

STATE
OF THE
PARKS®

August 2010

GRAND CANYON NATIONAL PARK

Resource Challenges and Future Directions



National Parks Conservation Association®
Protecting Our National Parks for Future Generations®

STATE ♦ OF THE ♦ PARKS®

Center for State of the Parks®

More than a century ago, Congress established Yellowstone as the world's first national park. That single act was the beginning of a remarkable and ongoing effort to protect this nation's natural, historical, and cultural heritage.

Today, Americans are learning that national park designation alone cannot provide full resource protection. Many parks are compromised by development of adjacent lands, air and water pollution, invasive plants and animals, and rapid increases in motorized recreation. Park officials often lack adequate information on the status of and trends in conditions of critical resources.

The National Parks Conservation Association initiated the State of the Parks program in 2000 to assess the condition of natural and cultural resources in the parks, and determine how well equipped the National Park Service is to protect the parks—its stewardship capacity. The Center for State of the Parks also authors reports detailing threats to park resources and contributes technical information to inform NPCA's work.

For more information about the Center for State of the Parks, visit www.npca.org/stateoftheparks or contact: NPCA, Center for State of the Parks, P.O. Box 737, Fort Collins, CO 80522; phone: 970.493.2545; email: stateoftheparks@npca.org.

Since 1919, the National Parks Conservation Association has been the leading voice of the American people in protecting and enhancing our National Park System. NPCA, its members, and partners work together to protect the park system and preserve our nation's natural, historical, and cultural heritage for generations to come.

* More than 325,000 members

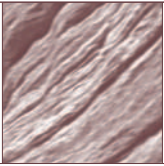
* Twenty-three regional and field offices

* More than 120,000 activists

A special note of appreciation goes to those whose generous grants and donations made this report possible: Robertson Foundation, G.D.S. Legacy Foundation, Ray Bingham, Ben and Ruth Hammett, Lee and Marty Talbot, and anonymous donors.

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EXECUTIVE SUMMARY



In acknowledgment of the significance of Grand Canyon National Park to America's national heritage and to the global community, the National Parks Conservation Association evaluated significant challenges and opportunities with regard to resources that the park currently faces. Grand Canyon National Park has a long and storied history of resource protection, visitor use, and park-focused legislative efforts, all of which have contributed

to the current status of park resources and are considered in this evaluation.

After analyzing existing information on natural and cultural resources at Grand Canyon National Park, the National Parks Conservation Association concludes that the park's resources face serious challenges. This report details why this is the case and provides recommendations on how to meet these challenges.

Grand Canyon National Park attracts visitors throughout the year, receiving more than 4.5 million annually.

The Colorado River appears as a vibrant green ribbon winding through the more muted tan, gray, and terra cotta-colored canyon walls.



MARK LELLOUCH/ NATIONAL PARK SERVICE

EXECUTIVE SUMMARY

The Grand Canyon is both a geological and biological wonder, featuring rocks that are more than a billion years old, a major river running through an arid region, and a wide diversity of species that live along an 8,000-foot elevation gradient. Human connections to the area date back thousands of years, and some tribes associated with the area include the canyon in their origin stories. Expanded exploration of the region in the late 1800s brought increased tourism and settlement, and with this came increasing pressure to privatize and exploit the area and its resources. The emerging threats to this unique place galvanized preservation efforts. Formal federal attempts to protect the canyon began in the 1880s, and finally in 1919 Grand Canyon National Park was created with the National Park Service as its managing agency. Additional legislation has increased the park's size over time, with the most significant being the Grand Canyon Protection Act (1975), which brought the park to approximately 1.2 million acres.

Although its designation as a national park provides many protections, Grand Canyon still faces threats to its resources. Currently, ongoing external activities, such as water diversion, overflights, mining, and power generation, all can deleteriously affect park resources. In addition, the park's popularity continues to grow. As the second-most visited National Park in the system (Great Smoky Mountains National Park is the first), Park Service staff experience significant pressure in trying to preserve resources and provide high-quality visitor experiences. In a number of cases, many of which are documented in this report, legislation has been enacted to address complex problems involving these efforts. Unfortunately, this report also documents that legislation has often been unsuccessful at correcting the degradation of resources and the visitor experience.

Stresses on this iconic American national park are numerous. NPCA, in this report, identifies and proposes solutions to the primary resource challenges facing the park. These challenges are:

- Colorado River management actions that do not incorporate adaptive strategies for protecting and restoring fish, river flows, riverine habitats, cultural sites, and archaeological resources along the river corridor;
- soundscape management for natural quiet, including managing overflights that may disturb park visitors, wildlife, and the traditional activities of the park's 11 affiliated American Indian tribes;
- mines that could be developed on lands adjacent to the park, as well as environmental contamination from past mining activities within the park;
- air pollution from miles away that has the potential to obscure scenic vistas, harm visitor and employee health, and damage sensitive plants;
- other threats from adjacent lands, including damage caused by grazing and water development, as well as the presence of non-native, invasive plants and animals;
- frontcountry and backcountry management and protection needs, particularly in regard to the challenges of park size, visitation patterns, and shortfalls in funding, which compromise efforts to preserve and protect the park's resources;
- the need for permanent funding for more proactive, strategic consultation activities to continue to foster effective relationships with the park's 11 affiliated American Indian tribes; and,
- potential impacts due to climate change on the Colorado Plateau.

A summary of each challenge is presented in this report to highlight its current status and discuss efforts to address it.

NPCA, as the leading voice of the American people in protecting and enhancing our

National Park System, also provides in this report information on further actions to meet these challenges. Concrete steps can be taken in efforts to protect Grand Canyon National Park. Recommendations can be found in each chapter and are summarized below. The need for additional personnel is not included here, but is detailed in individual chapters.

- To address Colorado River management actions (i.e., Glen Canyon Dam operations) that continue to degrade natural and cultural resources along the river corridor, changes in water flows supported by the existing scientific evidence must be made to foster restoration of these resources.
- To provide for natural soundscapes largely free of noise caused by aircraft overflights, the Park Service must have the ability and authority to manage noise within the park's boundaries, including prohibiting flights in certain areas and capping air tour numbers.
- The Secretary of the Interior has temporarily barred the filing of new mining claims—including those for uranium—on the nearly one million acres of public land surrounding the Grand Canyon. Permanent protection of park waters, natural resources, visitor experience, and local communities from the impacts of uranium mining on lands near Grand Canyon National Park could be achieved by an act of Congress to permanently withdraw sensitive public lands from mineral extraction.
- Protecting Grand Canyon National Park's air quality and scenic vistas, as well as the health of its visitors, from air pollution depends to a great extent upon the actions of state and tribal authorities and the U.S. Environmental Protection Agency, because the National Park Service does not have direct authority over external sources of pollution that affect the Grand Canyon. The Park Service needs to communicate concerns

about emissions to regulators, who then must fully enforce laws aimed at cleaning up existing sources of pollution and preventing air quality degradation from new sources of emissions.

- To ensure the protection of water sources within the park, aside from the Colorado River, better accounting and tracking of groundwater pumping is needed so that groundwater extraction to support municipalities and industries does not deplete seeps and springs critical to plants and wildlife. In addition, the park should continue to support and conduct research on regional aquifers and the effects of groundwater pumping on the unique seep and spring habitats within the park.
- Avoiding impacts from trespass grazing can be addressed by continued work with federal agencies that manage nearby land where grazing is permitted and with private individuals who graze their cattle on these federal lands. Maintaining or building fences to exclude cattle from the park would greatly improve the protection of park resources.
- Preventing the introduction of non-native plants and animals is the best way to avoid negative impacts from these species. If they are already established in the park, support for removal and restoration efforts is essential to prevent non-native species from degrading native habitats.
- To address the park's main challenges in the frontcountry, which include providing visitor services, ensuring visitor safety, and safeguarding the historic structures and cultural resources of the North and South Rims, the park needs resources to complete necessary historic structure reports and address fire concerns. In addition, the park requires significant funding for maintenance as well as funding to address concessionaire interest and thus allow continued generation of

adequate franchise fees for building improvements and visitor services.

- The small percentage of visitors who venture beyond the park's frontcountry still represents thousands of people. Official wilderness designation by Congress and the resources to update the park's backcountry management plan would assist the park with managing visitors and resources in this area.
- Continuing to strengthen relationships with the 11 American Indian tribes affiliated with the park is essential and can be fostered through more frequent consultations with these groups. Topics of discussion could include ideas for increasing the role of tribal history, contemporary arts, and cultural significance in visitor education. A lack of funding has prevented park staff from extending the scope of such efforts.
- Grand Canyon National Park is not an isolated island shielded from activities occurring outside its borders. In the same way, it is not immune to the effects of climate change, some of which are already apparent, and a research program is needed to examine how this global phenomenon is affecting park resources.

Resource protection and visitor services needs at Grand Canyon National Park are further exacerbated by a lack of sufficient operating funds. The park's financing system, both currently and at levels projected for the future, will further compromise the resources as well as the safety and enjoyment of the park for its visitors. Fiscal needs are discussed in specific chapters of this report, but in general, three issues hamper park staff as they strive to achieve the park's mission. First, the park's appropriated base funding, used to support all full-time equivalent employees, is woefully deficient, with approximately 62 percent of the full-time equivalent workforce funded with non-base funds, a situation that results in substantial inefficiencies due to

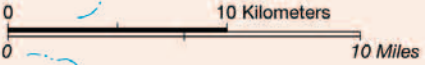
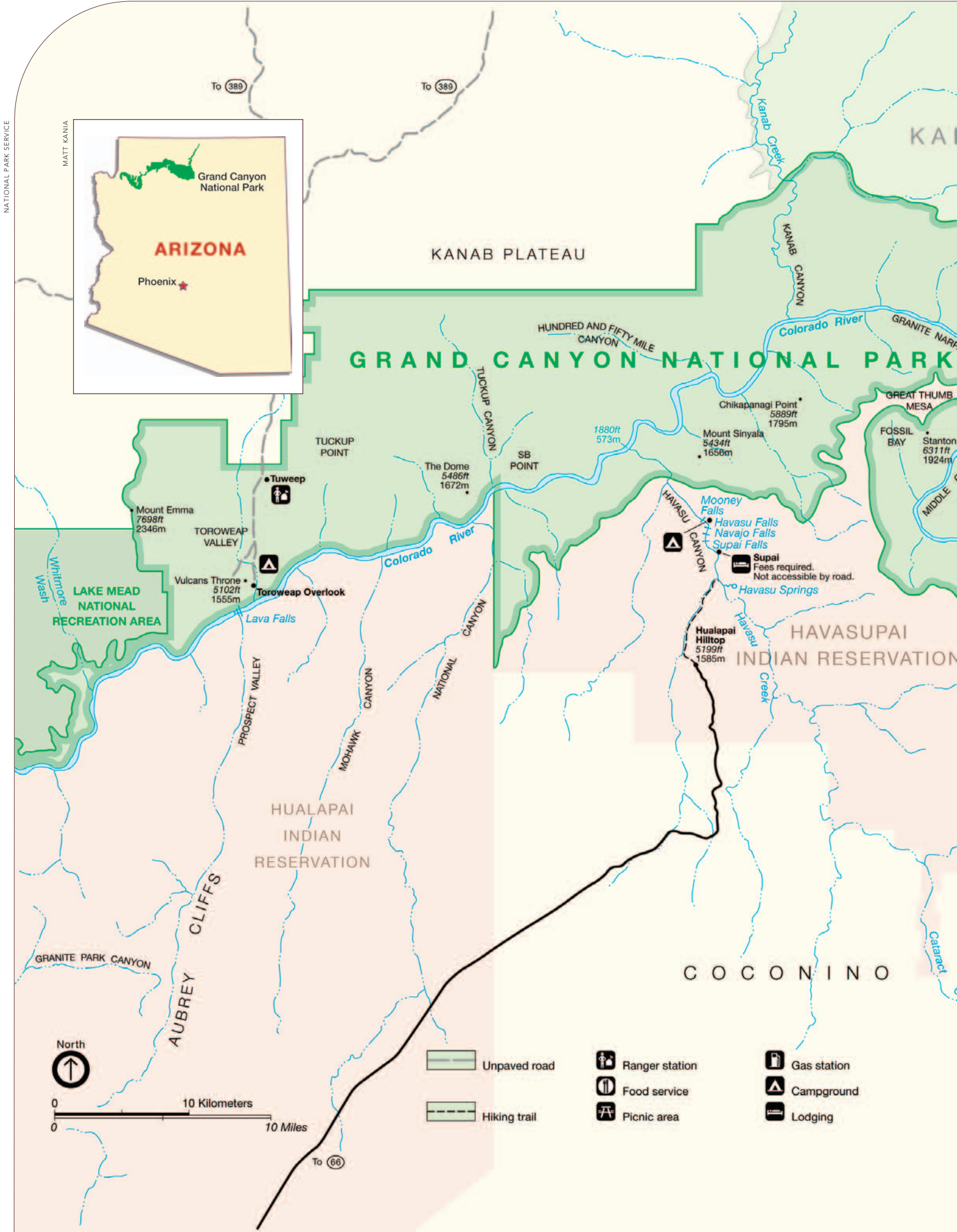


Grand Canyon National Park has been a family vacation destination for decades. In this 1958 photograph, a family reads an interpretive panel along the canyon's rim.

turnover and seasonality. A 2009 analysis estimates an additional \$6.2 million in base funding is needed to support all critical positions necessary to achieve basic park functions. Additionally, buildings, roads, and shuttle buses necessary to support and sustain this park's popularity and safety have resulted in more than \$300 million in deferred maintenance, a number that will certainly increase even as \$11 million each year in fee income is directed towards deferred maintenance. Finally, Grand Canyon contracts with private concessionaires to provide services that are necessary and appropriate for public use and enjoyment. These contracts also generate franchise fees that are paid to the park. A contract with the largest concessionaire, awarded in 2002 and up for renewal in 2011 has amassed a "leasehold surrender interest" (essentially the value established as the equity or investment of the leaseholder in park assets to perform these services) in excess of \$200 million. This huge liability limits the National Park Service from competitively re-bidding this contract in a manner that

can both generate adequate franchise fees and assure quality visitor services. Grand Canyon would need approximately \$40 million just to make the new contract feasible.

The resources and assets at Grand Canyon National Park and the National Park Service staff that manage them are both under intense pressure. Efforts to protect the park are compromised by profound financial shortfalls, legal and political ambiguities that seek to or have the effect of limiting park authority, and external threats that require acknowledgment of the problems and a willingness to confront them. This report highlights critical and select issues that need to be dealt with and proposes paths to do so. The Grand Canyon is a unique, awe-inspiring treasure, which requires and deserves strong stewardship efforts. Together we must make and implement the decisions that will preserve the park and its resources for future generations.



-  Unpaved road
-  Ranger station
-  Gas station
-  Food service
-  Campground
-  Picnic area
-  Lodging
-  Hiking trail





INTRODUCTION



The global significance of the Grand Canyon's natural features prompted UNESCO to declare it a World Heritage Site in 1979.

SNAPSHOT OF GRANDEUR

Grand Canyon National Park is an American icon, one of the nation's best known and most popular destinations among both domestic and international travelers. More than 4.5 million people visit Grand Canyon National Park each year. The global significance of the park's natural features prompted the United Nations Educational, Scientific and Cultural Organization (UNESCO) to declare it one of

the first World Heritage Sites in 1979.

Grand Canyon National Park covers 1,218,376 acres, encompassing the canyon and portions of the north and south plateaus along 277 miles of Colorado River, starting at the confluence of the Colorado and Paria Rivers near Lees Ferry (15.5 miles below Glen Canyon Dam) in northern Arizona. The rim-to-rim distance of the canyon varies from as narrow as 600 feet to as wide as 18 miles, with an average

span of 10 miles. The park's elevation is just as varied, ranging from 9,160 feet near the park entrance on the North Rim to 1,200 feet at the park's western boundary, where the Colorado River enters an adjoining national park unit, Lake Mead National Recreation Area.

The park's diverse natural resources begin with the Grand Canyon itself, a geological wonder carved over the last 6 million years by the waters of the Colorado River. Rocks almost 2 billion years old lie exposed in the bottom of the canyon. The Colorado, the river that created the canyon, extends 1,450 miles from its headwaters in Rocky Mountain National Park in Colorado to the Gulf of California (Sea of Cortez), which separates Baja California from the mainland of Mexico.

The Colorado River is a remarkable water feature in a land of little water. Its world-class white-water rapids draw tens of thousands of recreational visitors to the park each year. The park also includes four major and several minor tributaries of the Colorado River, as well as streams, seeps, and springs. Because very few lakes or ponds form on the semiarid Colorado Plateau, all of the water sources of Grand Canyon National Park are crucial for sustaining the region's many terrestrial and aquatic species.

Grand Canyon National Park is home to a wide diversity of species and ecosystems, in large part due to its location on the Colorado Plateau and the elevation gradient formed by the canyon. Three of the four desert systems in North America—Great Basin, Sonoran, and Mojave—are represented within the park. Grand Canyon National Park provides habitat for more than 1,500 vascular plant species and about 90 mammal, 373 bird, 48 reptile, nine amphibian, 17 fish, and more than 4,800 invertebrate species. Nine plant and animal species are endemic to the park—meaning they are found nowhere else on Earth—and an additional 23 species are regionally endemic, with ranges that extend from within the park to just outside its boundaries.

For thousands of years American Indians have had strong ties to the Grand Canyon area. Some live in the area, while others have hunted and gathered resources there. The Grand Canyon and nearby features are sacred locations for a number of tribal groups. The Hopi view the San Francisco Peaks to the southeast, visible from the park, as the dwelling place of their ancestral spirits. Their people emerged from the canyon, and upon death, their spirits will return there. For the Zuni, the Grand Canyon is also where their ancestors originated. For the Pai people, the Grand Canyon and the Colorado River are known as *hakatai'a* or "the backbone."

European exploration of the region began in the 16th century and expanded in the 18th

Grand Canyon National Park encompasses a wide diversity of species and ecosystems. An interpretive panel along the Cape Royal Trail describes the Sonoran life zone present along this part of the Grand Canyon's North Rim.



ALAN ENGLISH

The park's museum collection includes historic Colorado River boats, which are cared for by trained conservators.



BRYNN BENDER/NATIONAL PARK SERVICE

century with visits by Spanish missionaries. U.S. Civil War veteran John Wesley Powell led an expedition down the Colorado River in wooden boats during the late 1860s and retraced his route during a second expedition in the early 1870s. John D. Lee established a Colorado River-crossing business in 1871 on a site later called Lees Ferry—still the departure point for many river-running trips today.

Miners attracted to the region found copper, silver, lead, and uranium. The cost and difficulties of transporting the ore prompted some miners to turn to tourism as a commercial enterprise. The early 20th century saw an increase in tourism and human settlement, which led to a growing awareness of the significance of the Grand Canyon's resources, as well as to a movement to protect them.

The Grand Canyon's long and extensive human history is evident today in the national park's extensive museum and archival collections, hundreds of historic structures and associated cultural landscapes, thousands of archaeological sites, and connections to contemporary American Indian peoples who maintain tradi-

tional ties to the canyon and its resources. The park's collection of more than 889,000 museum and archival objects includes archaeological artifacts such as pottery and split-twig figurines (animal figures fashioned from a single twig, approximately 2,000–4,000 years old); documents from John Wesley Powell's explorations; and more than 20,000 historical photos.

The park's 898 historic structures include several designed by Mary Colter (e.g., Hopi House, 1905, and Desert View Watchtower, 1932) to reflect traditional American Indian structures, as well as many others built by private citizens (e.g., Kolb Studio, 1904), the Santa Fe Railroad (e.g., El Tovar Hotel, 1905), the Civilian Conservation Corps (e.g., the rock wall along much of the South Rim at Grand Canyon Village, 1936–1940), and the Park Service (e.g., Yavapai Observation Station, 1928). Nearly 4,000 archaeological sites have been documented so far; these include ancestral Puebloan dwellings, a 12th-century Pueblo settlement at Tusayan Ruin, historical mining camps, and much more.

ESTABLISHMENT AND GUIDING LEGISLATION

John Wesley Powell's exploration of the Colorado River brought the Grand Canyon to public attention in the 1860s and 1870s. Shortly thereafter, concern for the preservation of the Grand Canyon's unique resources began to grow as more and more people visited the canyon or settled there. Sen. Benjamin Harrison of Indiana introduced legislation that would grant formal protection for the Grand Canyon as a public park in Congress in 1882, 1883, and 1886—well before Arizona became a state in 1912. However, his various attempts at legislation to protect the canyon did not pass. Harrison served as president of the United States from 1889 to 1893, and in the last year of his term, he set aside the Grand Canyon as a forest reserve. Tourism development on the canyon's rim was not affected, and grazing, lumbering, and mining were still allowed with permits.

In 1906, President Theodore Roosevelt declared portions of the forest reserve a game preserve; that same year, the Act for the Preservation of American Antiquities ("Antiquities Act") gave broader authority to federal agencies and departments to protect archaeological and other cultural sites and objects on lands under their jurisdiction. In 1908, President Roosevelt used the Antiquities Act to create the 818,560-acre Grand Canyon National Monument and thus grant the canyon and its resources more protection.

The National Park Service was created in 1916. The mandate for the agency was stated in the Organic Act: "The Service such established shall promote and regulate ... to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such a manner and by such means as will leave them unimpaired for the enjoyment of future generations." Grand Canyon National Monument was redesignated as Grand Canyon National Park by an act of

Congress in 1919, and its management was transferred to the National Park Service. This law also reaffirmed the rights of specific native peoples, permitted rights-of-way that were consistent with primary park purposes, permitted development and mineral exploration, and revoked game preserve provisions on park lands.

