



Grand Canyon Science Information Needs

High Priority Information Needs Identified by Program

Cultural Sciences, Anthropology, and Archaeology

Grand Canyon contains abundant evidence of human occupation dating from many different cultures and time periods. The Park has a strong cooperative program to locate, characterize and preserve cultural sites within the Colorado River corridor, and recognizes the need for comprehensive archaeological inventories throughout the rest of the Park, especially in high-use areas. Development of a model archaeological research design for scientific investigations of prehistoric sites, patterns of occupation, and human ecology within the Canyon and surrounding areas is currently a top priority. Regional ethnographic and traditional-use studies are also needed to document tribal interests (i.e., Hopi, Navajo, Hualapai, Havasupai, Southern Paiute, Zuni, etc.) for Grand Canyon and other National Park Service areas on the Colorado Plateau. Other research needs include a determination of the effects of forest fire on archaeological sites and data recoveries for site-specific mitigation.

Specific Information Needs (Resource Management Plan project statements applicable to these studies are listed in parentheses.)

- **Research**
Develop and implement archaeological research design(s) applicable to investigations of archaeological sites throughout the Park. (GRCA-C-400.001)
- **River Corridor Archaeological Monitoring and Mitigation**
Monitor cultural sites potentially impacted by Glen Canyon Dam operations to determine present condition, rate of change due to erosion, bank collapse, etc. Develop mitigative measures to ensure long-term site integrity and recover data as needed. (Important ongoing studies, being accomplished through current programs). (GRCA-C-410.003)
- **Ethnographic Studies**
Conduct an ethnographic overview and assessment of tribal interests and uses Colorado Plateau parks (i.e., Hopi, Navajo, Southern Paiute, Hualapai, Havasupai, Zuni, etc.). These studies have application to several NPS areas and should be specific to each tribe, rather than to the particular park. (GRCA-C-700.001, GRCA-C-700.002)
- **Archaeological Site Inventories**
Conduct comprehensive archaeological inventories of developed and high-use areas (i.e., campgrounds, trails, road corridors, etc.) (GRCA-C-410.000, .001, .002)

- **Fire Archaeological Impact Studies**
Assess effects of management-ignited fires on archaeological resources. The focus of this study should be applied to known and expected resource types within the proposed areas of prescribed fire. First priority should be a thorough literature search and direct communication with specialists in other locations (e.g., Mesa Verde), to help guide planning for any needed field studies. (GRCA-C-430.001, .002)
- **Tribal Use Studies**
This subject deals exclusively with traditional uses, collections, ceremonials, etc., which occur within the landscape of NPS units. The study should be tribe specific, and applicable to all NPS units within the tribe's areas of concern.
- **Grand Canyon National Park History**
Develop a comprehensive history of Park CCC activities to support National Register nomination as a multiple property district. (GRCA-2-220.020)
- **Cultural Landscape Studies**
Identify, document, and evaluate cultural landscapes, beginning with areas identified in the Grand Canyon National Park General Management Plan, and incorporating NPS-28 defined categories which occur within the Park. (GRCA-C-331.000 -GRCA-C-331.011)
- **Data Recovery**
Site-specific mitigation plans for impacted sites within Grand Canyon backcountry. Site priorities should be established from the Backcountry Management Plan, with Clear Creek and Boucher as likely first priorities. (GRCA-C-420.003)

Natural Resource Program

The great diversity of ecosystems within Grand Canyon National Park support a wide variety of vertebrate and invertebrate wildlife, including large and small mammals, migratory and resident birds, reptiles, amphibians, and invertebrates. The Park's enormous size (1.2 million acres), extremely variable terrain, and logistical difficulties of wilderness research have limited knowledge about the abundance, distribution, and life history of many Park species. Current information needs include wildlife inventories and basic life-history data for many species, as well as studies directed towards the preservation of rare and special status species.

