well. Identifying these sources is much more difficult. Thus, a two-tiered approach to source identification is needed:

- Identification and quantification of local sources define those air pollution sources close to or within the Park.
  Only one large pollution source lies within 100 km. of the Park (the Navajo Generating Station), but many smaller sources lie within this radius. Because of their proximity, these sources may have a disproportionate impact on air quality and its related values. An inventory of pollution sources is the first step toward ensuring they do not degrade air quality related values in the Park or violate environmental compliance regulations. This inventory will also show NPS commitment to clean air goals.

- Identification and quantification of regional pollution sources defines sources contributing to the regional haze that limits visibility in the Park, and other pollutants carried into the Park, such as ozone precursors.
  These pollutants also may damage Park resources other than visibility. Because of the distances involved in regional studies, emissions from individual facilities usually disperse and blend. Therefore, sources are often defined as regions (e.g., Los Angeles Basin, Las Vegas metropolitan area). However, the individual contribution from large, isolated sources (e.g., Mohave Power Project) may have significant, measurable impacts.

**Mitigate Air Pollution Effects on Park Resources** Reducing pollution levels is the primary focus for mitigating air pollution effects on Park resources. Some pollution-sensitive objects could be collected and preserved in the Park Collection. However, collection is not an option for most Park resources, nor is it compatible with NPS preservation goals. While the NPS has no direct control over the issuance of air pollution permits, it does have a responsibility under the Clean Air Act to work with State, Tribal, and Federal air pollution control agencies to ensure the permits the agencies issue do not damage Park resources. Mitigation of impacts can proceed on two fronts, inside the Park and outside the Park.

- Controlling in-Park emissions will mitigate air pollution impacts from sources over which the Park has direct control. These sources may include wildland fires for ecosystem management, concession operations (e.g., tour buses, boilers), visitor and domestic emissions (e.g., campfires, wood stoves), and Park operations (e.g., vehicle fleets, surface coatings, construction projects).

  In areas where the Park has direct control, mitigation will not only reduce threats to Park resources, but also set a good example for general pollution management. It may be possible to obtain special funding for demonstration projects.

- Control of external emissions requires close cooperation between the Park (either directly or through the Air Quality Division) and State, Tribal, and Federal permitting authorities.
  Cooperation and dialogue are often on a reactive, issue by issue basis. In a better, proactive program, the Park participates in regional planning efforts. Multi-state, multi-agency efforts can promote coordinated strategies to address regional air quality issues that do not respect legal boundaries.

**Interpret Air Quality Issues** Air quality issue interpretation is continuous at Grand Canyon. The program has been successful in informing the public about the pollution problems faced by the Park and its resources. Interpretive efforts must continue and evolve as impacts to Park resources change.

A strong interpretive program also allows the public an opportunity to understand, or at least appreciate, the complexities of air pollution, its sources, impacts, and remedies. Individual human actions multiplied by millions of people have caused pollution problems. Educating people to reduce their impacts, multiplied by millions of Park visitors, reduces pollution problems.

# Vegetation Management

## Program Overview

This chapter describes both the vegetation and restoration programs.

### *Vegetation Management*

The vast diversity of vegetation at Grand Canyon is most likely unsurpassed by other national parks. The Park contains representatives of the four North American deserts (Mohave, Great Basin, Sonoran, and Chihuahuan) as well as montane ecosystems (boreal forests such as subalpine coniferous forests of spruce, fir and aspen), cold temperate forests and woodlands (ponderosa pine, pinyon pine and juniper), grasslands (subalpine, plains and Great Basin), cold desert scrub, warm desert scrub and riparian woodlands/scrub.

There are over 1,500 species of vascular (seed plants) in the Park within an elevation range of almost 8,000 feet, based upon information gathered from field surveys and herbarium collections. The species list is incomplete because large portions of the Park, generally within the inner canyon, have never been botanically surveyed. The number of non-vascular plants is unknown. A preliminary study done in the 1940s found 64 moss species, over 167 species of fungi are reported, and a recent 1993 study found 195 lichen species. Additional numbers of vascular and non-vascular plants are to be expected, due to the Park's remote nature, the wide varieties of habitats, and ongoing invasions by nonnative or exotic plants.

Although Grand Canyon has a completed 1982 vegetation classification and map, there is little known about the Park's vegetation dynamics, and how they are related to internal and external threats. Little is also known about the location, extent and health of threatened, endangered and sensitive plant species.

### *Restoration Program*

Native plant communities at Grand Canyon are adversely impacted by human activities. Approximately five million people visit each year, with predictable consequences for the Park's vegetation; native plants are trampled at viewpoints, trailheads, and along trails. Construction projects also devastate vegetation. Vegetation loss has resulted in erosion of scarce topsoil, further degrading sites. Alien species such as Mediterranean sage (*Salvia aethiopsis*), cheat grass (*Bromus tectorum*), horehound (*Marrubium vulgare*), and mullein (*Verbscum thapsus*) have invaded disturbed areas.

Native vegetation within the proposed wilderness, including along the Colorado River, is adversely impacted by recreationists. Active mitigation programs are conducted to reduce impacts and restore damaged areas. This often requires trail delineation, trail relocation, and site preparation for eventual revegetation. In addition, exotic species such as Russian olive (*Elaeagnus angustifolia*), ravenna grass (*Saccharum ravennae*), and camel thorn (*Alhagi camelorum*) are invading the Colorado River corridor and seriously threaten the native biodiversity of this system. Current efforts to eradicate Russian olive and control ravenna grass appear effective to date. Attempts at site specific control of camel thorn are ongoing.

## Program Objectives

*Vegetation Management*

*NPS Management Policies* state that, "The National Park Service will seek to perpetuate native plant life as part of natural ecosystems" and that,

> *The National Park Service will assemble baseline inventory data describing the natural resources under its stewardship and will monitor those resources...to detect or predict changes. The resulting information will be analyzed to detect changes that may require intervention and to provide reference points for comparison with other, more altered environments.*

*Restoration Program*

The revegetation program's primary objective is to restore native vegetative cover to impacted areas. This includes locations in the heavily impacted South and North rims, in the backcountry, and at sites along the Colorado River. Secondary objectives, which enable the achievement of the primary objective, include: collecting native seeds for growing transplanting stock; constructing and operating greenhouses and nursery areas; transplanting; and tree salvaging. Complementing these secondary objectives are programs to eradicate alien species, to develop a systematic habitat restoration plan for disturbed sites, and to develop and operate a resource damage assessment protocol.

## Issues

*Rare, threatened, endangered and sensitive species are at risk*

Little is also known about the location, extent and health of threatened, endangered and sensitive plant species. An understanding of the impacts to riparian vegetation and hanging gardens, considered extremely important communities within the desert ecosystems of the inner canyon, is also unknown.

*Alien plants are displacing native species*

There are over 116 alien species known in Grand Canyon representing 26 families and 81 genera. Their extent and impact is currently not known. Although the South Rim area was inventoried about ten years ago, no other inventories have been completed to date. It is apparent that such species as tamarisk pose a great threat to the native vegetation especially of riparian areas. Hundreds of acres of native vegetation have been replaced by tamarisk along the Colorado River and its tributaries. Many springs vital to wildlife and humans are also being invaded by the plant. Though removal along the Colorado River may not be practical, removal in the tributaries, isolated springs, and on the rims is achievable. Other alien plants are more specific to certain Park regions, and may be more easily controlled.

*Lack of knowledge of native plant communities puts them at risk*

Although Grand Canyon has a completed 1982 vegetation classification map there is little known about the vegetation dynamics in the Park and how they are related to internal and external threats. This map only provided a snapshot of vegetation types for that specific project. The classification field work did not establish permanent vegetation plots in order to follow changes in composition over time. Without such a system of plots, it is unknown if the vegetation classification has become obsolete in certain Park areas, or if changes to the vegetation are due to natural or human-caused variation.

*There is a need for a comprehensive, integrated vegetation management plan*

The issue that is most critical is the lack of baseline information on species, communities, and ecosystem dynamics, as well as for threatened and endangered species. The lack of this baseline data affects all other programs.

*Native plant communities have been disrupted*

The enormous visitation to Grand Canyon causes dramatic impact to native vegetation including trampling, social trailing, vehicle parking, and construction, barren ground, tree root exposure, social trails, and erosion. Glen Canyon Dam has also altered the native riparian plant community.

Those areas that are rehabilitated do not have an adequate evaluation program to determine if techniques are working in the long term. There are no planning documents that lay out strategies for restoration on a Parkwide basis. Plans are written on a site-specific basis.

*Lack of base funding for this program puts resources at risk*

Lacking base funding, the efforts of the revegetation crew are not necessarily directed by the needs of Grand Canyon National Park but by the amount and type of funding they can raise each year.

## Current Funded Program

*Vegetation Management*

The current funded program is limited and needs expansion to address the many issues and threats to vegetation resources at Grand Canyon, including:

- Surveying for sensitive plant species in areas to be disturbed by construction and prescribed fires
- Monitoring the condition and trend of the endangered sentry milk-vetch
- Management of a vegetation program
- Identifying impacts to plants resulting from adjacent landowner or in-Park activities
- Preparing management plans, monitoring protocols, publishing articles on Park research, and making presentations at symposiums and for Park staff
- Incorporating data from research, resource inventories, baseline studies, and monitoring into appropriate GIS and other long-term databases
- Develop grant and research proposals, contract supervision (to insure that contracted research meets contract specifications and scientific credibility) and review of independent research proposals and collecting permits

**Figure 3-9**
NR-MAP FTE allocation required to fully staff a Vegetation Management Program which would address most of the issues and threats described above.

| Vegetation Management | NR-MAP* FTE Allocation | CURRENT FTE** Allocation |
|---|---|---|
| Native Terrestrial Plant Management and Monitoring | 3.91 | 0.25 |
| Native Aquatic Plant Management and Monitoring | 0.62 | 0 |
| **Threatened And Endangered Plant Management** | | |
| Federal Threatened and Endangered Species | 0.34 | 0.25 |
| Federal Candidate 1 & 2 Species | 0.56 | 0.50 |
| Other Species Listed by State(s) | 0.56 | 0 |
| **Exotic Plant Management** | | |
| Control | 2.26 | 0.5 |
| Monitoring | 0.34 | 0 |
| Reintroduction of Extirpated Plants | 0.0 | 0 |
| Subsistence Use Management - Plants | 0.11 | 0 |
| TOTAL | 8.71 | 1.5 |

** Natural Resource Management Assessment*
***Full Time Equivalent*

| Restoration Program | NR-MAP* FTE Allocation | CURRENT FTE** Allocation |
|---|---|---|
| **Disturbed Area Rehabilitation** | | |
| Abandoned Road Restoration, Rehabilitation, and/or Revegetation | 3.0 | 4.5 |
| Rehabilitation of Backcountry Campsites, Trails, and/or River Corridors Commonly Used by Boaters | 9.0 | 0.7 |
| Rehabilitation of Other Disturbed Areas (e.g. campgrounds, picnic areas, ORV-impacted areas, abandoned landfills, mines and borrow pits) | 6.0 | 0.5 |
| TOTAL | 18.0 | 5.7 |

**Figure 3-10**
*NR-MAP FTE allocation required to fully staff a Restoration Program which would address most of the issues and threats described above.*

- Planning and implementing revegetation projects at construction sites throughout the Park, and at other Park sites when volunteers are available
- Implementing alien plant eradication program
- Staff is unavailable to implement planning, comprehensive monitoring, or studies pertaining to ecosystem dynamics.

*Restoration Program*

The revegetation program's projects and staffing, with the single exception of the program manager, are funded from external sources through a variety of funding sources and competitively procured contracts. The absence of base funding for this program has numerous negative consequences.

Among these are the constant drain of proposal writing; the timing and insecurity of contract awards which makes programmatic decision making and long-term planning imprecise and difficult; and funding insecurity which contributes to turnover in personnel and increased personnel training costs. Perhaps most importantly, the projects the revegetation crew undertakes are set by the funding agencies and the contracts won, not the Park. That is, reliance on external funding removes the direction of the program's efforts from the Park.

A revegetation specialist was hired in November, 1994, to establish a revegetation program. He remains the Park's only base-funded employee in the revegetation program. The revegetation specialist currently manages a staff of seven term employees who are funded by contracts they procure through various proposal processes.

In the two years since the program's creation several large restoration projects have been completed and others are in progress.

The program's accomplishments include construction of greenhouses enabling local propagation of native transplanting stock, over 6,000 native plants planted, over 300 trees salvaged from construction zones and replanted in other locations, and the eradication of two alien plant species from the Park. The following discusses the program areas within the revegetation program.

*Volunteer Program*

Much of what the revegetation program has achieved has been through the recruitment and integration of volunteers—both visitors and organized groups—into the revegetation program's work efforts. Volunteers involvement is perhaps the greatest success of the revegetation program. By being involved in hands-on work, the volunteers better understand Park issues and commit themselves to Park values. The tasks completed by volunteers have been as diverse as the people themselves. From first and second graders collecting seed to elders planting trees and shrubs, volunteers were integrated into all aspects of the revegetation program. Some visitors spent two hours removing nonnative weeds while others committed several weeks to the salvage and transplanting of large pine trees. In 1996, over 600 people volunteered more than 11,000 hours to the revegetation program. Unfortunately, a number of volunteers were turned away due to a lack of camping or housing facilities.

During the course of one season, hundreds of people of all ages are trained and supervised. Each person leaves Grand Canyon with a greater awareness of the importance of native plant species. Many past volunteers have informed us that they have taken the skills and awareness gained in this program back to their local communities and closest national park. They leave knowing that the displacement of native plants by alien species reduces community biological diversity. They understand native plant communities' significance and benefits from an ecological perspective.

The volunteer program has greatly expanded the numbers and types of projects the revegetation crew has been able to complete. Volunteers completed restoration projects at Pima, Powell and Yavapai points, and at Mather Campground. But more important, the volunteer program helped the Park Service effectively uphold its mission to preserve what is inspirational and wonderful, and to bring that message to many people in a way which perpetuates those ideals.

*Partnership with Grand Canyon Schools*

One of the most fulfilling volunteer programs is the partnership established with the Grand Canyon Unified School District (GCUSD) to incorporate restoration activities into the curriculum at different grade levels. The lower grades collect seeds from several native species in fall and propagate these seeds in their classrooms. The middle school participated in two different planting days as part of their Earth Day Project. Teaching restoration skills to a new generation has been an enriching and motivating experience for both students and the revegetation crew while providing an important labor contributions to the revegetation program.

In 1996-97 this partnership has been expanded to a "School to Work" habitat restoration project. This program integrates academic learning with a community service project to develop broad workplace competencies by cultivating "real-world" occupational skills in students. Grand Canyon High School students, with guidance for the revegetation crew and GCUSD teachers, will develop, plan, organize and implement a restoration project.

Elementary and middle school students will compete components of the project under the supervision of the high school students.

Specific objectives of this program include: providing hand-on learning experience for more than 300 students in the GCUSD; providing a setting for older students to develop organizational and occupational skills; providing a coherent sequence of instruction for students regarding the importance of native habitat restoration and the techniques used in rehabilitating areas; rehabilitating a heavily impacted area; and serving as an archetype for future partnerships with others schools and organizations.

*Salvage*

The revegetation program is developing a process for salvaging and transplanting large pine trees. The revegetation crew salvaged more than 300 trees from the housing development area. Many of these trees were over 20 feet tall and had a total a commercial value of over $200,000. The use of these mature trees greatly enhances the aesthetic appeal of rehabilitated areas. Other benefits gained from transplanting trees include accelerating the process of plant succession, providing shade for the understory species, and providing habitat for various animals. A survival rate of nearly 90% has been achieved for the transplanted trees.

*Alien Species Eradication*

A separate volunteer program, the Grand Canyon Alien Invaders Program, began in 1994. The Grand Canyon Revegetation Crew and the Division of Interpretation cooperatively designed a program which educated Park visitors about the importance of native plant restoration and preservation and provided visitors with the opportunity to gain hands-on experience restoring disturbed areas.

Several thousand nonnative plants were removed and replaced with native species through this program. Most notably, two alien species (*Linaria dalmatica* and *Cynoglossum officinale*) were eradicated from the Park in 1996.

The focus and goals of the Alien Invaders Program continues to mature. New, more effective methods of nonnative species removal are being developed. We are now using direct competition in many areas by interplanting native plant species in addition to or instead of manual removal. For example, thousands of plugs of *Poa fendleriana,* or mutton grass, (a native grass component of the understory in rim plant communities) were collected by volunteers and transplanted into project sites. In addition, the revegetation crew spreads mulch on project sites to aid in moisture retention and discourage growth of various nonnative species.

A plan prioritizing the nonnative species for control is being developed. This plan will direct the Habitat Restoration Program in the future. Any eradication projects will be completed in accordance with a site plan. All NEPA and NHPA compliance will be completed in conjunction with the site plan.

*Habitat Restoration Plan*

To facilitate future project planning, the revegetation crew is developing a Habitat Restoration Plan. The plan will detail the procedures for the documentation of disturbed sites, assess revegetation and erosion control needs, prioritize the projects, outline cultural resource needs and compliance issues, and detail the guidelines for revegetation projects which consider the genetic integrity of plant stock. The plan also considers the logistical needs for backcountry plantings.

**Figure 3-11**
*Species of special concern within Grand Canyon*

- *Arctomecon californica* (California bearclaw poppy)
- *Argemone arizonica* (Roaring Springs prickly-poppy)
- *Camissonia confertiflora* (bunch flower evening-primrose)
- *Camissonia specuicola* ssp. *hesperia* (no common name)
- *Rosa stellata* ssp. *abyssa* (Grand Canyon rose)
- *Silene rectiramea* (Grand Canyon catchfly)
- *Talinum validulum* (Tusayan flame-flower)

Following this plan, after a site is identified for revegetation the Park's landscape architect will develop pedestrian traffic flow plans, the nonnative plant species will be eradicated, native species will be planted, the project area will be fenced if necessary for protection from foot traffic, and monitoring techniques will be designed and implemented to evaluate restoration success.

*Resource Damage Protocol*

To address other issues involving vegetation damage, a draft Resource Damage Protocol was developed. This program proposes to recover resource damage and restoration costs, such as those caused by vehicle and vehicle accidents, from the responsible party's insurance company. These recovered funds will allow establishment of a restoration fund used to support a variety of revegetation projects.

## Proposed Unfunded Program

*Vegetation Management*

Figure 3-9 shows the NR-MAP allocation of the FTEs required to fully staff a vegetation management program which could address the most compelling issues and mitigate the greatest threats to Grand Canyon's vegetation. It is imperative that staff from all Divisions work cooperatively to achieve a successful program of resource inventory, monitoring, protection, and restoration.

The vegetation program needs to be expanded to effectively address the many issues and threats to vegetation resources. The Interagency Adaptive Management Monitoring and Research Program associated with the Grand Canyon Monitoring and Research Center will mostly likely include a terrestrial, botanical component. In order to play a leadership role in the process, and to provide stewardship of the River corridor vegetation resource, funding will be necessary for vegetative monitoring and/or research coordination.

The proposed program elements include:

- Planning, inventory, comprehensive monitoring, management, and protection of native vegetation and ecosystems throughout the Park
- Applied studies of ecosystem dynamics. Inventory, monitoring, management, and protection of the endangered, threatened, candidate, rare, and sensitive flora throughout the Park
- Monitoring the effects of prescribed fire on plant life
- Provide research coordination and/or monitoring for the Interagency Adaptive Management Monitoring and Research Program along the River between Lees Ferry and Pearce Ferry.
- Promote research on imperiled species and ecosystems
- Develop a proactive integrated pest management program
- Expand eradication efforts for alien species
- Expand efforts to revegetate disturbed habitats, and provide maintenance or revegetated areas until they are stabilized
- Expand the GIS, data, and information management program and capabilities.

*Protect Threatened, Endangered, Sensitive and Rare Plant Species*

Due to the wide vegetation diversity at Grand Canyon, and the unique geologic features, a relatively large number of rare plants are known to exist.

**Inventory and Document** In addition to the sentry milk-vetch (*Astragalus cremnophylax* var. *cremnophylax*), which is the only listed endangered plant in the Park, seven plant species (Figure 3-11) from Grand Canyon are identified as species of special concern (formerly Category 2 species) by the U.S. Fish and Wildlife Service. There are no Category 1 plants at present. Status reports, many of them done nine to sixteen years ago, were done for these rare plants. Some work has been done to update their status, but additional work is needed. Surveys are only done when disturbances to possible habitats are proposed. For example, in order to provide NEPA compliance for a proposed prescribed burn area, threatened and endangered species must be surveyed first.

This presents a very tedious and time-consuming task when each prescribed-burn area must be surveyed separately. Good baseline data will not only save time and money in the long run, it will provide a better basis for understanding the Park's vegetation and lead to better management practices; and a proactive perspective.

Plants found on lands adjacent to the Park, with possible occurrence within the Park, have been listed or are candidates for listing. In addition, there are approximately 105-110 rare plants in and near the Park which have been assigned special status by other Federal or State agencies.

Prior to 1994, the sentry milk-vetch was known from two locations on South Rim, with a total population size of about 500. In 1994, a third location on the North Rim was discovered with over 1,000 plants. The largest South Rim population is protected by a fence, and has been monitored annually since 1988. Research on the plant's reproductive biology or abiotic requirements is lacking. Additional searches may find additional populations along both rims.

**Monitor** Establish long-term monitoring programs for those species most threatened in the Park. Monitoring protocols will be established for high-priority species. More funding will be pursued to conduct site-specific surveys of species threatened by disturbance in a more efficient manner. Results from monitoring programs are used to adjust use levels of areas containing sensitive species or implement mitigation strategies needed to preserve these resources.

**Foster Research** Solicit research focused on providing an understanding of reproduction, germination or environmental requirements of endangered species in the Park. Research on sentry milk-vetch will be pursued to better understand its reproductive biology and abiotic requirements.

**Develop Management Plan** Using an integrated and interdisciplinary approach, a comprehensive sensitive plant management plan should be developed within the overall Parkwide vegetation management plan. The plan should address the status and related issues for management of certain species. Mitigation of impacts, protection concerns, interpretive strategies as well as propagation and restoration alternatives can be addressed in such a plan.

**Mitigate Impacts and Protect** Actively promote the protection of sensitive plants in all Park projects.

**Interpret and Educate** Other Park divisions could aid in interpretation and education of rare and sensitive plants.

**Restore** Should areas where rare plants have been known to occur be damaged by management activities, mishap, or through natural means (fire, flood, etc.), then restoration of the habitat would be a high priority.

*Mitigate Alien Plant Impacts*

As identified in the Issues section of this chapter, there are over 116 alien plants known in Grand Canyon. Their full range and impact is not known. Although the South Rim area was inventoried about ten years ago, no other inventories have been completed to date. An alien plant eradication program has been initiated by the Park's Habitat Restoration Crew; however, the following actions remain to be achieved including:

**Inventory and Document** Gain an understanding of the extent of alien plants by conducting an inventory by location and invasion in acres for each species. A priority plant listing which can be treated will help to direct the program. Database for these inventories should be easily accessible and applicable for management objectives.

**Monitor** After alien plants are treated or removed, it is imperative that follow-up insures that plants do not re-sprout or become established from a buried seed source. In addition, areas which are disturbed by planned or accidental human activities need to be monitored to insure that alien plants do not reestablish.

**Foster Research** The Park is an ideal setting for research activities on alien plants given the wide variety of habitats and elevations. Treatment programs, research on specific species and/or their interactions with the native flora, and revegetation experiments could be done. The Park should encourage university, college, and environmental groups to undertake such research.

**Develop Management Plan** A realistic vegetation management plan must include information on alien invasion and naturalization. Treatment for newly introduced alien species should be timely and effective. Many alien plants which are few in number and limited in extent can, and are being, removed. However, several species, such as tamarisk and red brome, are abundant and widespread and cannot be realistically removed, except in isolated habitats.

**Interpret and Educate** Other Park divisions aid in interpretation and education of alien plants. This program could be greatly expanded.

**Mitigate Impacts and Restore** Expand proactive alien plant management by building a program and staff to eradicate noxious species, revegetate disturbed habitats, and monitor for reinvasion.

*Develop Knowledge of Native Plant Communities*

There is a lack of understanding of anthropogenic vs. natural long-term changes in both relict and altered areas. This information would be invaluable to accurately and comprehensively understand the external and internal threats that face Grand Canyon's vegetation.

There is a lack of consistent long-term monitoring protocols designed to better understand species and ecosystem dynamics. Data and information should be readily and easily accessible.

The condition and status of many unique riparian and aquatic areas are unknown. Water withdrawal outside the Park boundaries may have a negative effect on seeps and springs which feed these riparian areas. River corridor riparian and aquatic habitats have been studied through the GCES program, but these communities are continuing to change under the current operating criteria for Glen Canyon Dam.

**Inventory and Document** Inventory and characterize the Park's vegetation communities to develop a baseline for making scientifically sound management decisions.

**Monitor** Monitor both relict and altered systems to determine both anthropogenic and natural changes.

**Foster Research** Target studies in critical Park riparian, forest, woodland, meadow, and grassland communities, where both internal and external influences may cause irreversible impacts. Also, target studies in both relict areas and altered landscapes to determine long-term and anthropogenic changes.

**Develop Management Plan** An understanding of the native plant communities found within the boundaries (and extending into other areas outside the Park) is fundamental to management. Increased funding and staff time devoted to adequate data collection is necessary. A total of 129 vegetation associations (including series, associations, and subassociations) within forest, woodland, grassland, cold and warm desert scrub, and riparian areas were identified by a 1982 vegetation inventory. Preliminary information on only 63 vegetation mapping units and types were assembled at that time. How these communities respond in the short- and long-term to climatic change, natural change (such as flood, fire, insect invasions, etc.), and anthropogenic change (disturbance, prescribed natural burns, grazing, dam operations, water depletions, etc.) is not well understood. A management plan with protocols for inventory, documentation, and monitoring is essential.

**Mitigate Impacts and Protect** Impacts to native plant communities occur on spatial and temporal planes. Spatial impacts vary from impacts from outside sources which are widespread (for example Glen Canyon Dam operations on the riparian corridor, air pollutants from the Navajo Generating Station on all plant communities, ozone depletion and resultant increase in radiation, etc.), to inside sources which are localized (for example, the use of mules on two developed trails, the spread of nonnative plants through mule food and waste, and a resulting increase of brown-headed cowbird infestation through the availability of mule feed, etc.). Temporal impacts range from the short-term (trespass grazing, recent alien plant invasion, wildfires caused by campers, etc.) to the long-term (over 100 years of fire suppression and past mining activities, etc.).

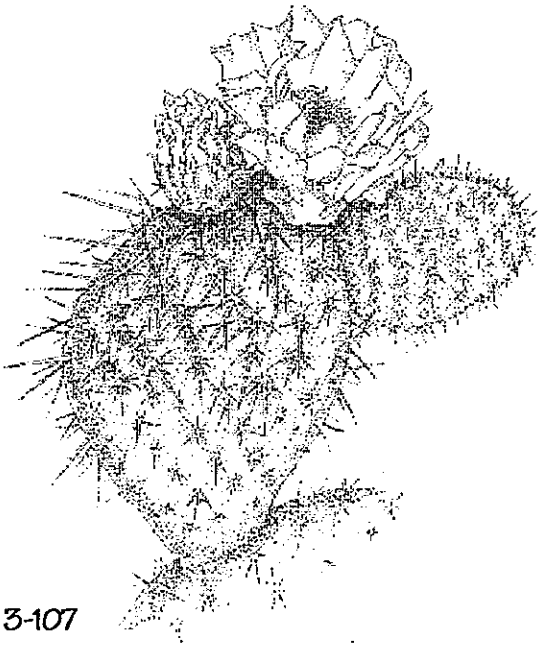
**Interpret and Educate** Other Park divisions could aid in interpretation and education of native plant communities.

**Restore and Maintain** Restoring altered ecosystems to health, and maintaining them in perpetuity, is an enormous task for the staff at Grand Canyon National Park. Vegetation is not self maintaining or separate from that of lands adjoining the Park. Past and recent fragmentation of ecosystems and changes in their abiotic foundations (nutrients, pollinators, ground water, climate, etc.) has far-reaching impact. Much of the information gathered in the past 100 years within the Park and in the western United States needs to be analyzed, and a vegetation management plan be drawn which adequately addresses the wide variety of habitats and issues.

*Restoration Program (Proposed Unfunded Program)*

The aspects of the revegetation program described above are "unfunded programs" to the extent that they are not base funded by Grand Canyon National Park. Lacking base funding, the efforts of the revegetation crew are not necessarily directed by the prioritized needs of Grand Canyon National Park but by the amount and type of funding they can raise each year.

To preserve program continuity, to achieve long-range planning objectives, to use the revegetation program according to the Park's priorities, and to address the tremendous backlog of habitat restoration needs at the Grand Canyon, the revegetation program must be based funded. Base level funding, at a minimum, will require funds to maintain existing facilities, complete restoration projects, and support a restoration specialist and a three-person crew. Figure 3-10 illustrates the staff numbers required to achieve a fully funded program.



# Forest Ecosystem Restoration

## Program Overview

Forest conditions as they appear today reflect significant changes caused by two major activities of early Euro-Americans—the unrestricted grazing practices in the late 1800s (and their continuance into the mid-1930s), and fire suppression efforts starting in the 1920s (and practiced to some extent up to present time). Both activities have resulted in significant alterations of the natural forest environment with which present-day managers are trying to cope.

Selective browsing by large numbers of livestock resulted in reduction of native grasses, forbs and other ground plants. Reduction in competition with grasses allowed forest densities to increase and expand into areas normally held by grasses.

Fire suppression has caused extensive change in the structure and vegetation composition of native forest, meadow, and shrub communities. Many communities are considered fire-dependent for the perpetuation of natural processes. Scientific research conducted on both the North and South rims has indicated that most of these ecosystems are adapted to frequent, low-intensity fire. However, portions of the North Rim, above 8,600 feet in the Engelmann spruce and subalpine fir associations, are characterized by a variable fire regime, including both low-intensity fire and infrequent, high-intensity fire. Fire suppression has eliminated the opportunity for such low-intensity fires in most Park areas. Unburned fuels due to fire suppression have accumulated to unsafe levels where stand-replacement wildfires threaten entire forest stands and endanger developed areas and lives in the Park.

Fire research initiated in the 1970s identified more clearly the adverse affects caused by suppression, and in 1978 a management plan was developed and approved allowing for the first-time fires to burn under an established set of conditions. The Yellowstone fires in 1988 ushered in a new era, new fire management policies, and considerable funding both for suppression and prescribed burning. Since that time there has been an increase in fire management staff professionalization, and development of an aggressive prescribed-fire policy. At Grand Canyon, the Fire Management Program is administered through the Division of Visitor and Resource Protection.

Despite the best fire management efforts, overall problems have worsened. Prescribed burning and natural fires have burned less than 20,000 acres between 1978 and 1996. For a forest encompassing approximately 200,000 acres with a natural fire frequency range of three to five years, the natural forest environment will not be restored at this rate of burning.