From the 1920s through the 1960s, authorized land purchases and exchanges, as well as boundary revisions, occurred at the park. In 1931, the park was closed to new mineral entry claims. Presidential proclamations in 1932 and 1969 provided certain lands around Grand Canyon National Park with national monument status. These lands were combined with existing park lands in 1975 under the Grand Canyon National Park Enlargement Act, increasing the size of the park to approximately 1.2 million acres to "further protect the outstanding

John Wesley Powell led his second expedition down the Colorado River in the 1870s. This image from 1872 shows two of his boats moored in Marble Canyon.



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scenic, natural and scientific values of the Grand Canyon," given that "the entire Grand Canyon, from the mouth of the Paria River to the Grand Wash Cliffs, including tributary side canyons and surrounding plateaus, is a natural feature of national and international significance." Provisions were also made for future acquisition of land, cooperative agreements with other political entities to provide uniform interpretation, and the termination of grazing rights by 1985. Additionally, the law required the National Park Service to manage and protect the soundscape of the park, the first time national park enabling legislation specifically identified natural sounds as a resource to protect.

The Enlargement Act also set aside 95,300 acres within Grand Canyon National Park to be held in trust for Havasupai Tribe traditional-use purposes, although these were not to affect existing scenic and natural values. Conservation programs on these lands continued to be the responsibility of the Department of the Interior. An amendment to the law in the same year allotted the Secretary of the Interior two years to make a recommendation on wilderness suitability (under The Wilderness Act of 1964) of any part of the park.

Small additions since the Enlargement Act have increased Grand Canyon National Park's size to its current 1,218,376 acres. The park is bordered by three other units managed by the National Park Service: Glen Canyon National Recreation Area to the north along the Colorado River, Lake Mead National Recreation Area to the west along the river, and Grand Canyon-Parashant National Monument (jointly managed with the Bureau of Land Management) from the drainage divide of the Virgin River to the boundary with Lake Mead National Recreation Area. American Indian reservations and lands managed by the U.S. Forest Service and Bureau of Land Management also border the park.

While a number of laws and proclamations specifically address establishment of Grand

Canyon National Park and management of its resources, several other laws not directed specifically at the park also have an important bearing on park resources. These include the Colorado River Compact (1922), which allocated Colorado River water and divided the river into the still-extant upper and lower basin designations; the Boulder Canyon Project Act (1928), which authorized construction of Hoover Dam and gave congressional consent to the Colorado River Compact; and the Colorado River Storage Project Act (1956), which authorized the Glen Canyon Dam upstream of the park. These laws have had long-lasting effects on river management and natural and cultural resources within the park. Recognition of detrimental effects from upstream water diversions resulted in the Grand Canyon Protection Act (1992), which requires the Secretary of the Interior to operate Glen Canyon Dam "in such a manner as to protect, mitigate adverse impact 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." While the Grand Canyon Protection Act has affected the park in various ways, including driving an increase in the collection of basic information on the Colorado River, its goal has not been achieved (see "Colorado River Management" on page 19).

The Wilderness Act (1964), which instructed the Secretary of the Interior to review certain national park lands and judge their suitability for wilderness classification, affects park management and character even though no lands within the park are legislatively designated wilderness. When the Grand Canyon National Park Enlargement Act gave a two-year window for wilderness recommendations by the Secretary of the Interior, the Park Service recommended to the secretary that more than 1 million acres be designated as wilderness. However, no legislative wilderness designations came from these recommenda-



In this 1901 photograph, visitors pose in front of the first train to carry passengers to Grand Canyon Village.

tions. Even so, as proposed wilderness under the Wilderness Act, this expanse must be and is managed as wilderness by park staff (see “Backcountry Management” on page 53), which helps preserve the park’s undeveloped areas. On a political level, this land is not wilderness and could be vulnerable to certain impacts that would not be allowed if it were official wilderness.

The Endangered Species Act (1973) guides protection of federally listed threatened and endangered species within the park. Both the Organic Act and an executive order from 1977 guide park efforts to restrict and remove non-native species. Efforts to preserve native species and eradicate non-native species are consistent with the park’s primary purposes.

Increasing concerns about noise, air traffic, and public safety in multiple parks, including Grand Canyon National Park, resulted in the National Parks Overflights Act of 1987, which directed the Secretary of the Interior to submit recommendations to the Federal Aviation Administration (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.” Overflights affect the character of Grand Canyon National Park and the park staff’s efforts to preserve its resources unimpaired, but, as with the Grand Canyon Protection Act, actions to meet the intent of this legislation have to date not happened (see “Soundscape Management” on page 29).

In 1977, amendments to the Clean Air Act designated Grand Canyon National Park as a federal Class I area, meaning visibility within the park is not to be impaired by any human source, and methods must be devised to monitor such visibility. Sweeping vistas are a defining characteristic of the park. Park staff work to ensure clean air and continued visitor enjoyment of the spectacular vistas the Grand Canyon offers, but their efforts are limited because primary sources of haze are located outside the park’s boundaries. A 1990 amendment to the Clean Air Act required creation of a commission to address interstate transportation of haze and haze-causing air pollution affecting Grand Canyon; however, the recommendations of this commis-

sion have no binding authority and its efforts have not significantly affected air quality at the park (see “Air Quality” on page 40).

Management policies and actions specific to cultural resources in the park are dictated by the Antiquities Act and its 1979 successor, the Archaeological Resources Protection Act, as well as a number of other laws, including:

- the Historic Sites Act of 1935, which authorized the preservation of objects of national historical and archaeological significance, including establishing and maintaining museums to house them;
- the Reservoir Salvage Act of 1960, which provided for the recovery and preservation of “historical and archaeological data (including relics and specimens)” that could be lost in the construction of dams and reservoirs;
- the National Historic Preservation Act of 1966 (amended in 1992), which created the National Register of Historic Places and established a program for the preservation of historic properties by requiring all federal agencies to inform the Advisory Council on Historic Preservation about actions that could affect properties eligible for or included in the National Register of Historic Places;
- the American Indian Religious Freedom Act of 1978, which mandated protection and preservation of American Indian religious cultural rights and practices and required consultation with traditional American Indian religious leaders; and
- the Native American Graves Protection and Repatriation Act of 1990, which mandated the repatriation of American Indian remains in institutions receiving federal funds and set out notification/consultation requirements for excavation and discovery of American Indian remains on federal or tribal lands.

Grand Canyon National Park’s staff are required to manage the park under these laws, as well as National Park Service policies that extend from them, such as the *Cultural Resource Management Guideline*, when addressing the preservation of cultural resources integral to the park experience. The intent behind these laws and policies is a guiding principle for resource management staff, but a lack of staff and money, along with conflicts with other management considerations and authorities (e.g., river management and soundscape), make it difficult to achieve all resource protection goals. The challenges that staff face in working under these policies are documented in this report.

The park’s enabling legislation and its additional resource protection laws and policies reflect and reinforce the principles of the Organic Act—conservation of resources and attention to visitor experience, where the means of providing enjoyable visitor experiences leave the resources unimpaired for future generations. These are to be the driving forces guiding the National Park Service’s management of Grand Canyon National Park. Even so, in the history of the agency, resource protection has not had as high a profile as visitor experience, and in many cases resources suffered at the expense of providing for visitor desires.

For the National Park Service the value of resources was again addressed in 1978 in the Redwoods Act, which stated, “The authorization of activities shall be construed 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 various areas have been established ... directly and specifically provided by Congress.” This law emphasized the reasons for park establishment and confirmed that the high priority of resource protection must be reflected in Park Service management actions. The greater emphasis on preservation continued in the 2006 National

Park Service *Management Policies*, which stated “The Secretary [of the Interior] has an absolute duty, which is not to be compromised, to fulfill the mandate of the NPS Organic Act of 1916 to take whatever actions and seek whatever relief as will safeguard the units of the national park system.” The Park Service’s *Management Policies* guide Grand Canyon National Park’s policies and plans, including its general management plan, resource management plan, and Colorado River Management Plan, which in turn guide day-to-day activities at Grand Canyon National Park. Park establishment occurred because of the resources present there, and protecting those resources is a focal point for Park Service resource management actions.

CONSIDERING THE VISITOR EXPERIENCE

While resource protection and preservation are the focus for the National Park Service at every national park unit, visitor experience is also an important component of every park. The complexities inherent in both appealing to diverse visitors with diverse expectations and balancing and blending visitor needs with resource needs become clear at a large park like Grand Canyon, which receives more than 4.5 million visitors each year.

Accommodating visitors at Grand Canyon National Park and providing them the opportunity for an engaging experience is no small feat. People come to the frontcountry (the North and South Rims and the major trail corridors) for a number of reasons, including the spectacular views, the interpretive programs, the history, the wildlife, and the trail hiking. On the South Rim, Grand Canyon Village is essentially the equivalent of a small town with extensive infrastructure that provides all of these experiences and

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Shuttle buses powered by natural gas transport visitors around the South Rim.



Park rangers provide daily programs to teach visitors about various aspects of Grand Canyon National Park's natural and cultural history.

more. People who leave developed areas and enter the backcountry (including the Colorado River corridor) are likely seeking recreation or solitude or both, and, because of current resource management actions, can have a "wilderness" experience.

Together, the Park Service, contracted concessioners, and commercial outfitters work to provide for the varying desires of visitors. Interpretive programs on topics such as the Colorado River, local geology, history, art, and wildlife are offered throughout the year at various locations and times on the canyon's rims. Exhibits and cell phone tours also add to the experience and interpretation of the canyon. Bus tours, mule trips, horse tours, guided hikes, air tours, and programs such as those offered through the Learning and Lodging Institute provide additional means to see and learn about the canyon. In the backcountry, hiking, camping, and participating in internationally

known river-running tours allow visitors a recreational experience that may have a more solitary component. The breadth and depth of offerings at Grand Canyon can be found on the park's website (www.nps.gov/grca) under the "Things to Do" link.

Even in the midst of accommodating millions of visitors, park staff still work within the established principles of the Organic Act, wherein visitor enjoyment is a fundamental charge, but providing for current visitors must be accomplished in a manner that leaves the park unimpaired for the enjoyment of future generations. Because visitors and visitation patterns at Grand Canyon National Park can result in resource impacts, this presents challenging management decisions. For example, most visitors enter the canyon in personal vehicles via the South Rim, where the extensive tourist facilities of Grand Canyon Village resemble a small town. Such a large number of vehicles can pollute the air and harm wildlife, and like any small town, Grand Canyon Village deals with many issues, such as ensuring adequate water supplies and determining how to deal with waste and the effects of development on local wildlife. In addition, with so many visitors present along the South Rim, additional steps must be taken for the protection of both natural and cultural resources (see "Frontcountry Management" on page 60).

Many visitors leave the developed areas along the South and North Rims, using the main trails (Bright Angel and North and South Kaibab) between the rims and the river, either for day hikes or overnight stays, while a smaller but still significant number are considered backcountry users. In 2007 there were 87,100 backcountry user nights (one person spending one night in the backcountry) and almost 220,000 river day users (one person spending any part of a day on the river). Impacts of visitors on cave resources and backcountry ecosystems, particularly those associated with scarce water resources, as well as in areas that may hold

archaeological resources, are constant possibilities (see “Backcountry Management” on page 53). Despite those concerns, law enforcement staff must focus the majority of their energy on frontcountry activities, particularly on the South Rim, which leaves the more than 1 million acres of backcountry “wilderness” largely unpatrolled. Additionally, visitors’ expectations for park access can result in actions that need to be managed to protect resources. For example, helicopter and airplane tours over the canyon continue to be a contentious issue due to distracting noise, which directly affects other visitors (on the ground), wildlife, and cultural resources (see “Soundscape Management” on page 29).

The number of visitors at Grand Canyon National Park, the expectations of these visitors, and the experience that the park’s staff attempts to provide must all be taken into consideration in day-to-day management actions at the park, including decisions that affect park resources. Staff at Grand Canyon National Park face an overriding tension: providing the services necessary for enjoyable and safe experiences, while simultaneously ensuring the protection of the natural and cultural resources that prompt more than 4.5 million visitors to visit the park each year. While park managers have attempted to mitigate this tension in a number of ways—including formation of the Socio-Cultural Resources Program within the Division of Science and Resources Management to address visitor experience—challenges remain. This report focuses on the primary resource challenges at Grand Canyon National Park, because resources are the reason the park was established; yet, attempting to optimize visitor experiences at the park is inextricably linked to some of the challenges these resources face.

NATURAL AND CULTURAL RESOURCE CHALLENGES

The lands, waters, wildlife, and cultural treasures within Grand Canyon National Park are entrusted to the National Park Service to preserve unimpaired for current and future generations. But simply designating the area as a national park is not enough to ensure that the irreplaceable natural and cultural resources of the Grand Canyon will be fully protected. Even ongoing legislative efforts, as noted above, may fail to sufficiently protect the park’s resources. The park’s staff, working under the guidelines of numerous laws, policies, and plans, currently have resource management duties focused on cultural resources, natural sounds, air quality, water quality, vegetation and wildlife, fire restoration, and wilderness and backcountry. Also, as noted above, they maintain a focus on visitor experience and its interplay with resource preservation.

In protecting the park’s resources, the National Park Service faces emerging, recurring, and continuing challenges that originate both within and outside of park boundaries. The primary challenges to the park covered in this report include:

- Colorado River management actions that do not incorporate adaptive strategies for protecting and restoring fish, river flows, riverine habitats, cultural sites, and archaeological resources along the river corridor;
- soundscape management for natural quiet, including managing overflights that may disturb park visitors, wildlife, and the traditional activities of the park’s 11 affiliated American Indian tribes;
- new mines that could be developed on lands adjacent to the park, as well as environmental contamination from past mining activities within the park;

- air pollution from miles away that has the potential to obscure scenic vistas, harm visitor and employee health, and damage sensitive plants;
- other threats from adjacent lands, including damage caused by grazing and water development, as well as the presence of non-native invasive plants and animals;
- frontcountry and backcountry management and protection needs, particularly in regard to the challenges of park size and visitation patterns and shortfalls in funding, which compromise efforts to preserve and protect the park's resources;
- the need for permanent funding for more proactive, strategic consultation activities to continue to foster effective relationships with the park's 11 affiliated American Indian tribes; and
- potential impacts due to climate change on the Colorado Plateau.

A summary of each challenge is presented in this report to highlight its current status and discuss efforts to address it. In addition, information is provided on further actions that could be useful in better protecting the park's resources. Grand Canyon is a highly visible, complicated park with issues that also appear at a similar or smaller scale in many other national parks. Because of this, discussing these issues and presenting possible solutions for Grand Canyon National Park not only can bring greater visibility to the challenges faced there, but also can illustrate potential directions in resource preservation that could be useful throughout the National Park System.

The park's high visitation, expansive backcountry, and extensive frontcountry facilities combine to present unique management challenges. Shortfalls in funding further complicate efforts to preserve and protect the park's resources.





COLORADO RIVER MANAGEMENT



COLORADO RIVER MANAGEMENT: PROTECTING AND RESTORING GRAND CANYON'S NATURAL AND CULTURAL RESOURCES

The Colorado River comes to life in the high evergreen forests of Rocky Mountain National Park in Colorado and is fed by other major waterways, such as the Green and San Juan Rivers, as it flows southwest to Grand Canyon National Park. After passing through the Grand

Canyon, the river continues its journey to the Gulf of California. Although the Colorado River comprises about one percent of Grand Canyon National Park's total area, it is one of the park's primary focal points. It was largely the work of the river that shaped the canyon. It is also the river that attracts tens of thousands of visitors each year to ride its white waters in rafts, kayaks, or dories. In addition, the Colorado River and its tributaries are the primary reasons that many

The Colorado River attracts thousands of visitors to Grand Canyon National Park each year, many of whom experience the canyon from the vantage point of rafts.



The waters of the Colorado River and its tributaries are the primary reasons that many plants, animals, and people survive in this dry desert region.

plants, animals, and people survive in this dry desert region.

The settlement and cultivation of much of the American West required water from the Colorado River, both for sustenance and for generation of electrical power. Many laws over the last 90 years have addressed Colorado River water rights, water storage, flood control, and power generation. The Colorado River Compact of 1922 was the first law to assign water rights to the states of the Upper and Lower Colorado Basin. Upper Basin states are Wyoming, Colorado, Utah, and New Mexico, while Lower Basin states are Arizona, Nevada, and California. A 1944 agreement allocated water from the Colorado River to Mexico. The Boulder Canyon Project Act (1928) authorized the creation of Hoover Dam on the Colorado River as well as an impoundment (Lake Mead) west of the modern Grand Canyon National Park. The Colorado River Storage Project Act (1956), which authorized the Glen Canyon Dam, impounded the Colorado River 15 miles upstream of the confluence of the Paria River.

THE GLEN CANYON DAM AND ITS IMPACT ON NATURAL AND CULTURAL RESOURCES

Today's Colorado River is a highly regulated river system, a carefully managed flow of water with only a passing resemblance to its natural origins. Prior to the completion of the Glen Canyon Dam, river flows measured at Lees Ferry (just upstream of Grand Canyon National Park) reached 120,000 cubic feet per second (cfs) during flood stage at six-year intervals, and gradually dropped to fewer than 3,000 cfs during late summer, fall, and winter. After 1963 (the completion of the dam) but before 1990 (when dam operations came under scrutiny), river flows were controlled not by rainfall, snowmelt, and other climatic factors, but by efforts to maximize power generation and revenues. Daily flows ranged from 5,000 cfs to 30,000 cfs to accommodate the needs of power consumers. This artificial flow regime ran contrary to the natural flow regime under which the Grand Canyon's flora and fauna had evolved. These artificial flows were also dangerous to visitors. Flows fluctuating daily from 5,000 to 30,000 cfs could change the level of the river up to 13 feet, and they raised concerns about the safety and quality of recreational boating and fishing.

The Glen Canyon Dam has altered other environmental conditions in the Colorado River as well. Before the dam was built, the river was naturally warm and filled with sediment; today the river is often cold and clear. Water temperature in the river once varied by season from 32 °F to 86 °F (0 to 30 °C). Today, because the water is released from well below the surface of Lake Powell, there is little seasonal fluctuation, and the temperature hovers around 46 °F (8 °C). In addition, the dam traps tremendous amounts of sediment. Before the dam was built, about 29 million tons of sediment reached the upstream section of the Grand Canyon each year. Today, even taking into account the sediment entering from the Paria River and other, smaller tributar-

ies, annual sediment input has been reduced to about 16 percent of the pre-dam level. The trapped sediment is no longer available for creating habitat downriver or for maintaining beaches and sandbars important to river runners. These physical changes in the river (sediment and temperature), coupled with unnatural flow rates, have resulted in the spread of non-native riparian vegetation, loss of native fish adapted to warm, muddy conditions, invasions of non-native fish, and beach and sandbar erosion.

Cultural resources in the park are affected by Glen Canyon Dam operations as well. The river corridor holds significant archaeological resources and cultural sites, such as the remains of prehistoric, ancestral Puebloan dwellings, many of which are traditional cultural properties of tribal people. According to the National Park Service, a traditional cultural property “is eligible for inclusion in the National Register [of Historic Places] because of its association with cultural practices or beliefs of a living community that (a) are rooted in that community’s history, and (b) are important in maintaining the continuing cultural identity of the community.” The Bureau of Reclamation (which operates Glen Canyon Dam) and the Park Service must protect such sites within Grand Canyon National Park as mandated by legislation such as the National Historic Preservation Act and must consult on protection with the park’s 11 traditionally associated tribes.

Archaeologists have surveyed much of the Grand Canyon’s river area for archaeological resources. So far, they have identified 674 sites in the Area of Potential Effect (APE). The APE is the area within which dam operations could affect historic properties such as historic structures, archaeological sites, and traditional cultural properties, and is generally within a two-mile hiking distance into side canyons. These cultural sites can be affected both by increased river visitor traffic and by diminished sediment input and unnatural flows caused by

dam operations. Before Glen Canyon Dam was constructed, flood flows quickly refilled gullies with sediment; after the dam was built, more intermittent flows containing much less sediment created destructive gullies and caused flood plain riverbanks to collapse and wash downstream, eroding archaeological resources. Post-dam flood patterns can irrevocably damage or destroy valuable archaeological resources and cultural sites.

In addition, sand that was once naturally deposited along the river’s banks is no longer replenished in some areas due to altered flows and reduced sediment loads in the river. Sites once covered and protected by sand may be exposed and become susceptible to damage or washout. Furthermore, research suggests that there are likely many more undiscovered sites in the river corridor that could be washed away or otherwise damaged before they can be identified and documented.

Glen Canyon Dam, which was constructed between 1956 and 1966, impounds the Colorado River at Page, Arizona, upstream of Grand Canyon National Park. The dam has altered environmental conditions in the river and has affected conditions of the park’s natural and cultural resources.



CAN BALCIOGLU/STOCKPHOTO

MITIGATING THE IMPACTS OF THE GLEN CANYON DAM: THE ADAPTIVE MANAGEMENT PARADIGM

A growing concern about the impacts of Glen Canyon Dam on downstream resources culminated in Congress passing the Grand Canyon Protection Act (1992), which directs the Secretary of the Interior to manage the 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” (GCPA §1805(c)). As a result, an experimental flow regime referred to as the Modified Low Fluctuating Flows (hereafter referred to as modified flows) began in 1996. The modified flow regime established as minimum flows 8,000 cfs during the day and 5,000 cfs at night, while daily maximum flows could not exceed 25,000 cfs. Between these limits, daily flows could fluctuate between 5,000 and 8,000 cfs, depending on the targeted monthly release amount. This new operating plan, it was hoped, would allow for the restoration of the damaged habitats of the river channel, particularly sandbars and beaches, and assist the recovery of native fishes.