Specific Information Needs

- **Forestry:**
 - **Biological Monitoring (Fire)** (See Fire History, Fire Ecology, and Management)
 - **Fire Ecology** (See Fire History, Fire Ecology, and Management)
 - **Management Alternatives (Fire)** (See Fire History, Fire Ecology, and Management)
- **Threatened and Endangered Species Study.** Population status and trends for Federally-listed species:
 - **Southwest Willow Flycatchers** (see Colorado River and Riparian Studies)
 - **Humpback Chub** (see Colorado River and Riparian Studies)
 - **Kanab Ambersnails** (see Colorado River and Riparian Studies)

- Resource Surveys:

- Relict Vegetation Surveys
Much of the remote backcountry of Grand Canyon has never been systematically explored. Surveys are needed throughout the Park to locate and characterize relict areas of unaltered natural vegetation. Opportunities for investigating previously undescribed communities are good. (GRCA-N-134.000)

- Bat Population Surveys
(GRCA-N-210.107)

- Invertebrate Surveys
Inventory spring, seep, wetlands, invertebrates (GRCA-N-230.103, GRCA-N-210.006)

- Cave Resource Inventory and Assessment
(See Groundwater, Cave and Karst Studies)

- Herpetofauna Surveys
(GRCA-H-210.102)

- Ecosystem Restoration:

- Prairie Dogs
Study feasibility of reintroduction. (GRCA-N-270.100)

- Exotic Flora and Fauna
Investigate routes of entry, colonization and suitable management alternatives to control infestations and limit damage to native species and other Park resources. (GRCA-N-250.100)

- Anthropogenic Effects Studies
(See Social and Recreational Science)

Social and Recreational Science Program

Understanding Park visitors, their needs, motivations, and how they use or abuse their parks is a basic need for informed management. Information about visitors, use patterns, perceptions, etc., is currently needed to support revisions of the backcountry, wilderness, river, and aviation management plans. Information needs in these areas include visitor surveys, resource-impact studies, and management alternatives.

Specific Information Needs

- Acoustic Monitoring
Design and operate an acoustic monitoring system for overflights by aircraft tour operators. (GRCA-N-800.005)

- Visitor Characteristics and Use Patterns Surveys:

- Backcountry Day-Users
(GRCA-N-800.006, .007)

- Backcountry Overnight Users
(GRCA-N-800.008)

- River Users

- Rim Users
(i.e., frontcountry)

- River-Use Allocation:

- Evaluate Alternative Strategies for Equitable Allocation of River-use Permits

- Develop or Refine a River Travel Simulation Model
(GRCA-N-8000.003)

- Monitor Visitor Impacts to Park Resources:

- Visitor Impacts to Day-Use Resources (GRCA-N-800.006)
- Visitor Impacts to River Resources (GRCA-N-800.002)
- Visitor Impacts to Backcountry Resources (GRCA-N-800.001)
- Visitor impacts to Rim Resources
- Anthropogenic Effects Studies Document effects of aircraft, research, trail maintenance, patrols, rescues, etc., on wildlife and other sensitive Park resources. (GRCA-N-260.100, .101, .102)

- General Visitor Surveys: Profiles, expectations, and satisfaction

High Priority Information Needs Identified by Ecosystem

Colorado River and Riparian Ecosystems

Completion of Glen Canyon Dam in 1963 greatly moderated downstream flows in the Colorado River. The frequency and magnitude of river flooding was sharply reduced, seasonal flow patterns altered (reduced in spring and summer, increased in fall and winter), suspended sediment nearly eliminated (except for downstream tributary inputs), seasonally-variable water temperatures stabilized (to an average 46°F at the Dam and 55-60°F at Diamond Creek), and the natural migratory routes of fish and wildlife were blocked. Resultant changes to downstream ecosystems have been enormous. Of eight species of native fish present when Glen Canyon Dam was constructed, three species including roundtail chub, the endangered Colorado squawfish and bonytail chub have been extirpated. Two species (razorback sucker and humpback chub) are listed as endangered. Three other native species, bluehead sucker, flannelmouth sucker, and speckled dace, remain relatively common. In the near absence of annual flooding, riparian vegetation has increased greatly, including native marsh plants and the exotic tamarisk. With the reduced frequency and magnitude of flooding, and the loss of sediment trapped in Lake Powell, beach building processes have been greatly diminished and erosion of archaeological sites and camping beaches has accelerated. Current information needs in the river corridor include surveillance and monitoring of impacted resources, and mitigative measures to preserve and restore sensitive species, cultural sites, and high-quality recreational opportunities. Studies are also needed to improve our understanding of riverine ecology and the effects of basic environmental conditions, including flooding, sedimentation, erosion, and water temperature. (GRCA-N-800.004)