Large fires in 1996 near Flagstaff, (16,000 acres) and on the North Kaibab Forest (53,000 acres) reinforce the position that it is only a matter of time before a large stand-destroying fire will sweep through a major portion of the Park destroying old-growth trees and the forest ecosystem.

## Program Objectives

- Protection of human life and property
- Restoration of fuel loads and ecosystem structure to within the natural range of variability in vegetative communities
- Restoration of fire as a natural process through prescribed burning for reduction of fuels to levels that allow additional acreage to be designated as prescribed natural fire areas.

## Issues

*High fuel loads and dense forest conditions on the North Rim hamper prescribed burn efforts*

In order to safely conduct prescribed burns at the higher elevations extensive site preparation is required such as stacking, piling of fuels, and thinning along block boundaries to prevent fire escapes. Many blocks will require two burns; the first to burn piles of dead and down materials, and the second the following year to broadcast burn the block. The need for such extensive site preparation is expensive and limits the amount of acreage fire crews can burn in any one season.

*Narrow windows of opportunity limit prescribed burns*

Days when burning conditions are within prescription parameters are limited. This is especially true for North Rim forests at higher elevations where fuels take longer to dry in the spring, and snows come earlier in the winter. Many times when conditions are in prescription, burns have to be postponed due to demands for fire crew and staff elsewhere for fire suppression purposes.

*Air quality degradation from prescribed burns and prescribed natural fires*

While impacts to air quality from forest fires within the Park are only temporary, the smoke causes direct impacts on visitor enjoyment through reduction of Canyon visibility. To mitigate impacts, restraints are put on the number of acres burned per day, the time of year burns are conducted, and fire intensity.

*Data are lacking for restoration work*

Data are lacking on pre-grazing and pre-suppression forest conditions in such areas as species composition, tree densities, and fuel load. The absence of such data hampers management's ability to set realistic goals for restoration. The original premise guiding fire management was that fire had only to be restored to the forest ecosystem to achieve forest restoration. Today it is recognized that fire management is only one tool of many available.

*The natural fire regime has been disrupted*

Only limited scientific research has been completed to support the goals and objectives of the fire management program. There is a very significant need for better information concerning fire's role in natural and altered ecosystems.

## Current Funded Program

The current FIREPRO program provides the majority of funding for a fire management crew of 30 including both permanent and seasonal staffing. Firepro funding is used for prescribed burning, establishment of fire effects plots and archeological and threatened and endangered species surveys. Depending upon the year and conditions approximately 2,500 acres are treated by management-ignited prescribed fire, and an estimated 2,000 acres are burned in prescribed natural fire zones. Monitoring is accomplished through establishment of fire effects plots which provide data pre- and post-burn, as well as long-term fire effects. The Science Center carries out archeological and endangered species surveys for all burn blocks.

## Proposed Unfunded Program

If the Park's old-growth forests are to be saved, and the area restored to pre-settlement conditions where natural fire can resume it's role, then the Park needs to revise and modify the current management program strategy. The use of fire in restoration needs to continue as a management tool; however, at the same time research needs to be implemented into determining pre-grazing and pre-suppression conditions, and identify what tasks are needed and how they can be implemented to bring about forest restoration.

For fire to be a more effective tool, additional research is also needed. A fire ecologist is needed to assist in program guidance and establish burn objectives. Fire monitoring needs to include effects on flora and fauna.

### *Forest Ecosystem Restoration Program*

**Inventory and Document** More extensive fuel surveys and forest-density surveys are needed to improve fire-behavior forecasting in long-range programs such as Farsite.

**Monitor** Fire monitoring needs to be continued for post-burn as well as pre-burn evaluations, and results compared with burning conditions, fire behavior, and whether burn objectives were achieved. Fire monitoring needs to be expanded to include effects on wildlife. Collection of data is needed on smoke dispersal for all forest fires.

**Foster Research** The Park is an ideal setting for research activities on the disruption of the natural fire regime. Research on specific species and/or vegetation communities and their response to fire suppression, burning outside the natural fire season, the impact of various types of burning prescriptions, vegetation response to stand replacing fires, and other fire behavior studies should be encouraged by Park management. The Park can encourage university programs in biology and forestry to undertake research in this area. A completed fire history will provide a better scientific basis for management objectives.

**Mitigate and Protect** Mitigation and protection is the primary objective of the management program.

**Interpret and Educate** Other Park divisions aid in interpretation and education of the importance of the natural fire regime. When prescribed burns are being conducted and after they are completed, rangers interpret the activity to the visitor via evening programs and informal gatherings near the burn site.

**Restore** Restoration of the forest habitat is one of the primary objectives of the fire management plan. As each area's fuel loads and tree densities are reduced to natural levels they will be designated as a part of the Park's prescribed natural fire zone where fires can be allowed to burn under predetermined conditions. Management actions will be based upon research into what forest conditions were prior to grazing and fire suppression times. A variety of treatments including, but not limited to, fire will be used in restoration.

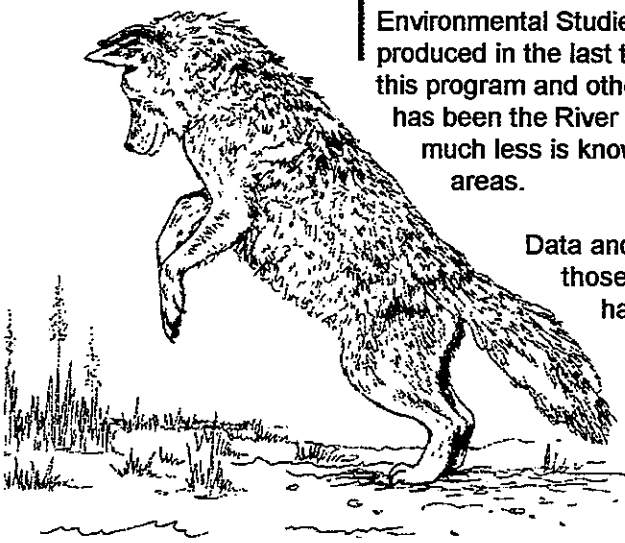
# Wildlife and Fisheries Monitoring and Management Program

## Program Overview

Grand Canyon National Park is considered to be a very valuable wildlife refugium due to its large size and the relatively unfragmented habitat resulting from NPS preservation policies.

Elevation gradients and the associated habitat variety support a diverse fauna. Checklists of species occurrences include: 315 bird species, 88 mammals, 50 reptiles, eight amphibians, 21 fishes (including five native species), and thousands of different aquatic and terrestrial invertebrates.

Unfortunately, historical funding and staffing levels have been inadequate to establish an active Park-based wildlife and fisheries management and monitoring program. Most studies relating to Park wildlife resources have been either contracted to outside researchers and agencies or done as projects by university scientists. A plethora of studies associated with the Glen Canyon Environmental Studies program have been produced in the last ten years. The focus of this program and other historical studies has been the River corridor, and therefore, much less is known about other Park areas.



Data and conclusions from those and earlier studies have not always returned to the Park, and improvements in data management are needed to better retrieve and use data that exist.

Therefore, basic inventory and monitoring data have not been readily available to Park staff for use in evaluating the status and trends of the Park's wildlife, identifying threats, and developing management actions to protect this valuable resource.

Efforts were initiated in the 1920s to reduce Park feral burro populations, and over 1200 were removed. This continued intermittently thereafter, with the latest reductions occurring in the 1970s and early 1980s with approximately 500 feral burros removed. These actions represent the longest-running wildlife management program in the Park. Most other Park-conducted wildlife work in recent years has consisted of pest reduction in and adjacent to buildings in developed areas, maintenance of boundary fences, and surveys for threatened and endangered species.

Recent developments promise to address some of these shortfalls. The addition of a full-time wildlife biologist to the staff will allow for increased focus on monitoring populations, surveys for threatened and endangered species, better implementation of an integrated pest management program, and increased collaboration with other agencies and researchers. The Park wildlife staff need to become involved with the Interagency Adaptive Management Monitoring and Research Program.

## Program Objectives

Wildlife program objectives are based upon *NPS Management Policies* and include:

- Protect genetic diversity through perpetuating natural evolutionary processes and minimizing human interference
- Reliance on natural processes to control populations of native species to the greatest extent possible
- Restore extirpated native animals wherever possible to their native habitat
- Identify and promote the conservation of all Federally listed endangered, threatened, or candidate species and their critical habitats
- Ensure the preservation of native migratory species in the Park, and work in close cooperation with adjacent land-management entities to insure the preservation of populations and habitats outside the Park
- Control animal populations in development zones when they present a threat to visitor safety and health, and in cultural and development zones when necessary to protect property.

Other guidance can be found in the General Management Plan, which calls for the following required additional studies and surveys for the management of natural resources:

- effects of fire exclusion and prescribed fire on Park wildlife and their representative vegetation communities
- the biology of Federally listed and sensitive species of plants and animals
- the status and trends of nonnative species within the Park
- the impacts that nonnative species have on native species within the Park
- Park wildlife species inventory and assessment
- feasibility studies on reintroducing extirpated wildlife

## Issues

The wildlife monitoring and management program at Grand Canyon should address the following broad categories:

*Threatened, endangered and candidate wildlife species are at risk*

Currently, seven animal species known in the Park on the Federal threatened and endangered species list. Of the six endangered species, data on species status are adequate only for bald eagles, peregrine falcons, and humpback chub. There are approximately 30 other species on various Federal and State species of concern lists found within the Park.

Information on the presence, distribution, and population trends of these species is lacking. Inventories need to be made for these other species to verify whether they reside in the Park, and if so, what their status is. Management objectives listed in the Park's General Management Plan call for the Park to, *preserve and protect the genetic integrity and species composition within the Park, consistent with natural ecosystem processes.*

In cases where threatened or endangered species are affected by visitor use and development, mitigation measures need to be taken, including closures and use restrictions where necessary. Proactive steps should be taken to protect species that are currently in decline and likely to be listed soon.

***Baseline information on certain species populations and interactions, habitats, and ecosystem dynamics is inadequate***

The lack of adequate data and understanding of organisms, communities, habitats, and ecosystems puts native wildlife at risk, and limits the ability of the Park to identify threats. Numerous studies describing species occurrences and distribution of mammals, birds and herpetofauna in the Park have been completed. The life history and habitat requirements are well-documented for the Kaibab squirrel, as well as the humpback chub (through GCES). However, the long-term impacts of dam operations on chub and other native fish are not fully understood. Little is known about the population of bighorn sheep within the Park, and research is needed to better understand how the removal of burros has impacted sheep and how sheep distribution and numbers may be affected by hunting on adjacent lands. Although the Park has an estimated 100 breeding pairs of Peregrine falcons, they are not currently being monitored to track their population or reproduction.

While additional population estimates for selected species are needed, acceptable checklists for Park vertebrates have been established. Invertebrates, however, are poorly known, and require much more basic survey work. Thorough inventories of specialized habitats important to wildlife such as seeps/springs, caves, and migratory stopover points need to be done.

Also lacking, due to the extreme complexity involved, is a good understanding of the dynamics within ecosystems, wildlife habitat relationships, and interactions between wildlife populations. As called for in the management objectives of the General Management Plan, the Park will *manage ecosystems to preserve critical processes and linkages that ensure the preservation of rare, endemic, and specially protected plant and animal species.* A multi-disciplinary approach is needed to address these ecosystem-level processes.

An example of an ecosystem-level management action taken by the Park is the restoration of fire through prescribed-fire activities. While the GMP's management objectives call for the Park to, *to the maximum extent possible, restore altered ecosystems to their natural conditions,* a better understanding of the impacts of such a program on wildlife is needed. More studies are necessary to evaluate how prescribed fire affects sensitive bird and bat populations, and the study results need to be incorporated into the fire program.

*Numerous activities, both inside and outside the Park, put native wildlife at risk*

These include: trespass livestock grazing; hunting; wood gathering and timber harvesting; fire suppression; concessions, commercial and residential developments; water diversion, ground water pumping, and dam operations; pesticide application; visitor-use impacts and facility development; and introduction of alien species. These activities affect wildlife by altering habitat quality and quantity, and the availability of food and water through direct mortality and the pollution of soils and water sources.

The grazing permits that existed for some of the lands added by the Grand Canyon National Park Enlargement Act of 1975 expired in 1985. Roads, trails and scattered stock tanks have been abandoned, and the area is gradually reverting to its previous state. However, grazing stock belonging to members of the Navajo Tribe trespass the Park's southeast corner. Livestock trespass also occurs along the Kanab Plateau boundary on North Rim, with frequent encroachment along the Kaibab Plateau. Livestock trespass is also increasing in the South Rim developed area because of the railroad corridor.

As mentioned in the fish section, Glen Canyon Dam has resulted in the extirpation of three native fish, reduced habitat for the remaining five native fish, and benefited many alien species. The signed record of decision for the Operation of Glen Canyon Dam specifies the flow regime. Decisions on selective water withdrawls to increase temperature still need to be made. These decisions will affect native fish in ways that are not well understood at present.

Many wildlife species migrate in and out of the Park, making them susceptible to hunting and habitat changes that result from timber harvest, residential development, and pesticide application on adjacent lands. This is particularly true of ungulates such as elk and deer and the animals that prey on them, such as coyote and mountain lion. This is also true for the many bird and bat species whose habitats are affected by pesticides and land use in other parts of the United States, Canada and South America.

Fire suppression over a period of 70 years has resulted in denser, more uniform plant communities, reducing habitat diversity and repressing many plants and animal populations. This is especially true in the Park's forested areas, where heavy buildups of dead and down trees are found. This change in plant communities is believed to have altered the fauna composition of the area, and may have contributed to the loss or severe decline of many species.

Ground water pumping outside the Park may disrupt spring flows that many wildlife species depend on. Pollution sources within and outside the Park could be affecting aquatic and terrestrial wildlife. Investigation into this issue has been very limited. A more detailed discussion can be found under the water resource description and issues section.

The Park's nearly five million visitors each year impact wildlife and their habitats. Misperceptions about wildlife lead to inappropriate behavior, most significantly feeding wildlife, with the result that the animals become habituated to visitors and their food. Disturbances to critical habitats that may occur from hiking, camping, and rafting need to be mitigated.

Development encroaches on the Park every day. Inside the Park, this occurs from expansion or construction of visitor facilities, Park infrastructure, and concessions operations. Outside the Park, new residential and commercial developments are proposed just beyond Park boundaries. The habitat fragmentation and degradation that occur from these activities need to be reduced.

*Alien species threaten Park resources, while native species have been extirpated*

Many alien species have been introduced within the Park. Aliens compete with native species for shelter and food, and their presence can result in outright displacement of native species. The routes and vectors of alien species introductions should be identified and closed. A control program needs to be developed to prioritize efforts on the alien species most apt to threaten native species, and determine the situations where success is most likely.

The native species that have been extirpated from the Park include prairie dogs, burrowing owls, condors, wolves, and bears. Assessments should be made to determine under what conditions it makes sense to attempt reintroductions and which species are the best candidates.

*The Park lacks a comprehensive proactive Integrated Pest Management Plan*

IPM problems are handled in a reactive rather than a proactive way. In order to increase staff efficiency and management in a comprehensive way, a management plan for IPM needs to be developed.

## Current Funded Program

Currently, there are 2.0 FTEs assigned with management of Park wildlife. Work involves the following:

- Surveying for threatened, endangered, and candidate wildlife species in areas scheduled for management-ignited prescribed fires
- Addressing integrated pest management problems such as feral pets, skunks, ringtail cats, rodents, beggar deer, etc.
- Participating in interagency monitoring efforts of sensitive species populations such as bald eagles, Southwestern willow flycatchers, bats, spotted owls, and the Kanab ambersnail
- Reviewing various plans and environmental compliance materials to mitigate impacts to wildlife resulting from developments and management practices on adjacent lands (i.e., hunting, trapping, timber harvesting, grazing, pesticide use, mining, etc.)
- Developing grant and research proposals, supervising contracts, reviewing independent research proposals and collecting permits
- Liaison with other Park divisions on wildlife-related matters such as interpretive materials and displays, and law enforcement issues.

## Proposed Unfunded Program

If the many issues and threats to resources at Grand Canyon are to be addressed effectively, the wildlife program needs to be expanded. The Interagency Adaptive Management Monitoring and Research Program includes biological components. If the Park is to play a leadership role in the biological aspects of this program, increased funding will be necessary for wildlife monitoring.

An expanded program would consist of nine primary wildlife program elements. These program elements are implemented at the present time to various degrees, but funding shortfalls prevent full execution. Each proposed wildlife project statement (See Section Two) fits into one of these programs. The proposed program elements include:

- Inventory, Monitor, Manage, and Protect the Park's Fauna
- Inventory, Monitor, Manage, and Protect the Park's Endangered and Declining Fauna
- The Interagency Adaptive Management Monitoring and Research Program
- Promote Research on Species and Ecosystems
- Develop Proactive Integrated Pest Management Program
- Control of Nonnative Species
- Assess Effects of People on Wildlife
- Assess Reintroductions of Native Species
- Expand Data Management and Information Management Program and Capabilities

*Threatened, endangered and candidate wildlife species are at risk*

**Inventory and Document** It is important to determine the current population status of species within the Park. One of the first tasks in resolving this issue is to inventory or survey the Park for all sensitive species, with a primary focus on those that are Federally listed. The first approach will be to perform literature searches on target species to gain a better understanding of their habitat requirements and optimum survey techniques. Then, an inventory over an extensive area will gather presence-absence information for each species. As a follow-up, relative abundance data will be collected were possible. Habitat relationships for target species will be analyzed, and inventories for critical habitats will be made. Accessibility of this information for management purposes will be assured through input of both geo-referenced spatial data and attribute data into the GIS.

**Monitor** Establishment of a long-term population monitoring program for those sensitive species that are most threatened is necessary to ensure their protection. Appropriate monitoring protocols will be developed with realistic goals that will permit detection of population changes and trends at the +/- 20% level.

**Foster Research** Based on monitoring needs and threats to threatened and endangered species, research priorities will be developed. Outside cooperators will be solicited to complete highest priority research. All proposals will be peer-reviewed and selected competitively.

**Develop Management Plan** Effective management is needed to provide direction and organization to overall protection and funding priorities. Appropriate threatened and endangered species protection will be one component of the wildlife monitoring and management plan. Life history requirements for species will be examined to identify particularly sensitive periods where management actions may be needed most. Threats from sources outside Park boundaries will be identified, and interagency and private cooperative management actions developed.

**Mitigate and Protect** Management actions will prevent or lessen impacts. Where threatened and endangered species are impacted by over-visitation, use may be limited or completely prohibited. Input will be solicited on visitor-use patterns and threats, and approaches developed. Close cooperation with outside agencies and organizations for the overall protection of habitat and species on surrounding lands is critical.

**Interpret and Educate** Education programs consisting of slide materials and written notices will be incorporated into the NPS private river guide orientation and the backcountry permit system to reduce visitor use impacts to threatened and endangered species. Information on closures and suggestions on how to minimize impacts will be emphasized. Interpretation also plays an important role and displays will be designed and constructed in the Visitor Center or other appropriate places to get the message across.

**Restore** Information on historical occurrences of extirpated, threatened and endangered species will be researched to pinpoint potential release sites in cases where reintroduction efforts are warranted. When evaluating any reintroduction proposals of extirpated species, attempts will be made to identify causes of original population decline, and assessments made as to whether those causes still exist. In some cases, additional populations of threatened and endangered species may be established in habitats where they are known to have inhabited previously.

*Baseline information on certain species populations and interactions, habitats, and ecosystem dynamics is inadequate*

**Inventory and Document** Information on Park wildlife has been gathered through past surveys, reported observations, and research projects. While checklists exist for vertebrates, the information is outdated for some species and needs to be verified. The invertebrate fauna is still poorly known; Kanab ambersnails were discovered in the Park only in 1991, and have since been listed as an endangered species. Basic inventory and assessment of wildlife species will be done to determine what species currently exist within the Park.

**Monitor** As in the case of threatened and endangered species, appropriate monitoring protocols will be developed with realistic goals that will permit the detection of population changes and trends at the +/- 20% level. Establishment of long-term population monitoring programs will be made for those species which are declining or most at risk from land-use changes outside Park boundaries. Information gathered from monitoring will then be used to assess and mitigate those proposed land-use actions.

**Foster Research** Although checklists are valuable references, they give little insight into the interactions between species and their habitats and important ecosystem level processes. Understanding at this level is a much more complex undertaking and requires multi-disciplinary approaches. This program envisions integrated projects being developed across academic disciplines to address these higher-level topics. Partnerships will be encouraged between the academic and agency research community to develop a long-term, ecosystem-level monitoring program.

**Develop Management Plan** A wildlife management and monitoring plan will be written to outline protocols and priorities for the wildlife program. An assessment will be made as to how much monitoring can be done internally, and how much needs to be contracted. Management strategies will attempt to include greater participation from Resource Protection in areas where it is feasible.

**Mitigate Impacts and Protect** Information on wildlife habitat relationships will be used to identify critical habitats. Where human actions threaten or impact those habitats (such as camping near springs and seeps), protection strategies will be developed and implemented. Where ecosystem-level processes are negatively influenced, (i.e., impacts of dam operations on river ecology or beach dynamics), adaptive management strategies will be adopted and changes made until the desired condition is reached.

**Interpret and Educate** Greater effort will be made to go beyond single-species issues and demonstrate the interactions between animal species and their environment. Ecosystem-level impacts (as they particularly relate to the Grand Canyon) that occur from actions of human society will also be stressed.

*Numerous activities, both inside and outside the Park, put native wildlife at risk*

**Inventory and Document** A simple inventory of external and internal activities that threaten Park wildlife resources is needed to focus attention and efforts on highest priorities. Those activities which the Park has jurisdiction and/or influence over should receive top attention.

**Monitor** Establishment of long-term population monitoring programs will be made for those species which are declining or most at risk from land-use changes outside Park boundaries. Information gathered from monitoring will then be used to assess and mitigate those proposed land-use actions.

**Foster Research** Research will be solicited on specific topics where human impacts to wildlife and their habitats are concentrated.

**Develop Management Plan** Management strategies to mitigate impacts will be developed, evaluated, and where logical, incorporated into the Wildlife Management and Monitoring Plan.

**Mitigate Impacts and Protect** Proposed internal development options will be evaluated and screened to eliminate or reduce negative impacts to wildlife. Suggestions will be made on preferred alternatives to best mitigate wildlife impacts. Relationships will be forged across Park boundaries to work with gateway communities to better plan development activities affecting Park wildlife. Other State and Federal agencies will be contacted early in the public review process if proposed plans for hunts, timber sales, or forest pest/disease programs adversely affect Park wildlife.

**Interpret and Educate** Outreach education plays an especially important role in communicating how human activities influence Park resources. Topics for interpretive talks and displays include development encroachment and associated habitat destruction and fragmentation, relationship between ground water pumping and potential reduced flow of springs/ seeps, and impacts of pesticide application on bird and bats.

**Restore** In some instances, wildlife habitats negatively impacted by human activities will need active restoration efforts. Cooperative efforts between the Science Center and the Maintenance Division will be needed to perform revegetation, trail rerouting, fence repair, etc.

*Alien species threaten Park resources, while native species have been extripated*

**Inventory and Document** Inventories of alien species, their associated habitats, and life histories will be made; as will occur for extirpated native species as well. Historical information will be gathered relating to previous distribution of extirpated species and the causes of extirpation. Genetic similarity between populations will be examined for potential reintroduction sources.

**Monitor** Where possible and logical, alien species populations will be monitored to better identify impacts to native species and focus control efforts. In cases where extirpated native species are being considered for reintroduction, food resources will be monitored and preferred habitats evaluated to gauge whether success is likely.

**Foster Research** Before reintroductions of extirpated species are attempted, thorough research will be conducted to examine genetic factors, assess habitat and food resources, sources of mortality, etc. Experts from academia and public agencies will be contacted to participate in research concerning these and other questions.

**Develop Management Plan** Alien species control efforts will be incorporated into the integrated pest management program addressed in the Wildlife Management and Monitoring Plan.

**Mitigate Impacts and Protect** In cases where funding and personnel levels allow and where success is likely, control measures will reduce alien species populations. New sources of alien species will be identified and controlled.

**Interpret and Educate** Efforts should concentrate on explaining the impact alien species have on native animals and ecosystems, what factors have led to the extirpation of some native species, and how reintroductions of natives can sometimes benefit the situation.

**Restore** Assessments will be made to determine whether it makes sense to attempt reintroductions, under what conditions it would be tried, and which species are the best candidates. Following public input, multi-agency efforts will be launched in those cases where it is determined that reintroductions are prudent to pursue.

*A proactive integrated pest management program is needed to address situations where Park resources and human health are threatened*

**Monitor** It is necessary to monitor the resident population of skunks and ringtail cats in the village area. Evidence suggests that intrusion by these species into structures exists on a seasonal basis. Intrusion by these and other small mammals and invertebrates should be monitored consistently to maintain standards of health and safety within restaurants, hotel operations, residential housing and Park and concession office spaces. Monitoring will also address the issue of feral animals residing in the Park as well as instances where the resource and human health are at risk.

**Develop Management Plan** An Integrated Pest Management Plan that addresses recurring issues will be developed. An assessment will determine what monitoring needs are in relation to intrusion by small mammals, ants, etc., and what can be done in relation to the invertebrate problem. Management strategies will include an increased and consistent level of participation by Park staff.

*Develop Functional Wildlife-related Data Management and Retrieval Capabilities*

**Inventory and Document** A computerized bibliography will be compiled of all wildlife studies that have been conducted on lands in and adjacent to Grand Canyon National Park. Where possible, originals or copies of the reports/publications will also be obtained and forwarded to the Park library. Field data will be archived in either paper or electronic formats for later retrieval.

GIS wildlife data themes will be inventoried, gaps identified, and sources found to fill those gaps. Relatively recent studies that contain geo-referenced data (and all the appropriate GCES program elements) will be incorporated into the Park's GIS.

All Park wildlife studies will be designed so that data are geo-referenced and collected in a way that is easy to input into computer databases. Where logical, data from previous Park wildlife studies will be input into computer. Wildlife observation record forms will be redesigned to allow for easy database entry, and old observation forms will be entered on the computer.

Historical records relating to wildlife will be researched and a chronological account produced of known wildlife management actions taken at Grand Canyon.

**Develop Management Plan** Management of wildlife-related data will be part of the Science Center's integrated data and information management program.

Figure 3-12 shows the NR-MAP FTE allocation required to fully staff a Wildlife Monitoring and Management Program which could address the most compelling issues and mitigate the greatest threats. Only 26% of this proposed staff is currently available.

**Figure 3-12**
NR-MAP FTE allocation required to fully staff a Wildlife Management Program which would address most of the issues and threats described above.

| Wildlife Management | NR-MAP* FTE Allocation | CURRENT FTE** Allocation |
|---|---|---|
| Native Terrestrial Animal Management and Monitoring | 2.71 | 0.75 |
| Native Aquatic Animal Management and Monitoring | 1.47 | 0.00 |
| **Threatened and Endangered Animal Management** | | |
| Federal Threatened and Endangered Species | 1.02 | 0.25 |
| Federal Candidate 1 and 2 Species | 1.13 | 0.25 |
| Other Species Listed by State(s) | 0.34 | 0.00 |
| Reintroduction of Extirpated Animals | 0.0 | 0.00 |
| **Exotic Animal Management** | | |
| Control | 0.0 | 0.00 |
| Monitoring | 0.56 | 0.00 |
| Native Animal Species Population Management (IPM) | 0.45 | 0.75 |
| Bear Management | 0.0 | 0.00 |
| Hunted and Trapped Species Management | 0.0 | 0.00 |
| Subsistence Use Management—Animals | 0.0 | 0.00 |
| Fisheries Management | 0.0 | 0.00 |
| TOTAL | 7.68 | 2.0 |

** Natural Resource Management Assessment*
***Full Time Equivalent*

# Geographic Information System Program

## Program Overview

Grand Canyon National Park has invested time and money into building a successful GIS program. All GIS programs go through growth stages including purchasing, data collection, analysis, and applications. The data collection stage usually consumes 70% to 90% of the time invested into GIS. Although data collection will continue, the program will focus on doing analysis and applications. The investment of years of data gathering is paying off.

GIS technology, like all computer technology is rapidly changing. The work stations are faster and less expensive. Memory is in terms of gigabytes or even terabytes. A five-year-old computer is considered out-of-date. Inter-operability of software programs and operating systems is making data easier to exchange. Inter-connectivity by networks and the Internet makes data transfer and data searches possible with researchers all over the globe.

The GIS program resides at the Colorado Plateau Research Station in Flagstaff, Arizona. This allows access to the Internet, a large-scale color plotter, color printers, a network (more powerful work stations, PCS, and Macs), 18 gigabytes of shared memory, shared statewide databases, and graduate students doing Grand Canyon GIS projects. This cooperative effort shares data, hardware, software, expertise, and training objectives. In these times of budget cutting, this is an alternative for a functional and successful GIS program.

## Program Objectives

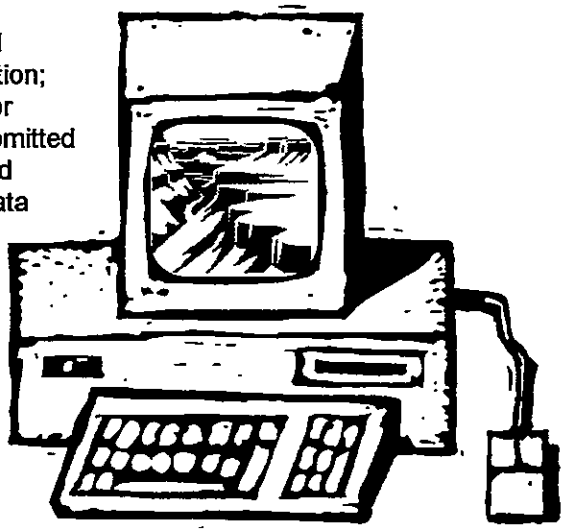
The GIS program at Grand Canyon is a service-oriented program. Project statements are written by other program managers which include GIS data collection, analysis, and applications. All the branches within the Science Center currently use the GIS specialist for database design, global positioning system (GPS), database conversion, new theme development, modeling, analysis, and ArcView applications. The eventual goal is to have a Parkwide GIS program so all managers can use GIS to make informed decisions.

## Current Funded Program

Currently, there is 1.0 FTE assigned to the GIS program. Examples of projects include the following:

*Grand Canyon Science Center*

**Database Development/Data Archive**
Acquire and archive on CD media spatial information, databases, digital photographic collections, and digital audio information. This information will be collected from various agencies and research groups. Examples: GCES GIS databases; USGS Hereford's geology (eight areas available); NAU Geography Department sandbar monitoring photo CDs; USFWS databases; USFS Biological Resource Division biological databases and GIS information; and base GIS information for Arizona. All final reports submitted to the Science Center should include digital forms of all data associated with the project (reports, databases, spreadsheets, GIS databases, metadata).



A project CD should be pressed with all this data and the software associated with the data. The idea is that a researcher could use the data 10, 20, 50, or 100 years from now.