The first step in managing the Glen Canyon Dam was choosing flows to first protect the resources of the Grand Canyon while striving to optimize hydropower generation. The Glen Canyon Dam Adaptive Management Program, under the Bureau of Reclamation, was created to evaluate the effectiveness of altered dam flows and to adjust flows and conduct activities that would be beneficial to Grand Canyon National Park resources, an approach known as adaptive management. The Adaptive Management Program included a work group made up of more than 25 entities, consisting of federal agencies (including the National Park Service), states, American Indian tribal governments, and a number of other stakeholders such as power distributors and recreation groups. The group

advises the Secretary of the Interior on implementation of the Grand Canyon Protection Act. The Bureau of Reclamation finances the Adaptive Management Work Group. The decisions of this group are to be informed by the best available science, which comes from the U.S. Geological Survey’s Grand Canyon Monitoring and Research Center. About \$9 million has been allocated annually to research conducted by the Grand Canyon Monitoring and Research Center on river corridor resources.

Modified Flows: The First Ten Years

The operating plan featuring modified flows was established in 1996, and some of the first adaptive decisions included adding some experimental flows, such as high flows to evaluate the effects of floods on downstream resources. Short-term changes in the operating plan of the dam included high flow tests in 1996, 2004, and 2008, a low summer steady-flow test in 2000, and some experimental fluctuating flows between 2003 and 2005. These short-term changes did not result in the restoration of resources in Grand Canyon. The regular operating plan followed the modified flow regime.

Intensive scientific research, summarized in the 2005 U.S. Geological Survey report titled *State of the Colorado River Ecosystem in the Grand Canyon* (SCORE), indicates that the modified flow regime had negative impacts on some downstream resources, positive effects on others, and mixed or unknown impacts on still others. As a general strategy, high flow tests at the tested intervals have not restored the park’s resources. In addition, scientists at the 2007 Grand Canyon Monitoring and Research Center Science Symposium who evaluated over 10 years of data collected along the Colorado River provided a summary conclusion that stated that ongoing experimentation was important and that seasonally adjusted steady flows were an appropriate flow regime to be implemented for the Adaptive Management Program. Nonetheless, the Adaptive Management Work

Group has failed to support tests of additional flow regimes that scientific research indicates might benefit the canyon's resources.

During the first 10 years of trials, the tested modified flows had a negative effect on sediment dynamics. Initial analysis had predicted that, under modified flows, sediment would accumulate in the system and contribute to sandbar formation and maintenance. This prediction was an important reason why the modified flow regime was established in the first place, because the dam and its operation were resulting in the destruction of sandbars and beaches. Subsequent research demonstrated, however, that sediment did not accumulate in the river under modified flows, and sandbars continued to erode. Also, while camping beaches were predicted to increase, the opposite occurred.

At the same time, effects of modified flows on some river resources were positive. Under the highly variable flows that occurred prior to dam construction, the river routinely scoured the woody riparian vegetation and sandbars along the river. By constraining flows through measured water releases from the dam, these habitats were predicted to increase. If these habitats improved, the birds and other wildlife populations that use them could be expected to increase. This prediction was somewhat borne out. The near-river riparian areas did recover, although the resulting habitat was largely colonized by the invasive, non-native tamarisk tree. While the habitat is not optimal, it is nonetheless used by birds, including the endangered southwestern willow flycatcher (*Empidonax traillii extimus*), and other wildlife.

The SCORE report found that other results of the modified flow plan have been mixed. Aquatic food webs were expected to improve based on increased sediment loads. Research suggests that this has occurred in the very upstream reaches of the river near Lees Ferry but not farther downstream. Populations of native sucker fishes (*Catostomus latipinnis* and *C.*

MONITORING CULTURAL RESOURCE SITES NEAR THE RIVER CORRIDOR

Park archaeologists monitor the impacts of Glen Canyon Dam operations on cultural resources. The Monitoring and Remedial Action Plan is designed to assess the effects of dam operations on historic properties, identify ongoing impacts to historic properties within the Area of Potential Effect, and develop and implement mitigation plans. For example, the park examined the potential impacts on archaeological sites of releasing various quantities of water, noting that archaeological sites identified in the Area of Potential Effect could be negatively affected. The park works cooperatively with the Bureau of Reclamation on mitigation for some of the sites affected by Glen Canyon Dam operations. One mitigation strategy the park has employed is the use of check dams—structures made of various materials such as stones and logs—to protect historic properties from erosion. Other treatment actions include minor trail work, re-vegetation, public interpretation, site closure, stabilization of landscapes or structures, artifact collection, testing, and archaeological data recovery.



In prehistoric times, granaries were built high along the rock faces of Marble Canyon. These and other archaeological remains are evidence of various cultural groups that have lived within the Grand Canyon. Operations of Glen Canyon Dam can affect archaeological resources along the Colorado River and side canyons; park archaeologists monitor these effects and develop remediation plans when necessary.

discobolus) have appeared to be stable or slightly increasing in the river. On the other hand, for much of the period since 1996, the endangered humpback chub (*Gila cypha*), which was predicted to improve in a modest way with increasing critical habitat (backwater breeding areas created by the increased deposition of sandbars) and temperature regimes more favorable for breeding, instead, appeared to experience a strong downward trend. The one population found near the confluence of the Colorado and Little Colorado Rivers declined from 9,000 to 10,000 individuals (aged 4+ years) in 1989 to a low of about 5,000 in 2001.

The 2008 Dam Operation Plan

The adaptive management process has at its center an evaluate-and-alter philosophy, an iterative approach that starts with an existing management policy, moves to evaluation of results under that management policy, and concludes with altering the existing policy to

create a new management policy if results suggest that alterations are needed. Given the evidence from more than 10 years of research on modified flows, a recommendation was made to develop a new comprehensive science and management plan. Instead, in February 2008, the Bureau of Reclamation released a plan for Glen Canyon Dam operations that included a high flow experiment in 2008 (with no further similar releases for five or more years) and two months of steady flows in the fall. The high flow test in March 2008 was designed to mobilize sediment available from floods of the Paria and Little Colorado Rivers and redistribute it within the Colorado River.

This action was intended to rejuvenate backwater habitats for native fishes, especially the humpback chub; improve the riparian resources and protect archaeological resources by building up sandbars and re-depositing sand at higher elevations; preserve and restore camping beaches; and reduce near-shore vegetation.

Operations of the Glen Canyon Dam play a large role in determining how much sand and sediment flow down the Colorado River into Grand Canyon National Park. Among other purposes, the sand and sediment are needed to improve fish habitats and riparian resources, protect archaeological resources, and preserve and restore camping beaches.



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While the benefit of high flow events was supported by research findings, investigators questioned the long proposed interval between events. The “steady flow portion” of the experiment during September and October was designed to mimic the low flows typical of the river in late summer and early fall, and was presented as helping the native fishes by mimicking flow dynamics and temperature regimes to complement the habitat created during the high flow phase. However, scientists identified this time frame as not an optimal period for the humpback chub, making the flow regime ineffective for protecting the resource.

Results suggest that there have been some improvements in river sediment resources from the high flow experiment in March 2008, and researchers continue to evaluate the 2008 high flow experiment. At the same time, scientists are concerned that relying on the modified flow regime during the remainder of the year will undo the improvements observed in some resources. The 2005 SCORE report expressed grave concerns that the modified flows were degrading many important park resources. That general consensus has not changed, and researchers worry that using modified flows for ten months of the year will wipe out much of the observed progress achieved by periodic high flows and steady flows. This concern was reinforced in spring 2010 when an analysis of the experiment by the U.S. Geological Survey concluded that gains in widespread building of sandbars were short-lived due to erosion occurring with resumed dam releases that followed normal fluctuating flow operations. Recently, Secretary of the Interior Ken Salazar announced his intention to direct the development of a protocol to conduct additional high flow experiments. These experiments are intended to send sediment downstream for the benefit of natural and cultural resources and recreational opportunities.



ARIZONA GAME AND FISH DEPARTMENT

ENDANGERED SPECIES: HELPING THE HUMPBACK CHUB THROUGH POPULATION TRANSLOCATIONS

Park staff have identified maintaining or attaining viable populations of native fishes as a desired future condition. Recent research shows that the humpback chub population has increased from a low of about 5,000 adults (age 4+ years) in the 1990s to somewhere between 6,000 and 10,000 (most likely number: 7,650) in 2008. This trend is encouraging, but the status of the chub is still precarious; the population is down an estimated 25 percent from where it was even at the time of the Grand Canyon Protection Act. In response, the staff at Grand Canyon are conducting new projects to increase the number of viable chub populations within the canyon. In June 2009, the National Park Service and several other agencies, including the Arizona Game and Fish Department, the U.S. Fish and Wildlife Service, and the Bureau of Reclamation, completed a translocation project by moving wild-caught and tagged humpback chub from the Little Colorado River to Shinumo Creek. This small tributary creek joins the Colorado River at about River Mile 109 and is considered appropriate habitat for the chub. The goal is to establish another population of this endangered fish to improve the chances of its long-term survival in the canyon.

DESIRED FUTURE CONDITIONS FOR RESOURCES ASSOCIATED WITH THE COLORADO RIVER

The staff of Grand Canyon National Park recognize that the resources of the Colorado River corridor will likely never return to the state they were in prior to Euro-American settlement. As a result, they have developed a list of actions aimed at achieving desired future conditions for natural and cultural resources tied to the Colorado River ecosystem. These include:

- Maintain or attain viable populations of existing native fish and prevent adverse modification to their habitat (including critical habitat).
- Establish water temperature, quality, and flow dynamics to achieve ecosystem goals.
- Protect or improve the biotic riparian, wetland, spring, and former high water zone plant communities and their associated biological processes within the Colorado River ecosystem (including threatened and endangered species and their habitat).
- Maintain or attain levels of sediment storage within the main channel and along shorelines to achieve ecosystem goals.
- Maintain or improve the quality of recreational experiences for users of the Colorado River ecosystem, within the framework of ecosystem goals.
- Preserve, protect, manage, and treat cultural resources for the inspiration and benefit of present and future generations.

To attain these desired future conditions, park staff have developed a dual approach. First, they continue to work to influence Glen Canyon Dam operations for the benefit of Grand Canyon resources. At the same time, the park's staff has developed management plans and initiated restoration projects (described below) that work toward these desired future states.

THE PARK SERVICE'S COLORADO RIVER MANAGEMENT PLAN: VISITOR EXPERIENCE AND RESOURCE PROTECTION

Each year, thousands of people experience the majesty of the Grand Canyon from the vantage point of the Colorado River. Park staff are concerned that high visitor use may affect aquatic habitats and native flora and fauna, spread non-native species, and degrade cultural resources along the river corridor. In 2006, the park finalized the Colorado River Management Plan, which is "a visitor use management plan that specifies actions to conserve park resources and visitor experiences while enhancing river running recreational opportunities on the Colorado River through Grand Canyon National Park."

The Colorado River Management Plan develops a framework for a research, monitoring, and mitigation program to evaluate the effects of visitor use on natural and cultural resources. Specific monitoring plans will be developed for identified resources, and the results of that monitoring feedback will be reported to the park and lead to changes in policy through an adaptive management approach. Individuals with the park's Science and Resource Management Program develop these monitoring plans. Ideally, this umbrella program will provide information on visitor impacts; in addition, it will provide research and monitoring information that will illuminate the impacts of dam operations on river resources.

GOALS AND NEEDS FOR COLORADO RIVER MANAGEMENT AT GRAND CANYON NATIONAL PARK

The staff at Grand Canyon National Park will continue to monitor and protect river resources through monitoring studies and management plans. In addition, staff will continue to work to protect the unique resources of the Colorado River through interaction with the other stakeholders of the Glen Canyon Dam Adaptive



Participants on a commercial rafting trip take a break on a sandy beach along the Colorado River. Ensuring adequate amounts of sand and sediment are allowed to flow through the canyon is essential to maintaining such beaches.

Management Work Group. However, degradation of natural and cultural resources is likely to continue under the current Glen Canyon Dam operating plan and, at some point, park staff will have limited options to act on behalf of the park's unique resources.

In many ways, the 2008 Glen Canyon Dam operating plan does not appear to fully consider the more than ten years and \$100 million spent on investigation by the Grand Canyon Monitoring and Research Center. The new plan fails to schedule periodic high flow events—instead focusing on only one event, which occurred in March 2008—to restore more natural sediment dynamics and the resources associated with that sediment. The plan also relies heavily on the older modified flows paradigm, the value of which is questioned by existing research.

The deliberations and decisions of the work group of the Glen Canyon Dam Adaptive Management Program minimize the influence of the National Park Service, because the Park Service is only one of more than 25 agencies and stakeholders who are part of the group.

Consensus rarely exists among members, and effects on park resources (which are required to be protected by law) are not always the primary factor considered by the group as a whole. Current management strategies promoted by the Adaptive Management Program Work Group hinder the Park Service from implementing management policies that would allow it to preserve resources under its stewardship.

Grand Canyon National Park and the interests of the National Park Service would have more influence within the work group if park managers were provided with sufficient resources to increase the number of staff focused on river planning, use, stakeholders, and research. Right now, a dramatic shortfall exists between the budget of Grand Canyon National Park and its needs. The Park Service has requested funds to establish eight professional-level positions at Grand Canyon National Park in order to strengthen its ability to implement a range of programs relative to dam operations and to employ and monitor management actions intended to lessen or eliminate resource impacts and restore park values.

*COLORADO RIVER MANAGEMENT:
NPCA RECOMMENDATIONS FOR
ACTIONS TO PROTECT PARK
RESOURCES*

Scientific research demonstrates that modification of water flows from Glen Canyon Dam would help restore natural and cultural resources within Grand Canyon National Park. However, since the implementation of the 1996 Record of Decision for the Operation of Glen Canyon Dam, no significant modifications have been made to these water flows. Furthermore, although the Secretary of Interior is required to review operating criteria for the dam, at least every five years, based upon the work of the Adaptive Management Program, this review has not occurred since 1997. Economic analysis indicates that restorative flows would not require reallocation or redistribution of basin waters. Restorative flows could result in deferral and/or acceleration of water releases but would likely require only infrequent reductions in hydropower that would impact electricity bills of end users by, on average, zero to ten cents per month.

- The Glen Canyon Adaptive Management Work Group should ensure that water flows known to benefit canyon resources are implemented. These include low flows during critical breeding and rearing periods of native fishes, particularly the humpback chub, and seasonally adjusted steady flows at other times during the year. Consistently low flows throughout the summer (June–August) were tested once (8,000 cfs in 2000) and seasonally adjusted steady flows have not been tested. In addition, regular high flows should be initiated when sediment levels from tributaries below the dam are appropriate to build beaches and habitat. The tested high flow event releasing water from Glen Canyon Dam in 2008 was initially successful in rebuilding Colorado River beaches, expanding recreational

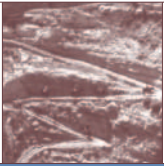
beaches, and establishing backwaters for critical habitat for humpback chub. It is critical that the Adaptive Management Program make the important recommendations that will impact the direct operating criteria for the dam.

There is currently within the Adaptive Management Program an emphasis on scientific certainty that can impede adaptation of alternative approaches to resource protection, including management efforts.

- Research and monitoring by the U.S. Geological Survey should be continued, but at reduced, more efficient levels. Funding directed from the Bureau of Reclamation and the Western Area Power Administration to the Adaptive Management Program can then be shifted from an emphasis on establishing scientific certainty about effects of dam operations to implementation of key management choices that the science identifies as having a clear and significant impact on river and resource restoration.

Grand Canyon National Park does not have sufficient, specialized staff to participate in and work with the Adaptive Management Work Group and efforts that spring from it. This affects both National Park Service influence within the work group and on-the-ground management efforts for resource protection.

- Congress should provide Grand Canyon National Park with funds sufficient to hire as permanent employees the additional professional-level staff needed to implement plans and programs on Colorado River dam operations and to employ and monitor management actions that lessen or eliminate resource impacts, evaluate visitor use, and restore park values.



SOUNDSCAPE MANAGEMENT



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Grand Canyon National Park

SOUNDSCAPE MANAGEMENT: RESTORING AND PROTECTING NATURAL SOUNDS IN GRAND CANYON NATIONAL PARK

National parks often commemorate solemn events, like the battles of the Civil War, the internment of Japanese-Americans during World War II, or the loss of lives in foreign conflicts. A respectful silence is appropriate and expected at such parks. At national parks that

commemorate and protect the natural landscapes of this country, many visitors also expect to experience a sense of peace and quiet. It is in these places that one can get away from the hustle and bustle and beeps and buzzes of modern life. A return to natural sounds, a bird song or the rustle of the breeze, is one thing many park visitors hope to experience. Around the country, national parks are one of the few remaining places to find these natural sounds.

Helicopter tours are a popular way to take in the beauty of the Grand Canyon. The Park Service must have the authority to regulate overflights to restore natural quiet at the park for the benefit of visitors and wildlife.

Many visitors to national parks expect to experience a sense of peace and quiet that is not intruded upon by the sounds of modern life, such as noise from traffic or aircraft.



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Yet, national park visitors do not always find the natural quiet they seek. Noise from traffic on adjacent highways intrudes on the soundscapes of some parks, while in others the natural quiet is interrupted by motorized equipment or recreational vehicles.

In recent decades, with annual visitation topping 4.5 million people and the popularity of air tours over the canyon, finding a quiet place to enjoy Grand Canyon National Park without the intrusion of human-generated sounds has become difficult. According to the park's website, the Grand Canyon's soundscape, "the natural ambient sound level of the park," should be unfettered by "human-produced noises." To benefit the visitor experience as well as protect wildlife, wilderness, and ethnographic resources, the park strives to preserve and restore Grand Canyon's soundscape—the natural music that is found only in this incredible place.

LEGISLATIVE HISTORY AND POLICIES DEFINE SOUNDSCAPE MANAGEMENT

The National Park Service, through the Organic Act of 1916, is charged to "conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations" (16 USC 1). The General Authorities Act (1970) and the Redwood Amendments (1978) further codify the role of the National Park Service in protecting the resources designated by Congress. In 1975, the Grand Canyon National Park Enlargement Act, recognized the importance of natural quiet as a resource to preserve and required the Park Service to manage and protect the natural quiet within the park much as it protects the landscape. The Enlargement Act specifically identified the noise from aviation overflights, as these were considered at the time to be the primary disruption to the "natural quiet and experience of the park."

Starting in the 1920s, the overflight tour industry began to develop rapidly to accommodate visitors choosing to view the majesty and breathtaking scope of the Grand Canyon from above. By 1987, there were approximately 50,000 overflights conducted each year by tour companies. The noise, as well as concern for public safety in the wake of midair plane collisions over the canyon, first in 1956 and again in 1986, led Congress to enact the National Park Overflights Act in 1987. Among other things, the law required the Secretary of the Interior to submit recommendations on ways to protect the Grand Canyon's resources from aircraft noise. "The recommendations shall 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 overflight" (PL 100-91, Sec 3(b)). The legislation targeted tighter regulation of the park's airspace and flight paths. In response, the National Park Service and Federal Aviation Administration established flight-free zones, specific flight corridors, and altitude restrictions for different airspace uses (e.g., air tours, commercial, military).

A variety of rules and announcements followed this, mostly addressing tour routes over the canyon or the technological dimensions of quiet aircraft. In 2000, Congress enacted the National Parks Air Tour Management Act, which deals generally with overflights and national parks, and makes some specific requirements for Grand Canyon. The law mandates that the FAA designate quiet aircraft technologies for fixed-wing airplanes and helicopters. It also created an advisory group, the National Parks Overflights Advisory Group, established jointly by the FAA and NPS, to "advise and counsel with respect to commercial air tour operations over and near national parks." The lack of any real progress in implementing the National Park Overflights Act led to the formation of the Grand Canyon Working Group, a subcommittee of the National Parks

Overflights Advisory Group. The Grand Canyon Working Group has been charged with advising the NPS and FAA to achieve the legal mandates regarding soundscape restoration and overflight regulation. Since the National Park Overflights Act, a more accurate tracking of flights indicates that there were between 40,000 and 55,000 commercial tours per year in the years 2001–2005. These numbers do not include certain types of flights, including those classified as transportation, repositioning, training, and maintenance.

In addition to following federal legislation, the Park Service also now includes the soundscape as part of its servicewide resource management strategy. National Park Service Director's Order #47, *Soundscape Preservation and Noise Management* (2000), set out "to articulate National Park Service operational policies that will require, to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources." This order was reaffirmed in the NPS *Management Policies* (2006): "the Service will restore to the natural condition wherever possible those park soundscapes that have become degraded by unnatural sounds (noise), and will protect natural soundscapes from unacceptable impacts." Grand Canyon is currently addressing the impacts of overflights in the context of a broad soundscape program.

GRAND CANYON NATIONAL PARK'S SOUNDSCAPE PROGRAM AND CURRENT RESEARCH

Grand Canyon National Park has an active soundscape management program. As the park's website points out, "the natural soundscape is an important resource of this park, and there are important relationships between how this environment is perceived and understood by individuals and society." Understanding the soundscape at Grand Canyon is an integral part of "determining the 'sound environment' for

park planning purposes and other environmental compliance actions stemming from human activity that may produce inappropriate or intrusive impacts on the park soundscape” (www.nps.gov/grca/naturescience/soundscape.htm). The soundscape program at Grand Canyon is currently focused on understanding how noise, including noise from overflights, affects the visitor experience, the natural sounds or wilderness character of the park, and the ethnographic resources of the park. Also being studied is how noise affects wildlife and activities such as breeding.

