GRCA

NATURAL & CULTURAL RESOURCES

MANAGEMENT PLAN

and Environmental Assessment

JUNE 1982 REVISION

GRAND CANYON NATIONAL PARK
Arizona

PREPARED BY
GRAND CANYON NATIONAL PARK

National Park Service / United States Department of the Interior

NATURAL AND CULTURAL RESOURCES MANAGEMENT PLAN

AND ENVIRONMENTAL ASSESSMENT

GRAND CANYON NATIONAL PARK

ARIZONA

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Regional Director, Western Region — Date

ABSTRACT

The Natural and Cultural Resources Management Plan for Grand Canyon National Park (GRCA) will restore, protect and perpetuate the natural scene of the park and its natural and cultural resources. It is a composite plan of basic research and specific management actions. The plan identifies a five-year scheduling program for implementing the above projects and describes the impacts of these actions as required by the 1969 National Environmental Policy Act and the 1980 Council on Environmental Quality Guidelines.

Research project titles include: Resources Base Inventory; Air Quality Study; Fish Ecology Study; Backcountry Carrying Capacity Study; Desert Bighorn Population and Ecology Study; Identification of Threatened/Endangered Plant Habitat Study; Predatory Mammal Study; Meadow Restoration and Ecology Study; Status and Ecology of Peregrine Falcon and Golden Eagle Populations Study; Impact of Stock Use in Inner Canyon Study; Visitor Impact at Mather Campground Study; Feasiblity Study of Re-introduction of River Otters; and an Aircraft Noise Sociological Study.

Management project statements identify actions needed to solve specific natural and cultural resources problems. Natural resources management and monitoring projects include: feral burro impact monitoring; Colorado River monitoring; Roaring Springs water withdrawal impacts monitoring; aircraft disturbance monitoring; air quality monitoring; water resources monitoring; fire management; boundary fencing and repair projects; native wildlife population monitoring; cave management; rehabilitation of unused roads and structures; mining and minerals monitoring; forest insects and disease monitoring; human disease control; exotic and nuisance species control; and pesticide use.

Cultural resources management proposals include: an inventory and mapping project; data recovery at sites endangered by erosion and internal visitor use; ruin stabilization; a cyclic maintenance program; monitoring of cultural resources; and liaison with neighboring Indian Tribes.