**Base data assessment, collection, documentation, and availability** The data themes need to be assessed for accuracy and completeness. New data themes need to be digitized or entered through GPS. Metadata needs to be created for all Park data. And the base data needs to be provided to all researchers through Internet access.

**Provide ArcView training for Park staff** This would enable Park staff to effectively use ArcView to develop their own databases and do their own GIS analysis.

**Provide technical assistance for database development which is GIS compatible for Science Center Staff** Current projects include: cultural resource databases and wildlife observations databases which can be used with Arc/Info or ArcView to make point coverages.

*Natural Resource Management*

**GIS analysis of wildlife observations** The Wildlife Biologist is creating several wildlife observation databases. GIS analysis will include spatial distributions and species associations to physical habitat (example: slope, elevation, aspect, distance from water, vegetation, etc.). Modeling of threatened and endangered species habitat will be performed. Maps and reports will be provided to the Biologist for distribution, habitat, and ecosystem research.

**GIS analysis of mining sites within watersheds of the Grand Canyon** Provide hydrologic analysis for what-if scenarios of various mining sites. Example: tailing pile leaching or settling pond failure (which streams and tributaries are/would be effected, tie this to water quality monitoring). This will provide maps and reports to the Hydrologist for water quality monitoring and emergency preparation.

*Cultural Resource Management*

**Support the Archeologist stabilization projects along the River corridor** This work includes surface and hydrologic analysis and check dam location mapping.

**GIS analysis of cultural distributions** Use existing cultural databases to show spatial distribution of prehistoric cultures, ceramic types, time periods, and possible cultural landscapes.

**Support Archeologists in scanning and editing site maps** The site maps will be hot-linked to the geographic location of each site in ArcView. When one selects a site, the associated detailed map will appear in a separate window. This will be an interactive tool for viewing, editing and geo-referencing existing site maps.

**Create a historical landscape GIS database** Collect existing databases of historical places, historical landmarks, natural landmarks and historic American building survey, and relate these databases to AutoCAD drawings of the village.

*Sociological Applications*

**Aircraft acoustical modeling** Support aircraft noise management program through modeling of aircraft noise, GIS plots, and data analysis.

**Create a river-running usage application in ArcView** This application will take existing dBASE river running scheduling databases and spatially reference the data by river mile, reach, and/or camping area. The spatial distribution of conflicting trips or bottlenecks could be analyzed for better trip scheduling.

**Create a backcountry use application in ArcView** This application will take existing dBASE backcountry databases and spatially reference the data by use-areas. This is a pilot project to determine usefulness of backcountry databases for spatial analysis. Possible applications could include use density, archeological site protection, impact analysis by buffering trails and camping areas, and/or social profile of user type.

## Proposed Unfunded Program

An expanded Parkwide program would consist of four additional program elements. These program elements may be implemented in the future to various degrees, but funding shortfalls prevent full execution. The proposed program elements include: Maintenance facility management, Interpretive applications, Law enforcement applications, and Fire management and modeling. This last program is the only one currently underway.

### *Fire Management and Modeling*

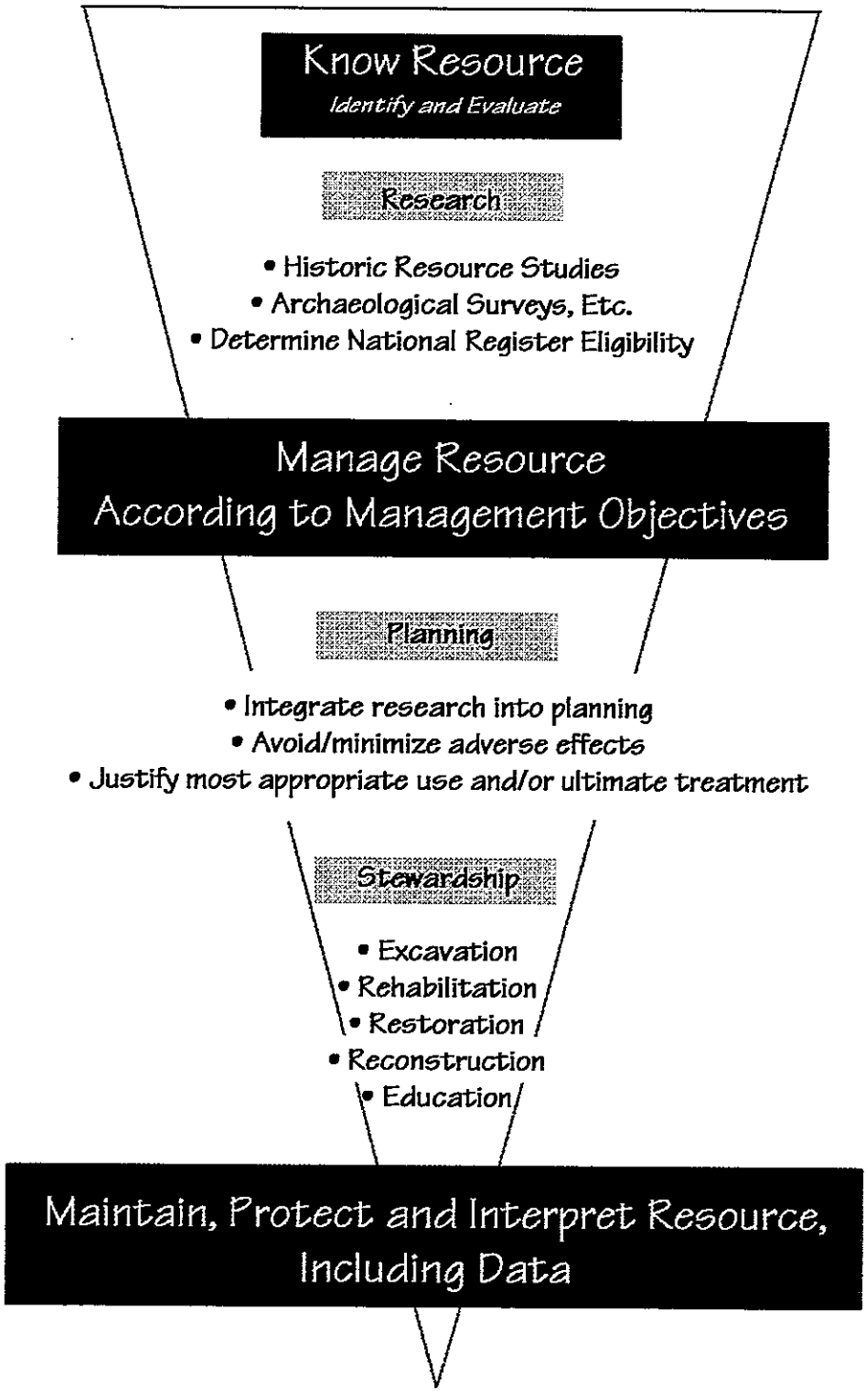
**Data needs** Fire history, fuel loads, tree-crown closure, slope, elevation, aspect, weather, and wind data. Fuel loads could be derived from our 1982 vegetation coverage, fire management's study areas database, and some ground truthing. The canopy cover could be created with supervised classification of thematic mapper (TM) or SPOT imagery. Image processing capabilities will be acquired. All of these datasets would be combined to form a landscape dataset.

**Applications** Install "Farsite" and develop necessary databases needed by the program. The program will provide Park Fire Management Staff with a software program capable of predicting rate of fire spread, fire intensities, time of arrival, heat per unit area, and flame length. This model goes beyond inventorying and monitoring. It allows the fire specialist to predict and test sensitivity of the model with various environmental conditions.

ArcView software has been set up to provide fire management staff a GIS tool for analysis of fire history, vegetation, fuels, roads, management zones, etc. Fire data from other government agencies adjoining Grand Canyon could also be used in this system.

## Cultural Resource Management Program

*The Cultural Resource Management Program follows a simple and logical process.*



## Program Overview

This function is devoted to the overall management of the basic programming requirements, maintenance, ongoing project needs, and oversight of activities within cultural resource management. Base professional staff needs are key components necessary for legal requirement administration of cultural resource management.

Established professional standards, as dictated by the Secretary of the Interior's *Standards for Archaeology and Historic Preservation*, are met at this time only by the program manager and archaeological staff. Technical evaluation and documentation for Sections 106 and 110 of the National Historic Preservation Act are conducted by the archaeological staff for projects related to archaeological resources and ground-disturbing activities. Compliance coordination for projects related to historic structures is done by the Compliance Officer. The Park Curator manages the Museum Collection program. Tribal consultation required by NHPA, NEPA, NAGPRA and NPS policies is conducted by the Cultural Resource Program Manager.

These program responsibilities are divided among various work units, with the majority carried out by the Cultural Resource Management Program. The Division of Maintenance and Engineering is also involved in the cultural resource due to the many historic structures used by Park staff, and the many landscapes which represent most Park administrative areas.

## Program Objectives

The primary objective of Grand Canyon's Cultural Resource Management Program is to meet the basic requirements as outlined in NPS-28, the *Cultural Resource Management Guideline*, to ensure that cultural resources in the Park are identified, properly managed and preserved. This is done through a systematic program of *research, planning,* and *stewardship.*

The Cultural Resource Management Program coordinates the various aspects of related cultural resource management for full integration. Addition of professional staff to be responsive to Park management needs is key to the Program's success. Development of interagency and intertribal agreements will foster working relationships outside our traditional boundaries and onto the Colorado Plateau areas where they are most useful.

Cultural resource management is mandated by law and policy. Major historic preservation laws include the Historic Sites Act of 1935, the National Historic Preservation Act of 1966 (as amended 1992), the National Environmental Policy Act of 1969, the Archaeological and Historic Preservation Act of 1974, and the Archaeological Resources Protection Act of 1979 (ARPA) (as amended 1988). Of particular importance are additional documents such as specific NPS regulations, *NPS Management Policies*, the Antiquities Act (1906), and the Native American Graves Protection and Repatriation Act of 1990. Additional legal framework for curation include the Museum Properties Management Act of 1955, 43 *Code of Federal Regulations* (CFR) Part 79 "Curation of Federally Owned and Administered Archaeological Collections," and 36 *CFR* Section 2.5 "Research Specimens."

Application of these laws, regulations and policies for cultural resource management at Grand Canyon is based upon the guidelines established in *Cultural Resource Management Guidelines*, NPS-28. These guidelines outline three principal areas:

- *Research*, to identify, evaluate, and establish basic information about cultural resources
- *Planning*, to ensure that this information is well integrated into management processes for making decisions and setting priorities
- *Stewardship*, under which planning decisions are carried out and resources are preserved, protected, and interpreted to the public.

## Issues

The following issues most pertinent to this program:

### *Lack of staff and expertise puts cultural resources at risk*

The lack of professional staff positions, such as a Historical Architect, Historical Landscape Architect, Historian, and Ethnographer, hampers program development. In some cases, Federal law, compliance agreements and *NPS Management Policies* are violated due to lack of professional staff expertise. Additionally, outside research cannot be directed or administered in any consistent fashion to meet Park purposes and values given the lack of professional staff to create and direct programs. Current staff can address coordination of historic preservation *compliance*, curation, tribal consultation and archaeological issues, but lack professional status for the other required cultural resource programs. The greatest need is in the area of historic structures preservation.

Research and planning required for current Park plans, proposals and operations are nonexistent due to lack of expertise.

### *Lack of interaction with Park neighbors puts cultural resources at risk*

Effective cultural resource management in Northern Arizona and on the Colorado Plateau requires interaction with adjacent land managers, universities and Indian tribes. Interactive relationships must be maintained with various neighboring land managers, and regional and State academic institutions.

Similarly, effective government-to-government relationships with eight separate American Indian tribes must be maintained. Continuance of this relationship requires professional staff and commitment. Tribal relationships are maintained by the Cultural Resource Manager as a Cultural Resource Management Program component. While the liaison is positive and active, the program is primarily project driven. The maintaining of tribal relations is required by several laws and *NPS Management Policies*. A Havasupai relationship is specifically required by the 1975 Enlargement Act.

### *Lack of knowledge of cultural resources puts them at risk*

For most Park resources, no inventory is available to provide managers necessary information concerning basic resource condition. Without basic information, resource status affecting management decisions cannot be determined. Ongoing degradation and cultural resource value loss continues due to a lack of comprehensive preservation programs to evaluate conditions and provide preservation treatments.

*Increased visitation threatens cultural resources*

Increasing visitation is one of the greatest threats to cultural resources throughout the country, but especially on the Colorado Plateau. Visitors are interested in the archaeological and contemporary American Indian heritage. Without appropriate inventories and research programs, the increased visitation threatens the very resource we are charged with preserving, protecting and interpreting

## Current Funded Program

The Cultural Resource Management Program at Grand Canyon National Park is coordinated within the Science Center, with some program implementation conducted by the Division of Maintenance, and compliance coordinated through Park Management. The program includes the following areas: Archaeology, Ethnography, Museum Collection, Cultural Landscapes, Historic Structures, and Historic Resource Studies. These areas are not necessarily limited to the Park boundaries, although with the limited staff, Colorado Plateau-wide studies are nearly impossible.

The Cultural Resource Program Manager coordinates archaeology, NHPA Section 110 and 106 compliance, NAGPRA, and American Indian liaison. One permanent archaeologist assists with these duties. Transition of program responsibilities for historic preservation and historic resource studies is currently underway, with the program moving from the Compliance Officer to the Cultural Resource Program Manager. The museum collection is supervised by the Curator with two permanent curatorial technicians. Historic preservation, archaeology, consultation and curation are in the Science Center. Compliance issues for both NHPA and NEPA are coordinated by the Compliance Officer.

Actual maintenance of historic buildings and structures is achieved through the Division of Maintenance under the Buildings and Utility Foreman for day labor and contracted preservation projects. A limited amount of cultural landscape inventory and analysis has been conducted by the Park landscape architect.

Monitoring and research related to Glen Canyon Dam operations are conducted at a Grand Canyon office located at Northern Arizona University, in Flagstaff, Arizona. This office implements the long-term monitoring and remedial action program for archaeological resources in the Colorado River corridor as part of the compliance required by Section 106 of NHPA. Aside from monitoring physical archaeology and geomorphological areas, the river corridor project addresses American Indian concerns by providing field experience to tribal representatives during scheduled monitoring trips. There are two term employees stationed at this office, and two full-time and one half-time university employees dedicated to the project.

*The Past Five Years*

Although Cultural Resource Management had been split between the Divisions of Maintenance, Professional Services, and Resource Management, the past five years has seen considerable activity and consolidation within the Park. Some of these accomplishments are noteworthy as they relate to some precedent-setting projects within the entire NPS system.

**Glen Canyon Dam Environmental Studies** On July 27, 1989, the Secretary of the Interior directed the Bureau of Reclamation to prepare an EIS on Glen Canyon Dam operations. Since then, Science Center staff (mainly through the archaeological and consultation programs) have spent a great deal of time and emphasis on this issue, representing the NPS in all meetings, reviews, studies, and American Indian concerns.

The Cultural Resource Program Manager has been the lead for all compliance-related activities for Sections 106 and 110 of NHPA, initiated and coordinated all tribal consultations, developed interdisciplinary research with the U.S. Geological Survey (USGS), prepared mitigation measures with tribal partners, and coordinated and prepared the Cultural Resource sections and analyses for the Operations of Glen Canyon Dam EIS.

**Adjacent Lands and Boundary Issues** Numerous pieces of legislation exist establishing the boundaries for Grand Canyon National Park and the Hualapai and Navajo Indian reservations. The legal descriptions conflict, and resolution has not been reached, although Department of the Interior Solicitor's opinions have been issued for each. Appropriate uses which promote the preservation of Grand Canyon's resource values within these boundary-disputed areas are in conflict. The Cultural Resource Program Manager has been involved in discussions, both interagency and tribal, related to adjacent land activities such as grazing and subsistence use.

**Recreational Impacts** The Cultural Resource staff has been involved in providing compliance and direction to trail and campsite restoration projects around archaeological sites. Many river trips, both private and commercial, take people to various archaeological sites, sometimes damaging and degrading the resource. An inherent conflict exists in backcountry areas given that preferred camping locations today were also preferred 100 and 1000 years ago. Most modern campsites are located on or near archaeological sites, and all hiking trails except the South Kaibab and River trails follow prehistoric routes.

**Curatorial** Grand Canyon's Museum Collection houses more than 250,000 artifacts including archaeological, fine arts, historical, archival, ethnological, as well as biological, geological, and paleontological. There are 17,000 photographic images alone in the collection. Current storage is not in a fireproof, secure or environmentally controlled facility, and thus the collection's very existence is threatened. The construction of a new facility has begun, with implementation in a piecemeal fashion as funding is available. Collection computerization is progressing with approximately half entered into the Automated National Catalog System (ANCS).

**Historic Structures** Grand Canyon contains a significant number of historic buildings and structures. A total of 884 buildings and structures appear on the List of Classified structures. The Park contains 124 National Historic Landmarks within four established districts. In addition, 336 buildings and structures are listed on the National Register of Historic places. Determination of eligibility was made for an additional 44 buildings and structures, and National Register nominations are pending for two additional districts.

**Cultural Landscapes** A Cultural Landscape Report was developed for the historic housing area on the South Rim in response to the urgent lead-abatement program. Some research and analysis has been developed for the South Rim's Grand Canyon Village in response to the current GMP. A Cultural Landscape Inventory was conducted for Phantom Ranch in response to vegetation management issues. The Historic Village District has been included within a thematic nomination for landscape architecture.

**Compliance** Compliance (mostly archaeological) documents related to Section 106 of NHPA have been prepared under the 1990 Servicewide Programmatic Memorandum of Agreement between the NPS and the State Historic Preservation Officers for "No Effect" projects for 145 separate projects in 1995. Grand Canyon has completed more clearance reports than any other park in the former Western Region, outnumbering both Yosemite National Park (total 98 reports) and Golden Gate National Recreation Area (88 reports) over the last five years. In addition to the "No Effect" reports, a Programmatic Agreement has been developed by the Cultural Resource Program Manager in coordination with the Bureau of Reclamation, State Historic Preservation Officer, Advisory Council on Historic Preservation, and eight separate American Indian tribes for the operations of Glen Canyon Dam.

Compliance funds were secured for the first time in Fiscal Year (FY) 94 from FIREPRO to augment ONPS dollars used for compliance surveys and documentation required as part of the prescribed burn program. Funding from FIREPRO has continued in FY95 and FY96.

**Consultation** In the past five years, there has been a resurgence in the Indian consultation/liaison program in response to the Glen Canyon Dam EIS, the GMP, NAGPRA, and the amendments to NHPA. Active consultation and communication is maintained with eight separate Indian tribes. Tribal representatives have been involved in the Interpretive Prospectus, GMP planning issues, and a variety of issues related to resource management and preservation related to Glen Canyon Dam. NAGPRA agreements are currently being developed with all of the Tribes.

**Archaeological** The archaeological program continues to grow through a combination of programs related to compliance surveys, Glen Canyon Dam operations, and research efforts. Active archaeological work is accomplished through the various survey projects, monitoring programs (rim, river and backcountry), and research conducted both internally and externally. An *Archaeological Overview and Assessment* was completed under contract in 1992, and Grand Canyon contributed to the Western Region Systemwide Archaeological Inventory Program (SAIP) report.

**Ethnographic** Although Grand Canyon does not have an ethnographer, progress has been made by using ethnographic work conducted through the Glen Canyon Environmental Studies as a component of the EIS on Glen Canyon Dam operations. In addition, a cultural affiliation study was conducted under cooperative agreement in FY95 related to NAGPRA considerations. Grand Canyon also participated as a test park for NAGPRA collection videotaping. An ethnographic overview and assessment, and ethnographic studies related to the GMP is hoped for within the next five years.

**Resource Protection** Resource protection for cultural resources is accomplished through the Division of Visitor and Resource Protection through patrols and site monitoring. Both rim and inner canyon districts have allowed personnel to conduct ARPA-related patrols to monitor site condition in coordination with the archaeologists. Central-office funds have been allotted ($5000) per year for the last few years to augment ONPS funds. Remote cameras have been installed to monitor activity, and fixed-wing overflights of the Kanab Plateau have been conducted in the past to aid in ground patrols.

**Interpretation** The Division of Visitor Services and Interpretation has the primary responsibility for providing a comprehensive educational program for visitors, including the interpretation of cultural resources. Current cultural resource management issues and concerns are transmitted routinely by management, Science Center and interpretation staff so that the Division of Interpretation can provide more focus to those topics considered top priority. Recent publications such as *Canyon Currents*, and *House Rules for Visiting Archaeological Sites* are important products of this program. The Division of Visitor Services and Interpretation is also professionalizing a number of positions that will work more closely with the Science Center. These positions will specialize and become experts in the major Park resources. By helping to provide an understanding and appreciation of cultural resources, the Division of Interpretation can help protect these resources for future generation's enjoyment.

**Concessions Management** The role of the Division of Concessions Management with cultural resource management takes two primary forms: tribal concerns and historic structures. Park concessionaires interact with NPS management over the appropriateness of Indian arts sales. This is done through coordination of Concessions and Science Center staff with the respective tribes. Historic structures preservation and maintenance involves primarily Maintenance and Science Center review, with Concessions Management serving as liaison.

## Proposed Unfunded Program

According to *NPS Management Policies*, *The NPS will conduct a coordinated program of basic and applied research to support planning for and management of park cultural resources.*

Within the research program, the overall management and research administration program should provide the direction for the research and management of the various cultural resources components. This includes establishment of professional positions to design and implement the necessary research to meet basic inventory requirements.

Effective cultural resource management serves to integrate cultural resource concerns into other Park planning and management processes; provide professional staff for appropriate design and integration of information to minimize adverse resource effects; and identify the most appropriate research and methodology for implementation. Planning should ensure that all compliance is carried out, and all consultation is taken into account in decision-making.

*NPS Management Policies* requires that *pending planning decisions, all cultural resources will be protected and preserved in their existing conditions.* In reaching decisions about resource treatment, preservation should always receive first consideration. Excavation, rehabilitation, restoration, and reconstruction may serve legitimate management purposes, but these treatments cannot add to, and will likely subtract from, the finite material and data sources remaining from the past (NPS-28).

The following pages present a more detailed description of the proposed cultural resource program for Grand Canyon, outlining a logical thought process for a suitable program for each area.

| Cultural Resource Management | CR-MAP* FTE Allocation | CURRENT FTE** Allocation |
|---|---|---|
| Archaeological Inventory, Research and Management | 14.48 | 0.8 |
| Cultural Landscape Inventory and Treatment | 3.8 | 0.5 |
| Historic Structure Inventory, Research and Treatment | 3.99 | 0.3 |
| Ethnographic Resource and Research | 2.4 | 0.3 |
| Museum Collection Documentation, Preservation and Use | 8.1 | 4.0 |
| Cultural Resource Library | 0.8 | 0.3 |
| Cultural Studies and Reports | 1.17 | 0.3 |
| Historic Preservation Compliance | 1.25 | 1.5 |
| External Assistance | 0.3 | 0.0 |
| Coordination with Natural Resource | 0.33 | 0.1 |
| Special Monitoring and Preservation | 0.99 | 2.2 |
| GIS/Data Management | 1.4 | 0.0 |
| Cultural Issues Interpretation | 1.2 | 0.7 |
| TOTAL | 40.21 | 11.0 |

**Figure 3-13**
*The CR-MAP FTE allocation required to fully staff a Cultural Resource Management Program which would address most of the issues and threats described above.*

** Cultural Resource Management Assessment*
***FTE—Full Time Equivalent*

# Archaeological Resource Management

## Program Overview

Archaeological resources are defined as those physical remains that provide the basis for understanding and interpreting prehistory and history. They include prehistoric and historic period sites and materials found in the museum collection.

At Grand Canyon, the past is represented by over 3500 known archaeological sites, dating from as early as 10,000 years ago to as recent as 50 years ago. With approximately two percent of Park lands systematically surveyed for archaeological remains, it is estimated that resources may total over 50,000 archaeological sites.

Grand Canyon's archaeological resources encompass a wide variety of cultural remains indicating use of the Canyon by people over the last 10,000 years. A single fragment of a Paleo-Indian projectile point suggests limited use by big-game hunters at the end of the Pleistocene nearly 10,000 years ago. Archaic hunter-gatherers left small, split-twig figurines in caves in the Redwall Limestone nearly 4000 years ago. Small campsites, projectile points and rock art provide further evidence of the Archaic tradition at Grand Canyon.

People moved in and out of Grand Canyon leaving behind evidence of their lives. Thousands of dwellings, shelters, and agricultural terraces have been located, providing evidence of ancestral Pueblo farmers living on both rims and in the inner canyon. Pottery, chipped stone, ground stone, and other artifacts remain to help tell the story of these people and their passing between 800 and 1200 years ago.

Other people lived here too, people known as the Cohonina. While they did not build the same types of dwellings as their neighbors, they, too, left remains of their houses, abandoned some 800 years ago. Cerbat peoples moved into the Canyon 600 years ago, occupying areas today used by their descendants, the Hualapai and Havasupai.

The Havasupai, Hopi, Hualapai, Zuni, Southern Paiute and Navajo all left remains that have become part of the archaeological record. These same people continue to use the Canyon today for traditional and religious reasons.

In addition to the prehistoric and historic Native American archaeological legacy, Euro-American history, from the time of contact in 1540 through development of the NPS, is represented in the archaeological record. The majority of the historic archaeological record comprises evidence of early exploration (for example, John Wesley Powell and Robert Brewster Stanton), exploitation (early mining sites from Ralph Cameron, Pete Berry, William Wallace Bass, and John Hance), and tourism (Grand View and Buggeln Hotel sites, Hance Ranch, and Bass Camp).

## Program Objectives

The management of archaeological resources is mandated by law and policy. Of particular importance to archaeological resource management are specific Federal laws and regulations, *NPS Management Policies*, the Antiquities Act of 1906, the National Historic Preservation Act of 1966 (as amended 1992), the Archaeological and Historic Preservation Act of 1974, the Archaeological Resources Protection Act of 1979 (as amended 1988), and the Native American Graves Protection and Repatriation Act of 1990.

According to *NPS Management Policies*, *The NPS will conduct a coordinated program of basic and applied research to support planning for and management of park cultural resources* (NPS-28, 1993:21).

The primary objective of Grand Canyon's archaeological resource management program is to meet the basic requirements as outlined in NPS-28 to ensure that Grand Canyon's archaeological resources are identified and preserved. This is done through a systematic program of *research* (inventory, evaluation, professional documentation, registration), *planning*, and *stewardship* (monitoring, protection, treatment, and interpretation).

*Research*

Identification and evaluation of archaeological resources is essential to informed decision-making for Park maintenance, visitor services and development. The National Register of Historic Places criteria for evaluating historic and prehistoric properties are fundamental to this process. Without basic inventory data on resources, Park planning processes cannot provide for their protection. Research must meet the Secretary of the Interior's *Standards for Archaeology and Historic Preservation*.

**Resource Identification, Evaluation, and Registration** Section 110 of NHPA requires park managers, in consultation with the SHPO, to establish programs to locate, inventory, and nominate to the National Register all properties that appear to qualify. Research begins by locating and evaluating cultural resources. Research should be driven by management concerns.

**Documentation in Servicewide Inventories** All archaeological resources must be entered into the appropriate servicewide inventories, primarily the Cultural Sites Inventory (CSI) and Archaeological Sites Management Information System (ASMIS). All field data must be maintained and catalogued through ANCS, ASMIS and CSI. Base maps must be maintained and updated for all projects showing the location and distribution of Park archaeological resources and the nature and extent of archaeological identification studies. Archaeological site information is provided to the State Historic Preservation Officer, as appropriate. All sites are evaluated using National Register criteria, and are nominated to the Register if they appear eligible.

**Reports** Reports are prepared to meet planning and management needs and professional standards are met. Research results are disseminated for use in the archaeological resource interpretation. Reports are accurate, up-to-date, relevant to Park themes, and consistent with resource preservation.

Research information confidentiality is maintained as identified in both ARPA and NHPA, which authorize withholding from the public information about the location and nature of archaeological resources within national parks to protect them from vandalism, looting, and commercial exploitation.

*Planning*

Effective archaeological resource management serves to integrate archaeological resource concerns into other Park planning and management processes; avoid or minimize adverse effects on archaeological resources; identify the most appropriate uses for archaeological resources; and determine their ultimate treatment (preservation, stabilization, rehabilitation, or restoration). Planning should insure that all compliance is carried out, and all consultation is taken into account in decision-making.

*Stewardship*

*NPS Management Policies* requires that *pending planning decisions, all cultural resources will be protected and preserved in their existing conditions.* In reaching decisions about resource treatment, preservation should always receive first consideration. Excavation, rehabilitation, restoration, and reconstruction may serve legitimate management purposes, but these treatments cannot add to, and will likely subtract from, the finite material and data sources remaining from the past (NPS-28).

*Archaeological resources are preserved and protected by eliminating and avoiding natural and human impacts, stabilizing sites and structures, monitoring conditions, complying with and enforcing protective laws and regulations, and other means as appropriate* (NPS-28, 1993:94).

## Issues

The major issues and threats facing archaeological resources in Grand Canyon include:

*Lack of baseline data puts archaeological resources at risk*

Without knowing where these resources are and what condition they are in, it is impossible to develop a mechanism for insuring their preservation. Increasing development and the preparation (and implementation) of Park projects will have an effect on archaeological resources. Full integration of resource concerns should be included in the planning for these programs.

*Internal and external influences are impacting archaeological resources*

Degradation from natural processes and increased visitation is affecting archaeological resources. Increasing visitation, especially in the backcountry, exposes archaeological sites to higher rates of general degradation and vandalism. Higher visitation and the lack of baseline data and site condition monitoring brings the potential of increased danger due to hazards at some archaeological and historic sites. These sites, primarily abandoned mines and cowboy camps, contain hazardous materials such as explosives which pose a threat to public and staff health and safety. There is a need to conduct long-term monitoring and remedial-action programs related to the operations of Glen Canyon Dam.

*The lack of a comprehensive archaeological resource management program puts these resources at risk*

Recent changes in legislation have increased Park legal responsibilities for both preservation and consultation related to cultural resources. In particular, changes in NHPA and ARPA, and the implementation of Native American Graves Protection and Repatriation Act require expanded response from Park staff. These basic issues are core to Federal responsibilities under the National Historic Preservation Act, Sections 106 and 110, and the Archaeological Resources Protection Act. This issue is directly tied to proper planning and compliance for comprehensive Park planning.

*The lack of a regional approach in managing archaeological resources puts them at risk*

Grand Canyon's archaeological resources cannot be viewed in isolation from the remainder of the Colorado Plateau. The archaeological record adds much to the Park's understanding of the human role in the changing ecosystem. This must be viewed as part of the larger ecosystem of the Plateau, and Grand Canyon data is an important component.

*Without an expanded interpretive role in preserving archaeological resources, these resources remain at risk*

Until the public is ashamed to privately and publicly display authentic artifacts, there will always be a demand for vandalism and theft. Visitors are uneducated as to how they should approach an archaeological site when encountered in both front and backcountry. Education is the most powerful tool known in protecting this resource. There is an increasing demand to meet public desire for interpretation of the archaeological record, and access to sites.