The park actively studies the impacts of human activity (of both visitors and park staff) and associated noises on the soundscape in which those activities occur. For example, the park has studied the impact of activities that require administrative and emergency helicopter use in the park (e.g., search and rescue, fire management, maintenance, and research). Staff at the park have measured the noise produced when helicopters are used—noise that could impact wildlife, visitors, or both. These measurements and others help the park minimize noise produced during administrative uses. When available, the park uses a helicopter with quiet technology to minimize noise in the park.

The impact of noise on park visitors is a central concern to the park. Surveys conducted during the 1990s revealed that almost as many people (91 percent of respondents) said they visit parks for the quiet as for the scenery (93 percent of respondents). Accordingly, staff of the Grand Canyon soundscape program are working to understand the impacts of noise from overflights and other activities on visitors. For example, the park has begun to quantify the effects of human activity, including air tours and motor vehicles, on the interpretive programs at various park sites. Staff have found that noise from helicopters and cars frequently interrupts ranger-led interpretive activities at the Tusayan Museum and Ruins.

Park staff are also evaluating the impact of

noise on wildlife. Animals are known to show physiological responses, including increased stress hormones as well as behavioral responses, to excessive noise. While some acute responses are measurable, it is unknown at this time how seriously noise affects population dynamics or higher-level ecological responses. In one project, park staff are collaborating with the U.S. Fish and Wildlife Service to determine whether behavioral changes in individual Mexican spotted owls, a federally listed threatened species, can be attributed to noise. This work is ongoing, and the data collected will be an important contribution to the soundscape program.

The soundscape program is also working to determine the impact of noise on the wilderness character of the park. More than 90 percent of the Grand Canyon’s acreage is proposed wilderness, and the park manages it as wilderness. The Wilderness Act states: “A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain.” The Wilderness Act generally bans the use of motorized equipment in wilderness areas and holds that primeval conditions should prevail. As a result, maintaining the natural soundscape in these areas is a priority.

Finally, natural sound is an important component of the ethnographic soundscape. The park’s natural sounds—such as the sound of the wind as it blows through the trees—are part of the cultural traditions of the park’s traditionally affiliated American Indian tribes. Aircraft can be both a visual and audible intrusion for traditional ceremonial activities, including plant collection, offerings, and prayer. There are significant sacred and culturally sensitive locations within the park that are not appropriate for such intrusion, and the park works with affiliated tribes, the Federal Aviation Administration, and air tour operators to ensure

that the natural sounds of these places and their traditional uses can be preserved. For this reason, the Federal Aviation Administration has moved a flight route away from a village in the Havasu Canyon.

The park's soundscape program, however, is still in its infancy. Understanding and quantifying the impacts of human noise in the park, whether it comes from a helicopter or from the park's shuttle system, is a complex task, and the park currently lacks the personnel to develop a comprehensive soundscape plan and the ability to implement a program. Park management has leveraged short-term project funds to initiate the soundscape program; more long-term funding for personnel is necessary to develop and strengthen the program.

GOALS AND NEEDS FOR PROTECTING THE SOUNDSCAPE AT GRAND CANYON NATIONAL PARK

The Park Service has identified natural quiet as an important resource, and the agency is committed to protecting or restoring, when necessary, the natural ambient sounds of national parks. The concern over degraded sound in Grand Canyon National Park arose because of the noise produced by overflights, and the park is currently working with the Federal Aviation Administration to develop a plan to address this issue.

The Park Service has defined a goal for the restoration of natural quiet: 50 percent or more of the Grand Canyon will achieve natural quiet (i.e., no audible aircraft) between 75 and 100 percent of the day (defined as the period of time between 7 a.m. and 7 p.m.). This goal is the benchmark. Improvements have been made, but there is still a long way to go. The Park Service and the Federal Aviation Administration are currently developing an environmental impact statement that will dictate the management actions needed to attempt to curtail overflight noise in the park. The Grand Canyon Working Group, which is made up of key stake-



holders, informed the process and assisted in the creation of seven draft alternatives that will likely be included in the draft environmental impact study. That document is expected to be finalized before the end of 2010.

At the center of achieving this goal for natural quiet is the park's soundscape program. This program will need to grow if staff are to support the park's soundscape goals. With additional trained staff, Grand Canyon's management officials can take the steps required to protect the soundscape, the natural sounds of the park, as it does the other unique resources of the canyon.

SOUNDSCAPE PROTECTION: NPCA RECOMMENDATIONS FOR ACTIONS TO PROTECT PARK RESOURCES

Grand Canyon National Park's natural soundscape is recognized by legislation as a resource that needs to be restored. Park visitors recognize the natural soundscape as a reason to visit and experience the park. The intrusion of human-generated sound threatens this resource. The extraordinary amount of time and effort taken by the agencies to finalize a plan for restoring

Park staff are collaborating with the U.S. Fish and Wildlife Service to determine whether behavioral changes in individual Mexican spotted owls, a federally listed threatened species, can be attributed to noise.

natural quiet at the Grand Canyon is regrettable. The Grand Canyon Overflights Protection Act states: "The plan shall, by appropriate regulation, implement the recommendations of the Secretary [of Interior] without change unless the Administrator determines that implementing the recommendations would adversely affect aviation safety." However, the Federal Aviation Administration has been resistant to recognizing National Park Service authority to manage noise within the boundaries of the park. In terms of management for soundscape protection, the new plan should

- reinforce increasing natural quiet to a greater percentage of the park 75%–100% of the day;
- establish periods of respite during the year when visitors can both plan for and expect periods of natural quiet free of air tour sounds;
- restrict certain areas of the Grand Canyon where new and expanded tour operations are contemplated;

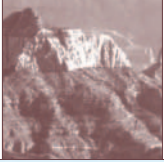
- cap the total number of air tours at levels that are consistent with the determination made by the National Park Service on current and historic uses;
- establish curfews that provide natural quiet at times that conform to seasons and use patterns of backcountry visitors; and
- allow for the NPS to establish the metrics and manner of sound measurement and authorize its enforcement of such.

A comprehensive soundscape program would allow the park to protect its unique resource. The park currently lacks the personnel to develop a comprehensive soundscape plan and the ability to implement a program. Park management has leveraged short-term project funds to initiate the soundscape program.

- Base funding for personnel working on the soundscape program is necessary to further develop and strengthen the program.

More than 90 percent of the Grand Canyon's acreage is proposed wilderness, and the park manages it as wilderness. The soundscape program is working to determine the impact of noise on the wilderness character of the park.





URANIUM MINING



URANIUM MINING: UNDERSTANDING THE IMPACTS IN AND AROUND GRAND CANYON NATIONAL PARK

America's national parks are located within a larger landscape of private and public lands, and resource use and extraction—including grazing, mining, and logging—take place on many of these lands. Because the National Park Service must manage park resources to ensure they remain unimpaired for future generations,

resource management at Grand Canyon National Park exemplifies the many problems the Park Service faces in protecting resources in the context of nearby resource extraction activities. One of the most challenging of these activities is mining within or near the national parks. Grand Canyon is both affected by past mining activities and challenged by the potential impacts of mining in the future.

The Orphan Mine, which produced copper, other precious metals, and uranium, is adjacent to the popular South Rim Trail. Fencing protects visitors from contact with the potentially harmful materials left over from mining activity.



In 1984, a flash flood carried tons of high-grade uranium ore from six existing mines north of the park down Kanab Creek and into the park. No studies have been done to determine if there have been long-lasting effects from this event.

LAWS AND PARK SERVICE POLICIES

The General Mining Act of 1872, which regulates mining on public lands, opened public domain lands to exploration and development for mineral extraction. Mineral claims under the General Mining Act soon were scattered across the nation, including in the Arizona Strip, the section of Arizona north of the Colorado River. Decades later, this activity still has implications for America's national parks.

The National Park Service has explicit management policies concerning mining activities within park boundaries and "may permit mineral development only on existing patented and valid unpatented mining claims" (*Management Policies*, 2006). On the other hand, the Park Service has limited ability to influence mining activities on lands that are adjacent to park lands. The Park Service recognizes that impacts to park resources frequently come from outside a park's legal limits, and park superintendents "will ... seek to avoid and mitigate potential adverse impacts on park resources and values" coming from outside park boundaries (*Management Policies*, 2006).

MINING ADJACENT TO GRAND CANYON: PROPOSED MINING CLAIMS COULD AFFECT PARK VALUES

The recent rise in the price of natural commodities, particularly uranium, has renewed interest in mining activities on lands adjacent to the park that are managed by the U.S. Forest Service and the Bureau of Land Management and remain available for mineral development subject to the provisions of the Mining Act of 1872. High-quality ore from the Arizona Strip and a market in which the price of uranium has risen from approximately \$10 per pound to \$133 per pound (May 2007) over the last decade (prices are currently in the \$40 to \$50 per pound range) have spurred great interest in uranium mining efforts on public lands around Grand Canyon. There are currently hundreds, and possibly thousands, of uranium claims staked on Bureau of

Land Management lands just to the north of the Grand Canyon and to the west of the Kaibab National Forest. Furthermore, hundreds more uranium claims exist within the boundaries of the Tusayan Ranger District of the Kaibab National Forest, south of Grand Canyon. The Canyon Mine near Red Butte, an area held sacred by the Havasupai, is one claim in the Tusayan Ranger District that could be reopened.

Uranium mining can result in a number of negative impacts on park resources as follows:

- **Groundwater and Related Aquatic Resources**

Many current uranium claims are clustered in watersheds and on the aquifers that feed the tributaries, springs, and seeps in Grand Canyon National Park. Seeps and springs support crucial vegetation and wildlife habitat; currently, there is inadequate data to predict the potential impacts of mining activities on these habitats. Groundwater also provides drinking water for local municipalities, including Tusayan; contamination could potentially lead to compromised drinking water in these areas.

- **Surface Waters**

In 1984, a flash flood carried tons of high-grade uranium ore from six existing mines north of the park down Kanab Creek and into the park. While no studies have been done to determine whether or not there have been long-lasting effects from this event, it is indicative of how future uranium mining could lead to contamination of surface waters. For example, Cataract Creek, a Colorado River tributary that flows through the Havasupai Indian Reservation on the canyon's South Rim, could be particularly vulnerable to contamination and could serve as a conduit for contamination of the Colorado River. Much of Cataract Creek's drainage comes from the Tusayan Ranger District, where hundreds of uranium claims exist. The Colorado River provides

MINING IN GRAND CANYON: MANAGEMENT CHALLENGES FROM PAST ACTIVITIES

Although areas near the Grand Canyon have been explored for minerals since the last decades of the 19th century, the federal government has taken steps to ensure that park resources and values are protected. In 1919, Congress passed the Grand Canyon National Park Establishment Act, which converted the existing monument into a national park, but still allowed mineral exploration and development within the park. By 1931, with the passage of 46 Stat 1043, lands within Grand Canyon National Park's boundaries had been excluded from new mineral claims. However, previously established claims both within the park and on public lands outside the park remained active. Prospecting ranged from the search for copper and lead to asbestos and uranium. While mining no longer occurs in the park itself, there is one mine-related inholding—containing an old asbestos claim—remaining in the park.

Although no mines are being actively worked within the modern boundaries of Grand Canyon National Park, the legacy of mining activities remains. Mine tailings still exist in several areas in the park. They can be a source of radioactive materials and dust that can contaminate soils and waters. The Orphan Mine, which produced copper, other precious metals, and uranium, is adjacent to the popular South Rim Trail, and fencing protects visitors from contact with the potentially harmful materials left over from mining activity. Signs warn against drinking water from nearby Horn Creek, which may contain radioisotopes leached from the mine site. Abandoned mines also present visitor safety issues; in fact, the park recently corrected safety hazards at the Last Chance copper mine by installing gates over open shafts to prevent people from falling into the mine. The gates still allow wildlife such as bats to use the cave habitats.



THOMAS SCHRANTZ

drinking water to 25 million people, so downstream water authorities, including the Metropolitan Water District of Southern California and the Southern Nevada Water Authority, are concerned about contaminated water supplies.

- **Wildlife**

In the arid climate of the Grand Canyon, scarce water resources provide water for wildlife, from mountain lions to macroinvertebrates. Impacts on water resources could harm the wildlife that depends on them. Mining activities could also affect movement and habitat use by wildlife such as the threatened Mexican spotted owl and the endangered California condor.

- **Soundscape**

The Park Service now strives to manage and restore the park's soundscape, the natural sounds of the park, much as it does the landscape. Given the proximity of many of the potential uranium claims to the park, it appears obvious that blasting, digging, motorized vehicles, and road traffic will impinge on the park's soundscape.

Mining activities could affect movement and habitat use by wildlife such as the endangered California condor.



MARK LELLOUGH/NATIONAL PARK SERVICE

- **Ethnography**

Another park resource that could be negatively affected by uranium mining is that of traditional cultural properties. Grand Canyon National Park includes the ancestral homeland of many native peoples, and further research is needed to document and characterize the impacts of mining on tribal peoples, their lands, and their way of life.

- **Visitor Experience**

Mining in areas adjacent to the park could potentially degrade the quality of the visitor's experience. From localized increases in ozone, a powerful lung irritant, to increased noise pollution, visitors may find that mining activities detract from their enjoyment of the park.

In the last few years, significant debate has emerged over the prospects of uranium mining near the Grand Canyon. According to mining advocates, the environmental record of modern mining has greatly improved, and mining creates high-paying jobs. Mining advocates claim that new and better technologies can greatly reduce the impact of mining on the natural environment, and that a place like Grand Canyon can be protected from the impacts of mining in its watershed. Other groups and individuals remain unconvinced. American Indian tribes in the region have expressed concern about the potential impacts of mining on these lands. The Havasupai, concerned because water that runs through their reservation would first traverse mining areas, staged a rally in July 2009 to protest proposed mining activities. Other American Indian tribes opposed to new mining activity include the Navajo, Hopi, Hualapai, and Kaibab Paiute tribes. Several water authorities downstream from the Grand Canyon are concerned about the potential effects on their drinking water.

GOALS AND NEEDS REGARDING URANIUM MINING NEAR GRAND CANYON NATIONAL PARK

During summer 2009, Department of the Interior Secretary Ken Salazar temporarily barred the filing of new mining claims—including those for uranium—on the nearly one million acres of public land surrounding the Grand Canyon. Secretary Salazar's two-year moratorium is designed to provide an opportunity for study of the potential impacts of uranium mining on public lands adjacent to the Grand Canyon. (The secretary has the authority to withdraw lands from mineral claims for up to 20 years. Removing lands for longer periods, or in perpetuity, requires an act of Congress.)

The secretary's order requires that all existing claims prove valid existing rights and that these claims are valid for "prudent men." Proving a valid claim could include providing evidence that uranium has been discovered at the surface in sufficient quality and quantity for the prudent man to pursue mining. This requirement puts a higher burden of proof for potential success on the mining companies, and it requires that companies provide this information to the government if they desire to mine on lands managed by the U.S. Forest Service or the Bureau of Land Management. Previously, the Bureau of Land Management could use its discretion in determining whether or not to conduct a formal review of the claim or simply accept the company's word. This new policy requires that both federal agencies treat mining claims in a similarly stringent manner, thus providing all nearby stakeholders with a higher level of protection from damaging activities.

The public debate over uranium mining highlights the need for targeted study and scientific data on the potential impacts of uranium mining near Grand Canyon National Park. In addition to a recent inventory and monitoring protocol designed to evaluate important spring and seep habitats, the park's staff has initiated a partnership with other federal agencies and

academic institutions to conduct crucial research that will improve the park's ability to characterize and identify potential impacts of mining. These impacts include effects on wildlife (including threatened and endangered species), soundscape, ethnographic resources, and vegetation. Only with more information can the park reasonably predict potential impacts of mining on adjacent lands, and only with a better sense of these impacts can the National Park Service, private industry, and public entities evaluate a path forward.

URANIUM MINING: NPFA RECOMMENDATIONS FOR ACTIONS TO PROTECT PARK RESOURCES

Uranium mining claims on federal public lands adjacent to Grand Canyon National Park pose a potential threat to a number of park resources, including groundwater, surface waters, related aquatic resources, and wildlife. Development of these claims is also likely to mar the visitor experience of the Grand Canyon, particularly with effects on the soundscape. The environmental legacy of mining, the proximity of the uranium claims to the park, and the lack of information on the effects of mining on adjacent areas (in this case, Grand Canyon National Park), support the current moratorium on mining claims and suggest a longer-term solution.

- A permanent withdrawal from mineral extraction of the remaining environmentally sensitive areas surrounding Grand Canyon National Park would provide the most appropriate protection for the park's unique cultural and natural resources. This withdrawal should include the Tusayan Ranger District and Bureau of Land Management lands in the Kanab Creek Drainage and House Rock Valley.



AIR QUALITY



Nearly every visitor to Grand Canyon National Park looks forward to admiring the sweeping views from the canyon's rims. Fog, smoke, and haze can obscure these vistas.

AIR QUALITY: PROTECTING SCENIC VISTAS AND UNIQUE RESOURCES

The Grand Canyon is visually breathtaking, and most people always remember their first view of the canyon. More than 4.5 million people visit the canyon every year, and the majority of these visitors (over 90 percent in 2004) enter the park via the south entrance, making their way to the South Rim. About a quarter of these visitors (26 percent in 2004) stay only a few hours and expe-

rience the canyon only from the vantage point of the rims. Given these short visits, the view afforded at the rims of the canyon may be the single most important factor influencing many visitors' experience. The Grand Canyon frequently delivers. However, visibility from the rim is influenced by many factors, including fog, smoke from nearby fires, regional haze, and high winds. On some days, visibility is degraded, and whenever park vistas are marred, visitors'

overall experience of the park is diminished.

Air quality is a continuing concern at national parks around the United States. In many parks, air pollution degrades visibility. Ground level ozone, a powerful lung irritant that also causes damage to plant leaves, is also a persistent problem throughout the National Park System, and sulfur and nitrogen compounds deposited on park soils and water harm plant and animal life. Because air quality has the potential to strongly affect the visitor experience at Grand Canyon and the park's natural and cultural resources, it is a critical concern.

REGULATIONS AND POLICIES IN PLACE TO PROTECT RESOURCES

Poor air quality, including haze, high ozone levels, and acid deposition, can have deleterious effects on park resources (e.g., decreased scenic vistas, leaf and plant death, acidified lakes). The National Park Service Organic Act (1916) and enabling legislation for the Grand Canyon clearly require the agency to protect the park's natural and cultural resources from air pollution. In addition, the 1977 Clean Air Act amendments require the restoration and preservation of air quality in large national parks and other scenic federal lands. National parks greater than 6,000 acres in size and other specified federal lands in existence on August 7, 1977, were given "Class I status," providing them with the highest level of protection under the Clean Air Act. While the U.S. Environmental Protection Agency is responsible for regulating new and existing sources of pollution that impact the parks, the National Park Service is responsible for managing the air resources of Class I national parks.

The Clean Air Act gives federal land managers, such as the National Park Service, an affirmative responsibility to protect air-quality-related values of Class 1 Areas. In order for the Park Service to fulfill its responsibility, air permitting agencies are required to provide the

Park Service with written notice and information about proposed air pollution permits if emissions from the proposed source may affect a park's Class 1 Area. The permitting agency must consider Park Service comments regarding the potential impacts of air pollution on a Class I Area and may deny a permit if the polluting source will have an adverse impact on park air quality. If the agency disagrees with Park Service concerns, that agency must explain its reasons for rejecting the Park Service's finding and provide that explanation in the notice of public hearing. When actively assumed, the federal land manager's affirmative duty can be a powerful tool in protecting air resources.

The pollutants that affect air quality at Grand Canyon can come from distant sources. Amendments to the Clean Air Act in 1990 recognized this and called for, among other things, the creation of the Grand Canyon Visibility Transport Commission to study the interstate transport of air pollutants into the region. In 1996, the commission's recommendations to the Environmental Protection Agency, which were aimed at protecting clear days and reducing dirty days at national parks and wilderness areas, included reducing air pollution emissions from industry and vehicles through changed energy policies and improved control technologies and reducing smoke from forest fires and agricultural burning.

The Western Regional Air Partnership, a voluntary organization of Western states, tribes, and federal agencies administered jointly by the Western Governors' Association and the National Tribal Environmental Council, is the successor to the Grand Canyon Visibility Transport Commission. The Western Regional Air Partnership works to implement the recommendations of the Grand Canyon Visibility Transport Commission and develop new technical and policy tools to assist Western states in complying with Environmental Protection Agency haze regulations.

While the Environmental Protection Agency

regulates air quality, the Park Service strives to protect park resources from air quality impacts. NPS *Management Policies* (2006) emphasize that “the Service will seek to perpetuate the best possible air quality in parks to (1) preserve natural resources and systems; (2) preserve cultural resources; and (3) sustain visitor enjoyment, human health, and scenic vistas.” This includes efforts to “minimize air quality pollution emissions associated with park operations, including the use of prescribed fire and visitor use activities.” Furthermore, since air quality impacts often depend on external parties or decisions, the Park Service will “participate in decision-making that affects park air quality.”

SOME ASPECTS OF AIR QUALITY HAVE IMPROVED, WHILE OTHERS HAVE DECLINED

Air quality has been monitored for many years at the Grand Canyon, both by the National Park Service and by other agencies as part of national air quality monitoring efforts. Monitoring for some air quality variables began as early as 1958, but most monitoring efforts were launched during the 1980s. These included monitoring for visibility, ozone, and pollution deposition. This nearly 30-year record for indicators of air quality is a critical piece of information for evaluating air quality, recognizing resource trends, and ultimately understanding the challenges at the Grand Canyon.

Colorful strata and distant natural monuments contribute to scenic vistas central to the Grand Canyon experience. The National Park Service monitors visibility closely as part of the Interagency Monitoring for Protected Visual Environments national network at three locations: the South Rim, Indian Gardens, and Meadview (located at the western end of the park near Lake Mead National Recreation Area). A report summarizing the results of visibility data during the period 1996–2005 concluded that the clearest days seem to be getting clearer but there did not seem to be any

improvement in the haziest days.