Specific Information Needs (Important ongoing studies, mostly funded through ongoing programs)

- **Threatened and Endangered Species**
Study population status and trends for Federally-listed species in the Colorado River and riparian areas potentially affected by operations of Glen Canyon Dam (GRCA-N-220.100):

Southwest Willow Flycatchers
(GRCA-N-230.100,
GRCA-N-220.103)

Humpback Chub
Determine current status and long-term trends in adult population, health, reproduction, and recruitment in the Colorado River main channel, Little Colorado River, and other tributaries. (GRCA-N-220.106).

Kanab Ambersnails
Study genetics and ecology. Monitor changes to populations, and determine potential for secondary populations within and outside the Grand Canyon. (GRCA-N-220.101).

- **Cultural Resources**
River Corridor Archaeological Monitoring and Mitigation (See Cultural Sciences, Anthropology, and Archaeology).

Identify Traditional Cultural Property Sites Potentially Impacted by Dam Operations

- **Integrated Ecological Study**
Investigate anthropogenic forces, environmental processes, and resource condition (keystone and indicator resources, status, cycles, and long-term trends) from the Glen Canyon Dam forebay to the headwaters of Lake Mead.

- **Dam Operations**
Monitor the primary physical factors controlled by dam operations: stream flow, stage, sediment load, discharge temperature, water composition, etc., in the main stem Colorado River and confluence of major tributaries.
- **Riverine and Riparian Processes**
Monitor initial ecological responses to dam operations (riparian climate, erosion, sediment transport and deposition, photosynthesis, downstream water temperature, water quality, etc.)
- **Sediment Resources**
Monitor distribution, elevation, open area, longevity, and other characteristics of sand bars and beaches suitable for camping and associated backwater areas.
- **Fisheries Resources**
Study reproduction, recruitment, population dynamics, distribution, frequency of occurrence, and other life history traits of native and nonnative fish species in the Colorado River between Glen Canyon Dam and Lake Mead.

Flannelmouth Sucker, Bluehead Sucker, Speckled Dace and Other Native Species (GRCA-N-210.101)

Salmonids, Ictalurids, Cyprinids, and Other Nonnative Species, and Impacts on Native Species (GRCA-N-250.102)
- **Vegetation**
Monitor distribution and abundance of native and nonnative riparian vegetation, including Federal, State, and tribal listed sensitive species, old high water zone, new high water zone, and near shore marshes (GRCA-N-105.000)

- Food Web

Determine status and trends in species composition and population structure of ecologically important food web organisms originating from aquatic and riparian sources, and influence of ecologically significant processes. (GRCA-N-230.104)

- Wildlife Resources

Monitor distribution, abundance, and population structure of wildlife species with the Colorado River corridor, including resident and migratory birds, mammals, and herpetofauna. (GRCA-N-210.104, GRCA-N-220.103)

- Models and Trend Data

Develop information systems and mathematical models for evaluating alternative operations of Glen Canyon Dam under the Adaptive Management Program:

Flooding

Evaluate through modeling and experimentation, the beneficial and deleterious effects of floods and flood exclusion on natural, cultural, and recreational resources within the Colorado River from Glen Canyon Dam to Lake Mead.

Sediment Transport

Model and measure sediment contributions to the Colorado River from all significant sources, determine the amount of sediment needed to maintain sandbar, backwater, and bank deposits, and track sediment supplies available for redistribution through flow manipulation.

Selected Temperature Withdrawal

Evaluate the feasibility of long-term and short-term changes to discharge water temperature from Glen Canyon Dam, and the potential effects on distribution, reproduction, recruitment, and survival of native and nonnative fishes, on the aquatic food base, and on other resources (GRCA-N-230.101)