## Current Funded Program

The current archaeological resource management program is coordinated by the Cultural Resource Program Manager and one permanent staff archaeologist. These two positions, totalling 2.0 FTE, attempt to insure that Grand Canyon's archaeological resources are preserved and maintained for the future. An additional base FTE (0.9) is used for a term archaeologist. The majority of the program is focussed on compliance with Section 106 of the National Historic Preservation Act and compliance related to the National Environmental Policy Act. Virtually all inventory surveys conducted are the result of compliance generated actions. Research is ancillary to compliance projects, although staff periodically coordinates short, research-oriented classes conducted through universities, volunteer programs, or extended education.

Additional FTE are currently dedicated to various compliance projects. Two full-time term employees are dedicated to the NHPA compliance requirements related to Glen Canyon Dam operations. Other temporary positions are used on an as-needed basis, depending upon project needs for compliance related to in-Park construction and prescribed fire.

Because of the nature of compliance-generated work, base inventory surveys have not been accomplished. The Park inventory represents an approximate two percent ground survey. There is no coordinated research design under which the surveys are completed. Survey design is generic, related to sample surveys for prescribed fire and complete inventories for construction projects. No funds have been provided for any noncompliance inventory.

Monitoring of archaeological sites along the rims and in the backcountry has been intermittent. Some coordination occurs with Visitor and Resource Protection personnel. Active, albeit limited, ARPA patrols are occurring in many districts. Non-ARPA monitoring is done along the primary canyon trails in conjunction with natural resource monitoring.

Site monitoring along the Colorado River has occurred regularly since 1978. Annual monitoring trips occur every October in conjunction with natural resource monitoring to evaluate visitor and natural impacts, recommend remedial actions, and to prepare necessary documentation. Additional site monitoring along the river is accomplished through the Programmatic Agreement on the effects of Glen Canyon Dam operations.

Cyclic maintenance of masonry ruins is inactive due to a lack of funds. Maintenance of the major interpretive ruins, Tusayan and Walhalla Glades, is done with volunteer help from other divisions.

Databases are maintained as a component of any field work. However, the computer database is incomplete, and considerable work needs to be done to rectify 60 years worth of paper records and maps.

Interpretive information and educational materials are provided by existing staff for both internal and external consumption. Displays are prepared, presentations made, and brochures created as requested by the Division of Interpretation, Grand Canyon Association, other Park staff, and other agencies.

## Proposed Unfunded Program

The Archaeological Resource Management Program is designed to address resource threats, and to comply with legal responsibilities to preserve these resources for the future. Goals for the program include:

### *Ensure Baseline Data Collection*

It is essential that archaeological inventories be completed to understand resource complexity, and to make appropriate management decisions that affect those resources. To correct this deficiency, the completion of baseline inventories is necessary to establish the database and provide evaluation of resource conditions.

### *Minimize Archaeological Site Degradation*

Archaeological resources are continuously threatened by both natural processes and increased visitation. By allowing this degradation to continue, the Park is in violation of Section 110 of NHPA and ARPA. Mitigation plans (including site stabilization and use plans) must be developed and implemented to insure resource preservation.

### *Provide Direction and Oversight for the Park's Increasing Legal Responsibilities for both Internal and External Programs*

Legislation, amendments to legislation, regulations, guidelines, and *NPS Management Policies* all require the inventory and preservation of archaeological resources. This body of law and policy has expanded, and continues to increase the need for Park planning and compliance documentation and implementation.

*Develop a Colorado Plateau Ecosystem Approach to Archaeological Resource Management*

The cultures of the Colorado Plateau do not exist in isolation. Administrative boundaries are arbitrary, and understanding the human role in the changing ecosystem is critical to understanding the system itself. Archaeology provides time perspective, and can shed light on many natural resource issues. These resources must be viewed as part of the larger Colorado Plateau ecosystem. The data from Grand Canyon is an important component. An Ecosystem Management approach needs to include:

- Establishment of partnerships which focus on new roles for Park neighbors (Plateau communities, agencies, Tribes)

- Increase the Park's understanding of the human role in changing ecosystems. This involves a greater understanding of the role of technological and cultural knowledge systems in adapting to an ever-changing ecosystem. Archaeology provides time perspective needed to understand change in many ecosystem components.

*Provide Interpretation of Archaeological Site Resources and Values*

Interest by the public in archaeology and contemporary American Indian issues has seen a dramatic increase. There is a need to expand interpretation to incorporate these issues with an emphasis on resource preservation. One of the most effective means of preservation is education through interpretation. Each time an archaeological site is recorded, the ability to interpret the past to the visitor is greatly improved. The public wants to know, and the Park's understanding of the resources is critical to that exchange of knowledge.

# Cultural Landscape Management

## Program Overview

The Grand Canyon Village Historic District is one of the earliest, most ambitious and most significant examples of 1920s American Town Planning which retains integrity. This cultural landscape has been included in a thematic nomination of NPS landscape architecture for National Historic Landmark designation.

Like historic buildings and districts, cultural landscapes reveal aspects of our country's origins and development through their form, features and the ways they were used. These special places also reveal much about our evolving relationship with the natural world.

A cultural landscape is defined, as *a geographical area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with an historic event, activity, or person or exhibiting other cultural or aesthetic values.* (NPS-28). In the broadest sense, a cultural landscape reflects human adaptation and use of natural resources.

This is often evident in the land's division and organization, the presence of both natural and cultural biotic features, the systems of circulation that allow movement, and the types of structures that are built. Cultural landscape character is defined by physical material, use, and function. Individual features, such as roads, buildings, walls, and vegetation are material components that, taken together, create the whole landscape. Patterns of use and function reflect cultural values and traditions. Specifically, Grand Canyon's program for managing cultural landscapes includes only those landscapes associated with historic structures and districts within existing developed areas.

These are the resources most subject to visitor use, impact and change:

*South Rim*

Grand Canyon Village Historic District
Rim Trail
East Rim Drive and Overlooks
West Rim Drive and Overlooks
Yavapai Point Museum
Indian Watchtower at Desert View
Hermits Rest
Tusayan Museum
Grandview Mine Historic District

*North Rim*

North Rim Inn Historic District
Grand Canyon Lodge Historic District
North Rim Headquarters

*Corridor Trails*

Cross Canyon Corridor Historic District (Bright Angel Trail, South Kaibab Trail, connecting River Trail, North Kaibab Trail, Phantom Ranch Complex, Cottonwood Campground)

*Tuweep*

Ranger Station Complex

## Program Objectives

Managing a landscape as a cultural resource begins with historical research and landscape evaluation. This analysis is necessary in order to identify a landscape's character-defining features, and understand them in relation to each other and to significant historic events, trends, and persons. In many cases these features are dynamic in nature and change over time. In many cases, too, historic significance may be ascribed to more than one stage in a landscape's physical and cultural evolution. Landscape management involves identifying the type and degree of change that can occur while maintaining the character-defining features.

The identification and management of an appropriate level of change in a cultural landscape is closely related to its significance. In a landscape significant for its association with a specific style, individual, trend, or event, change may diminish its integrity, and needs to be carefully monitored and controlled. In a landscape significant for the pattern of use that has evolved, physical change may be essential to the continuation of the use. In the latter case, the focus should be on perpetuating the use while maintaining the general character and feeling of the historic period(s), rather than preserving a specific appearance (NPS-28, Chap.7, p.95).

According to Federal law (See Appendix A) and *NPS Management Policies*, all cultural landscapes are to be managed as cultural resources, regardless of the type or level of significance. Cultural landscape management focuses on preserving the landscape's physical attributes, biotic systems, and use when that use contributes to its historical significance. Research, planning and stewardship are the framework.

*Research* defines the features, values and associations that make landscapes historically significant; *planning* outlines the issues and alternatives for long-term preservation; and *stewardship* involves activities such as maintenance, condition assessment and training (NPS-28).

### *Research*

The primary purpose of research on cultural landscapes is to define the values and associations which make them historically significant. Research findings provide information for management decisions and actions extending from the development of long-term plans to compliance with preservation law and maintenance; assistance in determining appropriate treatment; and support to interpretive programs.

**Identification** Section 110 of the National Historic Preservation Act requires that the NPS identify and nominate to the National Register of Historic Places all resources under its jurisdiction that appear eligible, including cultural landscapes *(NPS-28).*

**Documentation, Evaluation and Registration** Baseline documentation includes maps, plans, drawings and photographs, as well as intensive field and records investigations to determine the extent and condition of historic and contemporary landscape features. Resource significance and integrity are analyzed and evaluated. Finally, cultural landscapes are listed in the National Register when their significant cultural values have been documented and evaluated within appropriate thematic contexts, and physical investigation determines that they retain integrity. This information is documented in a *Cultural Landscape Inventory* (NPS-28).

**Cultural Landscape Report (CLR)** A CLR is the primary report that documents the history, significance and treatment of a cultural landscape. A CLR evaluates the landscape's history and integrity including any changes to its geographical context, features, materials and use. CLRs are often prepared when a change (e.g. new parking lot) is proposed. In such instances, a CLR can be a useful tool to protect the landscape's character-defining features from undue wear, alteration or loss. A CLR can provide managers and others with information needed to make management decisions.

A CLR will often yield new information about a landscape's historic significance and integrity, even for those already listed on the National Register. Where appropriate, National Register files should be amended to reflect new findings.

A CLR is prepared, as a result of adequate documentation and evaluation of a landscape, according to *National Register Bulletin 30*. It is prepared by a qualified professional, and its findings are incorporated into the National Register. All field notes, primary documents, original maps, drawings, photographs, etc., gathered or associated with the research for CLRs are organized and preserved as archival material or museum objects in consultation with the park curator. All information regarding the condition assessment of character-defining landscape features is incorporated in the Inventory and Condition Assessment Program (ICAP). (NPS-28)

*Planning*

To outline the issues and alternatives for long-term preservation, the following planning considerations must be evaluated:

**Relationship to Park Plans** Cultural landscapes often influence proposals in a park's Statement For Management, General Management Plan, Development Concept Plan(s), Resource Management Plan, and Interpretive Prospectus. Cultural landscape issues, such as historic land uses and the location and character of significant resources should be considered in the development of all planning documents to avoid adverse effects on landscapes. Appropriate siting of wayside exhibits and signs, and techniques for cultural landscape interpretation should be addressed in the Interpretive Prospectus. (NPS-28)

**Decisions About Treatment** Information regarding cultural landscape significance and integrity is required before decisions about planning and treatment are made. This information is also required for many activities associated with park operations as well. (NPS-28).

**Compliance** In compliance with Section 106 of NHPA, particular attention must be given to identifying and evaluating landscapes and their character-defining features and uses so that the effects of proposed undertakings can be adequately evaluated (NPS-28).

**Use** Contemporary use of a cultural landscape is appropriate if it does not adversely affect significant landscape features; and if it either follows the historic use or does not impede public appreciation of it. (NPS-28).

*Stewardship*

Treatment of cultural landscapes is traditionally divided into four categories: *preservation, rehabilitation, restoration* and *reconstruction*. Standards and philosophies for treatment and management are identified in NPS-28.

## Issues

The Cultural Landscape Management Program at Grand Canyon should address the following issues:

*The lack of baseline information and documentation of cultural landscapes puts them at risk*

There is insufficient information for appropriate cultural landscape treatment and use. Proposed historic area improvements relative to life/safety/accessibility issues or future plans require a knowledge of what character-defining features must be preserved. This information is also necessary for compliance with Section 110 of NHPA. A historical landscape architect's expertise is required on teams developing plans and designs within cultural landscapes. This expertise is currently unavailable in the Park staff or even in the Field Office. Appropriate information and treatments will help gracefully bring Grand Canyon's cultural landscapes into the next century.

*Cultural landscapes have been impacted*

Over the years of ever-increasing visitation and use, many trails, features, planted areas and even whole districts have been trampled, altered and otherwise damaged. Some of these impacts are irreversible. Others may be mitigated with proper treatment or subtle changes in visitor use patterns and rehabilitation. Many Park areas have become eyesores and safety hazards. These can be subject to stopgap measures in order to incorrectly "beautify" or fix them. The lack of a preservation program also adds to the deterioration of these areas; resulting in a lack of preservation maintenance.

## Current Funded Program

There is no Historical Landscape Architect on staff or at the Field Office at present. Therefore, very limited guidance, inventory, documentation and preservation planning currently exist.

One Cultural Landscape Inventory for Phantom Ranch and one Cultural Landscape Report for the South Rim Housing Area have been developed within the past four years. Research and documentation for the Grand Canyon Village Historic District is in process as part of a larger servicewide thematic study.

## Proposed Unfunded Program

There are two major programs/projects which are on accelerated schedules; the current General Management Plan and Federal Highways Road Rehabilitation Program (FHWA). In light of the urgency of both these programs, Grand Canyon's cultural landscape program emphasis will be geared toward providing information, direction, recommendations and NEPA/ NHPA compliance for these projects and their implementation. Treatment of areas already impacted by increased visitation will also be addressed. The following goals and subsequent strategies reflect this emphasis:

*Provide Information and Direction for Appropriate Treatment of Cultural Landscapes*

Information regarding the appropriate treatment of cultural landscapes is urgently required. This information will be applied in decision-making for current planning, design, and operational programs. This data will provide information necessary for adequate compliance with Section 106 of NHPA.

**Research** Potentially significant cultural landscapes were identified in the beginning of this section. Historical research, inventory and documentation of existing conditions, and site analysis are all part of this program element. Documentation and evaluation of the significance and integrity of those landscapes within the scope of the GMP and FHWA programs are of highest priority. Cultural Landscape Inventories (CLIs) and Cultural Landscape Reports, outlining character-defining features to be preserved in areas potentially affected by all planning, design, construction or operations programs will be developed. Documentation of this information will follow guidelines established by the Park Museum Collection and GIS System.

**Planning** Information gathered during the research process for CLIs and CLRs will be incorporated into the planning and design processes in order to avoid adverse effects on cultural landscapes. For example, the vegetation management plan would include a section discussing what character-defining features of plantings should be preserved within certain landscapes, even if the exact species cannot be used. Certain relationships between zones of a cultural landscape are strengthened by certain elements such as walkways, views, distances between buildings, and strong site features. These can still be preserved even with contemporary changes in use.

A historical landscape architect's expertise is required on teams developing plans and designs within cultural landscapes. Especially with the current lack of such expertise in the Field Area Office and at the Park, this team member can provide valuable insight into what treatment and stewardship methods can accommodate necessary contemporary changes, while preserving character-defining features.

Section 106 of NHPA compliance requires the evaluation of landscapes and their character-defining features and uses so that proposed undertakings of planning, design and operations projects can be adequately considered.

Contemporary use of cultural landscapes such as the Grand Canyon Village Historic District is appropriate if it does not adversely affect significant landscape features; and if it either follows historic use or does not impede public appreciation.

**Stewardship** This includes the monitoring, preservation, rehabilitation, restoration, and/or reconstruction of cultural landscapes, although restoration and reconstruction treatments are very rarely recommended.

Landscapes can be monitored for changes and negative impacts due to planned changes in patterns of use. Various new operational activities may have incremental impacts, and these can be determined by appropriate monitoring protocols. Preservation of significant character-defining features is mandated by law for historic properties. "Beautification" treatments of landscapes may seriously alter these significant features. Recommendations for the appropriate rehabilitation, treatment and maintenance of cultural landscapes are included in CLRs.

Resource protection practices include careful monitoring of construction activities which may damage significant features such as walks, curbs, walls, site furniture, plants, etc. Prudent construction contracts and specifications in addition to regular inspections are sound resource protection methods.

Significant cultural landscape interpretation can yield valuable information for enhancing visitor experiences. Together with information about the various structures within the landscape, a complete picture of the use and character of these areas is made available through a CLR.

*Mitigate Impacts to Cultural Landscapes*

Over the years of ever-increasing visitation and use, many trails, features, planted areas and even whole districts have been trampled and otherwise damaged. Some of these impacts are irreversible, such as in the case of the complete obliteration of features through the simple lack of knowledge of their significance.

Other impacts are easily ameliorated by subtle changes in visitor use patterns and rehabilitation, such as in the case of certain planted areas. Many areas have become eyesores and safety hazards, and can be subject to stopgap measures in order to incorrectly "beautify" or to fix a safety problem.

**Research** CLIs and CLRs for those areas most impacted by increased visitation and use will yield valuable information as to what preservation and rehabilitation treatments will be most appropriate.

**Planning** Plans and designs which follow recommendations stated in a CLR will not only mitigate impacts to that cultural landscape, but will also provide appropriate changes to accommodate contemporary use. Even in the case of social trail mitigation, Section 106 requires evaluation of cultural landscapes and their character-defining features and uses prior to work approval.

**Stewardship** Standards and philosophies for cultural landscape preservation and rehabilitation are covered in Chapter 7 of NPS-28. These will be outlined in pertinent CLRs as well. Through appropriate monitoring protocols, damaging natural or human-caused actions or use patterns can be changed through various treatments. Resource protection against vandalism and destruction of cultural landscapes and features such as walls, plants, trails, bridges, and site furniture can be accomplished by regular patrols and law enforcement practices.

Interpretive messages which promote an appreciation and careful use of certain cultural landscape features can equally protect and safeguard these resources.

# Ethnographic Resource Management

## Program Overview

The Ethnography Program provides technical and administrative assistance to all personnel within Grand Canyon National Park. This assistance involves the inventory, management, and protection of ethnographic resources throughout the Park.

An ethnographic resource is defined as any natural or cultural resource linked to the traditional practices, values, beliefs, history and/or ethnic identity of a cultural group or groups. (NPS-28)

Grand Canyon has been home to various groups of people for thousands of years. These people, both American Indian and more recent Euro-Americans, have used the Canyon as both a home and a place linked to traditional practices, values and beliefs. To the Hopi and Zuni, the Grand Canyon represents their place of origin into this world. For the Hopi, it also represents the place where their spirits come to rest after death.

For the Pueblo people, archaeological remains in the Canyon provide evidence for their migration from their place of origin to their present homes. For the Pai people, the Canyon and the River are lands for which they have been entrusted to care; the River represents the backbone. For the Southern Paiute, the Canyon has always been a part of their world.

Euro-Americans recognized the Canyon's spiritual values in the establishment of the National Park in 1919. World Heritage Site designation told the world that the Grand Canyon had value beyond just the American people. The 1975 Grand Canyon Enlargement Act specified natural quiet and the view as important, yet intangible qualities, that must be protected. These, too, are ethnographic resources.

## Program Objectives

The Ethnographic Resource Management Program seeks to enhance the Park's management of its natural-resource base by conducting ethnographic research and consulting with Park-affiliated cultural communities; improve visitor services quality by providing accurate information on ethnographic resources; and increase the understanding of cultural diversity among Park personnel through increased awareness of potential cross-cultural resource issues.

Through the integration and improvement of resource management, visitor experience, and personnel sensitivity, the ethnographic program will raise the level of public and Park understanding and appreciation for the heritage of natural, cultural, and ethnic diversity.

Attention to the peoples whose lifeways are traditionally associated with resources under NPS stewardship is mandated in legislation and NPS policies. According to *NPS Management Policies* (1988, 5:1):

> *Certain contemporary native American and other communities are permitted by law, regulation, or policy to pursue customary religious, subsistence, and other cultural uses of park resources with which they are traditionally associated. Such continuing use is often essential to the survival of family, community, or regional cultural systems, including patterns of belief and economic and religious life. Recognizing that its resource protection mandate affects this human use and cultural context of park resources, the NPS will plan and execute programs in ways that safeguard cultural and natural resources while reflecting informed concern for the contemporary peoples and cultures traditionally associated with them.*

Given this direction, the program objectives for ethnographic resources can be summarized within the categories of Research, Planning and Stewardship.

*Research*

- Develop and implement a professional ethnographic research program to provide data to support sound management of cultural and natural resources. Studies are conducted to identify ethnographic resource-inventory data, interpretive uses, and resources with National Register potential as Traditional Cultural Properties (TCPs).

- Provide the Park with the capability of conducting research to gather baseline data to use in resource management plans, consultation plans, compliance documentation and day-to-day decisions concerning resource use.

- Design and implement an automated ethnographic resource data base that can be used by Cluster, System Support Office, (SSO) and Park personnel.

*Planning*

Ethnography provides perspectives on people and cultural systems affected by proposed or existing parks. It contributes to culturally appropriate strategies, and evaluates consultation results to identify sensitive issues.

- Consultation with traditionally associated groups is initiated during scoping or early project planning.

- Planning documents contain current information on American Indian and other traditional users, the status of ethnographic data, the legislative, regulatory, policy, or other bases for uses, and known uses.

- Design a method of effective consultation with Park-affiliated communities to comply with law and regulation, to improve working relationships between the Park and neighboring cultural communities, and to enhance the Park's consideration of traditional resource use.

*Stewardship*

> *Whenever park resources are part of a group's resource base, the Service becomes part of the local cultural system and contributes, however inadvertently, to the group's cultural vitality and the nation's cultural diversity. By maintaining the integrity of these resources, the Service helps maintain the nation's diverse physical, natural, and cultural heritages and acknowledges the human dimension of its stewardship role* (NPS-28).

- Ensure that traditionally associated groups, neighbors and the legislative, regulatory, or policy bases for relationships with them are identified and known to Park staff.
- Ensure that the Statement for Management addresses traditionally associated people, ethnographic resources, and resource uses.
- Design a system to monitor affects of use on cultural and natural resources, and effects of Park plans on authorized uses and traditional users.

## Issues

The following issues are most pertinent to managing Grand Canyon's ethnographic resource:

*The lack of a comprehensive ethnographic resource program threatens these resources and the Park's relationships with eight separate Indian tribes*

In order to meet current legal responsibilities and mandates, an Ethnographic Resource Program is necessary at Grand Canyon National Park. Given the Native American Graves Protection and Repatriation Act, the amendment to the National Historic Preservation Act, and the definition of Traditional Cultural Properties as National Register Eligible, the goals for an Ethnographic Resource Management Program are focused on immediate responsibilities and mandates. The Park has a responsibility to comply with these numerous Federal laws related to ethnographic resource and traditional cultural properties. This compliance is currently being done in a piecemeal fashion, with no coherent plan.

Numerous pieces of legislation exist establishing boundary locations for Grand Canyon National Park and the Hualapai and Navajo Indian reservations. The legal descriptions are in conflict, and resolution has not been reached.

During the scoping session for the current General Management Plan, many American Indian groups expressed their continued concern that their heritage and values have not been well represented within the management of the Park, and that the visitor must be better educated about their existing cultures. Traditional practices, in-Park concession sales of non-authentic Indian goods and a lack of representation of American Indian groups in Park management and operations are all examples of frustrations they experience. For example, the tribes were disturbed and not well-informed about the amount of development underway on both the North and South rims. They felt that although there was some interpretation about the Anasazi (Hisatsinum), it was just as important that visitors came away with some knowledge about *today's* various Indian cultures. The fact that in-Park concessionaires were allowed to sell less expensive imitation Indian jewelry confused visitors and deprived tribes of business. They felt that the NPS should be helping tribes in developing an environmentally sound economy which better meets Park management objectives. They also felt that the Park should actively seek input from tribal chapter elders, medicine men, and others not only as a matter of respect, but also because it will bring the Park toward a more holistic and comprehensive understanding of all values associated with Grand Canyon. The National Park Service is required to consult with tribes, based upon legislation and existing preservation compliance laws and NPS policies.

*The lack of baseline ethnographic resource information puts these resources at risk*

The knowledge base of the park's cultural diversity and history as well as the interpretation of this knowledge is seriously deficient. Specifically, there is a lack of baseline data. No database exists, and no information exists which can be used in Park planning and management. The only inventory information that exists for ethnographic resources is that which has been obtained through archaeological studies and consultation of compliance-generated projects.

## Current Funded Program

The current program at Grand Canyon consists of the Cultural Resource Program Manager who maintains relationships with the eight separate Indian Tribes. Visits by the Superintendent, Deputy Superintendent and Cultural Resource Program Manager do occur on a frequent, but irregular basis.

A cultural-affiliation study related to NAGPRA compliance and the GMP was completed in FY95. Preparation of a Havasupai use ethnographic study of the Grand Canyon Village area will be completed in FY97 as compliance related to GMP developments (Mather Orientation Center and Pinyon Park housing).

Discussions have taken place with all of the tribes related to the GMP and Park Interpretive plans. In addition, discussions continue with the Havasupai related to Supai Camp and the Havasupai Use lands.

Implementation of responsibilities under NAGPRA are underway, with draft MOA in process with most affiliated tribes. Grand Canyon met the mandated deadline for completion of NAGPRA inventories in both 1993 and 1995.

## Proposed Unfunded Program

Given the enactment of the Native American Graves Protection and Repatriation Act, amendments to the National Historic Preservation Act, and the definition of Traditional Cultural Properties as National Register eligible, the goals for the Ethnographic Resource Management Program are focussed on immediate responsibilities and mandates.

*Develop a Comprehensive Ethnographic Resource Management Program*

In order to meet current legal responsibilities and mandates, the following items are the most urgent in this program:

**Research** Implement a baseline inventory, identification and assessment of ethnographic resources. There is a lack of baseline data for the Park. No database exists, and no information exists which can be used in Park planning and management. The Park has a responsibility to comply with numerous Federal laws related to ethnographic resources and traditional cultural properties which is being done in a piecemeal fashion, with no coherent plan. Baseline studies have yet to be completed to assess the Park's ethnographic resources. With eight separate Indian tribes which claim ancestry in the Canyon, the lack of information hampers any program development

**Planning** Develop a process by which authorized American Indians, (and other ethnic group members) can obtain access to, and use of, specific NPS managed resources (e.g. "sacred places," natural and cultural resources, curated objects) for traditional cultural practices.

**Stewardship** As part of our basic legal responsibilities as specified in *NPS Management Policies*, Grand Canyon will work toward developing in-Park training programs which focus on ethnographic resource values, increase sensitivity of Park personnel to the diverse area cultures, and develop standard guidelines for conducting compliance-related consultations. In addition, Grand Canyon will develop a program to integrate ethnographic resource data into interpretive planning to enhance visitor services and visitor enjoyment.

*Provide Baseline Information for NAGPRA and Compliance-Required Consultations*

The Park's knowledge of cultural diversity and history, as well as the interpretation of this knowledge, is seriously deficient.

# Historic Resource Management

## Program Overview

Historic resources are cultural resources which have been determined through research to have significance within some historic context, or theme, of Park lands. The significance has been achieved during the historic period, as opposed to the prehistoric time period. Resources include districts, sites, buildings, structures, and objects.

At Grand Canyon, programs are in place which include aspects of the Historic Resource Management Program. See the appropriate sections on Museum Collection Management, Cultural Landscape Management, Archaeological Resource Management and Historic Structures Management Programs for discussion. However, to date there has been no focused effort on documenting resources associated with the broad historic contexts that have been identified for the Park.

## Program Objectives

The overall goal is to meet the basic requirements outlined in NPS-28, regarding historic resources. In addition to laying out the research, planning and stewardship guidelines, NPS-28 calls for compliance with laws and regulations applicable to cultural resources.

### *Research*

Section 110 of NHPA requires park managers (and all Federal agencies) to establish programs to locate, identify and nominate all properties that appear to qualify for the National Register of Historic Places. Two standard reports for such research are the Historic Resource Study and the Special History Study. The findings and conclusions of those studies form the basis for a historic resource inventory.

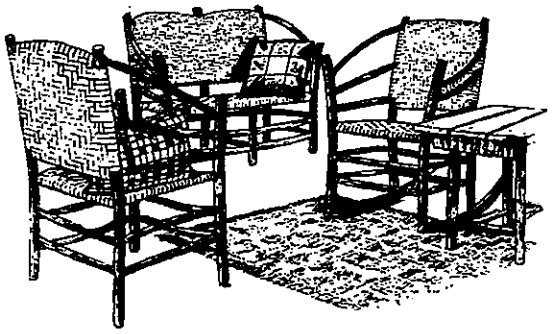
Additional research is performed based on the type of resource. Buildings and landscapes are carefully documented, objects are analyzed for physical makeup, etc.

### *Planning*

Planning for historic resources consists primarily of developing treatments for identified resources and integrating such treatments into other Park planning processes. It involves planning for the completion and/or application of these treatments, as when a new storage facility for historic objects has been identified as preservation treatment for objects. In addition, NPS-28 calls for the completion of basic documents known as Historic Resource Studies (HRS) as part of the cultural resource planning process.

### *Stewardship*

Carrying out those treatments, providing for the interpretation and use of those resources in appropriate ways.



## Issues

The following issues were determined to be most pertinent to this Resource Management Plan:

*Lack of documentation, and disseminated baseline data puts historic resources at risk*

Basic information on historic resources must be gathered in order to fully understand the Park's historic properties and human history. Oral histories, for example, would reveal a great deal about the Park's past. However, many of the people able to give such histories, such as Civilian Conservation Corps members, are growing older. Their memories will not be available forever.

*Lack of an administrative histories program threatens future Park plans and decision-making strategies*

According to NPS-28, *each unit of the park system should have a park administrative history....This document should be prepared or updated for those areas that are scheduled for preparation of management planning.* Information about past planning decisions is not in one place and readily available to help develop solutions to problems being addressed in current planning efforts.

In addition, Grand Canyon has been in the forefront of natural resource management. An administrative history of that program would help present managers learn from strategies tried in the past. Presented in narrative format, that information should also assist other agencies and parks throughout the world hoping to model their programs after the United States National Park Service.

*The lack of historic resource studies threatens National Register eligible resources*

Historic Resource Studies identify and evaluate National Register eligible programs. Grand Canyon's history has been greatly influenced by the Atchison, Topeka and Santa Fe Railroad and its predecessors; NPS development; tourism development on the North Rim; and mining. These have not yet been addressed in a HRS.

## Current Funded Program

There is no Park historian, historical architect, historical landscape architect or ethnographer. Few contracts have been funded for certain projects under this program. A cooperative agreement with Northern Arizona University has yielded some trail studies which are in process of National Register nomination. A Historic American Engineering Record (HAER) study on roads has been initiated.

## Proposed Unfunded Program

*Ensure Basic Data Collection and Dissemination*

It is imperative that basic information on historic resources be gathered to understand Grand Canyon's human history. Basic data for historic resources are gathered through a number of sources including, Historic Resource Studies, Cultural Landscape Reports, Ethnographic Studies, Administrative Histories, Special Historic Studies.

Revealing oral histories about Grand Canyon's past are being lost as people pass away. Oral histories which would reveal critical information about the intense development at the South Rim during the 1930s can still be collected while CCC members are still alive. The Ethnography Program would be greatly enhanced by these oral histories.

*Develop Administrative Histories Program*

According to NPS-28, *each unit of the park system should have a park administrative history. This document should be prepared or updated for those areas that are scheduled for preparation of management planning.* Grand Canyon's GMP was finalized in 1995, yet there is no Park administrative history. Information about past planning decisions is not in one place and readily available to help develop solutions to problems being addressed in the current planning effort.