Ozone is a reactive form of oxygen, and at high concentrations near the ground it can be dangerous to humans, plants, and wildlife. Ground-level ozone forms when certain chemical pollutants react in the presence of sunlight and warm temperatures. Ozone monitoring data from Grand Canyon indicate ozone concentrations are increasing; annual average ozone concentrations have crept upwards from 41 parts per billion (ppb) in 1990 to 50 ppb in 2006. The highest concentration measured over this period, though, was much higher: a one-hour concentration of 93 ppb in July 2005. The most recent data show that annual average ozone concentrations are currently below the regulatory National Ambient Air Quality Standards established by the Environmental Protection Agency and are thus considered protective of human health and welfare. However, rising ozone concentrations may damage park plants that are sensitive to ozone, including ponderosa pine and quaking aspen. A survey completed two decades ago (1990) did not detect damage to plant leaves from ozone. Given the trend in rising concentrations of ozone, however, a new survey would be useful to document potential impacts on sensitive plant species.

Another important indicator of air quality measured at Grand Canyon is wet and dry deposition; that is, deposition of common atmospheric pollutants as part of rainfall (e.g., acid rain) or as dust. Pollutant deposition in the form of acid rain can change the pH of streams, ponds, and lakes. Dry deposition of nitrogen compounds can affect biological systems by upsetting a delicate nutrient balance, as nitrogen is a key plant nutrient whose levels often limit growth. Grand Canyon National Park staff monitor these indicators of air quality as part of the National Trends Network/National Atmospheric Deposition Program. Data from 1990 through 2006 show that the deposition of sulfur compounds

through wet and dry processes has decreased slightly, while nitrogen deposition seems to be stable. These measures are, however, tied to regional rainfall patterns, and a regional drought during this period likely reduced the overall amount of pollutant deposition.

EXTERNAL SOURCES AND INTERNAL PRACTICES AFFECT AIR QUALITY

Nearby Coal-Fired Power Plants

Coal-fired power plants in the Four Corners region of Colorado, Utah, Arizona, and New Mexico contribute to air quality issues at many national parks in the region, including Grand Canyon. Several of the plants in the region are old and, because they use outdated technology compared to newer plants, emit atmospheric pollutants in higher quantities than newer plants. The Navajo Generating Station, the nation's eighth largest coal-fired power plant, is less than 12 miles from the Grand Canyon and emits fine, haze-causing particles and excessive amounts of nitrogen oxides and particulate matter.

The Four Corners Power Plant has the highest annual emission of nitrogen oxides of

any plant in the United States. This power plant is located in New Mexico, within the Navajo Nation, approximately 200 miles east of the Grand Canyon. The Environmental Protection Agency is currently in the midst of rulemaking that may affect the emissions of the Navajo Generating Station and the Four Corners Power Plant; under consideration is the technology used to reduce nitrogen oxides and fine particulate matter that contribute to haze. The outcome of this process may ultimately affect visibility in Grand Canyon National Park.

In addition to the power plants already in operation, other plants are currently in the permitting stage. The Environmental Protection Agency is in the permitting process for a new coal-fired power plant within the Navajo Nation. This plant, the Desert Rock Energy Project, would be located south of Farmington, New Mexico (farther east than the Four Corners Power Plant). Emissions from this plant are anticipated to affect the air quality of parks in the Four Corners region, including Grand Canyon.

To ensure the scenic vistas admired by the Grand Canyon's millions of visitors are preserved, it is necessary to protect the park's air from coal-fired power plant emissions. The Navajo Generating Station, shown here, is the nation's eighth largest coal-fired power plant. It is located less than 12 miles from the Grand Canyon.

ALAN STARK



Distant Industrial and Urban Sources

Grand Canyon's Class I status under the Clean Air Act affords it the highest level of protection from pollution. However, air masses and their pollutants do not recognize legislated airshed boundaries. Haze affecting visibility within the canyon often comes from industrial and metropolitan sources in southern Arizona, Nevada, California, and even northern Mexico. The prevailing winds in this area transport pollutants over long distances until they pass through the Grand Canyon area. The regional nature of these issues demands regional attention. The current work by the Western Regional Air Partnership to implement recommendations from the Grand Canyon Visibility Transport Commission for protecting clear days and reducing dirty days on the Colorado Plateau, as well as search for other policy avenues to improve visibility, has begun to address these regional issues. Through the Western Regional Air Partnership, the National Park Service represents the interests of parks, including Grand Canyon, and works towards consensus with other stakeholders to address the urban and industrial sources of air pollution that contribute to regional haze. Although the Park Service is a stakeholder affected by regional haze, the agency does not have sufficient regulatory authority over all air quality issues outside the parks.

Fire and Fire Management

Historically, fire has had an integral role in the health of ecosystems of the desert Southwest. Today, fire is employed as a critical management tool for maintaining many of the park's natural resources. Between 1993 and 2006, more than 115,000 park acres burned. Some of these burns were the result of intentional, prescribed burns to assist with vegetation management. Though they can benefit ecosystems, fires generate a large amount of particulate matter (smoke) and can lead to a drastic, albeit brief, decline in air quality and visibility within the park. Park staff

in the Resource Protection Division carefully plan prescribed fires to reduce the risk of decreased visibility. Staff must also consider the impacts that the park's fire program may have on visibility and air quality in surrounding communities.

GOALS AND NEEDS FOR PROTECTING AIR QUALITY AT GRAND CANYON NATIONAL PARK

Federal land managers, such as those of the National Park Service, are responsible for resources on their lands, including the mitigation of resource impacts from internal actions. They also gather information on resource conditions in order to inform management decisions. The National Park Service continues to work to minimize the impacts of air pollution associated with park activities, including prescribed fires. In addition, Grand Canyon National Park has a 30-year data record for indicators of air quality, though it currently only has one person on staff dedicated to air quality activities such as tracking trends in visibility, ozone, and nitrogen and sulfur compounds.

Sources of air pollution outside park boundaries are both local and regional. In terms of external pollution sources, park staff continue to participate in decision-making processes. As a member of the Western Regional Air Partnership, the Park Service makes recommendations to regulatory agencies about actions needed to decrease the interstate transport of air pollutants. Park staff also assess whether old and new point sources of local pollution will result in adverse impacts on the park and voice these concerns to regulatory agencies. Ultimately, though, it is incumbent on state and tribal air quality officials and the Environmental Protection Agency to ensure full enforcement of laws in place to clean up existing haze pollution and prevent degradation of air quality from new pollution sources.



The park uses prescribed burns as a vegetation management tool to benefit native ecosystems. Park staff carefully plan burns to reduce the risk of decreased visibility.

AIR QUALITY: NPCA RECOMMENDATIONS FOR ACTIONS TO PROTECT PARK RESOURCES

State and tribal regulatory authorities and the Environmental Protection Agency, working with the National Park Service, must effectively address Park Service concerns about emissions.

- Projected negative impacts on public lands of new sources of pollution should be identified in the permitting stage and prevented or mitigated.
- Pollution from existing sources should be reduced by installing the best available retrofit pollution controls or by adopting a transition schedule to terminate the sources operations according to an enforceable timetable.
- Minor sources of pollution, as well as large ones, should be considered in protection measures for Class I airsheds such as Grand Canyon, because they too contribute to resource degradation.
- Cumulative impacts of all point and non-point sources of pollution in a Class I airshed, such as Grand Canyon National Park, should be taken into account when evaluating overall air quality.
- Regulatory agencies must ensure full enforcement of laws to clean up existing haze pollution and prevent the degradation of air quality from new pollution sources.

In order to effectively protect air quality, the park needs to have adequate information and personnel to address this issue. A number of air quality parameters are measured in the park but the park currently has only one person on staff dedicated to air quality issues.

- The park must build its internal capacity to monitor and interpret measures of air quality. Current monitoring should be continued and the program needs to expand to analyze information and to better interact with state and regional partners on issues of air quality.



EXTERNAL THREATS



Vaseys Paradise is a spring-fed waterfall area in Marble Canyon that is home to the endangered Kanab ambersnail (see page 49 for a photograph of the snail).

EXTERNAL THREATS: GRAND CANYON CONTENDS WITH WATER DEVELOPMENT, GRAZING, AND INVASIVE SPECIES

Our nation's protected areas, including wilderness, parks, and wildlife refuges, do not exist in a vacuum. The surrounding landscape affects these protected areas, and in many cases problems from adjacent lands lead to challenges within the protected areas themselves. Examples

include degraded air quality and decreased water quantity, to name a few, which often begin well outside protected area boundaries. In this section, we refer to these as external threats.

The mandate to protect the resources of Grand Canyon National Park emanate from the park's enabling legislation. However, that mandate does not give the National Park Service the authority to regulate problems that originate outside the park's boundaries. The

capacity of park staff to deal with external threats comes from the NPS *Management Policies* (2006), which enable park officials to engage external stakeholders and advocate on behalf of the park's needs. The section of the *Management Policies* called "Cooperative Conservation Beyond Park Boundaries" states that "the Service will use all available tools to protect park resources and values from unacceptable impacts.... Superintendents will monitor land use proposals, changes to adjacent lands, and external activities for their potential impacts on park resources and values."

In the following pages, we describe three external threats to Grand Canyon National Park: water development, grazing, and non-native invasive species. Other challenges that can be considered external threats, including uranium mining and air quality, were discussed earlier in this report.

WATER DEVELOPMENT

Water is a scarce resource in the arid region of northern Arizona, and demand for water is expanding among municipal, agricultural, and industrial users. Much of the search for new water resources is directed underground, to the water-bearing aquifers that lie 1,000 to 3,000 feet below the Arizona landscape. Aquifers provide the lion's share of water for the communities of Flagstaff, Williams, and Tusayan. Groundwater also supports industrial activities; for many years water piped from deep underground was mixed with coal mined from the Black Mesa area east of the Grand Canyon to form a slurry that moved by pipeline to a coal-burning plant in Nevada.

Through the Arizona Groundwater Management Code passed in 1980, Arizona state law provides a framework for developing groundwater resources. This law established within the state a series of Active Management Areas (AMAs); the goal for these areas, located primarily in the densely populated southern part of the state, is to provide a safe balance

between groundwater withdrawal and recharge. Northern Arizona, including Flagstaff and the Grand Canyon, is not designated as an AMA. This law provides a framework for municipal and industrial uses in an arid region. Unfortunately, Arizona law does not recognize the potential impacts of water development projects on natural habitats, and increased water development in northern Arizona threatens vulnerable seep and spring habitats within Grand Canyon National Park.

Habitats in Peril: Seeps and Springs

The defining feature of the Grand Canyon is the Colorado River, which carved the canyon over thousands of years. Groundwater, on the other hand, is a critical but often unseen water resource. Deep underground, pockets of water exist within and between rock layers, and water travels through fractures in the rocks and sometimes emerges at the surface. Outside of the river's corridor, this underground water sometimes bubbles up to form seeps and springs that sustain plant and animal life. The canyon's seeps and springs are often small, but collectively they represent the largest source of surface water in the park aside from the Colorado River and its tributary channels. In dry areas of the Colorado Plateau, rare and unique species often depend upon these seeps and springs for survival. For example, Vaseys Paradise, a spring-fed waterfall area in Marble Canyon within Grand Canyon National Park, is home to one of the largest remaining populations of the Kanab ambersnail (*Oxyloma haydeni kanabensis*), an air-breathing land snail that is a federally listed endangered species. This species, and others that depend on these wet habitats, may be in peril from the development of groundwater resources occurring outside the park.

One of the main challenges in protecting these seep and spring habitats is understanding the relationship between underground aquifers and wet canyon habitats. The U.S. Geological Survey has begun to document these connec-

tions. A 2005 study by the agency showed that water sampled from select springs of the Grand Canyon's South Rim is comprised of water from both shallow and deeper aquifer reservoirs. While the study could not conclude where the water came from specifically, it did highlight how little is known about the groundwater source(s) of these habitats. A U.S. Geological Survey study conducted in 2007 showed that both the shallow aquifer (C aquifer) under the Coconino Plateau and the deeper Redwall-Muav aquifer contribute underground flows that move northward toward the canyon. Such studies suggest that developing these water resources to support municipal entities and industrial interests in the dry northern Arizona landscape could deplete the water available to sustain the seep and spring habitats so important to life in the canyon.

DOMESTIC LIVESTOCK GRAZING

As in many national parks in the western United States, commercial livestock grazing has been a major facet of the environmental history of Grand Canyon National Park. Legislators who voted to create and later expand Grand Canyon took into account the commercial livestock grazing that existed on the region's public lands before the park was created and, in some cases, grandfathered this use into the park's enabling legislation, allowing the practice to continue in some areas. Over time, commercial livestock grazing has been eliminated from the majority of the park itself, though it continues on surrounding lands. Within the park itself, grazing is permitted only on Havasupai Traditional Use Lands (95,300 acres within Grand Canyon National Park, bordering the Havasupai Reservation). Although commercial livestock grazing no longer occurs in most of Grand Canyon National Park, the park nonetheless must address the past impacts of grazing, as well as the problem of livestock trespassing into the park, and their effects on the canyon's natural and cultural resources.

Impacts of Grazing

Domestic livestock such as beef cattle pollute water resources with fecal waste, trample sensitive soils and habitats like stream banks, and are associated with increased numbers of non-native plant species. Cattle must have access to water sources, and they use spring and seep habitats dotting the landscape. Because cattle concentrate near water, their waste also becomes concentrated near these important water sources.

The soils of arid landscapes, such as that of Grand Canyon National Park, are characterized by a living soil crust composed of cyanobacteria, lichens, and mosses. This living crust protects the underlying soil from erosion and plays a vital role in nutrient cycling and the ability of the soil to absorb water. Trampling by livestock destroys these fragile soil crusts, and damaged soil crusts recover very slowly, if at all. A study within Grand Canyon in the early 1990s showed that grazing activity can reduce the cover of crusts by up to 80 percent.

The movement of cattle in large numbers also degrades sensitive habitats such as stream banks. Stream bank erosion has devastating consequences for the vitality of riparian areas and the native species dependent on these habitats. Livestock also increase the spread of non-native plant species, some of which can be invasive, by transporting the seeds of non-native plants on their hooves or in their waste.

The staff of Grand Canyon National Park must contend with the long-term effects of past commercial livestock grazing, while they simultaneously continue to deal with the problem of trespass grazing—when commercial cattle or other animals wander from adjacent public or private lands onto national park lands to graze. Horse grazing is legal on Havasupai Traditional Use Lands, but horses sometimes stray onto adjacent park lands. Trespass grazing from Grand Canyon-Parashant National Monument is also common. This national monument, administered jointly by the Bureau of Land



The endangered Kanab ambersnail, an air-breathing land snail, depends on Grand Canyon's seeps and springs to survive. These wet environments may be in peril from groundwater development occurring outside the park.

Management and the National Park Service, provides for legal commercial cattle grazing on 38 specific allotments. Much of the area that is contiguous to the Grand Canyon is not available for grazing, but a large fraction of the eastern part of the monument that adjoins Grand Canyon does contain commercial cattle allotments, and this conjunction sometimes leads to illegal trespass of cattle.

Grazing on adjacent lands can also have an indirect effect on important wildlife predators. Native predators, such as mountain lions, inhabited the territory of Grand Canyon-Parashant National Monument before it became a protected area, and these animals' ranges still extend throughout the area. To protect privately owned, commercial livestock in the national monument from these predators, the U.S. Department of Agriculture carries out predator control. When ranchers complain of suspected livestock predation or the presence of a predator near their grazing allotment, they contact the department's Wildlife Services program. The program's staff then kill any pred-

ators that leave Grand Canyon National Park in search of food on these adjacent, federally owned lands. Predator control causes further decline in population numbers for species such as mountain lions.

NON-NATIVE PLANT AND ANIMAL SPECIES

Plant and animal species have geographical ranges determined by many factors, including temperature, moisture, food, and natural enemies. While these ranges appear static when depicted on a map, they are in reality very dynamic. Over long time scales, changes in climate or other factors drive changes in species ranges. Recently, though, globalization of commerce and the widespread movement of people and natural products have resulted in the rapid and widespread movement of plant and animal species into new environments. The Park Service's *Management Policies* (2006) define non-native species as "those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human

activities" (Section 4.4.1.3). Non-native species that displace native plants and animals are considered aggressive invaders. National parks have not been immune to the spread of non-native species; indeed, most parks report that non-native invasive plants and animals currently threaten natural and cultural resources and even the interpretation central to the visitor experience.

The problem of non-native invasive species in Grand Canyon National Park begins when new species enter or are introduced into the park from outside the park's boundaries; consequently, the Park Service concentrates efforts on curtailing introductions. The Park Service's policy is that "new exotic [non-native] species will not be introduced into parks" (Section 4.4.4.1), and the Park Service generally will strive to remove non-native species if control is prudent and the non-native species have a negative impact on natural processes, native species, and cultural landscapes, or if they threaten public health or safety. In addition, the Park Service's *Management Policies* (Section 4.4.4) specify that "exotic species will not be allowed to displace native species if displacement can be prevented."

Non-Native Plants and Animals Affect the Grand Canyon

As of 2008, there were 186 known species of non-native plants within Grand Canyon, and of these, 79 are of special concern, because of either the speed with which they spread or their success at displacing native vegetation. Park managers estimate that half of the park's overall acreage is affected by non-native plants, and that the entire park is vulnerable to the spread of these alien plant species. Due to this, an aggressive removal and prevention program has been developed and is supported by upwards of 17,500 hours of volunteer time in a single year.

Many of the non-native plants present in the park were introduced to the Grand Canyon deliberately, sometimes as forage for grazing animals when grazing was allowed, sometimes

for erosion control, and sometimes for aesthetics. More recently, the roads, trails, and even the Colorado River corridor have become primary pathways for non-native plants. As a result, park staff focus considerable attention on removing plants from the developed parts of the park, including areas around buildings and near campgrounds. Plants of concern targeted in these removals include Dalmatian toadflax (*Linaria dalmatica*), Himalayan blackberry (*Rubus discolor*), bull thistle (*Cirsium vulgare*), Scotch thistle (*Onopordum acanthium*), musk thistle (*Carduus nutans*), rush skeletonweed (*Chondrilla juncea*), puncturevine (*Tribulus terrestris*), houndstongue (*Cynoglossum officinale*), and foxtail barley (*Hordeum jubatum*), among others.

In the park's expansive backcountry, resource managers have concentrated on a few aggressive species, including tamarisk (*Tamarix ramosissima*) and Russian olive (*Elaeagnus angustifolia*) along river corridors, camelthorn (*Alhagi maurorum*) downstream of the Little Colorado, Asian mustard (*Brassica tournefortii*) at Tuweep, raven-naggrass (*Saccharum ravennae*) and spiny sowthistle (*Sonchus asper*) in the inner canyon, and date palm (*Phoenix dactylifera*) and Himalayan blackberry at Indian Garden. Cheatgrass (*Bromus tectorum*) is a particularly aggressive species found on both rims and in the inner canyon.

Non-native plants affect the park's landscape and ecosystems in a variety of ways. Some, such as the hollyhock (*Alcea rosea*), are simply a nuisance and detract from the landscape because they obviously do not belong there. Others, like tamarisk, degrade the habitats they invade. Tamarisk trees line the shores of the Colorado River, and they have invaded areas around seeps, springs, and smaller tributaries draining into the Colorado River. Tamarisk has a very deep taproot, and it outcompetes other riparian trees and shrubs for water. This species disrupts the unique floral associations occurring around seeps and springs, rendering them less

Himalayan blackberry is one of the invasive non-native plant species found at Grand Canyon National Park.



useful for animal wildlife attracted to the available water. Because tamarisk is such a threat to the Grand Canyon's ecosystems, the park has expended great effort and resources to help control it. Field crews remove tamarisk through a combination of mechanical and chemical means, including pulling, cutting to stump level and applying herbicide, or girdling to leave the dead tree standing for wildlife habitat. As of 2008, park staff and park partners had removed upwards of 250,000 tamarisk trees from project sites near Colorado River tributaries. By aggressively controlling tamarisk in sensitive habitats, the Park Service is giving native vegetation the opportunity to recover.

Non-native animals also are a problem in Grand Canyon National Park. Burros, introduced by people as beasts of burden, were previously removed from the park but have since returned by moving in from adjacent lands. Feral burros are now present in the park, particularly in the western portion. Studies and monitoring are needed to discover how these animals may be affecting park landscapes. Bison-cattle hybrids have escaped from the Bureau of Land Management's House Rock Valley facility adjacent to the North Rim and entered the park. The potential impact of these grazers along the North Rim is similar to that of cattle and horses.

Non-native cowbirds are nest parasites: They lay eggs in other birds' nests and can affect the reproductive success of their victims. Cowbirds have affected the reproductive success of the southwestern willow flycatcher (*Empidonax trailii extimus*), a federally listed endangered bird, as well as other native birds. In the Colorado River, non-native fish, including rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and channel catfish (*Ictalurus punctatus*), were introduced to create and maintain a sport fishery, but they have harmed native fishes, including the endangered humpback chub (*Gila cypha*), by directly preying upon young chubs and also by competing with them for food resources.