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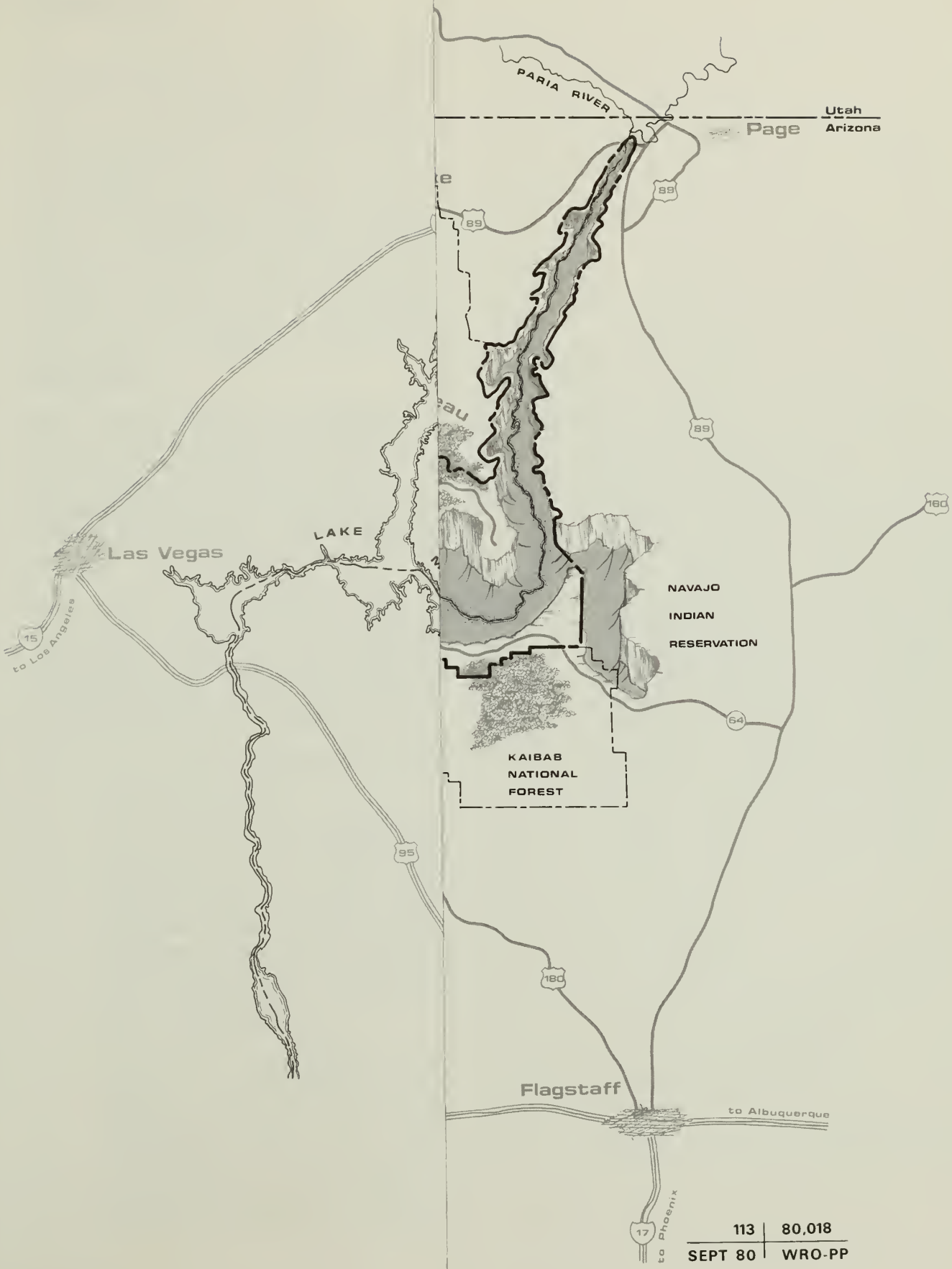

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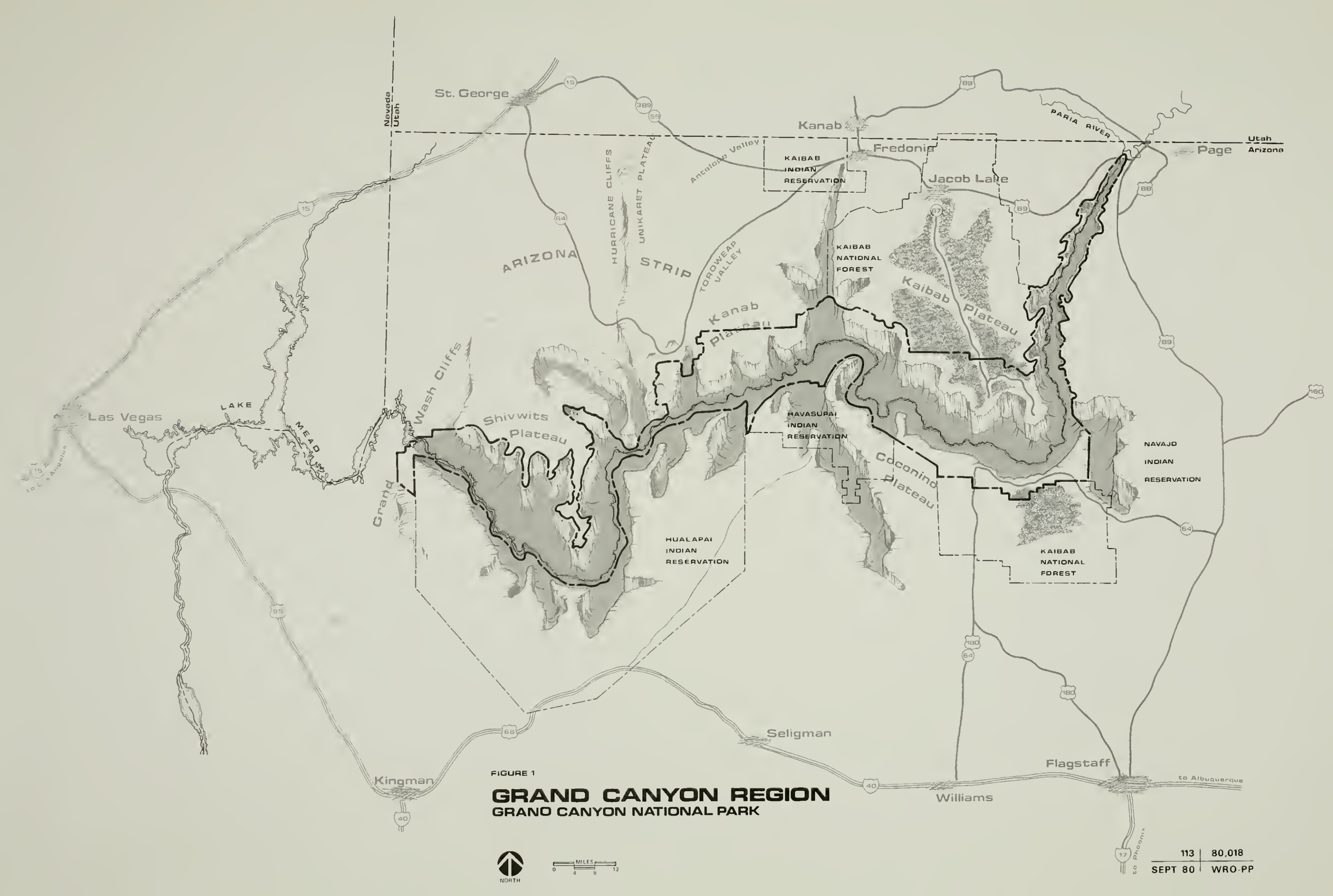