In addition Grand Canyon has been in the forefront of natural resource management. An administrative history of that program would help present managers learn from what has been done and tried in the past in natural resource management. Presented in a narrative format, that information could also assist other agencies and parks throughout the world hoping to model their programs upon the United States National Park Service

*Prepare Historic Resource Studies*

Historic Resource Studies are prepared to identify and evaluate National Register eligible programs. Study, using primary and secondary sources, produces three documents: the HRS itself, a historic resource base map, and National Register nomination forms for those properties not already on the National Register. Aspects of Grand Canyon's history which have yet to be addressed in an HRS include: the Atchison, Topeka and Santa Fe Railroad and its predecessors; NPS development; development of tourism on the North Rim; and mining.

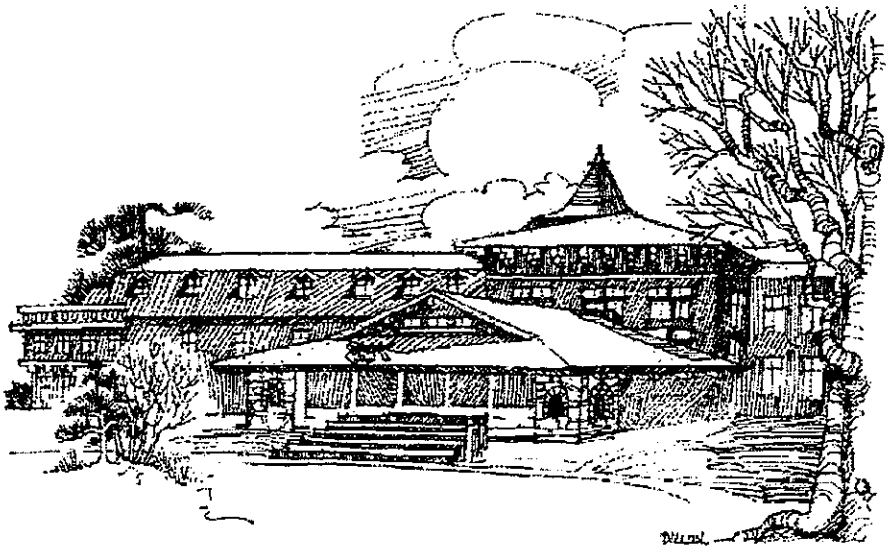
*Support Planning Efforts*

Awareness of the Park's historic resources at the start of the planning process will/should avoid last minute changes in plans to accommodate the need to preserve historic resources. Areas to be affected by planning decisions where historic resource information is lacking should be given research funding at the start of a planning process so the information is gathered in a timely manner and used to guide and support the planning decisions.

# Historic Structure Management

## Program Overview

According to NPS-28, a structure is a *constructed work...consciously created to serve some human activity.* Structures are usually immovable, although some have been relocated and others are mobile by design. They include buildings and monuments, dams, millraces and canals, nautical vessels, bridges, tunnels and roads, railroad locomotives, rolling stock and track, stockades and fences, defensive works, temple mounds and kivas, ruins of all structural types, and outdoor sculpture. In this section, the program will be specific to those structures that are historic (not prehistoric) in nature. Prehistoric resources are discussed in the archaeology and ethnography sections of this document. Cultural Landscapes and their elements are discussed in that program section.



Grand Canyon's historic structures represent the Canyon's Euro-American habitation since the late 1800s, which brought to the region the heritage of the great western frontier and tourism. The Park's historic properties include 124 buildings listed as National Landmarks, 336 listed on the National Register of Historic Places and an additional 884 properties on the List of Classified Structures.

## Program Objectives

According to both Federal law and *NPS Management Policies*, all historic structures in the Park are to be managed as cultural resources. Regardless of type, level of significance, or current function, every structure is to receive full consideration for its historic values whenever a decision is made that might affect its integrity.

The preservation of historic structures involves two basic concerns, slowing the rate at which historic material is lost, and maintaining historic character. Research on, planning for, and stewardship of historic structures focus on these concerns. *Research* defines historical associations, integrity, character, and the causes of material deterioration; *planning* develops and evaluates proposals for use and treatment in terms of their likely effects; and *stewardship* entails activities ranging from craft training to the identification and mitigation of threats. (NPS-28)

Preservation of historic structures is an interdisciplinary effort requiring cooperation and communication among historical architects, architectural conservators, preservation specialists, archaeologists, (historical) landscape architects, historians, ethnographers, and curators. Qualified professional historical architects are needed to oversee preservation treatment for historic structures.

*Research*

Research about historic structures is a prerequisite for treatment, and provides a basis for decision-making by managers. It also contributes to interpretation, compliance and facility design.

**Identification Evaluation, and Registration** Section 110 of the National Historic Preservation Act requires the NPS to identify and nominate to the National Register of Historic Places all structures under its jurisdiction that appear to qualify for the National Register. Often tools for identification, evaluation and registration include:

- Historic Resource Study, the primary document used to identify and manage a park's cultural resources.
- National Register Nominations, may be prepared either for individual structures or for groups of structures, as well as for landscapes.
- List of Classified Structures, is the inventory of all structures which are on or eligible for the National Register. LCS also refers to the computerized database containing information about historic and prehistoric structures.
- Categories of Significance, used to established LCS management categories, determine appropriate levels of recordation, and make other related management decisions.

**Documentation and Investigation** As a rule, research about a historic structure should complement existing information and strive to produce a comprehensive understanding of the structure in order to adequately address management concerns. Documentation includes:

- Historic Structures Report (HSR), the primary guide to treatment and use of a historic structure; in no case should restoration, reconstruction, or extensive rehabilitation of any structure be undertaken without an approved HSR;
- Graphic Documentation, to record preservation treatment, provide a baseline for monitoring, aid in interpretation, support scholarly research, and serve as an objective reference for repair or reconstruction in the event of damage or loss;
- Archival Considerations, to maximize the benefit of research and investigation, and minimize potential data loss, all field notes, primary documents, original maps, drawings, photographs, and material samples generated should be organized and preserved as archival material or museum objects in consultation with the park curator.

*Planning*

Planning for historic and prehistoric structures encompasses such diverse activities as involvement in park planning, facility design, preparation of maintenance work procedures, and compliance. The central purpose of all such activities is to identify ways of protecting cultural resources while achieving other management objectives. This is usually best done by a thoughtful evaluation of a diverse range of alternatives. Action plans that may affect historic structures should include furnishing reports and cultural landscape reports. Treatment and use are the central issues in planning for historic structures:

**Treatment Planning** According to NPS-28, "Historic structure treatment involves one or more of the following activities: preservation of existing materials; replication of missing historic features; addition of non-historic features; and/or removal of existing features or materials." Decisions about the ultimate treatment of a historic structure should reflect the value of a structure as a cultural resource, knowledge of craft techniques and building materials, consideration of current and intended uses, appreciation of threats to the structure, and projections of treatment costs relative to likely funding: preservation, rehabilitation, restoration, or reconstruction.

Historic Property Preservation Database (HPPD) is a computerized database containing technical information on the treatment of historic and prehistoric structures and cultural landscapes. It contains work procedures for the Inventory and Condition Assessment Program and the Maintenance Management System Program (MMS).

Removal or neglect is justifiable only when all alternatives have been determined infeasible in the planning process. *NPS Management Policies* prohibits demolition unless necessary for public safety or to eliminate an unacceptable intrusion.
No structure listed in or potentially eligible for the National Register will be removed or deliberately neglected without review and approval by the Field Director and State Historic Preservation Officer. Documentation recording it must be prepared in accordance with Section 110(b) of the National Historic Preservation Act, and must be submitted to and accepted by the Chief, Historic American Buildings Survey/ Historic American Engineering Record (HABS/HAER) Division, NPS.

**Use of Historic Structures** The primary preservation issue is the compatibility of use with the structure. Considerations include wear patterns, adequacy of space and spatial configurations, the need for new electrical or mechanical systems, increase in fire risk, and changes necessary to accommodate disabled employees or visitors.

**Compliance** All project plans for historic and prehistoric structures must be reviewed for compliance with Section 106 of the National Historic Preservation Act. Buildings over fifty years old must be evaluated for eligibility on the National Register as a first step in the compliance process.

**Funding and Staffing** Every treatment project, including preservation, is initiated by a programming document containing cost estimates and a scope of work. This information should be drawn from the Inventory and Condition Assessment Program or an approved HSR.

*Stewardship*

For historic structures, stewardship focuses on five major activities: control of treatment and use; monitoring conditions of deterioration and structural failure; protecting structures from human and environmental threats; retaining or delegating responsibility for structures; and developing skills, knowledge, and attitudes needed to support the program. These are discussed at length in NPS-28.

## Issues

The following issues were determined to be the most pertinent to this Resource Management Plan:

*Lack of baseline data and documentation puts historic structures at risk*

The inherent lack of baseline information, inventory and understanding of historic structures leads to an unclear direction for building use and preservation. Information regarding the appropriate treatment of these structures is urgently required to meet the needs of the current GMP. This information will greatly improve the efficiency of Section 106 of the NHPA Compliance process.

*Lack of a comprehensive historic structures preservation program puts these resources at risk*

The biggest threat to historic structures concerns the lack of a preservation program. The lack of a systematic, programmatic approach to rehabilitation, reuse, maintenance, emergency repair is putting these structures at risk. Life/safety and accessibility issues, Integrated Pest Management issues, increased visitation, lead abatement and asbestos removal, the Housing Initiative, and other urgent programs are driving the direction of Park historic structures preservation.

Park staff does not include the expertise required to develop plans and initiate compliance. In addition, a preservation crew is necessary to implement the preservation program. Minimum standards, at least, must be met.

## Current Funded Program

There is no architect or historical architect position currently on staff. A temporary architect's position had been overseeing the appropriate research, evaluation and treatment of historic houses under the Housing Initiative Program. That position is vacant. The Compliance Coordinator's position is currently occupied by an individual with a background and interest in historic resource preservation, but no academic training.

The Colorado Plateau System Support Office has a historical architect and historian on staff who can provide technical review for Park projects.

Preventative maintenance is an unfunded element at Grand Canyon. There is no preservation crew or preservation specialist at Grand Canyon.

## Proposed Unfunded Program

The single most important charge for the management of historic structures is the development of a systematic, programmatic approach to rehabilitation, reuse, maintenance and emergency repair of these structures. Therefore, the primary emphasis for the Grand Canyon historic structures program is to develop a strong preservation program.

*Provide Information and Direction for Appropriate Treatment of Historic Structures*

The inherent lack of baseline information, inventory and understanding of these structures leads to an unclear direction for building use and preservation. Information regarding the appropriate treatment of historic structures is urgently required. This information will be applied in decision-making for current planning, design and operational programs. Section 106 requires this information and evaluation in order to approve certain projects.

**Research** Research is necessary to satisfy Section 110 of the National Historic Preservation Act which involves the identification, evaluation and registration of Structures (HRSs, National Register Nominations, LCS, and categories of significance). Documentation and investigations necessary to produce a comprehensive understanding of the structure(s) is key to adequately address management concerns (HSRs, graphic documentation and archival considerations).

**Planning** Using the Historic Property Preservation Database, the Inventory and Condition Assessment Program, and the Maintenance Management System, develop treatment plans for the Park's historic structures. Ensure that proposed or existing use of historic structures is compatible with preservation of that particular building(s). Through an interdisciplinary team comprised of historical architects, historical landscape architects as well as planners and designers, provide direction for the use and adaptive reuse of historic structures. Pertinent projects include the current GMP and FHWA projects.

Develop a compliance program to meet policies, mandates, guidelines and standards concerning the treatment of historic structures.

**Stewardship** This includes the monitoring, preservation, rehabilitation, restoration and/or reconstruction of historic structures, although restoration and reconstruction are expensive and rarely appropriate. In cases where a structure has been lost, interpretation can serve as well as reconstruction.

Treatments under this subheading are covered comprehensively in the following section.

*Provide for a Comprehensive Historic Structures Preservation Program*

The biggest threat to historic structures concerns the lack of a strong preservation program. The lack of a systematic, programmatic approach to rehab, reuse, maintenance, and emergency repair is putting these structures at risk. Life/safety and accessibility issues, Integrated Pest Management issues, increased visitation, lead abatement and asbestos removal, the Housing Initiative and other urgent programs are driving the direction of historic structures preservation.

Park staffing should include the expertise required to develop plans and initiate compliance. In addition, a preservation crew is necessary to implement the preservation program. A comprehensive program should be developed to meet the minimum standards of this preservation program.

**Research** Using the research framework established in the Proposed Program above, develop research necessary to satisfy Section 110 of the National Historic Preservation Act which involves the identification, evaluation and registration of structures. This can be accomplished through HRSs, LCSs, HSRs, and other investigations.

**Planning** Ensure that treatment plans support and are in agreement with other Park plans and programs. Conduct necessary compliance measures to gain approval of all Park plans, designs, and operational programs proposed under this preservation program.

**Stewardship** Develop appropriate monitoring protocols to ensure that current impacts and contemporary changes are not adversely affecting structures. Protect structures during construction by including special clauses in contracts. Guard against vandalism and damage through law-enforcement techniques. Develop a strong educational and interpretive program.

# Museum Collection Management

## Program Overview

The goals of a professional museum collection include preservation, study and communication. The Grand Canyon Museum Collection has the specific goal of collecting and preserving objects which document the Canyon's unique cultural and natural history as well as protecting objects which would be destroyed on-site. The active museum collection allows access to a variety of researchers including local, national and international press, publishers, authors, students, park staff and Canyon visitors. The information provided retains a high quality through use of original objects in exhibits and information for creation of interpretation programs. An interpreter's collection, including illegally collected objects lacking provenience, is maintained for use during interpretive programs.

Grand Canyon National Park staff have been preserving natural and cultural history items since the Park was created in 1919. The natural history collection includes mammal, bird, insect, alcohol, geology, paleontology, tree ring, and a herbarium collection. The history collection includes archives, historic photographs, fine arts, rare books, components of historic structures as well as information and materials documenting the history of mining, tourism, railroad, early pioneers, river-running, concessions, resource management projects, and many more subjects.

The collection also includes ethnology and archaeological collections.

## Program Objectives

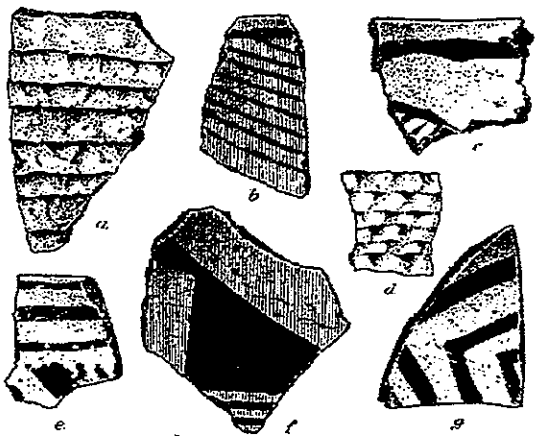
The purpose of the museum collection is to gather and protect objects and specimens which are representative of the cultural and natural history of Grand Canyon National Park. The program seeks to protect the objects by using archival storage techniques in controlled, secured storage areas to slow deterioration and preserve objects and the information they contain for research today and in the future. Special projects are continually being completed to better protect objects, such as microfiching information to provide a nondestructive means of accessing collection information. The other primary function of the museum collection is to provide controlled access to the material so that it is available and useful to Park managers and researchers. This includes proper cataloguing with information arranged to assist and simplify research data searches.

## Issues

The following issues were determined to be the most compelling and pertinent to managing the museum collection at Grand Canyon:

*Inadequate storage puts resources at risk*

The museum collection has grown from 20,000 catalogued objects in mid-century to over 250,000 today; staffing and storage have not kept pace. The Park's main storage was filled years ago; old wooden sheds are now used for storage. The Park's substandard storage does not allow proper protection of museum objects, and does not meet NPS or professional museum standards.



Fire, security, vandalism and deterioration due to lack of climate control all threaten the collection. Historic properties preservation, historic resource studies, archaeological preservation and interpretation are only some of the programs which would be severely affected were this collection lost.

*Inadequate care and access to the collection puts these resources and research efforts at risk*

There is insufficient staff and supplies to properly store, provide access to, and care for the collection. Providing care to collection materials is critical if objects are to last for the enjoyment of future generations. Staff must complete a variety of housecleaning, preservation, storage, pest monitoring and environmental monitoring projects to try to discover and reduce harmful events in collection storage areas.

Another element of the research collection is the Park photographic collection which contains an important visual record of Park developments. In order to conduct inventories and evaluations of historic properties, these photographs must be easily accessible. It is just as important to have an active program to document today's projects and events so as to record these in the museum collection for future generations. Further, at this time very little photographic documentation of the research collection exists.

*Inadequate information management puts these resources and research efforts at risk*

Both incomplete cataloging and computer-entry work do not allow thorough information searches to be completed. Data are not used because they are inaccessible. Other material can only be located through tedious hand searches through over 68,000 non-subject organized catalog cards.

Lack of knowledge of other sources of information, research work, etc., does not provide for efficient use of limited research work efforts. For example, without a thorough knowledge and copies of previous research work, efforts may be duplicated by current researchers.

The depth of the information available through the museum and library collections could be greatly increased by gathering information outside the Park as well as by collecting oral histories. Making more data available to researchers and Park management will help increase the quality of projects being completed. Further it will provide better understanding of past events which, in turn, may help develop better solutions for the future.

## Current Funded Program

ONPS and cyclic funds are used to provide the staffing necessary for basic collection care and preservation including housekeeping, environmental and pest monitoring projects, accessioning and cataloging projects, providing access, and providing basic accountability including completing yearly inventories. Funding in FY96 was not received from cultural cyclic programs, and curatorial staff were reprogrammed into other special funding sources unrelated to curatorial functions. Funding for the program must be moved to ONPS sources rather than cyclic to provide the stability necessary to maintain and operate museum programs. The Curator supervises the day-to-day activities of the museum collection as well as completes all long-range planning documents and budget.

Museum technicians assist researchers, complete preservation and storage projects, accession and catalog objects, and enter information on the computer for more efficient data management. The museum photographer maintains the historic photograph file by completing darkroom projects to maintain loan photograph files, copying historic photographs loaned to the Park to increase the subjects available, and making copy negatives of deteriorating originals. Depending on funding, additional staff are hired to complete projects related to the museum collection such as cataloguing the archive collection, completing oral history transcription work, etc.

## Proposed Unfunded Program

Special Directive 80-1 sets standards for museum property preservation, protection, and documentation. Grand Canyon does not meet many of these basic requirements. Information is lacking from museum and library collection which would assist Park staff and researchers in completing research projects as well as assist in preventing duplication of effort if previous work is available for review.

### *Provide Protection to Museum Artifacts*

Museum artifacts are currently stored in a variety of areas including old wooden sheds. To provide basic environmental, pest, and security protection to museum artifacts, a new museum storage and research facility should be completed. This would allow objects to be moved out of the substandard storage areas into a facility designed to meet Special Directive 80-1 requirements.

### *Provide Care and Access to the Collection*

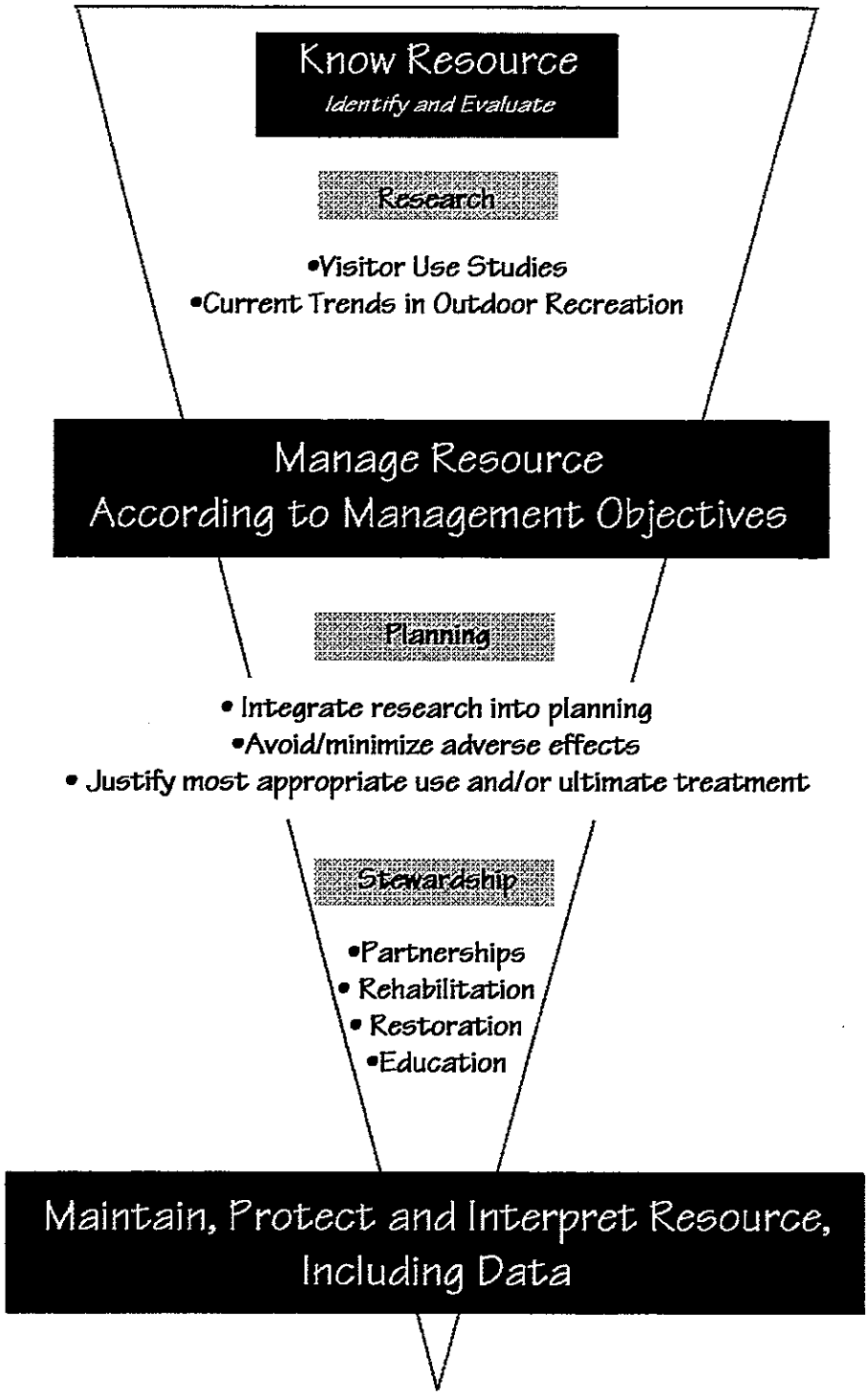
Personnel and supplies are needed to provide the required levels of care and maintenance to the collection. This includes providing the staff necessary to perform routine housekeeping, pest monitoring, and environmental monitoring tasks. To fully tap the information potential stored within the collection, the objects must be fully inventoried, catalogued, and entered into the computer. Unless these tasks are accomplished, information will not be available and used by Park staff and researchers. Controlled access must be provided to assure protection of the collection while assuring non-consumptive use of collection materials in educational, information, and management projects.

### *Provide a Quality Research Facility for Park Staff and Visiting Researchers*

The museum collection is missing research and information material which would help provide thorough information to Park staff and researchers completing projects on the Canyon's cultural and natural histories. Material should be collected from many sources, and made available at an adequate Canyon facility. The locations of other sources of information, materials and specimens should also be researched and provided so that researchers can find these other sources.

# Recreation Resource Management Program

*The Recreation Resource Management Program follows a simple and logical process.*



## Program Overview

The intent of management objectives presented in the General Management Plan is to preserve nature and wildness in the Grand Canyon as well as protect the visitor's experience of wonder and awe when first gazing into the Canyon's depths. Experiential quality at the Grand Canyon depends on the Park remaining wild below the overlooks, and staying quiet and uncrowded behind them. One important goal is to preserve and protect the maximum opportunities in every Park management zone for visitors to experience the Canyon's solitude, natural conditions, primitiveness, remoteness, and inspirational value. Such opportunities must be consistent with Park purposes, and the characteristics of each management zone. In deciding which recreational opportunities would be provided in the Park, consideration of recreational opportunities available outside the Park is important.

Grand Canyon is a world-renowned scenic, spiritual, and recreational arena that attracts nearly five million visitors each year. The primary Recreation Resource Management Program functions are to:

- review and develop the recreation and user-based research that supports visitor recreation management and planning
- monitor the effects of visitor use on Park resources, to restore damaged landscapes
- incorporate information gained through studies and monitoring into the decision making process and Park operations.

Based on information derived through the processes described above, the Science Center will lead or assist in the establishment of planning, education, and restoration programs designed to protect, minimize and mitigate the impacts of visitor use on natural and cultural resources. Protection of visitor experience will be a priority.

### *Developed Areas*

A spectrum of recreational opportunities exist in the developed areas, ranging from social to solitary. Many activities are centered around canyon viewing, and are supported by Park and concessioner-based visitor services. Day-use constitutes the principal use in these areas.

### *Proposed Wilderness*

Over 90% of the Park, including the River, is proposed for wilderness designation. These areas offer visitors outstanding opportunities for solitude and primitive recreation. Most of the activities require extended stays ranging from several days to several weeks, although some day-use of wilderness areas occurs. *NPS Management Policies* require the Park to manage proposed wilderness in a manner that preserves its wilderness values and character. The General Management Plan states that all actions proposed in the GMP, and all future implementation plans based on it (such as the Wilderness Management Plan, the Colorado River Management Plan, and the Fire Management Plan) will be consistent with NPS wilderness policy requirements. Non-wilderness undeveloped areas will serve primarily as primitive thresholds to wilderness. In addition, the GMP establishes the Park goal to actively pursue the designation of these lands as part of the National Wilderness Preservation System.

The Grand Canyon is recognized as a place with unusual and noticeable natural quiet, and direct access to numerous opportunities for solitude. The GMP calls for the protection of the Park's natural quiet and solitude, and mitigation or elimination of the effects of activities causing excessive or unnecessary noise in, over, or adjacent to the Park.

## Program Objectives

The goal of the National Park Service is to provide a diverse range of quality visitor experiences, as appropriate, based on the resources and values of Grand Canyon, and compatible with the protection of those resources. The National Park Service is committed to:

- protect and ensure an individual's opportunity to experience that awe-inspiring first look into the Grand Canyon
- provide access that is appropriate and consistent with the character and nature of each management zone and the desired visitor experience
- maintain the opportunity for threshold wilderness experiences along the many miles of rim and corridor trails
- minimize and mitigate the impacts of visitor use on natural and cultural resources.

Within the provisions for resource protection, the National Park Service will encourage recreational activities that are consistent with applicable legislation, and will promote visitor enjoyment of Park resources through direct association or relation to those resources. This is a challenging task, supported by *NPS Management Policies (Chapter 8:2)* on the management of recreational uses:

> *...The NPS will manage recreational activities and settings so as to protect park resources, provide for public enjoyment, promote public safety, and minimize conflicts with other visitor activities and park uses. Each park will develop and implement visitor use management plans and take management actions, as appropriate, to ensure that recreational uses and activities within the park are consistent with its authorizing legislation or proclamation and are not carried out in derogation of the values and purposes for which the park was established....*

These visitor-use management plans can be prepared as coordinated activity-specific documents (river use plan, wildlands recreation use plan, winter-use plan, etc.), or as action plan components of a resource management plan or general management plan. They can also consist of a single integrated plan, such as a program-level wilderness management plan, that addresses a broad spectrum of recreational and other activities. Such plans should:

- Establish indicators and standards for desired visitor experiences and resource conditions, monitor the condition of those indicators on a regular basis, and take actions to meet the standards if they are not being met.

- Inventory, monitor, and maintain data on Park natural and cultural resources and values, and use this information in the most effective ways possible to facilitate Park management decisions to better preserve the Park.

- Manage and monitor visitor use and park resources in the Park's undeveloped areas to preserve and protect natural and cultural resources and ecosystem processes, and to preserve and maintain a wilderness experience, or where an area is not proposed for wilderness, a primitive experience.

The most appropriate tools for managing recreational activities emphasize visitor information and education. Additional tools may include general or special regulations; permit and reservation systems; and local restrictions, public-use limits, closures, and designations implemented under the discretionary authority of the superintendent. Restrictions and public-use limits established by the NPS will be based on the results of scientific research and other available support data.

*Developed Areas*

**South Rim** The South Rim is the primary destination for most of the nearly five million visitors arriving each year. The vision for the South Rim is to allow visitors direct access to Canyon panoramas, and to offer a range of visitor experiences ranging from more social experiences in Grand Canyon Village to solitary experiences.

The GMP establishes the goal of preserving the wilderness threshold experience along the Canyon's rim. Actions proposed in the plan are intended to ensure enjoyable experiences as visitors arrive at the rim. The anticipation and sense of arrival for first-time visitors, as well as returning visitors, are key elements in the visitor experience goals. The GMP describes South Rim visitor experiential goals in two phases:

- The sense of arrival and viewing the Canyon, taking in the spectacular vistas from the rim. Most visitors participate in this experience.

- Exploring the Canyon below the rim, is discussed in detail below.

**North Rim** The GMP calls for the National Park Service to provide a low-key, uncrowded atmosphere that offers visitors opportunities to be intimately involved with the environment. Opportunities for day hikes on maintained trails through the forest environment away from developed areas will be provided.

The North Rim will be closed to motorized winter use, and concession facilities will remain closed. One group campsite with portable toilets will continue to be available. As part of the winter hut system, portable huts will be placed in three areas accessible to moderately fit skiers. Winter use will be addressed in the Wilderness Management Plan.

**Tuweep** Even though Tuweep is accessible by car, this area will continue to provide uncrowded, semi-primitive experiences that are dominated by nature and solitude. Visitor facilities will remain minimal. The Park will work cooperatively with State and county entities, as well as Federal agencies and other groups to ensure that lands outside the Park remain uncrowded, and that other land uses do not adversely affect Tuweep.

**Cross-Canyon Corridor** The developed Corridor Management Zone within the Canyon provides an opportunity for an "inner canyon" experience while providing limited facilities and services. Corridor trails, i.e., the Bright Angel, North and South Kaibab, and River trails, are the most popular inner canyon hiking trails with an estimated 800,000 hikers using at least portions of the corridor. An estimated 400 search and rescue efforts are conducted annually to assist visitors in trouble.

The Park will develop a Corridor Management Plan/Development Concept Plan to address long-term management strategies for this popular area. An active monitoring program, along with indicators and standards, will be established to determine carrying capacities for visitors and stock on corridor trails. Effective actions will be implemented to minimize and mitigate the impacts of trail maintenance activities, such as borrow pits, on the environment away from the immediate trail. Existing borrow areas will be rehabilitated.