GOALS AND NEEDS FOR PROTECTION FROM LAND ACTIVITIES ADJACENT TO GRAND CANYON NATIONAL PARK

National parks exist within a larger landscape, and many of the factors threatening parks disregard park borders. Cattle go where the forage is; invasive species take root in favorable new habitats; water pumped from deep underground 60 miles away no longer flows to its historical outlet. The Park Service has limited or no authority to regulate many activities that cross park borders to threaten park resources. Instead, normal Park Service policy is to work with outside partners to evaluate the impacts of external development or minimize cases of non-native species crossing onto park lands and degrading resources. In the case of water development, Grand Canyon National Park takes a proactive role in raising the issue of groundwater impacts during initial planning phases with outside partners, and park staff participate in U.S. Geological Survey support research necessary to define the impacts of mining water from the region's aquifers, particularly impacts on the park's crucial seep and spring habitats. Grand Canyon National Park would greatly benefit from having additional staff dedicated to hydrology and the study of resource impacts.

In the case of invasive species and commercial livestock, the key is to minimize the movement of plants and animals into the park. For example, the park pressure-washes any construction equipment such as bulldozers that could potentially introduce non-native plant species into the park. If alien species do move in, the park must have appropriate resources to mitigate the damage and restore the affected habitats, where possible. While park staff have been moderately successful in removing tamarisk and restoring riparian habitats that tamarisk has invaded, park managers do not have sufficient staff and money to address all invasions and all habitat types so thoroughly.

Nor is restoring grazing damage an easy task, because soil compaction, destruction of soil

crusts, and the loss of riparian habitats can require years of restoration. Additionally, grazing and the introduction of non-native plant species by grazers often occurs in backcountry areas, where both livestock and introduced plants are difficult to find and the plants are difficult to eradicate. Meeting the challenge of trespass grazing and non-native invasions requires more backcountry rangers to patrol areas where trespass grazing is likely and where non-native species may be taking hold. Park staff need to work collaboratively with the Bureau of Land Management and neighboring ranchers to maintain or construct new fences in areas where grazing is contiguous to the park.

Furthermore, education that addresses the general public is a critical element in addressing external threats. Public awareness of the potential impacts of wasting water in an arid climate and the effects of non-native invasive plants and animals on Grand Canyon ecosystems can help galvanize public support to effectively address these problems.

*EXTERNAL THREATS: NPFA
RECOMMENDATIONS FOR ACTIONS TO
PROTECT PARK RESOURCES*

In the arid Colorado Plateau, groundwater resources provide the majority of water for residential, industrial, and agricultural use. Underground aquifers are connected over regional scales and even connect to surface waters, so pumping water in one place will deplete it in another. This consequence suggests a framework is necessary to manage groundwater pumping along with data collection on the consequences of withdrawal.

- The State of Arizona should expand the groundwater AMA designation to include northern areas of the state. This would allow for better accounting and tracking of groundwater pumping activities and could put more emphasis on sustainable groundwater harvesting.

- Grand Canyon National Park should continue to support and conduct research on regional aquifers and the effects of groundwater pumping on the unique seep and spring habitats within the park. This will assist in managing these habitats as well as informing park managers about the potential effects of nearby external mining activities (see "Uranium Mining" on page 35).

Domestic grazers, such as cows and horses, damage the desert ecosystems of the Grand Canyon by destroying fragile soil crusts and trampling seep and spring habitats. Non-native plants and animals, introduced through a variety of pathways including domestic grazers, can change plant and animal communities and alter native ecosystems.

- The National Park Service should continue to work closely with the Bureau of Land Management, the U.S. Forest Service, and the private citizens who graze cattle on these federal lands to more closely monitor and prevent trespass grazing. Trespass grazing can be prevented by fence maintenance or construction, protecting Grand Canyon from the damaging effects of prohibited grazing.
- Grand Canyon should increase ranger presence in remote and wilderness areas of the park. Increased presence will provide better information on the locations of both trespass grazing and non-native plants and animals. There are technological advances that track and map these locations that the Park Service should consider adopting at Grand Canyon National Park.
- Grand Canyon National Park should foster continued support for volunteer coordination efforts in their non-native species removal and prevention program. This will allow the park to continue to leverage more than \$200,000 in matching public support.



BACKCOUNTRY MANAGEMENT



BACKCOUNTRY MANAGEMENT: RESOURCE AND VISITOR PROTECTION IN GRAND CANYON'S BACKCOUNTRY

Most visitors to Grand Canyon National Park experience only the park's frontcountry, including the historic buildings and developed areas of both the North and South Rims and the main corridor trails (Bright Angel Trail, Kaibab Trail) that connect the two rims. Only a fraction of visitors venture far enough off the beaten path

to sample Grand Canyon's expansive backcountry. The backcountry, which comprises over 95 percent of the park, includes a large segment of the North Rim, remote areas of the South Rim, and most of the inner canyon, including the river corridor. In the park's backcountry, it is possible for visitors to experience the majesty and grandeur of the Grand Canyon without the crowds present at the rims. Backcountry visitors can experience various habitats (e.g., spruce-fir

Grand Canyon's backcountry offers opportunities to experience the grandeur of the landscape without the crowds present along the rims. With more acreage than the state of Rhode Island, park managers face distinct challenges managing and protecting resources.

forests near the rims and riparian forests along the Colorado River) and elevations that range from about 9,000 feet on the rims to about 1,000 feet along the river. Because of its large area (Grand Canyon's 1.1 million-acre backcountry is larger than the state of Rhode Island) and its remote nature, park managers face distinct challenges managing and protecting the resources.

LEGISLATION AND POLICY DIRECT BACKCOUNTRY MANAGEMENT

Much of the backcountry of Grand Canyon National Park has been proposed as federally designated wilderness. The Wilderness Act of 1964 defined wilderness simply as "an area where the earth and its community of life are untrammelled by man, where man himself is a visitor who does not remain." From the agency's perspective, the backcountry area of Grand Canyon should reflect the natural ecological processes within the park, and management activities should seek to perpetuate these natural dimensions. The backcountry of Grand Canyon does not have official wilderness designation, but the National Park Service manages the proposed wilderness as if it did. For

Riparian habitat along the Colorado River supports the federally listed endangered southwestern willow flycatcher.

SUZANNE LANGRIDGE/USGS



proposed wilderness, section 6.1 of the Park Service's Management Policies (2006) specifies that "management will include the protection of these areas, the preservation of their wilderness character, and the gathering and dissemination of information regarding their use and enjoyment as wilderness." As such, the backcountry of Grand Canyon offers "outstanding opportunities for solitude or a primitive and unconfined type of recreation" (Section 6.2.1.1, NPS Management Policies, 2006).

GRAND CANYON BACKCOUNTRY CONTAINS DIVERSE NATURAL AND CULTURAL RESOURCES

Vegetation Provides Habitat for Unique Canyon Plants and Wildlife

Vegetation assemblages are established by varying climatic and geographic factors and maintained by ecological processes, such as fire, that occur at varying intensities. Seven major vegetation types exist at Grand Canyon. The first five (spruce-fir forest, mixed conifer forest, montane-subalpine grassland, ponderosa pine forest, and piñon-juniper vegetation) are found at the higher elevation rim and plateau habitats, while the other two (desert scrub and riparian woodland) are found in lower canyon elevations and around surface waters. Within these assemblages are several plant species of concern. For example, the ponderosa pine habitat contains several plant species that attract the attention of resource managers, including Grand Canyon goldenbush (*Ericameria arizonica*), which is found only in the Grand Canyon, Kaibab Plateau beardtongue (*Penstemon pseudoputus*), and Flagstaff rockcress (*Arabis gracilipes*). The rockcress is found only in two counties, while the beardtongue is known to occur in only three counties. Their geographical rarity makes them a focus for managers.

Grand Canyon also contains a rich array of wildlife. At last count, there were 90 mammal, 355 bird, and 56 amphibian and reptile species found within Grand Canyon National Park.

Many of these species are found only within certain vegetation types, so vegetation management is often synonymous with habitat management for these species. For example, the effort to restore native riparian vegetation along the Colorado River, which includes removal of invasive non-native tamarisk trees, is also aimed at restoring habitat that is critical for many bird species.

Among the park's rich fauna are several species listed as endangered or threatened under the Endangered Species Act. The Mexican spotted owl (*Strix occidentalis lucida*) is federally listed as threatened, while the southwestern willow flycatcher is federally listed as endangered. Spotted owl critical habitat within the park includes more than 75,000 acres of mixed conifer habitat on the North Rim, while the flycatcher utilizes the riparian habitat along the Colorado River. Another federally listed threatened species is the gopher tortoise (*Gopherus agassizii*), a denizen of the scrub habitat distributed throughout the canyon.

Significant Archaeological and Ethnographic Resources Present in Backcountry

Archaeological features in the backcountry include rock art sites, habitation sites, burial sites, and caves, many of which may be potential ethnographic sites with cultural significance to the park's traditionally associated American Indian tribes. Given the size of the backcountry, the true extent of both archaeological and ethnographic resources is unknown. At over 1,900 square miles, Grand Canyon National Park is too large to allow a comprehensive inventory of every area, but the park has determined that additional archaeological surveys are needed in high use areas of the backcountry, such as along trails and in the Tuckup Canyon area, where visitation has increased in recent years. Numerous caves found throughout the backcountry may contain potentially significant archaeological resources, and park staff identify the inventory and documentation of cultural resources in

caves as a high priority for cultural resource management. The park's ethnographic resources are also understudied, and additional research will be necessary to identify and document these resources in high-use backcountry areas.

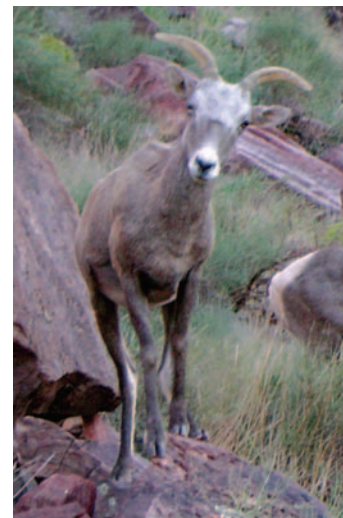
OVERARCHING RESOURCE MANAGEMENT AND PROTECTION CHALLENGES IN GRAND CANYON'S BACKCOUNTRY

The challenge of managing and protecting Grand Canyon National Park's backcountry is daunting. To begin with, relatively speaking, not much is known about either the natural or cultural resources within the park's enormous backcountry area; this lack of knowledge makes it difficult to know which tools should be employed to manage those resources and what effort should be expended to protect them from either intentional or unintentional damage. Second, the park has no current overarching management framework for the backcountry and needs to update its backcountry management plan. Third, because some visitors want to venture into the park's backcountry, the park must provide necessary public education and outreach to teach visitors about backcountry resources and how to protect them.

The Size of the Backcountry Provides Many Challenges

One problem inherent in managing the Grand Canyon's extensive backcountry is the relative dearth of information on the natural and cultural resources that exist within this expanse. That lack of information prevents park staff from determining how best to care for resources and protect them from damage.

Wildlife management in an area as large as the Grand Canyon requires long-term research. Understanding the dynamics of wildlife populations and both the natural and human-caused factors that influence these populations can take years of careful study. If those wildlife species are listed as threatened, endangered, or even of



Grand Canyon National Park is home to at least 90 mammal species, including bighorn sheep.

special concern, park staff are involved in studies to ensure that park management and recreational activities do not negatively affect those species with special status. For example, the Mexican spotted owl was federally listed as threatened in 1993. Throughout its range, this species is threatened by habitat destruction. Grand Canyon contains the largest block of critical habitat for the owl in all of Arizona, but very little is known about the bird's nesting behavior, breeding range, and reproduction. Information on such aspects of breeding ecology will be necessary to soundly manage this species within the park. As mentioned in "Soundscape Management" on page 29, researchers are concerned that noise from human activities might have a negative effect on the Mexican spotted owl. Park scientists are exploring whether or not recreational activities by visitors disrupt the habitat and abundance of spotted owl prey, thereby affecting the spotted owl population.

Many of the habitats within Grand Canyon National Park require fire to function naturally, but little is known about the role of fire in maintaining the vegetation of Grand Canyon's backcountry. Above the rims, the ponderosa pine (*Pinus ponderosa*) habitat historically had frequent, low-intensity fires; research shows that other forest types (spruce-fir, mixed conifer) above the rims had less frequent fires. However, in the canyon's backcountry below the rims, the role of fire is unknown. The necessary research has not yet been done to fully describe the role of fire in maintaining both the piñon-juniper and the desert scrub habitats. Without that information, the park is not able to fully use fire to keep the backcountry vegetation healthy. Furthermore, the potential impact of fire (either intentionally set for management purposes or accidentally started by a lightning strike) on the park's backcountry archaeological resources must be further explored. Additional inventories are needed, for

example, in piñon-juniper areas that may contain significant archaeological resources.

The size of the backcountry also presents challenges for visitor and resource protection. The backcountry is too big to patrol in the traditional sense, and the park lacks adequate staff to attempt to do so. With 200 full-time employees, Grand Canyon's Visitor and Resource Protection Program makes up nearly half of the park's entire workforce, responsible for fee collection, wildland and structural fire, government river trips and patrols, the aviation program, and providing emergency services for some surrounding communities. In addition, implementation of the new Colorado River Management Plan and subsequent increased river use has required the attention of the Visitor and Resource Protection staff in the backcountry, but that has been focused on increased river patrols and administrative trips by protection rangers. A relatively small number of backcountry rangers on patrol on the ground are left to carry out necessary law enforcement and assist visitors. A recent park asset analysis indicated that Visitor and Resource Protection had a shortfall of more than 20 full-time employees across the backcountry districts of the park.

Visitor Use Can Damage Fragile Resources; Backcountry Plan Needs Updating

Though the backcountry does not receive the level of visitation experienced in the frontcountry, backcountry hikers number 600,000 each year. Not only are more people visiting the backcountry, but these visitors are exploring all types of habitats. River runners and hikers are venturing deep into side canyons off the Colorado River; others search for spelunking adventures by exploring the canyon's many caves and abandoned mines. From the perspective of law enforcement rangers, the more people who probe the canyon's nooks and crannies, the more likely that search and rescue efforts will be needed. Visitor safety is an ever-increasing concern.



A transcanyon pipeline carries water from Roaring Springs, located 3,800 feet below the North Rim, to serve visitors at campgrounds, Phantom Ranch at the canyon's bottom, and along the North and South Rims. Increasing park visitation puts a strain on water resources.

Visitor pressure can also affect the condition and quality of both cultural and natural resources. Research conducted by park staff indicates that valuable archaeological sites in the backcountry may be disturbed by backcountry visitors. These impacts can be both inadvertent, such as minor ground surface trampling and camping on archaeological sites, or deliberate, such as gathering artifacts for photos, artifact removal, or occasionally graffiti.

The desert scrub habitat is also degraded by excessive visitation. Desert scrub vegetation and the associated soil crusts, like in other arid habitats, are fragile and are susceptible to impacts from visitors who go off-trail. Such disturbed habitats then become more susceptible to invasive plants. The staff of the vegetation program at Grand Canyon expend great effort to restore the vegetation when necessary. Methods include transplanting native plants and spreading native seeds or installing barriers to protect vegetation from inadvertent trampling by visitors.

Increased visitor use in the backcountry of

Grand Canyon during recent years has accentuated the need for an updated backcountry management plan. The park currently uses a plan completed in 1988. This plan sought to establish "the primary policies which manage visitor use and resource protection for the undeveloped areas of Grand Canyon National Park" by limiting visitor activities in order to protect the natural and cultural resources of the backcountry, as well as by promoting recreation compatible with a rich visitor experience and resource protection.

While this 1988 plan has provided the framework for backcountry management for more than 20 years, new information about resources and increased visitor numbers, as well as the pressure increased visitation exerts on resources, implies that the management of this area requires an updated plan. The park has begun the process of revising and updating the 1988 plan. This revision is necessary for two reasons. National Park Service policies require that parks with proposed or designated wilder-

ness address wilderness issues such as visitor use in their planning documents. The 1988 plan does not do this.

The park also agreed to revise and update the backcountry management plan as part of a lawsuit settlement that occurred during the development of the Colorado River Management Plan. The agreement required the park to complete a new backcountry plan after the Colorado River Management Plan was finished. The Colorado River Management Plan was finalized in 2006, but the park has not yet initiated a new backcountry plan due to limited funding. A new plan will take an updated look at backcountry issues and allow the staff at Grand Canyon to identify acceptable effects to backcountry resources by current visitor pressure, monitor any changes, and take action to ameliorate the negative impacts when necessary.

To Protect Visitors and Resources, the Park Focuses on Education and Outreach

One of the means through which the staff of Grand Canyon National Park protect backcountry visitors and resources is education and outreach. The challenge is to provide information that furthers visitors' backcountry experience, increases visitor safety, and protects resources.

Outreach materials target backcountry users as a means to protect resources. The park's vegetation program strives to educate the general public and backcountry users about fragile desert plants and soil crusts that are so critical to desert ecosystems. Outreach to the general public helps protect these plants and their habitat by keeping people on established trails and by discouraging the formation of social trails. Backcountry users are also encouraged to follow Leave No Trace principles during their visit. The park's website provides outreach videos and information to better inform visitors on ways to protect the resources.

The park requires permits for visitors entering the backcountry. These permits are a means to protect both visitors and park resources. When visitors apply for a permit, the park provides materials that highlight personal safety issues. These permits also allow the park to track visitor pressures on resources. Unfortunately, many visitors are not aware of the permit requirements. According to a 2008 survey, for instance, 41 percent of visitors did not realize that an additional permit is required to enter any cave in Grand Canyon National Park (except the cave on Horseshoe Mesa). Safety hazards can emerge from visitors entering caves; cave resources are also placed at risk. Grand

Visitors who wish to camp in the park's backcountry must obtain a permit from a backcountry information center, such as this facility on the North Rim.



ALAN ENGLISH

Canyon National Park must remain vigilant in educating visitors about backcountry permits, and through the education and permitting process, inform visitors about stewardship of natural and cultural resources.

GOALS AND NEEDS FOR BACKCOUNTRY MANAGEMENT AT GRAND CANYON NATIONAL PARK

Grand Canyon's backcountry is expansive at about 1.1 million acres. This area is managed as wilderness although it is not officially designated as such. Knowledge of the resources within this area is limited but park staff know that important resources such as threatened and endangered species are found there. From a resource management perspective, the park needs to more completely identify the natural and cultural resources in this area and better quantify threats to these resources. Protection of both visitors and resources is also an issue given the size of the backcountry and the limited number of rangers on patrol. And as visitation increases, protection is served by increased efforts at visitor education. An updated Backcountry Management Plan would assist park staff in tying together resource management and protection.

BACKCOUNTRY MANAGEMENT: NPCA RECOMMENDATIONS FOR ACTIONS TO PROTECT PARK RESOURCES

Much of Grand Canyon's backcountry has been proposed as wilderness. Better long-term protection of Grand Canyon's extensive backcountry through such a designation would ensure the preservation of this impressive area.

- Congress should provide official wilderness designation for the more than 1 million acres of Grand Canyon National Park that has been proposed as wilderness.

Resource management planning for the backcountry is complicated and involves consideration of resources, protection, recreation, and wilderness values. The park currently uses a plan completed in 1988 that does not incorporate more recent information on resources and visitor use. A lawsuit settlement dictated that a new backcountry management plan be completed after park staff finished the Colorado River Management Plan. The Colorado River Management Plan was completed in 2006.

- Grand Canyon National Park needs to initiate updates to its backcountry management plan, which will set goals and desired conditions for park resources and the visitor experience in backcountry areas. Funds and staff time are necessary to update this plan. The park will need assistance from the Park Service's Regional Office to obtain funding for this plan.

Numerous resources are present in Grand Canyon National Park's backcountry and limited information is available on many of them. In addition, as visitation increases, the need for visitor and resource protection efforts (including education) will increase.

- The park needs funds for research to identify the natural and cultural resources in this area and better quantify threats to these resources. In particular the park could use project funds for fire and wildlife management activities, as well as archaeological inventories. The park has also identified the need for a base-funded wildlife biologist who could focus on threatened and endangered species. In addition, there is a significant shortfall in full-time employees for backcountry districts in the Visitor and Resource Protection Division, which impacts the park's capacity to protect fragile resources and enhance visitor safety and education.

FRONTCOUNTRY MANAGEMENT



Grand Canyon has a highly developed frontcountry that consists of a host of visitor facilities, including museums, a visitor center, scenic overlooks, lodges, trails, and more.

**FRONTCOUNTRY MANAGEMENT:
VISITOR AND RESOURCE PROTECTION
IN GRAND CANYON'S FRONTCOUNTRY**
Grand Canyon National Park's frontcountry is the developed portion of the park, with visitor services and facilities, roads, maintained trails, exhibits, and programs. Although Grand Canyon's frontcountry represents only a small fraction of the park's total land area, it is a significant landscape that encompasses the

North and South Rims and the canyon's main corridor trails, the Bright Angel Trail and North and South Kaibab Trails. Visitor services and facilities in the frontcountry include the main South Rim Visitor Center and additional exhibit areas and museums; historic structures and designed landscapes; scenic overlooks and rim trails; ranger programs and hikes; curriculum-based education programs for local schools; and distribution points for a park newspaper

available in seven languages.

Virtually all of the park's more than 4.5 million annual visitors spend at least part of their visit in the frontcountry, and most do not venture beyond it. Most visitor use of the park is concentrated on the South Rim, though many visitors use the main corridor trails between the rims and the river for day hikes or overnight stays. Park management in the frontcountry is defined by this high volume of visitation and the need to provide adequate visitor and resource protection services well beyond resource-based interpretation.

The 1916 Organic Act, which established the National Park Service, describes the service's purpose: "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." On first reading, these purposes seem compatible. With 4.5 million annual visitors to Grand Canyon, however, it becomes a monumental challenge to provide for visitor enjoyment that conserves the resources in an unimpaired condition. Over the years, the Park Service as a whole and park staff at Grand Canyon in particular have developed a number of planning tools and policies to balance competing demands of visitor expectations and resource protection. These tools and policies include landscape design, stewardship messages, and temporary closures of sensitive habitat. Still, fulfilling the Park Service's purpose is an ever-present challenge, especially in the frontcountry.