Forest Ecosystems

After nearly 100 years of fire suppression in Northern Arizona forests, dangerously high fuel loads have accumulated because of understory vegetation, dead fall, and crowding. Pre-settlement tree density in ponderosa pine forests that once averaged 40 trees per acre (1869) have increased to a present day 850-1,000 trees per acre. The potential for catastrophic stand-replacing fires is extremely high. Although prescribed burns and managed natural fire can reduce fuel load in limited areas, broad application of these techniques within the Park is limited, notably by protection of cultural sites, sensitive wildlife species, air quality, and safety issues. The highest priority for fire research in national parks is to provide information for fire management decisions. Areas at high risk of catastrophic fire are identified, and present-day options evaluated through close cooperation of scientists and Park management. Innovative long-term management alternatives to fire suppression and limited prescribed fire regimens are also needed. The effects of wildfire, fire suppression and prescribed fire on human safety, wildlife, archaeological sites, and other important resource values (e.g., air quality, scenic vistas, etc.) should be documented and evaluated in an ecosystem context, so that appropriate protective and mitigative measures can be developed and relative advantages weighed.

Forest ecology studies are needed to describe the frequency, magnitude, and distribution of pre-settlement natural fires in several vegetative community types and numerous locations. Changes in vegetation, species occurrence, abundance, and population structure that can be attributed to fire suppression, grazing, exotic species, and natural succession (forest, meadow, scrub, etc.) should be documented over time, and projected into the future.

Specific Information Needs Management Alternatives (Fire). Develop improved and alternative management strategies to reduce risk of resource damage from catastrophic fires in coniferous and mixed forests, Mojave mixed desert scrub, etc. Prescribed fire, as currently implemented, can neither control the risk of wildfire, nor fully restore ecosystems to pre-settlement conditions. During the past few years, Park officials and subject-matter experts have pointed to the need for innovative techniques. Scientific research, founded in modeling and cognizant of the need for practical applications, will provide credibility to the use of such techniques.

- **Fire History**
Research the natural (pre-settlement) fire regime for plant communities through fire-scar analysis, and develop management recommendations based on findings (GRCA-N-121.000)
- **Biological Monitoring (Fire)**
Develop a prescribed fire biological monitoring program, including evaluation of the existing fire effects monitoring programs, with potential applications in other areas. (GRCA-N-121.100)

- **Fire Ecology**
Research the effects of fire exclusion and prescribed fire on Park wildlife and the representative vegetation communities including grasslands on the Kanab, Shivwits, Coconino, and Kaibab plateaus). To maximize the value of applied research in this area, the broad subject areas would need to be narrowed considerably through discussion with Park management. (GRCA-N-121.300)
- **Fire Archaeological Impact Studies**
(see listing under Cultural Sciences, Anthropology, and Archaeology).

Ground Water, Cave, and Karst Ecosystems

Grand Canyon National Park is located in the arid Southwestern United States. Park ecosystems range from upland coniferous and semiarid forests to Great Basin and Mojave deserts. Beyond the river corridor, availability of potable water is perhaps the Park's most limited resource. Lack of readily available water has also greatly constrained the growth of communities outside Park boundaries. The primary source for potable water within the Park, and for the gateway community of Tusayan, is the collection of ground water issuing from Roaring Springs, a solution cave within the Redwall Limestone. Numerous other springs and seeps throughout the Canyon provide localized pockets of moisture essential to the survival of native plants and wildlife (including the endangered Kanab ambersnail). Human visitors to backcountry areas also depend on natural springs for drinking water. The capacity of the aquifer and locations and flow rates of remote seeps and springs is largely undetermined. Park management is concerned about ground water development, and particularly about wells to be drilled south of Grand Canyon Village, because ground water withdrawals may reduce or eliminate flows within the Park.

Research is needed to determine aquifer storage, sustainable yield, ground water distribution patterns, and surface recharge conditions within the Park and surrounding areas. The potential effects of mine-waste and other surface contaminants should also be quantified. Hydrologic and ecological studies are also needed for documenting flows and associated dependent flora and fauna at existing springs and seeps.

Grand Canyon National Park contains extensive karst formations, but very little of a specific nature is known about the cave resources. Park files contain locations and other general information for several dozen caves within the Park that have been explored to some extent. However, few caves within the Park have been systematically surveyed to identify significant physical, biological, and cultural resources, and the passages of only a few caves have been accurately mapped. Detailed scientific information is needed for hundreds of unexplored caves within the Park. First priority should be inventories of known caves and establishment of long-term resource monitoring protocols, followed by exploration of wild caves, and research to better understand the nature and significance of cave resources within the Park.