*Proposed Wilderness*

The National Park Service will manage and monitor visitor use and resources in the Park's undeveloped areas to preserve and protect natural and cultural resources and ecosystem processes, and to preserve and maintain a wilderness experience, or where an area is not proposed for wilderness, a primitive experience:

> *...Park visitors must accept wilderness largely on its own terms, without modern facilities provided for their comfort or convenience. Users must also accept certain risks, including possible dangers arising from wildlife, weather conditions, physical features, and other natural phenomena, that are inherent in the various elements and conditions that comprise a wilderness experience and primitive methods of travel. The National Park Service will not eliminate or unreasonably control risks that are normally associated with wilderness, but it will strive to provide users with general information concerning possible risks, recommended precautions, minimum-impact use ethics, and applicable restrictions and regulations....*

*NPS Management Policies (Chapter 6:8)*

**Wilderness Management Plan** The Park will develop a Wilderness Management Plan to specify policy and set guidelines for management of recreational use in the proposed wilderness. The Park's 1988 *Backcountry Management Plan* will be revised to be consistent with the direction provided in *NPS Management Policies,* as well as in the management objectives and other sections of the GMP. This revised plan will provide a variety of primitive recreational opportunities consistent with wilderness in all proposed wilderness areas.

Consistent with the above goals, the National Park Service will reduce conflicts among undeveloped-area users including river, hiker, stock, motorized and non-motorized users.

Ways to manage use in non-wilderness backcountry areas, including the corridor trails and Tuweep, will generally be addressed in separate plans according to the direction provided in the GMP, including the possibility of day-use permits or other restrictions in certain areas.

Areas proposed for immediate wilderness designation will be managed as wilderness, including the preservation of a wilderness experience. Areas proposed as potential wilderness will be managed as wilderness, to the extent that existing nonconforming uses will allow, and the NPS will seek to eliminate the temporary conditions that preclude wilderness designation. In undeveloped areas not proposed for wilderness, a primitive experience will be provided.

The Park Service will conduct all administrative activities, including research, search and rescue, and emergency response in a manner consistent with NPS policies regarding wilderness management, and the use of minimum tool in wilderness areas.

The GMP requires Park management to manage and monitor visitor use and resources in the Park's undeveloped areas to preserve and protect natural and cultural resources, as well as ecosystem processes.

**Colorado River Management Plan (CRMP)** The 1989 *Colorado River Management Plan* outlines, in the Limits of Acceptable Change (LAC) section, a recreational opportunity spectrum that defines the potential social conditions (contacts and crowding) during each use period. Since the GMP establishes the Park goal to provide for a wilderness experience in the proposed wilderness, the CRMP will be revised to provide more emphasis on management of wilderness values that include "outstanding opportunities for solitude or a primitive and unconfined type of recreation." The Plan will address other river-management issues identified through the scoping process. The revised Plan will also conform to NPS direction and responsibilities as set forth in the *Operation of Glen Canyon Dam Final Environmental Impact Statement* (Bureau of Reclamation).

Consistent with the above goals, the Park Service will reduce conflicts among area users including river, hiker, motorized and non-motorized users.

**Regional Recreational Opportunities** When deciding which opportunities will be provided in Park undeveloped areas, consideration will be given to the recreational opportunities available outside the Park, as well as opportunities available in Park developed areas.

**Interagency Cooperation and Coordination** As required by *NPS Management Policies*, the Park will seek to achieve consistency in wilderness management objectives, techniques, and practices, on both a servicewide and an interagency basis. The Park will coordinate with adjacent land management agencies to protect wilderness resources.

**Wild and Scenic** The GMP requires the Park to actively pursue the designation of eligible segments of the Colorado River and its tributaries as part of the National Wild and Scenic Rivers System. Public Law 90-542, the Wild and Scenic Rivers Act of 1968, as amended and supplemented, establishes a national system of wild and scenic rivers and provides for adding river segments to the system through Congressional action or by approval of the Secretary of the Interior following formal application by the Governor of the State concerned. The Wild and Scenic Rivers Act is a strong Congressional directive that rivers designated pursuant to its authority be preserved in their natural, or at least existing, condition. This implies an adequate quantity of water, of acceptable quality, necessary to accomplish the purpose of preserving the free-flowing conditions of a designated river. Designation would hold long-term protection for the Colorado River in Grand Canyon and especially for its tributaries, some of which are already threatened by activities such as well drilling and development.

The following additional studies and surveys will be required for the management of water resources:

- the impact of water diversion or ground water withdrawal on seeps, springs, and hanging gardens
- the impact of water diversions or ground water withdrawal on stream channels
- quantification of flows and water-related values at various springs and streams in order to participate effectively in future water rights adjudications
- an instream flow study for Garden Creek
- identification of areas where water resources are excessively impacted by management activities and/or visitor use

- research and monitoring of the resources of the Colorado River corridor to obtain information to guide its management

- ecosystem and biodiversity studies on tributaries and springs to develop adequate protective strategies

Research and monitoring will be conducted to better understand and manage the Park's water resources and hydrogeology. Measures will be taken to ensure that well drilling or other outside water uses do not adversely affect Park water resources. Appropriate studies on aquatic and other riparian communities will be conducted.

**Cave Management** A cave management plan will be developed to address issues such as the following:

- a permit system

- specific standards, indicators, monitoring programs, and methods to address problems when standards are not met

- active or passive management by the National Park Service or cooperative management by another entity, such as the Cave Research Foundation

- use limits or restrictions, if necessary, including party size limits

**Aircraft Management** In September 1994 the National Park Service presented the *Report on Effects of Aircraft Overflights on the National Park System* to Congress, in compliance with Public Law 100-91. This report contained specific recommendations for substantially restoring the natural quiet and experience of the Park relative to aircraft overflights. The GMP establishes the goal of protecting the Park's natural quiet and solitude, and mitigation or elimination of the effects of activities causing excessive or unnecessary noise in, over, or adjacent to the Park. Future planning will address aircraft overflight issues in detail.

The number of air-tour flights over Grand Canyon exceeds levels in any other park. The air-tour industry is comprised of more than 30 companies from five states. This multimillion dollar industry carries approximately 750,000 passengers averaging 80,000 flights per year. In the summer months, flights are estimated to exceed 10,000 per month. Projections are that flights will double by the year 2010.

## Issues

The following issues are the most compelling and pertinent to managing the recreational resource.

*The lack of knowledge of the effects of increased visitation on both Park resources and visitor experience, puts resources and visitor experience at risk*

With increased visitation and resource use come either increased resource damage or increased expense to protect resources. The interrelatedness of resource qualities being impacted and the use they are experiencing indicates the importance of understanding the nature and magnitude of Park visitation as well as changes in patterns. In addition to impacting the resource base, visitors impact each other. To protect visitor experience quality, an understanding of such factors as visitor numbers and visit timing and duration is crucial.

*The lack of knowledge concerning the effects of various recreational uses on Park resources and visitor experiences puts these resources and experiences at risk*

Specifically, additional understanding of expectations of backcountry users in high-use areas such as the cross-canyon corridor as well as within the three lower-use opportunity classes is needed. Conflicts between recreational stock users and hikers need to be addressed, as well as information regarding user conflicts between hiker and river recreationists.

*The lack of integration of known information regarding visitor expectations within back-country and river management plans puts those resources at risk*

Extensive user-preference studies were conducted in the 1970s regarding river-recreationists preferences. Less extensive but relevant studies regarding hiker preferences have also been conducted and are available for analysis regarding management strategies.

*The lack of an effective implementation program of restoration efforts regarding backcountry trails is resulting in continued deterioration of natural and cultural resources*

The proposed wilderness contains over 30 hiking trails totaling over 375 miles. Eighteen of these trails (approximately 260 miles) contain historic features (i.e. retaining walls, tread riprap, log cribbing, etc.). Most of these trails have received little or no stabilization or rehabilitation work since the Park's establishment over 75 years ago.

*Laws, policies, and regulations regarding management of the proposed wilderness must be met in order to assure protection of wilderness suitability*

Visitor experience throughout the proposed wilderness is not always consistent with NPS wilderness policies. Nonconforming uses within the proposed wilderness also negatively impact visitors. Resource impact, primarily campsite expansion and development of ever-increasing multiple trailing, continue to occur. An unprecedented amount of tour aircraft over the Park also negatively impacts visitors, particularly river and backcountry users.

*The GMP calls for the management of the Colorado River and its tributaries to protect and preserve the resource in a wild and primitive condition, and to actively pursue the designation of eligible segments as part of the National Wild and Scenic Rivers System*

In determining suitability for designation, it is critical to define the parameters which constitute "outstandingly remarkable scenic, recreational, geological, fish and wildlife, historic, cultural and other values.

A key element for Wild and Scenic designation is a quantifiable minimum flow necessary to preserve these values. Threats to these resources include pollution and diversions of water flow thorough dam emplacements, but more likely through ground water pumping. Virtually all of these threats (except the diversion of Bright Angel Creek, discussed elsewhere) originate outside the Park. The GMP calls for the NPS carrying its concern for the environment beyond Park boundaries, including the protection of Park resources and values from external influences. Protection of watersheds and spring-dependent streams requires long-range, cooperative planning and other proactive management strategies.

*The General Management Plan identified the impact created by the annual crush of nearly five million visitors and their private cars along the Canyon rims as the most pressing visitor-related issue*

Crowding and congestion adversely affect the visitor's experience. Staffing levels and infrastructure necessary to provide relevant and essential visitor education and information is inadequate. Significant environmental impacts result from pedestrian and vehicular trampling and destruction of vegetation due in part to inadequate trail design and location, as well as inadequately delineated parking areas. Development of the physical infrastructure necessary to accommodate large number of visitors within the Park's existing developed areas is the focus of the GMP. Development of requisite recreation management and resource restoration programs will result from implementation plans outlined in the GMP and this Resource Management Plan.

## Current Funded Program

In spite of the abundance of recreational activities and the enormous visitor influx into the backcountry, only three FTEs from within the Science Center are assigned to manage this program: a Sociologist, a Wilderness Coordinator, and one Biological Technician.

Resource management specialists and backcountry rangers are currently conducting monitoring and inventory of campsites in backcountry use areas. One three-week river trip is launched in the fall on the Colorado River. This trip is conducted in cooperation with a water quality specialist, an archeologist, and river rangers. In addition, two three-week-long river trips are launched every year, where a staff of approximately 10 to 16 volunteers works to restore disturbed wilderness areas. Much is accomplished on these trips, but the program cannot keep up with the damage caused by visitors throughout the backcountry.

The current Aircraft Overflight Management Program has only 0.8 FTE to handle this extremely complex and volatile issue. The need for 3.75 FTE has been identified to adequately operate this program.

## Proposed Unfunded Program

*Program Goals*

**Understand the Effects of Increased Visitation** The increase in the number of people visiting the Park has been dramatic. In 1919, the year Grand Canyon National Park was established, the Park received 44,173 visitors. By 1956, over one million visitors came to Grand Canyon. In 1991, over four million people visited, and the number is projected to increase to over five million by 1997.

In 1991, backcountry permits were issued to users who spent 87,384 nights below the rim. Approximately 23,000 visitors annually float the River. Although the exact figure is not known, it is estimated that 800,000 visitors per year day-hike below the rims into the Grand Canyon. All in all, a total of 233,000 user-nights is the estimated inner canyon annual use.

Resource impacts continue to occur at numerous campsites and visitor attraction sites. Campsite expansion, direct impacts on archaeological sites, and the development of social trailing are primary impacts.

On some River sections, visitors have difficulty locating unoccupied campsites, and must change their itinerary, often bypassing important hikes and other attraction sites. The number of visitors at some River attraction sites frequently exceeds 100, resulting in crowding and congestion in areas recommended for wilderness designation. Visitors often perceive these impacts as negative.

Visitor experience impacts include camping within sight and sound of other campers, contacts with large river parties and backpacking groups at attraction sites, and disturbance of natural quiet as a result of aircraft overflights or motorized rafts.

The proposed wilderness contains 30 hiking trails of approximately 375 miles. Eighteen of these "backcountry" trails (approximately 260 miles) contain historic features (i.e., retaining walls, tread riprap, log cribbing, etc.). Most of these trails have received little or no stabilization or rehabilitation since establishment of the Park over 75 years ago. As a result, most of the historic components are deteriorating. This results in erosional problems that adversely impact soils and vegetation.

- Inventory and Document
  One of the first tasks in resolving this issue is a thorough analysis of existing data. This is needed to develop comprehensive visitor profiles and visitor use patterns. The current General Management Plan conducted surveys in 1991, especially for frontcountry areas. Additional backcountry surveys are necessary for areas lacking baseline data.

- Monitor
  Monitoring requires periodic and systematic reinvestigation to maintain current data. Monitoring compares existing conditions against LAC standards for recreational impacts on backcountry and wilderness resources, and for visitor experience.

- Foster Research
  Visitation, especially international tourism, has never been carefully studied. The long-term effects of overcrowding within Grand Canyon's backcountry should be studied in terms of its impacts on all Park resources, visitor experience, and staffing and facility requirements. Conduct necessary research to establish Limits of Acceptable Change standards.

- Develop Management Plans
  Develop appropriate management plans for resource and visitor impacts identification and issue resolution. Management plans shall follow *NPS Management Policies*, Chapter 8.

- Mitigate Impacts and Protect
  Mitigate resource impacts exceeding LAC standards. Public-use levels will be managed, and impacted areas will be restored.

**Understand The Effects of Various Recreational Uses on Park Resources and Visitor Experience** It is important to provide for diverse recreational opportunities consistent with Park purposes. Coordination with adjacent land managers and other agencies to provide information on regional recreational opportunities will insure that this goal is met.

The Grand Canyon is recognized as a place with unusual and noticeable natural quiet, and direct access to numerous opportunities for solitude. The GMP calls for protection of the Park's natural quiet and solitude, and mitigation or elimination of the effects of activities causing excessive or unnecessary noise in, over, or adjacent to the Park.

Stock use is limited to approximately 40 miles of established trails. These include the Whitmore, Uncle Jim and Long Jim trails, as well as the Kaibab, the North Kaibab, River and Bright Angel trails located within the inner canyon Corridor Management Zone. Contacts between hikers and stock are frequent and often negative. Accumulation of stock excrement has a generally negative impact on hikers. Maintenance of trail conditions to NPS stock standards is costly and continual.

The Colorado River through the Grand Canyon is floated by nearly 23,000 visitors annually. The 17 permitted commercial outfitters provide trips from three to eighteen days, by motorized or oar-powered rafts and dories. Up to 150 commercial passengers may launch in one day. In addition, two noncommercial trips with up to 16 per trip may launch daily. The types and numbers of trips launching daily have an effect on the number of river party contacts and congestion at attraction sites. Mechanized off-road travel is prohibited within the proposed wilderness. Opportunities for Off-Road Vehicle (ORV) use are available on adjacent public lands.

Mountain biking is limited to non-wilderness rim areas. Inquiries and special use permits for outfitted mountain bike trips have been applied for, although no statistics on actual use have been documented. As is the case for ORV use, opportunities for mountain bike experiences, including access to the rim of the Grand Canyon, are available on adjacent National Forest, BLM, and National Park Service lands.

- Inventory and Document
  Surveys which document visitor perceptions of recreational uses and/or conflicts of uses were initiated at the General Management Plan scoping sessions in 1991-1992. Other surveys include the Backcountry Visitor Survey conducted in 1991, and the Aircraft Management Visitor Survey conducted in 1992. Additional surveys are necessary for inner canyon use; specific information is needed for the corridor, wilderness, and the Colorado River. To remain current, survey data needs to be updated at periodic intervals.

- Monitor
  Monitor recreational impacts on backcountry/wilderness resources and visitor experience against LAC standards.

- Foster Research
  Research regional recreational opportunities and understand the role of Grand Canyon National Park in this context. Projects include wilderness research and monitoring, further study and mitigation of stock impacts, and development of a travel simulation model for the Colorado River. Conduct necessary research to establish LAC or Visitor Experience and Resource Protection (VERP) standards.

- Develop Management Plans
  Develop appropriate management plans for resource and visitor-impacts identification and issue resolution. The revised Wilderness (Backcountry), Cross-Canyon Corridor, and Colorado River activity-level plans will include policies and standards for management of the Grand Canyon wilderness. The GMP treats all proposed wilderness areas as wilderness and anticipates the final resolution of wilderness issues and the preparation of a wilderness management plans as future actions. A Wilderness Management Plan will be drafted to guide these activity-level plans, and will identify future research needs on visitor experience. Follow *NPS-77*, Chapter 4, "Planning"; and *NPS Management Policies*, Chapter 8, "Use of Parks," and Chapter 6, "Wilderness Preservation and Management."

- Mitigate and Protect
  Mitigate resource impacts exceeding LAC standards. Mitigate visitor-use conflicts through appropriate management and planning techniques. Public-use levels will be managed, and impacted areas will be restored based on management actions prescribed in the respective plans. Mitigate the disturbance of natural quiet as a result of aircraft overflights or motorized rafts and vehicles.

*Meet Laws, Policies, and Wilderness Designations*

Goals include:

- Write a Wilderness Management Plan, and integrate "NPS Wilderness Preservation and Management Guidelines" (from *NPS Management Policies*) into Wilderness, Corridor and River Management Plans. In areas proposed for wilderness, establish LAC consistent with wilderness standards for resource impacts and visitor experience

- Pursue Wilderness, and Wild and Scenic River designations for suitable areas.

*Interpret and Educate*

Emphasize the role of interpretation and education in the management of various recreational activities and their impacts. Interpretation and public education provide an effective, cost-efficient means of protecting resources and values by fostering an understanding of Park goals, objectives, and policies. Visitors will be informed of minimum-impact techniques and Park, as well as regional, recreational opportunities. This approach is consistent with the NPS mission, and is most appropriate for wilderness environments.

Projects include the cooperative development of a wilderness visitor education and information program as part of the Wilderness, Cross-Canyon and River Management plans revision processes. The Divisions of Interpretation and Visitor Protection, and the Science Center will play a key role in this effort.

**Figure 3-14**
*The FTE allocation required to fully staff a Recreational Resource Management and Social Science Research Program which would address most of the issues and threats described above.*

| Recreation Resource Management and Social Sciences Research | NEEDED FTE** Allocation | CURRENT FTE Allocation |
|---|---|---|
| Wilderness Planning, Compliance, and Coordination | 0.70 | 0.70 |
| Wilderness Impact Restoration | 0.20 | 0.20 |
| Visitor Use Planning | 1.35 | 0.60 |
| Visitor Use Monitoring | 2.00 | 0.50 |
| Overflight Program Development and Coordination | 0.50 | 0.80 |
| Overflight Acoustic Monitoring | 3.75 | 0.00 |
| Social Science Visitor-based Research | 0.50 | 0.20 |
| TOTAL | 9.00 | 3.0 |

** Full Time Equivalent*

# Research Program

## Program Overview

A new comprehensive research program within the Grand Canyon Science Center was created in 1996. The focus of this newly defined program is to more effectively develop, organize, and communicate scientific information supporting a more complete understanding of the Park's resources and resource-management alternatives. Accurate information about the Park's resources, ecological processes, and human influences is essential for informed decisions about current and future management alternatives.

Research is the process of collecting new information, and the critical reexamination of existing information to test a hypothesis or to answer a specific question. The Grand Canyon comprises a truly world-class outdoor laboratory, unparalleled in its revelation of much of the North American continent's geologic, biologic, and human history, and breathtaking in its majesty and extent. It is only natural therefore, that the Canyon continually attracts the interests and energies of many scientists, including some investigators working on basic scientific questions and others addressing more applied problems. Here, scientists find a proving ground to develop and test theories of the origins of the continent and of the earth's earliest life forms. Scientists conduct studies on the behavior, life history, and habitat requirements of wildlife, fish and plants. They conduct paleoecological research to answer questions dealing with species extinctions, and to provide insight into opportunities for preserving modern-day threatened and endangered species, such as the California condor.

Scientific investigation of the Canyon's historic and prehistoric human occupation helps form a better understanding of the complex relationships between human societies and arid ecosystems, a timely subject throughout much of the American West and the world.

Much of the research in Grand Canyon is directed toward the solution of immediate or long-term resource management questions. In addition to natural or cultural resource issues, these research questions center upon visitor-based issues including visitor profiles and visitor-use patterns, visitor-resource preservation issues, or determining more effective visitor-management practices.

This applied-research component is vitally important to fulfillment of the National Park Service mission at Grand Canyon. The Research Program thus includes a broad range of activities including basic and applied research, resource inventory, monitoring, and information synthesis. In theory, the program potentially encompasses all relevant facets of scientific investigation in the broad scientific disciplines of the biological, physical, and social sciences, including such seemingly diverse topics as: archaeology, anthropology, botany, climatology, ecology, geology, history, hydrology, paleontology, psychology, sociology, and zoology.

In the context of Park management, interpretation, and resource protection many of these topics are closely interrelated. Consider, for example, how climate patterns, canyon geomorphology, land-use history, and modern water-management practices affect flooding along the Colorado River. Erosion and deposition of sediments by flood waters determines the quantity and quality of habitat available for endangered fish and wildlife, the condition of ancient cultural sites, and the distribution of campsites accessible to recreational users.

Through studies of tributary debris flows, plant remains preserved in stratified river-bank deposits and caves, and channel geomorphology, scientists are able to mathematically reconstruct past flooding events and to model and predict future changes to the system to preserve and protect valuable resources.

## Program Objectives

### *Obtain High Priority Information*

The Research Program is focused on meeting the highest priority information needs of Park resource management. This includes providing new information about the Canyon's natural and cultural history as well as information on park visitors, visitor-resource relationships, and visitor-management issues. Additionally, this program seeks to identify and address fundamental scientific questions, and to provide baseline information and historic trend analysis that may influence our ability to address future management options.

### *Create a Program Balance*

Experience shows that the solutions to natural resource information requirements often call for a mix of both short-term and long-term investigations, using both basic and applied research. No single formula is applicable to all situations, and the effort expended in each area is best determined on a case-by-case basis. Factors involved in this decision include the importance and urgency of the particular topic, and the resources available to address the issue.

### *Focus on Responsiveness*

Although the Grand Canyon has a long and productive history as a subject of scientific studies, this comprehensive program was not established until 1996. Consequently, defining appropriate areas of program emphasis, developing project-needs statements and priorities, and instituting appropriate administrative processes will be especially important ongoing processes. We will promote responsiveness through development of prioritized research-needs statements, including research-funding proposals for the highest priority needs. Topics for tactical research will be identified with the close participation of Park resource management staff. We will also invite active participation by scientists from major universities, other agencies, American Indian nations, and nongovernmental organizations to help develop a long-range vision, by identifying emerging issues that could help us to anticipate and address the information needs of future Park resource managers, policy makers, and visitors. Park management, resource managers, field scientists and interpretive specialists will be consulted frequently throughout this process to obtain their suggestions and to solicit feedback on progress.

### *Create Effective Partnerships*

To leverage greater accomplishments than would be possible with only Park personnel and funding, we intend to develop strong partnerships with other organizations, including Federal and non-Federal government agencies, adjoining land and water management offices, universities, scientific organizations, and conservation organizations. These partnerships will take many forms, including collaboration on joint research efforts, shared support for research of mutual interest, and facilitation of studies appropriate to the Park's mission and responsibilities. Park scientists will also participate in cooperative efforts to address relevant and important regional, national or international issues.

*Achieve Scientific Excellence and Credibility*

The Research Program seeks to attain a world-class standard of excellence, quality and credibility in natural resource research and resource management applications. We will promote excellence by working to establish competitive, merit-based support of all research financed by the National Park Service or by other funding agencies. We will ensure quality and credibility by requiring peer reviewed study plans for research in the Park. Peer review will be required for NPS-funded research proposals, for development of standard methods and monitoring protocols, for studies with the potential to conflict with other Park functions, and for any work involving rare, fragile, vulnerable or otherwise controversial resources (e.g., threatened and endangered species or habitats, cultural resources, caves, and vertebrate paleontology, etc.).

## Issues

Many of the important issues affecting Park management will also influence our selection of research questions and the way in which we address those problems. Some of the important current trends include the following:

*Park visitation is increasing, and many visitors are seeking more challenging recreational opportunities. This intensifies the pressure on limited and vulnerable Park resources (e.g., riparian ecosystems, back country, and caves)*

Basic data on visitation is needed, as well as new and improved solutions to minimize visitor impacts on Park resources, and to maximize visitor enjoyment.

*The cumulative effects of environmental degradation from air and water pollution, past mining activity, contaminants, dam operations, exotic species, and other pressures put fragile and irreplaceable resources (e.g., endangered species, rare biotic communities, cultural treasures) at risk*

Environmental degradation also reduces the quality of the Park experience, and has the potential to impact visitor/employee health and regional economic growth. New alternatives for resource protection and restoration are needed.

*Shifting national priorities and changing organizational structures are increasing competition for research dollars needed to address Park-relevant problems, while at the same time, research methods are becoming increasingly complex, costly, and multi-disciplinary in scope*

This makes it increasingly important to pursue creative mechanisms for funding Park research, including cost-sharing, competitive grants, and other options.

*Other Federal and non-Federal organizations, American Indian nations, and the general public are becoming increasingly sophisticated in their resource knowledge, and in some cases are demanding a greater role in influencing Park resource management decisions*

This reinforces the Park's need for timely and credible information, while at the same time, represents an opportunity for greater cooperation and cost-sharing.

*Conflicts over multiple-resource uses are becoming increasingly polarized and politically and legally contentious*

This makes it difficult if not impossible to reach consensus on needed solutions once the issues have become the subject of intense public debate. Resource use and preservation issues must be clearly understood in a broad ecological context, and alternative solutions must be developed before significant concerns evolve into critical dilemmas.

## Current Funded Program

### *NPS-Funded Research*

Research, inventory, and monitoring activity by Park staff is heavily focused on meeting legal mandates calling for the protection of cultural heritage, sensitive species, and other vulnerable Park resources. Although only one full-time position is currently assigned specifically to the Research Program, Park Science Center staff conduct inventory or monitoring activities as part of their responsibilities (e.g., wildlife biology, botany, and archaeology).

### *Extramural Funded Research*

In addition to Park-led projects, about 80 studies with non-NPS investigators are underway in 1996. Overall, extramural funding greatly exceeds NPS research funding in Grand Canyon. Other Department of the Interior agencies with significant research commitments in the Grand Canyon include the Bureau of Reclamation, the U.S. Fish and Wildlife Service, the U.S. Geological Survey, and the National Biological Service.

Other studies are partially or fully supported by the National Science Foundation, Arizona Game and Fish Department, American Indian nations, and private nonprofit, organizations such as the Grand Canyon Association and the National Geographic Society. Several scientists working in the Grand Canyon receive financial support from their college or university, and some are privately funded.

River-related research made up approximately half of all the studies within Grand Canyon National Park in 1996. Most of these were designed to document the effects of the first floodwater release from a major U.S. hydropower facility intended solely for the purpose of environmental restoration. The range of other studies underway in 1996 includes: archaeology, botany, cave and karst science, climatology, entomology, environmental monitoring, erosion, exotic species, fire, fisheries, forestry, geography, geology, herpetology, history, hydrology, invertebrate biology, limnology, mammalogy, ornithology, paleontology, recreation science, sedimentology, threatened and endangered species.

### *Glen Canyon Dam Adaptive Management Science Program*

The single, largest externally-funded research program is the Interagency Adaptive Management Monitoring and Research Program carried out by the Grand Canyon Monitoring and Research Center (GCMRC). This organization, created in 1996, is lead by a Director that reports to the Office of the Assistant Secretary of the Interior for Water and Science.

This program is the successor to the Glen Canyon Environmental Studies Program (GCES) which concluded in 1994. The primary objective of this program is required by Congress as part of the Grand Canyon Protection Act. Its mission is to better understand how dam and reservoir operations (i.e., Glen Canyon Dam and Lake Powell) affect geological, biological and climatological processes, resource condition and human uses of the Colorado River within Grand Canyon National Park and Glen Canyon National Recreation Area. This information is needed to provide the scientific basis for managing Glen Canyon Dam to reduce the impacts to sensitive resources and recreation activities within the two national parks.

*Consolidated Research Planning and Permitting Process*

Research, inventory, and monitoring activities have previously been authorized under a variety of legal authorities and instruments including: Park resource office operations, cooperative agreements, interagency agreements, special use permits, and collecting permits. In fact, one or more of at least 15 permitting instruments may be required for scientific investigations in the Grand Canyon depending on the subject matter, location, planned activities, and investigator's affiliation. However, the level of scrutiny and control exercised for each type of permitting instrument has been variable, as has the Park's return on its investment (i.e., deliverables). In the future, more than one permitting type or instrument will continue to be used when required by law or policy. However, all types of scientific inquiry will be coordinated through a single office (i.e., Senior Scientist) to ensure that the work meets the Park's reporting standards and is completed in the most timely, efficient and least intrusive manner. Standards will also be established for project review, restrictions, and required deliverables.

New or revised processes and tasks to be implemented include the following:

**Administrative Processes and Tasks**

- Coordinate new research permit applications through a single office
- Simplify and consolidate permitting requirements, as appropriate
- Develop and periodically revise research proposal/study plan guidelines
- Establish consistent reporting standards, deliverables, terms, and conditions
- Inform adjacent park units as new proposals are received and permits issued
- Ensure independent peer review of research proposals and study plans
- Facilitate investigator communications with other Park offices and authorities
- Ensure compliance with contract and permit requirements
- Develop and maintain databases to track activities and accomplishments
- Report on accomplishments
- Seek and apply feedback from principal investigators, Park management, and others

**Grand Canyon Comprehensive Research Program** The Research Program will identify, promote, and develop studies to meet the information needs of Grand Canyon National Park, the Department of the Interior, and of the larger scientific and educational community. Most of the research project statements, previously developed under the Natural Resource or Cultural Resource programs, and not yet completed, remain important priorities. The planning process for new research includes the following steps:

**Identify Research Needs**

- Identify immediate applied science (tactical) information needs of Park resource managers
- Identify gaps in our basic scientific understanding of natural and anthropogenic (human-influenced) processes involved in the formation, maintenance, or impairment of Park resources
- Identify gaps in our basic scientific understanding of social science variables and processes involved with visitors, visitor-use patters and impacts, and visitor-management practices in the Park
- Identify long-term trends likely to influence future information needs
- Establish ad hoc or formal advisory groups of subject-matter experts to help formulate research needs and to establish the urgency and relative importance of competing needs

**Forge Partnerships**

- Identify potential clients, partners, and users of information produced in the Park
- Foster consensus within the Park and among cooperators about current research priorities
- Develop partnerships with other Interior and Federal agencies, States, local government, American Indian nations, universities, private individuals, and organizations to cooperate in sharing research costs and scientific information

**Plan, Implement, and Report on Results**

- Promote development, funding, and implementation of specific research proposals to meet highest priority research needs
- Facilitate appropriate research activities and encourage close interaction with Park personnel and offices
- Ensure that the research findings are communicated to Park management, interpretive staff, and other users through publications, professional conferences, workshops, symposia, electronic media, or other appropriate means
- Ensure that permanent access to archival-quality data and museum specimens is retained by the NPS, including physical transfer of data sets and collections to the Park or to partner offices (e.g., GCMRC) when appropriate

## Proposed Unfunded Program

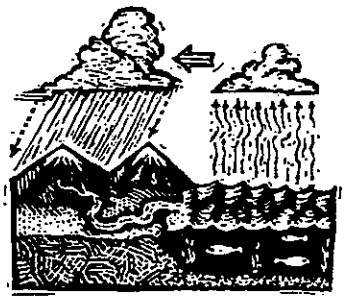
### *Grand Canyon Long-Term Monitoring Program*

Monitoring involves the repeated collection of data at regular time intervals using standardized protocols in order to determine changes in resource condition relative to a previously defined standard. Analysis of monitoring data provides information on resource status and trends (e.g., increasing or decreasing abundance, composition, distribution, etc.) which can be applied by resource mangers to initiate or modify appropriate management actions (e.g., conservation, restoration, control).