Grand Canyon's staff face the challenge of ensuring visitor safety while monitoring and protecting natural and cultural resources. Visitor concentration on the South Rim—roughly five percent of the park—keeps protection rangers similarly concentrated. At 200 full-time employees, Grand Canyon's Visitor and Resource Protection Division makes up nearly half of the park's entire workforce, responsible for fee

collection, wildland and structural fires, government river trips and patrols, and the aviation program, in addition to providing emergency services for the surrounding community. Employees in Facility Management, which number between 70 and 75 full-time employees, maintain the buildings (two-thirds of which are historic), the trails, and historic landscapes of the frontcountry. Major issues of concern for these teams are fire, maintenance of historic structures and trails, protection of endangered species, and eradication of non-native invasive species.

FIRE MANAGEMENT: PROTECTING VISITORS AND HISTORIC STRUCTURES AND RESTORING UNIQUE HABITATS

At the Grand Canyon, fire and fire management are viewed in two ways. First, the park's frontcountry receives millions of visitors every year, and those visitors stay in the hotels, eat meals in the restaurants, and visit the important cultural resources. For these buildings, structural fire is a significant threat to both visitor safety and cultural resource protection. Grand Canyon has approximately 1,600 structures that are at risk from fire; more than 300 of these are historic structures listed in the National Register of Historic Places. One such structure is the El Tovar Hotel, constructed of old growth forest timber. If lost to fire, the materials that give this building its historic character and appearance could not be replaced. Furthermore, few buildings are outfitted with fire prevention devices. The park lacks sufficient pre-fire planning, fire prevention inspection, and fire prevention orientation and training programs.

On the other hand, fire is often an essential part of vegetation dynamics and, in the hands of resource managers, can be a vital tool for ecological restoration. Fire management plays a role in the backcountry (see "Backcountry Management" on page 53). In the case of the Grand Canyon frontcountry, fire has historically played a prominent role in the ecological health

of the rim forests. The ponderosa pine (*Pinus ponderosa*) forests, common at both the North and South Rims, require frequent (less than every 10 years) low-intensity fires for maintenance. The challenge to the park is how to restore and maintain these high-elevation forest habitats, using fire where appropriate, while at the same time protecting visitor safety, air quality, property, and cultural resources within or near the frontcountry. Fire management staff avoid prescribed fires when they present too great a risk to visitor health or safety or may degrade air quality (see “Air Quality” on page 40); exclude fire-management activities from fire-sensitive archaeological sites or feature areas; and ensure that a cultural resource specialist is present at prescribed fires, fire-suppression projects, and wildland fire events to prevent adverse effects on the park’s irreplaceable cultural resources.

Managing ecosystems with fire can be a difficult proposition; at Grand Canyon National Park, where many of the fire-dependent ecosystems surround the cultural and natural resource treasures of the frontcountry, management concerns are heightened.

High-elevation forests in the park need regular fires to maintain them. Park staff must ensure the safety of visitors and resources, such as historic structures and archaeological sites, when conducting prescribed burns.

FACILITY MANAGEMENT AND HISTORIC PRESERVATION: PARK CHALLENGED BY MEETING VISITOR NEEDS AND MAINTAINING HISTORIC RESOURCES

Historic Structures

Ever since Grand Canyon National Park was established and the railroad and automobile brought visitors there en masse, the Park Service, private contractors, and concessionaires have sought to build the infrastructure necessary to support increasing levels of visitation. Trails or trail corridors from the canyon rim to the Colorado River have existed since humans began to visit and occupy the canyon. Some buildings and structures on the rim predate the park’s establishment, but the majority of development has taken place under National Park Service management.

Several phases of National Park Service design are evident in the landscape design of the park’s roadways and walkways, the walls and trails built by the Civilian Conservation Corps in the 1930s, and the Mission 66-era park headquarters. While design styles changed throughout the 20th century, the intent of the National Park Service remained the same: to provide visi-



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Kolb Studio was the home and studio of photographers, filmmakers, and brothers Emery and Ellsworth Kolb. Now it features a bookstore and various photography and art exhibits.

tors with a safe and enjoyable experience that allows them to appreciate the resources they came to see. Walkways and trails are designed to allow visitors to view or enter the canyon, and by designating such pathways, the park can control where visitors go and prevent them from taking dangerous routes or damaging resources along the way. Lodges, visitor centers, and museums likewise serve to optimize the visitor experience by providing a designated location for the facilities, information, and programming that visitors seek, while at the same time allowing park staff to manage visitors' activities and communicate important safety, resource protection, and interpretive messages.

Most of the park buildings that are listed in the National Register of Historic Structures are located on the South Rim in the Grand Canyon Village area. These structures include the El Tovar Hotel, which has served Grand Canyon's tourists since 1905, and Kolb Studio, built as a photog-

raphy studio in 1904, which now houses a bookstore and exhibit hall. Other historic structures, however, such as Desert View Watchtower, Lookout Studio, and Hermits Rest, are not owned by the park, making it difficult to incorporate them into the park's plans to maximize the visitor experience while ensuring the safety of visitors and protection of resources. If the park could smoothly integrate these structures, proposed design concepts include establishing the Desert View Watchtower, located at the park's East Entrance, as a primary information and interpretive center for this area; installing natural history exhibits at Lookout Studio in Grand Canyon Village, which would serve as the staging area for park interpretive programs; and providing interpretation on the legacy of long-standing activities such as hiking and backpacking in the Grand Canyon at the termination of Hermit Road, known as Hermits Rest.

Preservation of historic structures is critical to ensuring the safety of visitors as well as to the

The Grand Canyon has been a popular destination for over a century. This historic photograph, which was taken in about 1905, shows a horse-drawn carriage in front of El Tovar.



structures' usefulness as visitor facilities. Preserving the historic structures at Grand Canyon implies research as well as maintenance. Little documentation exists on many of the park's historic structures; many lack preservation plans; and past maintenance activities have in some cases altered historic integrity. The park lacks funds and expertise to complete historic structure reports for Colter Hall, Victor Hall, Powerhouse, Tusayan Museum, Shrine of the Ages, North Rim Grand Canyon Inn and Cabins, and Tuweep Ranger Station and associated buildings. These reports would document the structures, provide treatment recommendations, and give staff the necessary information to enhance the level of protection and interpretation of these cultural resources.

In addition, funding for historic structure maintenance at Grand Canyon is not sufficient for continuing to adequately protect historic structures with a proactive maintenance approach. While the park has an active mainte-

nance crew, a lack of funds prevents staff from addressing preventive maintenance on all of the nearly 900 historic structures; the park's Asset Management Program allocates maintenance funds to the highest priority resources currently in good condition first, and the funds do not extend to all needed maintenance. Repeated requests for additional preservation funding have not been met. Overall, Grand Canyon National Park is burdened with \$300 million in deferred maintenance, with \$22 million in deferred maintenance for historic buildings alone. Eleven million dollars earned through fee income from concession contracts go toward deferred maintenance each year, but that sum does not adequately address the overall costs. In addition, the concession contracts contain a provision specifying compensation for capital improvements to buildings made by the concessioners. The total value of these improvements at the end of the contract period (2011) is estimated at more than \$200 million. This huge

liability limits the National Park Service from competitively re-bidding this contract in a manner that can both generate adequate franchise fees and assure quality visitor services.

Maintaining Grand Canyon National Park's inventory of historic structures is a key element of the park's responsibility to preserve resources unimpaired for future generations. Of equal importance is the role these structures play in optimizing the visitor experience by providing visitor facilities and services, conveying the history of the park, and structuring traffic patterns to efficiently and safely manage the high volume of visitors. The park must be provided with the funding and staffing needed to adequately maintain its historic structures.

Trails

Approximately \$24 million of the park's deferred maintenance is related to the park's 630-mile trail system. Grand Canyon's visitation has increased significantly during the past 25 years, and increased visitation has brought with it increased impacts on the park's historic resources, particularly trails. Corridors connecting the North and South Rims, including trails such as the Bright Angel, South Kaibab, North Kaibab Trails, comprise 42 miles of the park's network of trails. These trails are particularly important as historic features because they not only are evidence of the history and significance of Grand Canyon with a history of their own, but also because they help sustain Grand Canyon's mission to protect natural and cultural resources while providing a way for visitors to experience them.

Maintaining Grand Canyon's extensive network of trails ensures both the protection of visitors and resources, yet maintenance and mitigation of impacts, such as erosion and rockslides, have not kept up with visitation, largely due to lack of funding and staff capacity. Currently, the operation, maintenance, and rehabilitation activities of the park's trail crews

remain entirely project funded, meaning funds are available only for specific projects and not for regular maintenance. Under the 2009 American Reinvestment and Recovery Act, project funds were provided for repair of historic North Rim forest trails, including the Uncle Jim Trail, Ken Patrick Trail, Widforss Trail, and Transept Trail, and for rehabilitation of the trans-canyon South Kaibab Trail. Though helpful, these funds were not enough to keep up with mitigating erosion on the trails. Furthermore, while a mule ride down the Bright Angel Trail may be an iconic Grand Canyon experience, the park just released a draft environmental assessment on the effects of stock on the trails. The plan's goals are to establish appropriate trail use by stock in order to maintain the trails, improve visitor and stock safety, and preserve this unique visitor experience.

Park trails, including the South Kaibab shown here, are historic features and they also provide a means for visitors to experience the park. Park staff struggle to maintain the extensive trail network in the face of increasing visitation and a lack of funding and staff capacity.



NATIONAL PARK SERVICE

NATURAL RESOURCES: PARK MANAGES PLANTS AND WILDLIFE AND PROVIDES OPPORTUNITIES FOR VISITORS TO ENJOY THESE RESOURCES

Plants and Wildlife

Plant species characteristic of the dry northern Arizona climate are an important resource in the park's frontcountry. One plant that receives much attention from resource managers is the native, endemic sentry milkvetch (*Astragalus cremnophylax* var. *cremnophylax*). This plant is known to exist only at three locations in the frontcountry area of the South Rim. The species has been decimated by visitor trampling, and the park now protects populations of this endangered plant by fencing off critical habitat to prevent visitors from accidentally killing the few remaining individual plants. Another rare desert plant, the Tusayan flameflower (*Phemeranthus validulus*), also grows in rim habitats. According to the park's website, nearly 10 percent of these tiny plants exist in a population near the Canyon View Information Plaza. Grand Canyon staff did extensive surveys and also transplanted individual Tusayan flameflower plants before modifying the transportation system as recommended in the South Rim Visitor Transportation Plan.

In addition to ensuring the survival of native desert plants, park staff must contend with invasive non-native plants that have a tendency to establish in disturbed soils in the frontcountry. Some of the common non-native plants found in the frontcountry include rush skeletonweed, Dalmatian toadflax, and knapweeds (*Asteraceae* family). The park has developed a non-native plant management plan to directly address protection of native species and cultural resources from non-native species throughout the Grand Canyon.

Many visitors go to the Grand Canyon in hopes of spotting the park's native wildlife. Wildlife of public interest often seen in the frontcountry include mule deer (*Odocoileus hemionus*), bighorn sheep (*Ovis canadensis*), coyotes (*Canis latrans*), and bobcats (*Lynx rufus*). Grand

Canyon's staff studies park wildlife to determine the status of important wildlife species and to understand and minimize the impact of people on resident wildlife, which also enhances visitor safety. Grand Canyon's staff also actively monitor the bats of the canyon, including five species listed as federal species of concern [long-legged myotis (*Myotis volans*), spotted bat (*Euderma maculatum*), pale Townsend's big-eared bat (*Corynorhinus townsendii pallascens*), Allen's big-eared bat (*Idionycteris phyllotis*), and greater western mastiff bat (*Eumops perotis californicus*)]. Park efforts to protect bat species and visitors have resulted in the closures of abandoned mines such as Last Chance Mine, which is off-limits to people but accessible to bats that use the habitat for roosting.

GOALS AND NEEDS FOR VISITOR AND RESOURCE PROTECTION IN GRAND CANYON'S FRONTCOUNTRY

The mandate of the National Park Service requires the Service to protect cultural and natural resources in national parks. Fulfilling this mandate, even in a remote park with few visitors, provides many technical and management challenges. Grand Canyon National Park protects and interprets for visitors diverse cultural and natural treasures—from the Colter buildings at Desert View and Hermits Rest, to the endangered sentry milkvetch plant—and it does so while providing visitor and interpretive services to more than 4.5 million visitors each year. A majority of these visitors make the frontcountry their primary destination, and this affects the condition of the historic structures, trails, and natural resources the park is charged to protect. One necessary tool for preserving the forests of the Grand Canyon rims—fire—poses a threat to the cultural treasures and visitor safety and must be used with great care. All of this requires staff and funding, and the budget for Grand Canyon National Park falls woefully short of the level required to do the job.



Mary Colter designed Desert View Watchtower, built in 1932, along with a number of other structures at the Grand Canyon. Park staff would like to make it into an information and interpretation center, but it is not federally owned, which makes it difficult to incorporate it into plans meant to maximize visitor experience while protecting resources.

FRONTCOUNTRY MANAGEMENT: NPFA RECOMMENDATIONS FOR ACTIONS TO PROTECT PARK RESOURCES

For most visitors, the frontcountry of Grand Canyon's is the gateway to the park. The frontcountry tells part of the unique story of Grand Canyon through the significant and invaluable historic structures. These structures, though, require maintenance and protection.

- The park lacks sufficient pre-fire planning, fire prevention inspection, and fire prevention orientation and training programs. The park should have the necessary resources to update personnel and programs to secure historic structures from the threat of fire.
- Congress should provide funding to purchase and maintain several specific historic structures, such as Desert View Watchtower, Lookout Studio, and Hermits Rest, which are not currently owned by the park. The funding will need to be sufficient to buy out the capital improvements provisions of concessions contracts held by the current owners.
- Congress should provide funding to the park to complete historic structure reports for Colter Hall, Victor Hal I, Powerhouse, Tusayan Museum, Shrine of the Ages, North Rim Grand Canyon Inn and Cabins, and Tuweep Ranger Station and associated buildings. These reports would document the structures, provide treatment recommendations, and give staff the necessary information to enhance the level of protection and interpretation of these cultural resources.
- Congress should provide funding to the park to add and fill a historic preservation coordinator position.
- Permanent funding is needed for historic structure and trail maintenance.

TRIBAL RELATIONS AND ETHNOGRAPHY PROGRAM

ALAN ENGLISH

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Grand Canyon National Park



The Tusayan Ruins are the remains of a 12th-century Pueblo settlement. They are among the nearly 4,000 archaeological sites that have been documented at Grand Canyon National Park so far.

TRIBAL RELATIONS AND GRAND CANYON NATIONAL PARK'S ETHNOGRAPHY PROGRAM

Many different American Indian groups subsisted and used resources along the Colorado River for centuries before Europeans and Euro-Americans arrived in the area. Today, Grand Canyon's 11 affiliated tribes continue to view the park—the Colorado River landscape and the resources it supports—as a sacred land-

scape, as an original homeland, and in some traditions, as their literal point of origin. Both the natural and the cultural features of the Grand Canyon are a testament to this long history of occupation and significance to the tribes of the Colorado Plateau.

The human history of the Grand Canyon began nearly 10,000 years ago, as evidenced by a single fragment of a Paleo-Indian projectile point preserved in the park's museum collec-

tion. This archaeological evidence along with additional cultural remains—including 2,000- to 4,000-year-old split-twig figurines (i.e., animal figures fashioned from a single twig), baskets, pottery, and hundreds of archaeological sites preserving the story of human habitation of the Grand Canyon—are examples of the cultural features of the park sacred to the park’s affiliated American Indian tribes. Likewise, many of the natural features found in and around Grand Canyon National Park also hold subsistence and spiritual significance. The Colorado River corridor in particular is the location of traditional collection areas for plants and minerals, as well as contemporary prayer and offering places, traditional cultural properties including seeps and springs, emergence sites, and other sacred sites.

Today, the Grand Canyon and its natural and cultural resources are entrusted to the care of the National Park Service. As part of its duty to preserve resources unimpaired, the Park Service must ensure that resources valued by the groups of people traditionally associated with the park—long before its inclusion in the National Park System—are properly cared for, protected, interpreted, and available for traditional uses to continue. Commitment to this endeavor entails ongoing research and consultation efforts, requiring significant staff time dedicated to working successfully with 11 different traditionally associated American Indian tribes and improving relationships that have not always functioned positively in the past.

While Grand Canyon park staff have made significant progress in building relationships in recent years, key challenges remain and a more proactive approach to consultation—through continuing research and strategic activities even in the absence of specific project activities—is needed to foster effective relationships with the park’s affiliated tribes. The park has recently hired a full-time tribal liaison to lead its tribal relations efforts, a role that was formerly filled on a part-time, collateral duty basis. However,

no permanent funding has been allocated for research, relationship-building, or consultation activities; all funding for the tribal liaison’s work must come from project funds designated for specific compliance or project activities. This lack of permanent funding constrains the park to a reactive, compliance-focused approach to consultation and precludes the tribal liaison from initiating activities that could promote a more positive relationship with the park’s 11 affiliated tribes.

FEDERAL LAWS AND POLICIES GUIDE CONSULTATION WITH AFFILIATED TRIBES

The Grand Canyon is the ancestral homeland for many of the contemporary American Indian tribes of the Colorado Plateau. Federal laws and policies extending from the Organic Act, including the National Historic Preservation Act of 1966 (as amended in 1992), the National Environmental Policy Act of 1969, and Director’s Order 28: Cultural Resource Management Guideline (1998), require the National Park Service to work with these traditionally associated people in an effort to include their perspectives in planning, management, and interpretation of the “ethnographic resources” of the park. Ethnographic resources include both the cultural and the natural features in a park that are assigned significance in the cultural system of a people traditionally associated with park lands before designation as a national park. Federal policy further recognizes American Indian tribes that have attained federally recognized status as sovereign governments, designating the relationship between tribes and the federal government, including the National Park Service, as “government to government” (Executive Order 13175). Policies for ethnographic resources and consultation are further established by the following:

- 2006 Park Service *Management Policies*;
- Native American Graves and Repatriation Act of 1990;

- Archaeological Resources Protection Act (1979); and
- Executive Order 13007: Indian Sacred Sites.

These policies require the Park Service to conduct research, participate in consultation, and take action where necessary to include the knowledge and perspectives of traditionally associated people in park management, as well as to provide for access to and ceremonial use of sacred sites. Specific to the Grand Canyon, the park is guided in its consultation efforts by formal agreements with neighboring tribes. These include agreements such as the “Memorandum of Agreement Regarding Collections, Inadvertent Discovery, and Intentional Excavation of Native American Human Remains, Funerary Objects, Sacred Objects, and Objects of Cultural Patrimony at Grand Canyon National Park, Arizona” to address compliance with the Native American Graves Protection and Repatriation Act and a 1994 Programmatic Agreement to address compliance with the National Historic Preservation Act and the effects of the operations of Glen Canyon Dam on historic properties in the Colorado River corridor.

As dictated by these laws and policies, Grand Canyon National Park’s ethnography program consists of both research and consultation with affiliated tribes, and the park maintains active government-to-government relationships with 11 tribal governments. These tribes include the Havasupai, Hualapai, Navajo, Hopi, San Juan Southern Paiute, Kaibab Band of Paiute Indians, Paiute Indian Tribe of Utah, Moapa Band of Paiute Indians, Yavapai-Apache Nation, White Mountain Apache Nation, and the Pueblo of Zuni. Each has a unique and individual relationship to the Grand Canyon and with the National Park Service.

The perspectives of the park’s 11 traditionally associated tribes influence various resource management strategies at Grand Canyon

National Park. The Park Service consults with its affiliated tribes on numerous projects, including management of the Colorado River, discussions of resource impacts associated with aircraft overflights, carrying capacity for visitor numbers in sacred places, fire management, and the development of management strategies for cultural and natural resources. Consultation also takes place in order to address compliance activities associated with the National Environmental Policy Act and the Native American Graves Protection and Repatriation Act. Archaeologists, for example, consult with tribes in conjunction with projects planned for areas that may be culturally significant, as well as when projects have the possibility to unearth objects of cultural or religious significance to tribes. The park is currently working with affiliated tribes to identify human remains and other objects of cultural patrimony long held in the park’s museum collection, in order to repatriate items to the appropriate groups or provide for reburial within the established Grand Canyon Cemetery. Consultation with tribal people also takes place on the Colorado River itself, through river trips hosted by park staff in which representatives from all tribes are invited to participate and share their concerns regarding management of the Colorado River, increases in visitation, impacts to archaeological sites, and appropriate recreational activity on the river.

CURRENT EFFORTS INCLUDE SUCCESSSES, BUT KEY CHALLENGES REMAIN

While consultation efforts and achievements have increased significantly over the last ten years, relationships have often been contentious, and key challenges inherent from both the creation of the park and the creation of reservations—which did not effectively account for traditional tribal territories—remain. Grand Canyon National Park is bordered to the east by the Navajo Nation and to the south by the Hualapai and Havasupai



Interpreters provide programs at the Tusayan Ruins to teach visitors about the culture of the ancestral Puebloans who once lived there.

Reservations. As a result, boundary disputes and access issues have made up a significant portion of challenges for the Park Service, constituting a different consultation relationship with each of these three tribes.