Specific Information Needs

- Ground Water Studies
Conduct detailed hydrogeologic studies of South Rim areas. Document real and potential effects of surface and ground water diversions within and outside the Park (Roaring Springs, Tusayan, South Rim). Identify alternative sources of potable water. (GRCA-N-330.500, GRCA-N-330.501, GRCA-N-360.101)
- Cave Resource Inventory and Assessment
Plan and implement cooperative program of study (GRCA-N-510-001, GRCA-N-570.101)
- Bat Population Surveys
(See Other Biotic Resource Studies)

- Invertebrate Surveys
(See Other Biotic Resource Studies)
- Kanab ambersnails
(See Colorado River and Riparian Studies)

Other Information Needs

Administrative and Legal Topics

- Legal Boundary Studies
Research legal and administrative history of Grand Canyon/Reservation boundaries (GRCA-C-130.002) (study initiated, 1996)
- Administrative Park History
(GRCA-I-310.010) (study underway by Grand Canyon Association)
- Assemble Information to Support NPS Water Rights Claims
(GRCA-N-390.101) (Little Colorado River studies initiated, 1996)
- Consolidate and Summarize Law, Treaties, and Administrative Mandates Affecting Grand Canyon, Including any State, Local, and Tribal Authorities
- Prepare Administrative History of Natural Resource Management and Research
(GRCA-I-310.020)

Life Science Topics

- Inventory, Assess and Monitor Sensitive Plant Species Including Sentry Milk-vetch and Cryptobiotic Soil Crusts
(GRCA-N-133.000) (sentry milk-vetch studies underway, 1996)
- Inventory and Monitor Carnivores
(GRCA-N-210.109)
- Inventory and Monitor Upland Birds
(GRCA-N-210.103)
- Monitor Kaibab Squirrel Population Trends
(GRCA-N-220.107)

- Inventory and Monitor Bighorn Sheep (GRCA-N-210.110)
- Conduct Survey of Spotted Owl Population (GRCA-N-220.102)
- Monitor Peregrine Falcon Population (GRCA-N-220.105)
- Monitor Native Grazing Herbivores and Forage Base Carrying Capacity (GRCA-N-210.108)
- Monitor Introduced Grazing Herbivores and Forage Base Carrying Capacity
- Monitor and Control Cowbirds at Corrals and Stock Areas (GRCA-N-220.104) (initiated, 1996)
- Reintroduction of California Condors (GRCA-N-270.103) (studies for Vermilion Cliffs release site underway, 1996)
- Reintroduction of Colorado River Squawfish (GRCA-N-270.102)
- Reintroduction of Bonytail Chub (GRCA-N-270.101)
- Reintroduction of Burrowing Owls
- Reintroduction of Wolves
- Reintroduction of Roundtail Chub
- Delineate Wetlands in Areas of Development (GRCA-N-310.201)

Physical Science Topics

- Measure Flows and Water-related Values at Various Springs and Streams to Participate Effectively in Future Water Right Adjudications (GRCA-N 330.400,.502,.503)
- Develop Parkwide Soil Map and Classification System to the Series Level or to Soil Type (GRCA-N-510.101)
- Locate and Characterize Important Geologic Exposures That Should be Protected (e.g. vertebrate fossils, track-ways and other trace fossils, rare minerals or crystals) (GRCA-N-410.102)

**Geographic Information Systems—
Resource Database Development
(GRCA-N-900.101, .102, .103, .104,
.201):**

- Archaeological Sites (GIS database development underway in 1996) (GRCA-C-500.001)
- Motorized Transport Sound Monitoring Data (aircraft, boat, road traffic) (aircraft sound GIS modeling underway, 1996)
- Caves, Karst Formations, and Mine Shafts (GRCA-N-570.101)
- Species Occurrence Records (wildlife, fish, and plants)
- Principle, Relict, and Sensitive Plant Communities
- Surface and Ground Water Hydrography
- Soils and Bedrock Types
- Climate Data (rainfall, temperature means and extremes, solar radiation, etc.)

- Air Quality Data
- Water Quality Data
- Rare, Important, and Unprotected Paleontological Resources (GRCA-N-410.101)
- Original Location and Attribute Data for Existing Museum Specimens