A comprehensive long-term monitoring plan follows specific indicators of change for all significant resource categories over an extended time frame. The selection of the specific indicators to be monitored, frequency of sampling or data collection, level of detail studied, methods, and program scope will be determined from the anticipated level of change (predicted or previously measured), statistical requirements, potential or measured impact (of monitoring activity on resource condition), technological and logistic factors, cost/benefit analysis, and other factors.

It is important to recognize that many potentially valuable data sets already exist, and that in some instances complementary regional, national, or local monitoring programs may already be underway. The Research Program will therefore develop partnerships, and use data from ongoing programs whenever feasible and appropriate. Whenever possible, new monitoring plans will also be linked to the initial resource inventories and to ongoing research on the forces which maintain or drive changes within the ecosystem. Standardized protocols will also be adopted or established in cooperation with other agencies to enhance comparability of data and methods.

Routine monitoring will be carried out primarily by Science Center staff and cooperators working under the auspices of the resource management programs (e.g., GCMRC). However, development of new inventory and monitoring programs, complex data evaluation, and information synthesis will be a collaborative process involving resource management staff, research staff and other scientists. The Grand Canyon Long-Term Monitoring Plan will include consideration of the same broad resource categories and topics as for research.



# Grand Canyon Science Information Needs

## High Priority Information Needs Identified by Program

*Cultural Sciences, Anthropology, and Archaeology*

Grand Canyon contains abundant evidence of human occupation dating from many different cultures and time periods. The Park has a strong cooperative program to locate, characterize and preserve cultural sites within the Colorado River corridor, and recognizes the need for comprehensive archaeological inventories throughout the rest of the Park, especially in high-use areas. Development of a model archaeological research design for scientific investigations of prehistoric sites, patterns of occupation, and human ecology within the Canyon and surrounding areas is currently a top priority. Regional ethnographic and traditional-use studies are also needed to document tribal interests (i.e., Hopi, Navajo, Hualapai, Havasupai, Southern Paiute, Zuni, etc.) for Grand Canyon and other National Park Service areas on the Colorado Plateau. Other research needs include a determination of the effects of forest fire on archaeological sites and data recoveries for site-specific mitigation.

**Specific Information Needs** (Resource Management Plan project statements applicable to these studies are listed in parentheses.)

- Research
  Develop and implement archaeological research design(s) applicable to investigations of archaeological sites throughout the Park. (GRCA-C-400.001)

- River Corridor Archaeological Monitoring and Mitigation
  Monitor cultural sites potentially impacted by Glen Canyon Dam operations to determine present condition, rate of change due to erosion, bank collapse, etc. Develop mitigative measures to ensure long-term site integrity and recover data as needed. (Important ongoing studies, being accomplished through current programs). (GRCA-C-410.003)

- Ethnographic Studies
  Conduct an ethnographic overview and assessment of tribal interests and uses Colorado Plateau parks (i.e., Hopi, Navajo, Southern Paiute, Hualapai, Havasupai, Zuni, etc.). These studies have application to several NPS areas and should be specific to each tribe, rather than to the particular park. (GRCA-C-700.001, GRCA-C-700.002)

- Archaeological Site Inventories
  Conduct comprehensive archaeological inventories of developed and high-use areas (i.e., campgrounds, trails, road corridors, etc.) (GRCA-C-410.000, .001, .002)

- Fire Archaeological Impact Studies
  Assess effects of management-ignited fires on archaeological resources. The focus of this study should be applied to known and expected resource types within the proposed areas of prescribed fire. First priority should be a thorough literature search and direct communication with specialists in other locations (e.g., Mesa Verde), to help guide planning for any needed field studies. (GRCA-C-430.001, .002)

- Tribal Use Studies
  This subject deals exclusively with traditional uses, collections, ceremonials, etc., which occur within the landscape of NPS units. The study should be tribe specific, and applicable to all NPS units within the tribe's areas of concern.

- Grand Canyon National Park History
  Develop a comprehensive history of Park CCC activities to support National Register nomination as a multiple property district. (GRCA-2-220.020)

- Cultural Landscape Studies
  Identify, document, and evaluate cultural landscapes, beginning with areas identified in the Grand Canyon National Park General Management Plan, and incorporating NPS-28 defined categories which occur within the Park. (GRCA-C-331.000 -GRCA-C-331.011)

- Data Recovery
  Site-specific mitigation plans for impacted sites within Grand Canyon backcountry. Site priorities should be established from the Backcountry Management Plan, with Clear Creek and Boucher as likely first priorities. (GRCA-C-420.003)

*Natural Resource Program*

The great diversity of ecosystems within Grand Canyon National Park support a wide variety of vertebrate and invertebrate wildlife, including large and small mammals, migratory and resident birds, reptiles, amphibians, and invertebrates. The Park's enormous size (1.2 million acres), extremely variable terrain, and logistical difficulties of wilderness research have limited knowledge about the abundance, distribution, and life history of many Park species. Current information needs include wildlife inventories and basic life-history data for many species, as well as studies directed towards the preservation of rare and special status species.

**Specific Information Needs**

- Forestry:
  - Biological Monitoring
    (Fire) (See Fire History, Fire Ecology, and Management
  - Fire Ecology
    (See Fire History, Fire Ecology, and Management)
  - Management Alternatives
    (Fire) (See Fire History, Fire Ecology, and Management)
- Threatened and Endangered Species Study. Population status and trends for Federally-listed species:
  - Southwest Willow Flycatchers
    (see Colorado River and Riparian Studies)
  - Humpback Chub
    (see Colorado River and Riparian Studies)
  - Kanab Ambersnails
    (see Colorado River and Riparian Studies)

- Resource Surveys:

  - Relict Vegetation Surveys
    Much of the remote backcountry of Grand Canyon has never been systematically explored. Surveys are needed throughout the Park to locate and characterize relict areas of unaltered natural vegetation. Opportunities for investigating previously undescribed communities are good. (GRCA-N-134.000)

  - Bat Population Surveys
    (GRCA-N-210.107)

  - Invertebrate Surveys
    Inventory spring, seep, wetlands, invertebrates (GRCA-N-230.103, GRCA-N-210.006)

  - Cave Resource Inventory and Assessment
    (See Groundwater, Cave and Karst Studies)

  - Herpetofauna Surveys
    (GRCA-H-210.102)

- Ecosystem Restoration:

  - Prairie Dogs
    Study feasibility of reintroduction. (GRCA-N-270.100)

  - Exotic Flora and Fauna
    Investigate routes of entry, colonization and suitable management alternatives to control infestations and limit damage to native species and other Park resources. (GRCA-N-250.100)

  - Anthropogenic Effects Studies
    (See Social and Recreational Science)

*Social and Recreational Science Program*

Understanding Park visitors, their needs, motivations, and how they use or abuse their parks is a basic need for informed management. Information about visitors, use patterns, perceptions, etc., is currently needed to support revisions of the backcountry, wilderness, river, and aviation management plans. Information needs in these areas include visitor surveys, resource-impact studies, and management alternatives.

**Specific Information Needs**

- Acoustic Monitoring
  Design and operate an acoustic monitoring system for overflights by aircraft tour operators. (GRCA-N-800.005)

- Visitor Characteristics and Use Patterns Surveys:

  - Backcountry Day-Users
    (GRCA-N-800.006, .007)

  - Backcountry Overnight Users
    (GRCA-N-800.008)

  - River Users

  - Rim Users
    (i.e., frontcountry)

- River-Use Allocation:

  - Evaluate Alternative Strategies for Equitable Allocation of River-use Permits

  - Develop or Refine a River Travel Simulation Model
    (GRCA-N-8000.003)

- Monitor Visitor Impacts to Park Resources:
  - Visitor Impacts to Day-Use Resources (GRCA-N-800.006)
  - Visitor Impacts to River Resources (GRCA-N-800.002)
  - Visitor Impacts to Backcountry Resources (GRCA-N-800.001)
  - Visitor impacts to Rim Resources
  - Anthropogenic Effects Studies Document effects of aircraft, research, trail maintenance, patrols, rescues, etc., on wildlife and other sensitive Park resources. (GRCA-N-260.100, .101, .102)
- General Visitor Surveys: Profiles, expectations, and satisfaction

## High Priority Information Needs Identified by Ecosystem

### *Colorado River and Riparian Ecosystems*

Completion of Glen Canyon Dam in 1963 greatly moderated downstream flows in the Colorado River. The frequency and magnitude of river flooding was sharply reduced, seasonal flow patterns altered (reduced in spring and summer, increased in fall and winter), suspended sediment nearly eliminated (except for downstream tributary inputs), seasonally-variable water temperatures stabilized (to an average 46°F at the Dam and 55-60°F at Diamond Creek), and the natural migratory routes of fish and wildlife were blocked. Resultant changes to downstream ecosystems have been enormous. Of eight species of native fish present when Glen Canyon Dam was constructed, three species including roundtail chub, the endangered Colorado squawfish and bonytail chub have been extirpated. Two species (razorback sucker and humpback chub) are listed as endangered. Three other native species, bluehead sucker, flannelmouth sucker, and speckled dace, remain relatively common. In the near absence of annual flooding, riparian vegetation has increased greatly, including native marsh plants and the exotic tamarisk. With the reduced frequency and magnitude of flooding, and the loss of sediment trapped in Lake Powell, beach building processes have been greatly diminished and erosion of archaeological sites and camping beaches has accelerated. Current information needs in the river corridor include surveillance and monitoring of impacted resources, and mitigative measures to preserve and restore sensitive species, cultural sites, and high-quality recreational opportunities. Studies are also needed to improve our understanding of riverine ecology and the effects of basic environmental conditions, including flooding, sedimentation, erosion, and water temperature. (GRCA-N-800.004)

**Specific Information Needs** (Important ongoing studies, mostly funded through ongoing programs)

- Threatened and Endangered Species
  Study population status and trends for Federally-listed species in the Colorado River and riparian areas potentially affected by operations of Glen Canyon Dam (GRCA-N-220.100):

  Southwest Willow Flycatchers (GRCA-N-230.100, GRCA-N-220.103)

  Humpback Chub
  Determine current status and long-term trends in adult population, health, reproduction, and recruitment in the Colorado River main channel, Little Colorado River, and other tributaries. (GRCA-N-220.106).

  Kanab Ambersnails
  Study genetics and ecology. Monitor changes to populations, and determine potential for secondary populations within and outside the Grand Canyon. (GRCA-N-220.101).

- Cultural Resources
  River Corridor Archaeological Monitoring and Mitigation (See Cultural Sciences, Anthropology, and Archaeology).

  Identify Traditional Cultural Property Sites Potentially Impacted by Dam Operations

- Integrated Ecological Study
  Investigate anthropogenic forces, environmental processes, and resource condition (keystone and indicator resources, status, cycles, and long-term trends) from the Glen Canyon Dam forebay to the headwaters of Lake Mead.

- Dam Operations
  Monitor the primary physical factors controlled by dam operations: stream flow, stage, sediment load, discharge temperature, water composition, etc., in the main stem Colorado River and confluence of major tributaries.

- Riverine and Riparian Processes
  Monitor initial ecological responses to dam operations (riparian climate, erosion, sediment transport and deposition, photosynthesis, downstream water temperature, water quality, etc.)

- Sediment Resources
  Monitor distribution, elevation, open area, longevity, and other characteristics of sand bars and beaches suitable for camping and associated backwater areas.

- Fisheries Resources
  Study reproduction, recruitment, population dynamics, distribution, frequency of occurrence, and other life history traits of native and nonnative fish species in the Colorado River between Glen Canyon Dam and Lake Mead.

  Flannelmouth Sucker, Bluehead Sucker, Speckled Dace and Other Native Species (GRCA-N-210.101)

  Salmonids, Ictalurids, Cyprinids, and Other Nonnative Species, and Impacts on Native Species (GRCA-N-250.102)

- Vegetation
  Monitor distribution and abundance of native and nonnative riparian vegetation, including Federal, State, and tribal listed sensitive species, old high water zone, new high water zone, and near shore marshes (GRCA-N-105.000)

- Food Web
  Determine status and trends in species composition and population structure of ecologically important food web organisms originating from aquatic and riparian sources, and influence of ecologically significant processes. (GRCA-N-230.104)

- Wildlife Resources
  Monitor distribution, abundance, and population structure of wildlife species with the Colorado River corridor, including resident and migratory birds, mammals, and herpetofauna. (GRCA-N-210.104, GRCA-N-220.103)

- Models and Trend Data
  Develop information systems and mathematical models for evaluating alternative operations of Glen Canyon Dam under the Adaptive Management Program:

  Flooding
  Evaluate through modeling and experimentation, the beneficial and deleterious effects of floods and flood exclusion on natural, cultural, and recreational resources within the Colorado River from Glen Canyon Dam to Lake Mead.

  Sediment Transport
  Model and measure sediment contributions to the Colorado River from all significant sources, determine the amount of sediment needed to maintain sandbar, backwater, and bank deposits, and track sediment supplies available for redistribution through flow manipulation.

  Selected Temperature Withdrawal
  Evaluate the feasibility of long-term and short-term changes to discharge water temperature from Glen Canyon Dam, and the potential effects on distribution, reproduction, recruitment, and survival of native and nonnative fishes, on the aquatic food base, and on other resources (GRCA-N-230.101)

*Forest Ecosystems*

After nearly 100 years of fire suppression in Northern Arizona forests, dangerously high fuel loads have accumulated because of understory vegetation, dead fall, and crowding. Pre-settlement tree density in ponderosa pine forests that once averaged 40 trees per acre (1869) have increased to a present day 850-1,000 trees per acre. The potential for catastrophic stand-replacing fires is extremely high. Although prescribed burns and managed natural fire can reduce fuel load in limited areas, broad application of these techniques within the Park is limited, notably by protection of cultural sites, sensitive wildlife species, air quality, and safety issues. The highest priority for fire research in national parks is to provide information for fire management decisions. Areas at high risk of catastrophic fire are identified, and present-day options evaluated through close cooperation of scientists and Park management. Innovative long-term management alternatives to fire suppression and limited prescribed fire regimens are also needed. The effects of wildfire, fire suppression and prescribed fire on human safety, wildlife, archaeological sites, and other important resource values (e.g., air quality, scenic vistas, etc.) should be documented and evaluated in an ecosystem context, so that appropriate protective and mitigative measures can be developed and relative advantages weighed.

Forest ecology studies are needed to describe the frequency, magnitude, and distribution of pre-settlement natural fires in several vegetative community types and numerous locations. Changes in vegetation, species occurrence, abundance, and population structure that can be attributed to fire suppression, grazing, exotic species, and natural succession (forest, meadow, scrub, etc.) should be documented over time, and projected into the future.

**Specific Information Needs** Management Alternatives (Fire). Develop improved and alternative management strategies to reduce risk of resource damage from catastrophic fires in coniferous and mixed forests, Mojave mixed desert scrub, etc. Prescribed fire, as currently implemented, can neither control the risk of wildfire, nor fully restore ecosystems to pre-settlement conditions. During the past few years, Park officials and subject-matter experts have pointed to the need for innovative techniques. Scientific research, founded in modeling and cognizant of the need for practical applications, will provide credibility to the use of such techniques.

- Fire History
  Research the natural (pre-settlement) fire regime for plant communities through fire-scar analysis, and develop management recommendations based on findings (GRCA-N-121.000)

- Biological Monitoring (Fire)
  Develop a prescribed fire biological monitoring program, including evaluation of the existing fire effects monitoring programs, with potential applications in other areas. (GRCA-N-121.100)

- Fire Ecology
  Research the effects of fire exclusion and prescribed fire on Park wildlife and the representative vegetation communities including grasslands on the Kanab, Shivwits, Coconino, and Kaibab plateaus). To maximize the value of applied research in this area, the broad subject areas would need to be narrowed considerably through discussion with Park management. (GRCA-N-121.300)

- Fire Archaeological Impact Studies (see listing under Cultural Sciences, Anthropology, and Archaeology).

*Ground Water, Cave, and Karst Ecosystems*

Grand Canyon National Park is located in the arid Southwestern United States. Park ecosystems range from upland coniferous and semiarid forests to Great Basin and Mojave deserts. Beyond the river corridor, availability of potable water is perhaps the Park's most limited resource. Lack of readily available water has also greatly constrained the growth of communities outside Park boundaries. The primary source for potable water within the Park, and for the gateway community of Tusayan, is the collection of ground water issuing from Roaring Springs, a solution cave within the Redwall Limestone. Numerous other springs and seeps throughout the Canyon provide localized pockets of moisture essential to the survival of native plants and wildlife (including the endangered Kanab ambersnail). Human visitors to backcountry areas also depend on natural springs for drinking water. The capacity of the aquifer and locations and flow rates of remote seeps and springs is largely undetermined. Park management is concerned about ground water development, and particularly about wells to be drilled south of Grand Canyon Village, because ground water withdrawals may reduce or eliminate flows within the Park.

Research is needed to determine aquifer storage, sustainable yield, ground water distribution patterns, and surface recharge conditions within the Park and surrounding areas. The potential effects of mine-waste and other surface contaminants should also be quantified. Hydrologic and ecological studies are also needed for documenting flows and associated dependent flora and fauna at existing springs and seeps.

Grand Canyon National Park contains extensive karst formations, but very little of a specific nature is known about the cave resources. Park files contain locations and other general information for several dozen caves within the Park that have been explored to some extent. However, few caves within the Park have been systematically surveyed to identify significant physical, biological, and cultural resources, and the passages of only a few caves have been accurately mapped. Detailed scientific information is needed for hundreds of unexplored caves within the Park. First priority should be inventories of known caves and establishment of long-term resource monitoring protocols, followed by exploration of wild caves, and research to better understand the nature and significance of cave resources within the Park.

**Specific Information Needs**

- Ground Water Studies
  Conduct detailed hydrogeologic studies of South Rim areas. Document real and potential effects of surface and ground water diversions within and outside the Park (Roaring Springs, Tusayan, South Rim). Identify alternative sources of potable water. (GRCA-N-330.500, GRCA-N-330.501, GRCA-N-360.101)

- Cave Resource Inventory and Assessment
  Plan and implement cooperative program of study (GRCA-N-510-001, GRCA-N-570.101)

- Bat Population Surveys
  (See Other Biotic Resource Studies)

- Invertebrate Surveys
  (See Other Biotic Resource Studies)

- Kanab ambersnails
  (See Colorado River and Riparian Studies)

*Other Information Needs*

**Administrative and Legal Topics**

- Legal Boundary Studies
  Research legal and administrative history of Grand Canyon/Reservation boundaries (GRCA-C-130.002) (study initiated, 1996)

- Administrative Park History
  (GRCA-I-310.010) (study underway by Grand Canyon Association)

- Assemble Information to Support NPS Water Rights Claims
  (GRCA-N-390.101) (Little Colorado River studies initiated, 1996)

- Consolidate and Summarize Law, Treaties, and Administrative Mandates Affecting Grand Canyon, Including any State, Local, and Tribal Authorities

- Prepare Administrative History of Natural Resource Management and Research
  (GRCA-I-310.020)

**Life Science Topics**

- Inventory, Assess and Monitor Sensitive Plant Species Including Sentry Milk-vetch and Cryptobiotic Soil Crusts
  (GRCA-N-133.000) (sentry milk-vetch studies underway, 1996)

- Inventory and Monitor Carnivores
  (GRCA-N-210.109)

- Inventory and Monitor Upland Birds
  (GRCA-N-210.103)

- Monitor Kaibab Squirrel Population Trends
  (GRCA-N-220.107)

- Inventory and Monitor Bighorn Sheep (GRCA-N-210.110)
- Conduct Survey of Spotted Owl Population (GRCA-N-220.102)
- Monitor Peregrine Falcon Population (GRCA-N-220.105)
- Monitor Native Grazing Herbivores and Forage Base Carrying Capacity (GRCA-N-210.108)
- Monitor Introduced Grazing Herbivores and Forage Base Carrying Capacity
- Monitor and Control Cowbirds at Corrals and Stock Areas (GRCA-N-220.104) (initiated, 1996)
- Reintroduction of California Condors (GRCA-N-270.103) (studies for Vermilion Cliffs release site underway, 1996)
- Reintroduction of Colorado River Squawfish (GRCA-N-270.102)
- Reintroduction of Bonytail Chub (GRCA-N-270.101)
- Reintroduction of Burrowing Owls
- Reintroduction of Wolves
- Reintroduction of Roundtail Chub
- Delineate Wetlands in Areas of Development (GRCA-N-310.201)

**Physical Science Topics**

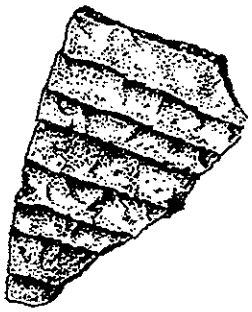
- Measure Flows and Water-related Values at Various Springs and Streams to Participate Effectively in Future Water Right Adjudications (GRCA-N 330.400,.502,.503)
- Develop Parkwide Soil Map and Classification System to the Series Level or to Soil Type (GRCA-N-510.101)
- Locate and Characterize Important Geologic Exposures That Should be Protected (e.g. vertebrate fossils, track-ways and other trace fossils, rare minerals or crystals) (GRCA-N-410.102)

**Geographic Information Systems—Resource Database Development (GRCA-N-900.101, .102, .103, .104, .201):**

- Archaeological Sites (GIS database development underway in 1996) (GRCA-C-500.001)
- Motorized Transport Sound Monitoring Data (aircraft, boat, road traffic) (aircraft sound GIS modeling underway, 1996)
- Caves, Karst Formations, and Mine Shafts (GRCA-N-570.101)
- Species Occurrence Records (wildlife, fish, and plants)
- Principle, Relict, and Sensitive Plant Communities
- Surface and Ground Water Hydrography
- Soils and Bedrock Types
- Climate Data (rainfall, temperature means and extremes, solar radiation, etc.)

- Air Quality Data
- Water Quality Data
- Rare, Important, and Unprotected Paleontological Resources (GRCA-N-410.101)
- Original Location and Attribute Data for Existing Museum Specimens

# Appendix A



## Legislation Affecting Grand Canyon National Park

***Executive Orders (unnumbered)***
June 8, 1880; November 23, 1880; March 31, 1882
Yavai Suppai Indian Reservation withdrawn from sale and settlement.

***Presidential Proclamation Number 15***
February 20, 1893
Grand Canyon Forest Reserve established, and lands exempted from all public land laws except those involving mineral claims.

***An Act for the Protection of Wild Animals in the Grand Canyon Forest Reserve***
November 8, 1906 (16 USC 684-687)
Established Grand Canyon Game Preserve wherein hunting, trapping, killing and capturing game animals on the Grand Canyon Forest Reserve were prohibited. Lands withdrawn from mineral entry.

***Act for the Preservation of American Antiquities***
June 8, 1906 (16 USC 431-433)
Authorized the President to declare national monuments to protect sites and objects; authorized Federal departments to grant permits for survey and excavation, and to enforce protection of archeological sites and objects under their jurisdiction; and required that materials excavated be permanently preserved in public museums.

***Presidential Proclamation Number 794***
January 11, 1908
Grand Canyon National Monument established for protection of this "object of unusual scientific interest." Grand Canyon Forest Reserve lands combined with other Federal lands to form the Monument. All Monument lands withdrawn from any new claims. Destruction and appropriation of Monument features prohibited.

***The Organic Act***
1916
Directed the National Park Service to regulate park use and promote enjoyment of park lands in a manner consistent with the conservation of park scenery, natural and historic objects, and "wild life." In order to fulfill these mandates, all planning activities must insure that public use facilities do not disrupt or damage resources to a degree whereby their ability to serve future visitors is reduced; that appropriate nondestructive public use and enjoyment of resources is made possible; and that natural and cultural park resources are preserved.

***Grand Canyon National Park Establishment Act***
February 26, 1919 (40 Stat 1175)
Converted Grand Canyon National Monument to Grand Canyon National Park, established as a "public park for the benefit and enjoyment of the people." Concessions are to be competitively bid. Havasupai Reservation rights reaffirmed. Secretary of the Interior permitted to establish rights-of-way within the Park for reclamation projects, irrigation projects, and railroads, wherever consistent with the primary purposes of the Park. Mineral exploration and development within the Park permitted. Provisions of Grand Canyon Game Reserve revoked on Park lands.

***Colorado River Compact***
1922
Allocated Colorado River water, assigning 7.5 million acre-feet per year each to the upper and lower basins of the Colorado. The dividing line was set at Lees Ferry, Arizona. Six of the basin states (California, Colorado, Nevada, New Mexico, Utah, Wyoming) approved the Compact in 1923; Arizona approved it in 1944.

***Department of the Interior Appropriations Bill***
June 5, 1924 (43 Stat 423)
Secretary authorized to purchase the Bright Angel Toll Road, and construct a south entrance road.

***44 Stat 497***
May 10, 1926
Authorized exchange of certain patented lands within Grand Canyon National Park for certain Government lands in Grand Canyon National Park.

***An Act to Revise the Boundary of Grand Canyon National Park***
February 25, 1927 (44 Stat 1238)
Grand Canyon National Park enlarged and exempted from 1920 Federal Power Act.

***Boulder Canyon Project Act***
1928
Authorized construction of Hoover Dam and the All-American Canal (Lake Mead, impounded by Hoover Dam, extends 41 miles into the lower Grand Canyon). In the Act, Congress consented to the Colorado River compact, placing it in force.

***46 Stat 1043***
January 26, 1931
Grand Canyon closed to mineral entry.

***Presidential Proclamation Number 2022***
December 22, 1932
Established Grand Canyon National Monument (under Antiquity Act authority) for protection of portions of the Grand Canyon downstream from Grand Canyon National Park which are of unusual scientific interest. Destruction or removal of any Monument features prohibited. Lands are reserved from all forms of appropriation, and set aside as a national monument.

***Historic Sites Act***
1935 (16 USC 461-467)
Authorized the Secretary of the Interior through the National Park Service to preserve and maintain objects of national historical or archeological significance, and to "establish and maintain museums in connection therewith."

***Presidential Proclamation Number 2393***
April 4, 1940
Certain lands excluded from Grand Canyon National Monument as not necessary for proper care and management of objects of scientific interest situated in the Monument.

***Museum Properties Management Act***
1955 (16 USC, Sect. 18 [f])
Authorized the Secretary of the Interior through the National Park Service to acquire collections through donation and purchase, and to loan and exchange collections.

***An Act to Provide for the Acquisition of a Patented Mining Claim on the South Rim of the Grand Canyon***
May 28, 1962 (76 Stat 79)
Permitted the Secretary of the Interior to acquire Orphan Mine, strategically located to adversely affect visitor enjoyment of the Park. Mineral rights were reserved to the owner for 25 years at which time they would revert to the Federal government; which they did in 1987.

***The Wilderness Act***
1964
The passage of the 1964 Wilderness Act, Public Law 88-577, Section 3(c), instructed the Secretary of the Interior to review all roadless areas of at least 5,000 acres in the national park system, and to submit a report regarding the suitability of these areas for wilderness classification. The Act provided a ten-year review period and timetable.

The passage of the 1975 Grand Canyon National Park Enlargement Act established a new emphasis for wilderness in Grand Canyon. Not only did the Act expand the Park to 1.2 million acres, but it also required that the Secretary of the Interior submit within two years a new wilderness recommendation accommodating the enlarged Grand Canyon National Park.

A final wilderness recommendation (February 1977) was signed by the Director of the National Park Service. The NPS sent this recommendation to the legislative counsel in 1977, where it was held in abeyance pending completion of the river management plan. Upon completion of the 1980 *Colorado River Management Plan*, the Park Service sent its wilderness recommendation to the Department of the Interior.

***The National Historic Preservation Act***
1966 (as amended in 1992)
Required all Federal agencies to inform the Advisory Council on Historic Preservation of the effect of any undertaking on any district, site, building, structure, or object which is eligible for, or included in, the National Register of Historic Places, and to afford the Council a reasonable opportunity to comment.

***Wild and Scenic Rivers Act***
1968 (Public Law 90-542)
As amended and supplemented, establishes a national system of wild and scenic rivers and provides for adding river segments to the system through Congressional action or by approval of the Secretary of the Interior following formal application by the Governor of the State concerned. The Wild and Scenic Rivers Act is a strong Congressional directive that rivers designated pursuant to its authority be preserved in their natural, or at least existing, condition. This implies an adequate quantity of water, of acceptable quality, necessary to accomplish the purpose of preserving the free-flowing conditions of a designated river.

***Presidential Proclamation Number 3889***
January 21, 1969
Established Marble Canyon National Monument to protect "unusual geologic and paleontologic features and objects and other scientific and natural values."

***To Improve the Administration of the National Park System***
August 18, 1970 (Public Law 91-383)
Authorized the Secretary of the Interior to enter into contracts to sell or lease to persons, States, or their political subdivisions, services, resources, or water from a national park if (1) they provide services or accommodations in the immediate vicinity of the park, ***and*** (2) there are no reasonable alternatives to these services without these resources or water. The House Report on this bill (H.R.91-1265) suggests that the NPS should provide reports to Congress prior to entering into any legally or morally binding commitments.

***Section 208 of the Federal Water Pollution Control Act***
as amended in 1972
Dictated that, among other things, Federal areas are subject to State and local water quality regulations. Thus Grand Canyon National Park must meet Arizona State Water Quality Standards.

***The Endangered Species Act***
1973
Required all Federal agencies to consult with the Secretary of the Interior on all projects and programs having potential impact on endangered flora and fauna. The legislation further required Federal agencies to take "...such action necessary to ensure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of such endangered species and threatened species or result in the destruction or modification of habitat of such species which is determined...to be critical...."

***Executive Order 11987***
May 24, 1977
Stated that "executive agencies shall, to the extent permitted by law, restrict the introduction of exotic species into the natural ecosystems on lands and waters which they own, lease, or hold for purposes of administration and shall encourage States, local governments, and private citizens to prevent the introduction of exotic species into natural ecosystems of the United States."

***Grand Canyon National Park Enlargement Act***
January 3, 1975 (Public Law 93-620)
Combined Marble Canyon and Grand Canyon national monuments with existing Grand Canyon National Park to "further protect the outstanding scenic, natural and scientific values of the Grand Canyon." Congress recognized that the entire Grand Canyon from the Paria River to the Grand Wash Cliffs, including side canyons, is a natural feature of national and international significance.