When Grand Canyon National Park was created in 1919, the National Park Service restricted the Havasupai Tribe—including members who had been living at Indian Garden and in areas along the South Rim—to just over 500 acres in the bottom of Havasu Canyon as well as to a 160-acre encampment on the South Rim known as Supai Camp, which was established in the 1930s. It was not until 1975 that the Grand Canyon National Park Enlargement Act, while doubling the park to more than 1.2 million acres, required the return of 83,800 acres to the Havasupai Tribe. This increased the size of the reservation to 185,000 acres of land along the rim, and further set aside 95,300 acres within the park to be used by members of the tribe for hunting and gathering, grazing, and

other traditional uses. The law also required that the tribe give up its claim to Supai Camp. While the park did allow the Havasupai to occupy the camp through special use permits renewed every five years, the arrangement did not provide funds for improvements to the camp and the rent charged did not help pay for maintenance and upkeep of the park-owned structures. Only in the late 1990s, following repeated requests from the tribe, did the park begin consultation to come to an agreement over the long-term use of the camp. Members of the tribe currently live at Supai Camp under a 50-year memorandum of understanding signed in 2008, which provides for the use and occupancy of the area. For the Park Service, this agreement represents a step in a new direction, down a path of commitment to cooperation.

The park and the Hualapai have also worked to address boundary disputes. The Hualapai Reservation was established in 1883, years before the establishment of Grand Canyon

National Park. The legislation establishing the reservation indicated that its northern boundary was the southern shore of the Colorado River; thus, the federal government contended that the river was not included within the reservation, but instead was a 108-mile boundary between the park and the reservation. To the Hualapai, the Colorado River is the backbone or *hakatai'a* of their lifeline, and they believe the center of the Colorado River is within their lands. The Department of Interior clarified the boundary through a solicitor's opinion formally sent to the tribe at their request that places the boundary at the historic high-water mark on the south bank of the river; the tribe did not accept this placement. In early 2000, the Park Service and the Hualapai signed a memorandum of understanding formalizing a government-to-government partnership, acknowledging different interpretations of the boundary, but agreeing to cooperatively address the area of dispute in the Lower Gorge, now identified not as the boundary, but as the "Area of Cooperation."

A related debate also exists with the Navajo Nation over the park's boundary as defined by the 1975 Enlargement Act. The park administrative boundary defined by this law included Marble Canyon lands, an area also included within the lands of the Navajo Nation. The 1975 Enlargement Act was passed with the intention of meeting Navajo concurrence, but concurrence was never given. A solicitor's opinion supports the Park Service's contention of the boundary location, one-quarter mile east of the Colorado River and the Canyon Rim. Though interaction with the Navajo continues, the boundary contention remains unresolved.

Increased visitation, especially into Grand Canyon National Park's backcountry, is a challenge that the Park Service and traditionally associated American Indian groups must address together. A significant portion (nearly 14 percent) of the park's backcountry hikers travel across American Indian lands to access trailheads and other areas. Little is known about

visitor awareness of cultural resources in these areas; the park seeks to better understand visitor awareness and behavior, as well as address tribal concerns, in order to preserve backcountry resources. The research and informal consultation needed to achieve this understanding are not covered by compliance-based project funds, thus illustrating the need for permanent base funds to be allocated to the park's tribal relations efforts.

Beyond the Park Service's legal responsibilities for government-to-government relationships, park managers also are committed to fostering effective relationships with the park's affiliated American Indian tribes through informal consultation. Likewise, the tribes have an interest in working with park staff on issues that may affect park resources and values. Many tribes, including the Hopi, Hualapai, and Southern Paiute Consortium, have their own cultural resource monitoring programs associated with the Colorado River and the Glen Canyon Dam Adaptive Management Program. Monitoring programs include traditionally important resources such as culturally valued plants and gathering locations, mineral resources, landscape features, archaeological sites, and other traditional use areas. Overall, the park's ethnography and consultation program focuses on improving and enhancing the working relationships with all tribes that have an interest in the Grand Canyon and finding intersections between the Park Service and tribal interests.

GOALS AND NEEDS FOR TRIBAL RELATIONS AND GRAND CANYON'S ETHNOGRAPHY PROGRAM

Specific to ethnographic resources, the Grand Canyon National Park staff seek to maintain resources in good condition, incorporate tribal values into resource monitoring programs, and provide opportunities for traditional use access by neighboring American Indian tribal members. Continuing to conduct research—

such as ethnographic assessments, collection of oral and life histories, and collection of traditional ecological knowledge—is an ongoing challenge that requires a significant amount of staff time and dedication and a permanent source of funds not tied to specific projects. Park staff also seek to expand the positive relationships that enhance the significance and protection of resources of the Grand Canyon. Park officials have worked diligently during the last ten years to rebuild relationships that were historically negative and have worked to foster the consultation program in effect today. Having a tribal liaison in place gives Grand Canyon the opportunity to be proactive in maintaining positive relationships, serving to enhance the protection of natural and cultural resources that are sacred to American Indian Tribes.

An example of proactive efforts to strengthen relationships with traditionally associated tribal people includes increasing the role of tribal history, contemporary arts, and cultural significance in visitor education and linking them to adaptive reuse of the park's Mary Colter buildings, which reflect traditional American Indian structures. The agreement with the Havasupai for the occupancy of Supai Camp is a positive, recent achievement, but the five park-owned residences located at the camp lack running water, require both general and historic preservation maintenance, and are not suitable for year-round occupation. Improvements to these structures will require additional funding, because the annual rent does not cover operating costs to maintain them. Funding is also required to continue to work with the Hualapai in the Area of Cooperation in Lower Gorge.

Most fundamentally, the park must increase the number of strategic consultations with all tribes; currently, consultation efforts are conducted as needed and tend toward compliance and project-based meetings. The park is making efforts toward increased consultation. As an example, in fiscal year 2010, the park made a \$30,000 request for outside project funds to

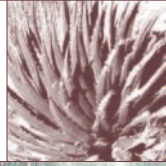
initiate consultation with affiliated tribes for the collection of oral history interviews from tribal representatives, a project that will both support the protection of the park's cultural and natural resources and the interpretive program. This project has not yet been funded.

While continued commitment to the ethnography program and ongoing work is required, efforts of Grand Canyon National Park's staff to build better relationships with American Indian groups with traditional associations to park resources have met with success in recent years, as evidenced by achievements like memoranda of agreement with all 11 tribes for compliance with the Native American Graves Protection and Repatriation Act. Agreements like these establish frameworks and protocols for cooperative relationships between the Park Service and tribal governments. As a key aspect of the Grand Canyon's human story, strong relationships with the park's traditionally associated people will remain critical in the future.

TRIBAL RELATIONS: NPFA RECOMMENDATIONS FOR ACTIONS TO PROTECT PARK RESOURCES

Grand Canyon National Park recently was able to hire a tribal liaison, a position critical to the success of Park Service efforts to maintain positive relationships with the 11 affiliated American Indian tribes associated with the park. But while the work of the tribal liaison, including increased consultation with American Indian tribes at a programmatic level, is essential for effective management of park resources and tribal interests, it is currently funded on a project-by-project basis rather than from a consistent funding source.

- Grand Canyon National Park requires consistent funds to more comprehensively involve the affiliated tribes in management and research initiatives that go beyond the as-needed efforts that are currently possible, which tend to be limited to compliance activities and specific projects.



CLIMATE CHANGE

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Grand Canyon National Park



Grand Canyon National Park is full of microenvironments, including this surprisingly lush area around Ribbon Falls. It's unclear how climate change will affect the park's habitats.

CLIMATE CHANGE: UNDERSTANDING ITS POTENTIAL EFFECTS ON GRAND CANYON NATIONAL PARK

Many visitors to the Grand Canyon are stunned by its remarkable geology, the river's inexorable etching of the landscape, and the overwhelming depth of the canyon. They also experience the hot, desertlike conditions that prevail in the canyon and note the unique plants, animals, and cultural systems that have evolved in concert

with the seemingly inhospitable climate. Over the millions of years that it took for the Grand Canyon to reach its present depth, the region's climate has gradually changed. Grand Canyon National Park's staff interpret for visitors the biological and cultural adaptations that have emerged over thousands of years in response to changing climatic conditions.

Current scientific consensus holds that the world's climate is undergoing unusually rapid

change, driven in large part by the emission of greenhouse gases associated with human activity. This situation raises the question of how climate change will affect the southern Colorado Plateau—including the Grand Canyon. The regional climate of this area is expected to shift rapidly, and natural and human systems will have to adapt quickly in response. Regional hydrology is expected to change, while temperatures are expected to increase. These changes will affect the Grand Canyon, and the character of the area—with the exception of its geology—may quickly be transformed. The exact implications of these changes for Grand Canyon National Park are still unclear, but concerns about potential impacts on natural and cultural resources exist.

THE CHANGING CLIMATE OF THE COLORADO PLATEAU AND THE SOUTHWEST

The impacts of climate change are not entirely certain, even though predictive models show broad consistency and are becoming more precise. What, then, is expected to occur on the southern Colorado Plateau as a result of climate change?

Temperature

Temperatures on the southern Colorado Plateau and at the Grand Canyon are expected to rise. This rise will continue a trend of increasing temperatures witnessed over the last century. The Colorado River basin has warmed between 1 and 2 °F since 1900, while during the early part of the 21st century, the state of Arizona as a whole has become more than 2 °F warmer than its average 20th-century temperatures. The Climate Change Science Program of the National Oceanic and Atmospheric Administration predicts that, by 2050, temperatures in the southwestern United States may rise as much as 6 °F, averaged over the entire year, and extreme temperatures may be more severe and more frequent.

Under these scenarios, the canyon and the park overall would likely be hotter places than they are today.

Precipitation

Increased average annual temperatures are only part of the changes predicted by climate change models; altered precipitation patterns are expected as well. The Grand Canyon region and the larger Colorado Plateau are generally dry (with some areas receiving fewer than 10 inches of rain annually). Much of the water that enters the region comes in seasonal pulses of melting snowfall from higher elevations or as heavy rainfall during the summer monsoon season. The Intergovernmental Panel on Climate Change reports that models of regional precipitation patterns demonstrate that the southern Colorado Plateau and the Grand Canyon region will receive up to 10 percent less annual precipitation by the end of the century due to the anticipated climate disruption. These findings imply that the dry ecosystem might get even drier over the next century, a prospect that has many implications for this park and its users. One aspect that will require further research and increased management attention is the potential effects of precipitation changes on Colorado River flows and how those future flows are managed for both park resources and human use.

IMPACTS OF A CHANGING CLIMATE ON THE GRAND CANYON

A hotter, drier climate will change the ecosystems of the Grand Canyon, and these changes are expected to affect the park's plants and animals, the nature and dynamics of the Colorado River, and even the experiences of visitors.

Plants and Animals

C. Hart Merriam, an American zoologist, ornithologist, entomologist, and ethnographer, proposed in 1889 the concept of "life

zones” using elevation and gradients of moisture to describe and explain the distribution of species across the landscape. The Grand Canyon area, because of its steep elevation and moisture gradients, has five of the six life zones Merriam described. The plant diversity observed at the North Rim and following down to the bottom of the canyon is comparable over that short distance (approximately 1 mile) to the diversity observed along the thousand mile coast from Mexico to Canada. The vegetation and the wildlife dependent on these habitats are expected to migrate to compensate for the changing climate. With such migrations, habitats and associations that now characterize these life zones would change into something very different in the near future; some species and habitats may even become locally lost. For example, piñon pine and juniper trees, under future climate scenarios, will no longer demonstrate an association long familiar to Grand Canyon visitors. Instead, piñon pine will be restricted to the area south of Desert View, while the juniper will shift further to the southeast, separating the two species and eliminating the park’s classic piñon-juniper habitat. These changes would result from the two species responding in different ways to a changing climate.

Wildlife is expected to move with the changing climate, but that movement is no guarantee that those animals will survive. For example, birds are highly mobile and expected to shift in response to climate change; however, the changing climate is simultaneously affecting the insects that birds rely on for food. Insect distribution will also be affected by the changing climate. So while birds might be able to relocate, a primary food source for many of them— insects—might not be available in the right habitats or at the right times.

Colorado River Flows

The Colorado River basin covers approximately 246,000 square miles, and the water in this basin provides people with both drinking water and irrigation. Within the Grand Canyon, the conditions of natural and cultural resources along the river’s corridor are well documented and tied to the flow dynamics of the river. A changing climate over this basin may change flow dynamics and the amount of water in the river. Such a change would affect human and nonhuman users alike. If basin-wide precipitation does change, this could have a profound effect on water available to nourish and protect resources in the Grand Canyon.

The Colorado River and its tributaries are water resources for a large region. Many of the waterways in the basin are carefully regulated by impoundment dams. As a result, non-natural flows are the rule, not the exception. Natural resources along the river corridor, including plants, fish, and wildlife, depend on the amount and dynamics of river flows, and since the creation of the Glen Canyon Dam directly upstream of the Grand Canyon, the conditions of natural resources in the canyon have generally degraded. For example, the endangered humpback chub requires flows that maintain and increase the number of sandbar habitats in the river channel. The Glen Canyon Dam has not been operated in the past in such a way to achieve these flows, and the chub populations within the Grand Canyon have declined as a result.

Non-natural river flows seen since the creation of the Glen Canyon Dam have also impaired cultural resources. The constrained flows of the river have degraded archaeological sites along the river; these sites require sediment and high water flows for protection from the elements and also from human impacts.

Management of the river to protect and conserve the resources of the Grand Canyon has been a challenge; a changing climate that may alter temperature and precipitation patterns at a

regional scale will add another layer of complexity to an already difficult management endeavor. Currently, management of the river is guided by past flow records, but the uncertainty of future Colorado River flows could leave water managers unprepared for the challenges ahead.

Park Visitors and Their Experience

The geologic grandeur of the Grand Canyon will not change perceptibly under any future climate scenarios. The rock strata and distant natural monuments that are a central part of a visitor's experience of the canyon will remain. Instead, change will occur at a finer scale. The unique wildlife and vegetation that are currently characteristic of the region are expected to change. For example, the piñon-juniper forests along the heavily visited South Rim may cease to exist. Previously unseen plants and animals may move in. A changing climate may exacerbate air quality impacts that already are a concern in the park. Higher temperatures, for instance, combined with nitrogen oxides and other volatile air pollutants emitted from nearby power plants, gas wells, and automobiles, will create more ozone, a powerful lung irritant linked to breathing problems, and contribute to haze that impairs visibility. Higher temperatures will likely also cause a higher incidence of heat-related illnesses for visitors in the summer season. Increased incidence of wildland fire could result in impaired visibility, particularly along the rims. It may also create additional safety issues for backcountry hikers. Visitor and Resource Protection staff at Grand Canyon National Park are currently stretched thin with regards to backcountry patrol; a changed fire dynamic threatening visitor safety would require additional staff and resources.

CLIMATE CHANGE: RESEARCH AND OUTREACH OPPORTUNITIES AT GRAND CANYON

The scientific models that describe climate change predict that the Colorado Plateau and the northern Arizona region will see higher temperatures and lower precipitation in the next century. These changes in climate will likely drive changes in the canyon's plants and animals, the hydrology of the Colorado River and its tributaries, and the experience of visitors to the park. It is difficult to think of these changes in a positive light—the habitats of the canyon that are part of its storied history will change to something now unpredictable. The park staff recognize that, under future climate scenarios, the Grand Canyon will be a different place.

Because the park has such a wide diversity of plants, fish, and wildlife, the Grand Canyon can serve as a natural laboratory for documenting changes in vegetation and wildlife and provide important scientific information on the impacts of climate change. The response of vegetation and wildlife within Grand Canyon National Park will also provide a natural comparison for other U.S. public lands. Those public lands are often used for mining, grazing, and resource extraction, activities that also change the landscape, but it is often unclear how much of that change is due to direct human activity versus the

Climate change, which could result in altered precipitation and temperature patterns in the Grand Canyon region, will add another layer of complexity to the already difficult task of managing flows in the Colorado River.



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effects of a changing climate. Measuring the impacts of climate change on Grand Canyon, particularly in backcountry areas that have been largely spared direct human impacts, may offer insight on the potential effects of climate change in places where causes cannot be easily identified and isolated.

Hand in hand with the research that goes toward understanding the impacts of climate change is a unique opportunity to share that information with the public. Grand Canyon National Park receives more than 4.5 million visitors each year, a fact that positions the park to serve as a leader in engaging and educating the public about the effects of climate change, using the Grand Canyon as a case study. Outreach to schools and youth groups by park staff will provide a pathway by which this information is disseminated to tomorrow's leaders.

GOALS AND NEEDS FOR RESEARCH AND MANAGEMENT IN THE FACE OF CLIMATE CHANGE

Climate change is a global phenomenon, but the effects of climate change will be felt from the global and regional down to local scales. In the face of changes to the climate, Grand Canyon National Park may be a very different place in the future. The staff at Grand Canyon need resources to better understand and thereby predict potential effects of climate change to the park. Research will suggest ways to mitigate the effects of climate change.

The diversity of ecosystems in the canyon means that research results may be applicable to other places in the Colorado Plateau, suggesting management or mitigation strategies in other parts of the arid western United States. In addition, interpreting climate change research for the millions of people who visit the canyon could quickly disseminate important information. A research program in Grand Canyon could serve public officials and private citizens nationally and internationally.

CLIMATE CHANGE: NPCA RECOMMENDATIONS FOR ACTION TO PROTECT PARK RESOURCES

The Grand Canyon can serve as a natural laboratory for documenting the effects of climate change. Research undertaken there could inform management efforts both inside and outside park boundaries.

- A research program on climate change impacts on resources should be developed, funded, and implemented at Grand Canyon National Park, and it should include work on Colorado River hydrology, endemic species, invasive species, plant community dynamics, and food webs.

The high annual number of visitors to Grand Canyon National Park offers a substantial opportunity to educate a wide audience on the topic of climate change, its impacts, and effective solutions. Grand Canyon National Park has committed to becoming a "Climate Friendly Park" by reducing its own greenhouse gas emissions and serving as a model and inspiration to its visitors for taking similar steps in their everyday lives. The Climate Friendly Parks Program is a collaboration between the National Park Service and the U.S. Environmental Protection Agency to "provide national parks with management tools and resources to address climate change" (www.nps.gov/climatefriendlyparks).

- Interpretive materials on potential and ongoing climate change impacts and on effective solutions should be expanded at Grand Canyon National Park through the development of outreach materials such as ranger talks, fact sheets, web-based materials, and podcasts.



CONCLUSION



The Grand Canyon is like no other place on Earth. People from around the world travel thousands of miles for the opportunity to experience this vast geological wonder, carved over millennia by the waters of the Colorado River. The canyon's magnificence inspires poems and works of art. It is a place of spiritual connection for many groups of people. Archaeological evidence dating back nearly 10,000 years speaks to its longstanding importance to various

cultures. It is home to a multitude of plants, animals, and fish—some of which are found nowhere else on Earth. It is a place that must be protected.

The National Park Service has been entrusted with the care of Grand Canyon National Park since 1919. Managing this national treasure, which encompasses more than 1.2 million acres, to conserve its scenery, wildlife, and natural and cultural resources, while still allow-

The Grand Canyon features ecosystems ranging from high-elevation pine forests to desert scrub to the stunning green vegetation communities shown here at Elves Chasm.

ing visitors to enjoy them, is a responsibility fraught with challenges. Park Service staff must guard endangered plants, fish, and wildlife, maintain quiet soundscapes and historic structures, and protect the park from heavy visitor impacts, noise from helicopter and airplane overflights, and potential vandals and looters. In addition, the National Park Service at Grand Canyon National Park is responsible for the safety of more than 4.5 million visitors annually.

The vast majority of the park's visitors spend their time on the South and North Rims. The park's main challenges include providing visitor services, ensuring visitor safety, and safeguarding the historic structures and resources along the canyon's rims. Although the percentage of visitors who venture from the park's frontcountry is relatively small, it still represents thousands of people, and the park struggles with patrolling the canyon's expansive backcountry, providing resource protection information to visitors, and, when necessary, ensuring visitor safety in this often harsh desert environment.

As massive as it is, the Grand Canyon is only part of the larger landscape of the southwestern United States, a mosaic of state and federal lands, rural communities, tribal lands, and metropolitan areas. As such, it is impacted by activities that occur on the surrounding landscape, including livestock grazing, uranium mining, power generation, air pollution from

vehicle emissions and distant cities, and river regulation and groundwater development.

The park staff's capacity to protect Grand Canyon National Park's natural and cultural resources, as well as provide quality visitor experiences, is compromised by a shortage of funding and trained staff, a lack of research capacity and resource protection staff, and limited authority to influence or control damaging activities occurring on lands outside the park's boundaries. Additionally, legislation passed by Congress and National Park Service initiatives directed at preserving park resources have not been successful at making significant progress in minimizing noise from scenic overflights, restoring more natural flows of the Colorado River, or addressing other serious resource degradation and threats.

Despite the challenges inherent in managing such an expansive national park that receives millions of visitors each year, and the reality that many factors affecting the condition of park resources originate from outside the park's boundaries, there are concrete steps that can be taken to protect the natural and cultural resources of Grand Canyon National Park, while still providing unique and awe-inspiring experiences. This report identifies many of these actions and outlines the steps necessary to begin them. A number of these echo broad recommendations from a recent report by the National Parks Second Century Commission.

The commission's vision for the National Park System's second century includes enhancements to the Park Service's authority to protect park resources, expansion of the role of the parks in the education of youth and adults including increased service-learning opportunities, stronger personal connections between parks and diverse audiences, and invigorated capacities to engage in historical and scientific research. This vision for the National Park System applies to Grand Canyon National Park, one of the nation's most iconic national parks. The park needs increased support to achieve it.

Hikers take a break to enjoy the scenery from the Grandview Trail.

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ACKNOWLEDGMENTS

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NPCA thanks the staff at Grand Canyon National Park who provided research materials used in this report. We also thank peer reviewers for their valuable comments and suggestions.

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