FIGURE 1

GRAND CANYON REGION
GRAND CANYON NATIONAL PARK

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I. INTRODUCTION

The preservation of natural and cultural resources within Grand Canyon National Park (GRCA) is the fundamental requirement for its continued use and enjoyment by park visitors as an unimpaired natural area of the National Park System. The Master Plan (1976) for Grand Canyon National Park and its accompanying Final Environmental Statement (FES 75-97) and the park's Statement for management (1979) established the broad conceptual base for more specific development and action plans to follow. Among these is the Natural and Cultural Resources Management Plan and Environmental Assessment for Grand Canyon National Park (hereafter referred to as the Natural and Cultural Resources Management Plan). This document, an expanded and updated version of the 1977 Natural Resources Management Plan, will guide park managers in achieving the resources management goals and objectives set forth in the 1976 Master Plan and park Statement for Management.

The natural resources management proposals for Grand Canyon National Park are guided by the fundamental tenet that we will maintain and perpetuate ecosystems rather than simply protect and preserve individual features or favored species. This is, and must remain, a distinguishing aspect of resources management so that the park remains a place where natural forces remain unimpaired and the complete richness of the ecosystems can prevail.

The plan also recognizes that historic and cultural resources are presently not receiving adequate care within the park. In keeping with the edicts of the National Park Service Management Policies Handbook (1978 edition), the plan includes cultural resources management proposals which form the basis of a comprehensive long-range program for the preservation of structures and artifacts.

A. Legislation Affecting the Natural and Cultural Resources Management Plan.

The Grand Canyon Enlargement Act, dated January 3, 1975, provided for ". . .the further protection of the Grand Canyon in keeping with its true significance. . ." and established the current park boundary as shown in Figure 2. This law incorporated Marble Canyon National Monument, Grand Canyon National Monument, portions of Lake Mead National Recreation Area and the Kaibab National Forest, as well as some Bureau of Land Management lands and other lands, create today's enlarged 1,226,656 acre national park.

Public Law 93-620 also removed 83,809 acres of land from the park in the Manakacha-Topocoba and Tenderfoot Plateau areas and placed them in Bureau of Indian Affairs Trust as part of the Havasupai Reservation. The Enlargement Act also provided for traditional uses, including grazing, by the Havasupai on approximately 95,300 acres of park land (the "Havasupai Traditional Use Area"). The extent of this use will be based upon a National Park Service study currently being planned.