Congress provided for "further protection and interpretation of the Grand Canyon in accord with its true significance." Studies of Tuckup Point, Jensen Tank, and Slide Mountain were required in order to determine their suitability as park lands. Authority to acquire private lands was vested in the Secretary of the Interior but lands owned by the State of Arizona, or any political subdivision thereof, could only be acquired through donation or exchange. Cooperative agreements with other Federal, State, and local public departments or Indian Tribes are authorized in order to provide uniform interpretation of the Park. Continuation of grazing rights for either ten years or the life of the leaseholder was provided. Grazing rights were terminated in 1985.

The Secretary of the Interior was empowered to make recommendations to control aircraft traffic to protect the Park's natural quiet. The Secretary is authorized to permit use of former Lake Mead lands (now within Grand Canyon National Park) for the development and maintenance of reclamation projects. A total of 95,300 acres were withdrawn from Grand Canyon to be held in trust by the United States for Havasupai Tribe traditional-use purposes (gathering/hunting native wild plants or animals, medicinal gathering, grazing, burials, etc.). However, no uses were to be made of this land which will impact the existing scenic and natural values.

Further, the Secretary is responsible for conservation programs for fire protection, grazing management and erosion control, etc., on these lands. Elimination of Supai Camp provided for.

***Amendment to the Grand Canyon Enlargement Act***
June 10, 1975 (Public Law 94-31)
Provided the Secretary of the Interior two years to make a recommendation as to the suitability or non-suitability of any portion of Grand Canyon National Park as Wilderness.

***The Clean Air Act Amendments of 1977***
Designated Grand Canyon National Park as a Federal Class I area, which means that visibility within the Park is not to be impaired by any human source, and methods must be devised to monitor such visibility.

***Public Law 95-589, Title XII***
November 3, 1978
Authorized the Secretary of the Interior, without derogation of any United States water rights, to sell Grand Canyon water to Tusayan customers upon determination that such sale is not detrimental to the resources of Grand Canyon or its visitors.

***Executive Order 11593***
May 13, 1971
Directed Federal agencies to survey all properties under their administration which might qualify for listing in the National Register of Historic Places, and to nominate them to the register.

***The American Indian Religious Freedom Act***
1978 (Public Law 95-341)
Mandated that Federal agencies "...protect and preserve American Indian religious cultural rights and practices." Each Federal agency must undertake consultation on its missions, statutes, regulations, and policies with traditional native American religious leaders.

***The Redwood Act***
1978
Amended the NPS 1916 Organic Act, reaffirming the vast public value of the National Park System by stating, "The authorization of activities...and the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these areas have been established."

***The Archeological Resources Protection Act***
1979 (Public Law 96-95)
Superseded the Antiquities Act of 1906, and established (1) that archeological resources on public and Indian lands are protected, (2) permit requirements for resource excavation or removal, and (3) civil and criminal penalties for illegal removal of these resources.

***National Parks Overflights Act***
1987 (Public Law 91-100)
The Secretary of the Interior charged to submit recommendations to the FAA that would "provide for substantial restoration of the natural quiet and experience of the park and protection of public health and safety from adverse effects associated with aircraft overflights.

***National Park Service Management Policies***
1988
The management of the national park system and NPS programs is guided by the Constitution, public laws, proclamations, executive orders, rules and regulations, and directives of the Secretary of the Interior and the Assistant Secretary for Fish and Wildlife and Parks. NPS policy must be consistent with these higher authorities and with appropriate delegations of authority.

*NPS Management Policies* is the basic servicewide policy document of the National Park Service, and sets the framework and provides direction for management decisions. Adherence to policy is mandatory unless waived or modified by the Secretary, the Assistant Secretary, or the Director.

***The Federal Cave Resources Protection Act***
***November 19, 1988***
***(16 USC 4300-4309, 102 Stat. 4546)***
To secure, protect, and preserve significant caves on Federal lands for the perpetual use, enjoyment, and benefit of all people, and to foster increased cooperation and exchange of information between government authorities and those who use caves located on Federal lands for scientific, educational, or recreational purposes. The Act states that it is the policy of the United States that Federal lands be managed in a manner which protects and maintains, to the extent practical, significant caves. Finally, the Act requires the Secretary of the Interior to achieve the purposes of the Act on National Park System lands.

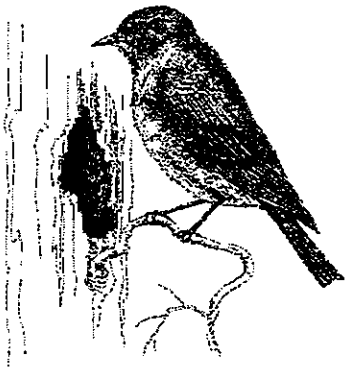
The National Park Service (16 USC 1 et seq., *NPS Management Policies* 1988) recognizes that all park caves are significant, and that they will be secured, protected and preserved as if they are significant regardless of their status under the Federal Cave Resources Protection Act.

***Clean Air Act***
1990 Amendment
Made many changes to the Clean Air Act, including sections allowing the creation of visibility transport commissions to address interstate transportation of haze and haze-causing air pollution. The amendments required creation of a Grand Canyon Visibility Transport Commission.

***Grand Canyon Protection Act***
1992
Requires the Secretary of the Interior to operate the Glen Canyon Dam, "...in such a manner as to protect, mitigate adverse impacts to, and improve the values for which Grand Canyon National Park and Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use."

# Appendix B

Information Needs
- Natural
- Cultural
- Recreation and Social Science



## Natural Resource Information Needs

**Table B-1**

*This table describes the minimum baseline information required to effectively manage Grand Canyon National Park (NPS-75)*

| Minimum Available Natural Resources Information | Minimum Standards NPS-75 | | |
|---|---|---|---|
| | Meeting | Exceeding | Not Meeting |
| **Historical Database** | | | |
| Collection of historical scientific material stored at the park: | | | |
| •Rare event records | | | X |
| •Maps | | | X |
| •Photographs | | | X |
| •Manuscripts | | | X |
| •Specimen Collections | | | |
| Automated bibliography of documents regarding park resources: | | | |
| •Extended search for published and unpublished documents | | | X |
| •Incorporation into an automated program | | | X |
| •Establishment of procedures for maintaining currency | | | X |
| **Species Information** | | | |
| Lists of the following biota identified as occurring in the park: | | | |
| •Vascular plants | | | X |
| •Vertebrate animals | | | X |
| •Federal/State T&E* Species | X | | |
| •Species of special concern | X | | |
| Surveys to confirm occurrence and to discover new species of: | | | |
| •Vascular plants | | | X |
| •Vertebrate animals | | | X |
| •Federal/State T&E Species | | | X |
| •Species of special concern | | | X |
| Species status and distribution information: | | | |
| Federal/State T&E Species | | | X |
| Species of special concern | | | X |

| Minimum Available Natural Resources Information | Minimum Standards NPS-75 | | |
|---|---|---|---|
| | Meeting | Exceeding | Not Meeting |
| **Digital Maps of Vegetation Associations in the Park and Environs** | | | |
| Maps | X | | |
| **Digital Cartographic Data** | | | |
| Digital elevation models/digital line graphs (DEM/DLGs) of: | X | | |
| •Hydrography | X | | |
| •Hypsography | X | | |
| •Boundaries | X | | |
| •Transportation | X | | |
| **Digital Soil Maps** | | | |
| SCS "Order 3" surveys | | | X |
| Detailed surveys | | | X |
| **Digital Geology Maps** | | | |
| Bedrock | | | X |
| Surficial | | | X |
| **Water Resources Inventory** | | | |
| Locations (include digital cartographic information) of: | X | | |
| •Streams | X | | |
| •Lakes | X | | |
| •Wetlands | | | X |
| •Ground water (hot/cold springs) | | | X |
| Water quality use classifications | X | | |
| **Water Chemistry for Key Water Bodies** | | | |
| Alkalinity | X | | |
| pH | X | | |
| Conductivity | X | | |
| Dissolved oxygen | X | | |
| Rapid bioassessment baseline (EPS/State protocols, involving fish and macroinvertebrates) | | | X |

**Threatened and Endangered*

| Minimum Available Natural Resources Information | Minimum Standards NPS-75 | | |
|---|---|---|---|
| | Meeting | Exceeding | Not Meeting |
| Temperature | X | | |
| Flow | | | X |
| Other constituents where important as determined on a case-by-case basis: | | | |
| •Toxic elements | | | X |
| •Clarity/turbidity | X | | |
| •Nitrate/Nitrogen | | | X |
| •Phosphate/Phosphorus | | | X |
| •Chlorophyll | | | X |
| •Sulfates | | | X |
| •Bacteria | | | X |
| **List of Existing Nearby Ambient Air Quality Monitoring Stations and Sources** | | | |
| Air quality-related values | X | | |
| Visibility goal | X | | |
| **Precipitation and Meteorological Data** | | | |
| Precipitation amount | X | | |
| Relative humidity | X | | |
| Wind speed and direction | X | | |
| Maximum and minimum air temperature (daily) | X | | |

Table B-2

*Suggested Parameters for Biological Inventory and Monitoring (NPS-75)*

| Suggested Parameters for Biological Inventory and Monitoring | Minimum Standards NPS-75 | | |
|---|---|---|---|
| | Meeting | Exceeding | Not Meeting |
| **Historical Database** | | | |
| Rare event records | | | X |
| Bibliography of all resource descriptive documents | | | X |
| Collection of manuscripts, old maps, photos, etc. | | | X |
| GIS and related maps | | | X |
| **Species** | | | |
| Gather species lists for vascular plants and vertebrate animals | X | | |
| Inventory of vascular plants including distribution | | | X |
| Inventory of mammals, birds, fish, amphibians, and reptiles, including distribution | | | X |
| Inventory of other species of special interest (e.g., sensitive to air pollution) | | | X |
| Listing of species that are threatened, endangered, endemic or nonnative | | | X |
| Distribution maps of plant and animal species of special interest | | | X |
| Inventory of invertebrates and non-vascular plants | | | X |

| Suggested Parameters for Biological Inventory and Monitoring | Minimum Standards NPS-75 | | |
|---|---|---|---|
| | Meeting | Exceeding | Not Meeting |
| **Populations** | | | |
| For selected species: | | | X |
| •Distribution | | | X |
| •Population size (including density/cover if appropriate) | | | X |
| •Age/stage/size class structure | | | X |
| •Growth/recruitment/productivity/ mortality | | | X |
| •Population genetics | | | X |
| **Communities** | | | |
| Vegetation/land cover map | X | | |
| Community structure | | | X |
| Species composition | | | X |
| Important abiotic components associated with sample plots | | | X |
| **Ecosystems** | | | |
| Important nutrient pools | | | X |
| Decomposition | | | X |
| Biomass (living and dead) | | | X |
| Productivity | | | X |
| Energy flow | | | X |
| **Integration** | | | |
| Qualitative community descriptions to correspond with vegetation map | | | X |
| Landscape patterns (e.g., fragmentation, corridors) | | | X |
| Population models for species of special interest | | | X |
| Quantitative descriptions | | | X |
| •population dynamics | | | X |
| •trophic relationships | | | X |
| •changes in species composition | | | X |
| •community dynamics | | | X |

| Suggested Parameters for Biological Inventory and Monitoring | Minimum Standards NPS-75 | | |
|---|---|---|---|
| | Meeting | Exceeding | Not Meeting |
| Community models from population models | | | X |
| Nutrient cycling models | | | X |
| Ecosystem models | | | X |
| **Geography** | | | |
| Determination of study area and location of resources associated with an appropriate base map series and coordinate system | | | X |
| Resources mapped accurately to GIS standards | | | X |
| Accurate and comprehensive representation of park landscape (e.g., satellite, aerial photography, survey as appropriate) | X | | |
| Digital GIS data base as appropriate (using consistent and stable base | X | | |

Table B-3

*Suggested Parameters for Geophysical and Chemical Inventory and Monitoring (NPS-75)*

| Suggested Parameters for Geophysical and Chemical Inventory and Monitoring | Minimum Standards NPS-75 | | |
|---|---|---|---|
| | Meeting | Exceeding | Not Meeting |
| **Geology** | | | |
| Maps at reconnaissance level | | | |
| •Geologic maps (bed rock and surficial) | X | | |
| Special purpose maps showing: | | | |
| •Geologic hazards (e.g., floodplain, features) | | | X |
| •Channels and channel characteristics | | | X |
| •Other special purpose maps | | | X |
| •Soil maps | | | X |
| Physical geology, mineralogy and soils | | | |
| •Soil analysis (organic content, water holding characteristics, mechanical analysis, physical analysis, radon flux, water erodibility (index), infiltration rate, soil productivity (composite index), cation exchange) | | | X |
| •Principle mineral composition of geological units (same scale as bed rock geology) | | | X |
| •Geo-hazards | | | X |
| **Hydrology** | | | |
| Watershed maps/delineation | | | X |
| Special purpose maps | | | |
| •Groundwater (water table) | | | X |
| •Bathymetry | | | X |
| •Other | | | X |
| Location and Classification | | | |
| •Streams | | | X |
| •Lakes | | | X |
| •Wetlands | | | X |
| •Groundwater (hot and cold springs) | | | X |

| Suggested Parameters for Geophysical and Chemical Inventory and Monitoring | Minimum Standards NPS-75 | | |
|---|---|---|---|
| | Meeting | Exceeding | Not Meeting |
| Physical parameters | | | |
| Temperature | | | |
| •Stream (monthly) | | | X |
| •Lakes (seasonally) | | | X |
| •Wetlands (seasonally) | | | X |
| •Groundwater (seasonally) | | | X |
| Turbidity | | | |
| •Streams (episodically) | | | X |
| •Lakes | | | X |
| •Wetlands | | | X |
| Discharge | | | |
| •Streams | | | X |
| •Lakes (in and out flow) | | | X |
| •Wetlands | | | X |
| •Springs | | | X |
| **Meteorology** | | | |
| (Rainfall amount, Snow amount, Temperature (2 meter agl), Temperature difference (between 10 m and 2 m agl), Relative humidity, Wind speed, Wind direction, Solar radiation, Fog or cloud emersion time, Surface wetness, Fuel moisture, Soil moisture, Mixing height) | X | | |
| UV-B Radiation (Global Climate Change Related) | X | | |
| **Water Chemistry** | | | |
| (Alkalinity, pH, Conductivity, SO4=, PO4, Total P, Cl, Total N, NO3+, NH4, K+, Na++, Ca++, Mg++, SO2, CO2, O3, SiO2, Coloform and fecal strep, DO, DOC, CO3, HCO3, HNO3NH3NOx, Trace Metals) | | | X |
| **Aquatic Bio-monitoring** | | | X |

| Suggested Parameters for Geophysical and Chemical Inventory and Monitoring | Minimum Standards NPS-75 | | |
|---|---|---|---|
| | Meeting | Exceeding | Not Meeting |
| **Air Quality** | | | |
| General characteristic | X | | |
| •Existing Nearby Emission Sources (and non-attainment areas) | X | | |
| •Existing Nearby Ambient Monitoring Locations | X | | |
| •Air quality Related Values | X | | |
| Atmospheric gases (SO2, O3, NO/NO2, CO, HNO3, Non-methane Organics (NMOCs), Total and Speciated, CO2, N2O, CH4, CFCs, Total Organic Chlorine) | | | X |
| Atmospheric particulates (S)4, NO3-, H+, NH4+, Ca++, Mg++, Pesticides, Trace Metals (Na-Pb), Carbon (Elemental and Organic), Aerosol Acidity) | X | | |
| Wet Deposition | | | |
| •Precipitation, Rain and Snow (Alkalinity/Acidity, pH, Conductivity, SO4=, NO3-, PO4+, Cl-, NH4+, Ca++, K+, Na+, Mg++, Peroxides, Pesticides, Trace Metals, Organic Anions) | X | | |
| •Cloud/Fog (So4=, NO3-, H+, NH4+, Peroxides) | | | X |
| Visibility | | | |
| •Atmospheric Extinction ($b_{ext}$) | X | | |
| •Atmospheric Scattering ($b_{scat}$) | | | X |
| •View | X | | |

# Cultural Resource Information Needs

Table B-4

*This table describes the minimal cultural resource baseline information required to effectively manage Grand Canyon National Park*

| Cultural Resource Documentation Checklist TITLE | CURRENT or Approved | INCOMPLETE Needs revision | NEEDED |
|---|---|---|---|
| **Planning Documents** | | | |
| Preauthorization/Authorization | | | |
| •Statement for Management | X | | |
| •Planning Requirements Outline | X | | |
| •General Management Plan | X | | |
| •Development Concept Plan | | X | |
| •Resources Management Plan | X | | |
| •Interpretive Prospectus | X | | |
| **Servicewide Inventories, Lists, Catalogs, and Registers** | | | |
| Cultural Resources Bibliography | | X | |
| Cultural Sites Inventory | | | X |
| List of Classified Structures | X | | |
| National Catalog of Museum Objects | | | X |
| National Register of Historic Places | | X | |
| **Basic Cultural Resource Documents** | | | |
| Archeological Overview and Assessment | X | | |
| Archeological Identification Studies | | | X |
| Archeological Evaluation Studies | | | X |
| Ethnographic Overview and Assessment | | | X |
| Ethnographic Oral Histories and Life Histories | | X | |
| Ethnographic Program | | | X |
| Historical Base Map | | X | |
| Historical Resource Study (HRS) | | | X |
| Park Administrative History | | | X |
| Scope of Collection Statement | X | | |

| Cultural Resource Documentation Checklist TITLE | CURRENT or Approved | INCOMPLETE Needs revision | NEEDED |
|---|---|---|---|
| **Special Resource Studies and Plans** | | | |
| Archeological and Ethnological Collections Studies | X | | |
| Archeological Data Recovery Studies | | | X |
| Collection Management Plan | | | X |
| Collection Storage Plan | X | | |
| Collection Condition Survey | | | X |
| Cultural Landscape Report | | | X |
| Ethnohistory | | | X |
| Exhibit Plan | | X | |
| Historic Furnishings Report | | | X |
| Historic Structure Preservation Guide (HSPG) | | | X |
| Historic Structure Report | | | X |
| Social Impact Study | X | | |
| Special History Study | | | X |
| Traditional Use Study | | | X |

Table B-5

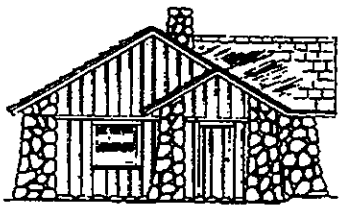
*Summary Chart of Archaeological Sites*

| Significance | | Condition | | | | | Impacts | | | | Documentation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Good | Fair | Poor | Destroyed | Unknown | Severe | Moderate | Low | Unknown | Good | Fair | Poor |
| National | | | | | | | | | | | | | |
| State/Regional | 2 | | 1 | | | 1 | | 1 | | 1 | 2 | | |
| Local | 1 | | 1 | | | | | 1 | | | 1 | | |
| Not Evaluated | 2700 | 420 | 575 | 145 | 35 | 1525 | | 165 | 1695 | 840 | 430 | 950 | 1320 |
| Totals | 2703 | 420 | 575 | 145 | 35 | 1526 | | 167 | 1695 | 841 | 433 | 950 | 1320 |

***Note: These are approximate figures*

Table B-6

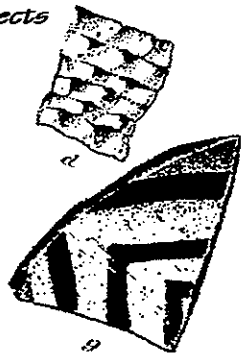
*Summary Chart for Historic Structures*



| Significance | | Condition | | | | Impacts | | | | Documentation | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Good | Fair | Poor | Unknown | Severe | Moderate | Low | Unknown | Good | Fair | Poor |
| National | 147 | 120 | 26 | | 1 | 1 | 22 | 123 | 1 | 108 | 15 | 24 |
| State/Regional | 57 | 45 | 11 | 1 | | | 37 | 20 | | 1 | 0 | 56 |
| Local | 102 | 24 | 39 | 38 | 1 | 37 | 47 | 17 | 1 | 0 | 43 | 59 |
| Not Evaluated | 233 | 62 | 76 | 9 | 86 | 3 | 111 | 22 | 97 | 18 | 22 | 193 |
| Totals | 539 | 251 | 152 | 48 | 88 | 41 | 217 | 182 | 99 | 127 | 80 | 332 |

Table B-7

*Summary Chart for Objects*



| Documentation* | Archaeo | Ethnology | History | Archives | Biology | Paleo | Geology | Total |
|---|---|---|---|---|---|---|---|---|
| Registration Data Only | | | | | | | | |
| Registration and Catalog Data | 150,916 | 182 | 15,884 | 26,587 | 15,299 | 16,092 | 5700 | 230,660 |
| Total Items Cataloged | 150,916 | 182 | 15,884 | 26,587 | 15,299 | 16,092 | 5700 | 230,660 |
| Backlog to be Cataloged | 491 | | | 4,536 | 1,000 | | | 6,027 |
| Total Collection Summary | 151,407 | 182 | 15,884 | 31,123 | 16,299 | 16,092 | 5700 | 236,687 |

**Form 10-254 Submitted to National Catalog at Harpers Ferry*

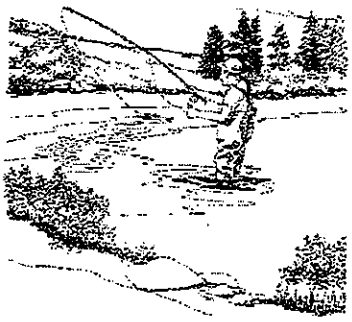
| Condition* | Archaeo | Ethnology | History | Archives | Biology | Paleo | Geology | Total |
|---|---|---|---|---|---|---|---|---|
| Excellent | 53 | 5 | 1,561 | 2,319 | 53 | 42 | 2 | 4,035 |
| Good | 82,947 | 150 | 7,025 | 20,036 | 6,256 | 5,693 | 251 | 122,385 |
| Fair | 2,077 | 0 | 1,104 | 3,704 | 1,216 | 667 | 3 | 8,771 |
| Poor | 287 | 0 | 465 | 528 | 209 | 11 | 0 | 1,500 |
| Unknown | 65,552 | 27 | 5,702 | 0 | 7,565 | 9,679 | 5,444 | 93,969 |

**The percentage of Collection in the Categories Listed.*

## Social Science/ Recreation Checklist

Table B-8

*This table describes the minimal social science/recreation resource baseline information required to effectively manage Grand Canyon National Park*



| TITLE | CURRENT or Approved | INCOMPLETE Needs revision | NEEDED |
|---|---|---|---|
| **Planning Documents** | | | |
| Statement for Management | X | | |
| Outline of Planning Requirements | X | | |
| Wilderness Recommendation | | X | |
| General Management Plan | X | | |
| Resources Management Plan | X | | |
| Wilderness Management Plan | | | X |
| Backcountry Management Plan | | X | |
| Colorado River Management Plan | | X | |
| Aircraft Management Plan | | | X |
| Day Use Management Plan | | | X |
| Interpretive Prospectus | X | | |
| **Servicewide Inventories, Lists, Etc.** | | | |
| Social Science Research Bibliography | | | X |
| Recreation Research Bibliography | | X | |
| Wilderness Research Bibliography | | X | |
| Nationwide Rivers Inventory | | X | |
| National Wilderness System | | X | |

| TITLE | CURRENT or Approved | INCOMPLETE Needs revision | NEEDED |
|---|---|---|---|
| Inventory of Research Activities In the National Parks: NPS Annual Science Report | | X | |
| Social Science Net-Work-Book for the Colorado Plateau | | X | |
| **Basic Recreation Resource and Social Science Documents** | | | |
| Basic Recreation Studies | | | |
| •Visitor Experience | | | X |
| •Day Use | | | X |
| •Campsite Impacts | | X | |
| •Carrying Capacity | | X | |
| •Visitor Characteristics, Use Patterns, and Profiles: back-country day-users, back-country visitors, river, and rim | | | X |
| **Basic Wilderness Resource Studies** | | | |
| Acoustic Monitoring Of Overflights | | | X |
| Allocation of River Use | | | X |
| Develop River Travel Simulation Model | | | X |
| Visitor Impacts: day-use, river, back-country, rim areas | | | X |

| Resource Data Needed | Adequate | Partial or dated | Absent |
|---|---|---|---|
| **Developed Rim Frontcountry** | | | |
| Carrying Capacity | | X | |
| Visitor Utilization | | X | |
| Visitor Profiles | | X | |
| User Preferences | | X | |
| User Perceptions | | X | |
| Use Distribution and Allocation | | X | |
| Permit Systems | | | X |
| Resource Inventories | | X | |
| Site Recovery and Rehabilitation | X | | |
| User Conflicts | | | X |
| Day Use | | X | |
| Socioeconomics | | | X |
| Regional Tourism | | X | |
| Accessibility | | X | |
| **Backcountry Corridor** | | | |
| Carrying Capacity | | | X |
| Visitor Utilization | | X | |
| Visitor Profiles | | | X |
| User Preferences | | X | |
| User Perceptions | | X | |
| Use Distribution and Allocation | | X | |
| Permit Systems | | X | |
| Resource Inventories | X | | |
| Site Recovery and Rehabilitation | X | | |
| User Conflicts | | | X |
| Day Use | | | X |
| Socioeconomics | | | X |
| Regional Tourism | | | X |
| Accessibility | | X | |
| **Backcountry Wilderness** | | | |
| Carrying Capacity | | X | |
| Visitor Utilization | X | | |
| Visitor Profiles | | X | |
| User Preferences | | X | |
| User Perceptions | | X | |
| Use Distribution and Allocation | | X | |
| Permit Systems | X | | |
| Resource Inventories | X | | |
| Site Recovery and Rehabilitation | X | | |

Table B-9

*This table describes the availability of social science/recreation resource data by management area.*

| Resource Data Needed | Adequate | Partial or dated | Absent |
|---|---|---|---|
| User Conflicts | | X | |
| Day Use | | | X |
| Socioeconomics | | | X |
| Regional Tourism | | | X |
| Accessibility | | | X |
| **River Corridor** | | | |
| Carrying Capacity | | X | |
| Visitor Utilization | X | | |
| Visitor Profiles | | X | |
| User Preferences | | X | |
| User Perceptions | | X | |
| Use Distribution and Allocation | | X | |
| Permit Systems | X | | |
| Resource Inventories | X | | |
| Site Recovery and Rehabilitation | X | | |
| User Conflicts | | X | |
| Day Use | | | X |
| Socioeconomics | | | X |
| Regional Tourism | | | X |
| Accessibility | | X | |

# Management Plans

Table C-1
*This table describes the resource management and related plans mentioned in the RMP, their status, and need.*

Appendix C

| TITLE | CURRENT or Approved | INCOMPLETE or Needs revision | NEEDED |
|---|---|---|---|
| Air Quality Management Plan | | | X |
| Aircraft Management Plan | | | X |
| Backcountry Management Plan | 1988 | X | |
| Cave Resource Management Plan | | Draft, 1997 | |
| Colorado River Management Plan | 1989 | X | |
| Corridor Management Plan | | | X |
| Cultural Landscape Management Plan | | | X |
| Fire Management Plan | 1995 | Draft, 1996 | |
| Geologic Hazard Management Plan | | | X |
| Grand Canyon Long-Term Monitoring and Research Plan | | | X |
| Grand Canyon Land Protection Plan | 1996 | | |
| Habitat Restoration Plan | | Draft, 1997 | |
| Interpretive Prospectus | 1996 | | |
| Paleontological Resource Management Plan | | | X |
| Resource Management Plan | 1996 | | 2000 |
| Vegetation Management Plan | | | X |
| Water Resource Management Plan | 1984 | X | |
| Wetland Preservation Plan | | | X |
| Wilderness Management Plan | | Draft, 1997 | |
| Wildlife Management Plan | | | X |

# Appendix D

*A listing of the texts cited in the Resource Management Plan.*

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# Appendix E

*A listing of the acronyms used in the Resource Management Plan.*

## Acronyms

| | |
|---|---|
| AGFD | Arizona Game and Fish Department |
| ANCS | Automated National Catalog System |
| AQD | Air Quality Division, National Park Service |
| ARPA | Archaeological Resources Protection Act |
| ASMIS | Archaeological Sites Management Information System |
| BIA | Bureau of Indian Affairs |
| BLM | Bureau of Land Management |
| BOR | Bureau of Reclamation |
| CA | Catagorical Exclusion |
| CCC | Civilian Conservation Corps |
| CFR | Code of Federal Regulations |
| CLI | Cultural Landscape Inventory |
| CLR | Cultural Landscape Report |
| CR-MAP | Cultural Resource Management Assessment Program |
| CRMP | Colorado River Management Plan |
| CSI | Cultural Sites Inventory |
| EA | Environmental Assessment |
| EIS | Environmental Impact Statement |
| EPA | Environmental Protection Agency |
| ESA | Endangered Species Act |
| FAA | Federal Aviation Administration |
| FHWA | Federal Highways Road Rehabilitation Program (3-95) |
| FLHP | Federal Lands Highway Program |
| FTE | Full Time Equivalent |
| FY | Fiscal Year |
| GCA | Grand Canyon Association |
| GCES | Glen Canyon Environmental Studies |
| GCFI | Grand Canyon Field Institute |
| GCMRC | Grand Canyon Monitoring and Research Center |
| GCNPSC | Grand Canyon National Park Science Center |
| GCUSD | Grand Canyon Unified School District |
| GIS | Geographical Information System |
| GMP | General Management Plan |
| GPS | Global Positioning System |

| | |
|---|---|
| HABS | Historic American Buildings Survey |
| HAER | Historic American Engineering Record |
| HPPD | Historic Property Preservation Database |
| HRS | Historic Resource Study |
| HSR | Historic Structures Report |
| HUL | Havasupai Use Lands |
| ICAP | Inventory and Condition Assessment Program |
| IPM | Integrated Pest Management |
| LAC | Limits of Acceptable Change |
| LCS | List of Classified Structures |
| MMS | Maintenance Management System |
| MOA | Memorandum of Agreement |
| MOU | Memorandum of Understanding |
| NAAQS | National Ambient Air Quality Standards |
| NAGPRA | Native American Graves Protection and Repatriation Act |
| NAU | Northern Arizona University |
| NEPA | National Environmental Policy Act |
| NHPA | National Historic Preservation Act |
| NPS | National Park Service |
| NR-MAP | Natural Resource Management Assessment Program |
| NRA | National Recreation Area |
| NSS | National Speleological Society |
| ONPS | Operation of the National Park Service |
| ORV | Off-Road Vehicle |
| PPB | Parts per billion |
| RMP | Resource Management Plan |
| SAIP | Systemwide Archaeological Inventory Program |
| SHPO | State Historic Preservation Officer |
| SSO | System Support Office, National Park Service |
| TCP | Traditional Cultural Property |
| USFS | U.S. Forest Service |
| USFWS | U.S. Fish and Wildlife Service |
| USGS | U.S. Geological Service |
| VERP | Visitor Experience and Resource Protection |
| WOS | Wilderness Opportunity Spectrum |