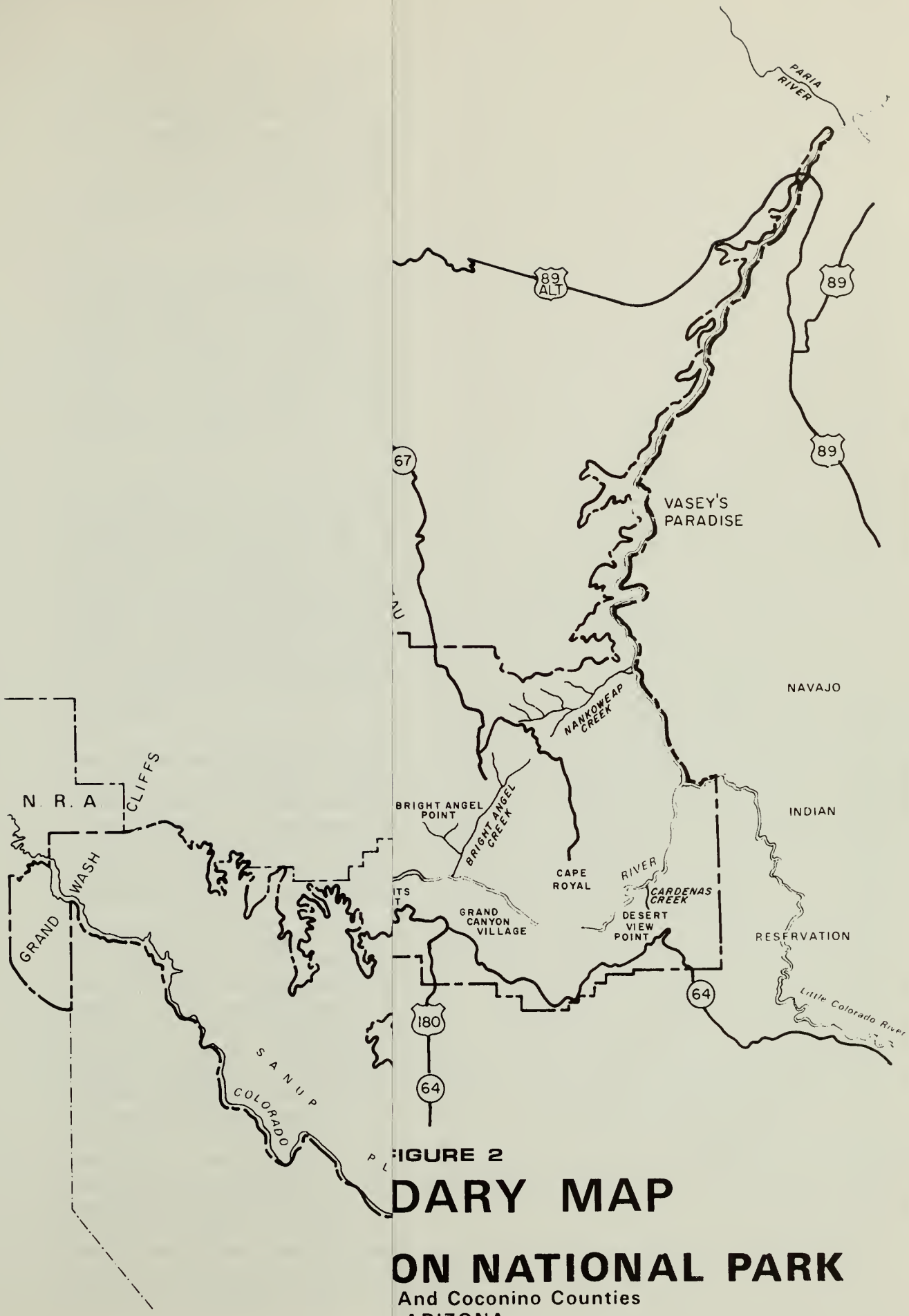

FIGURE 2

DARY MAP

ON NATIONAL PARK

And Coconino Counties
ARIZONA

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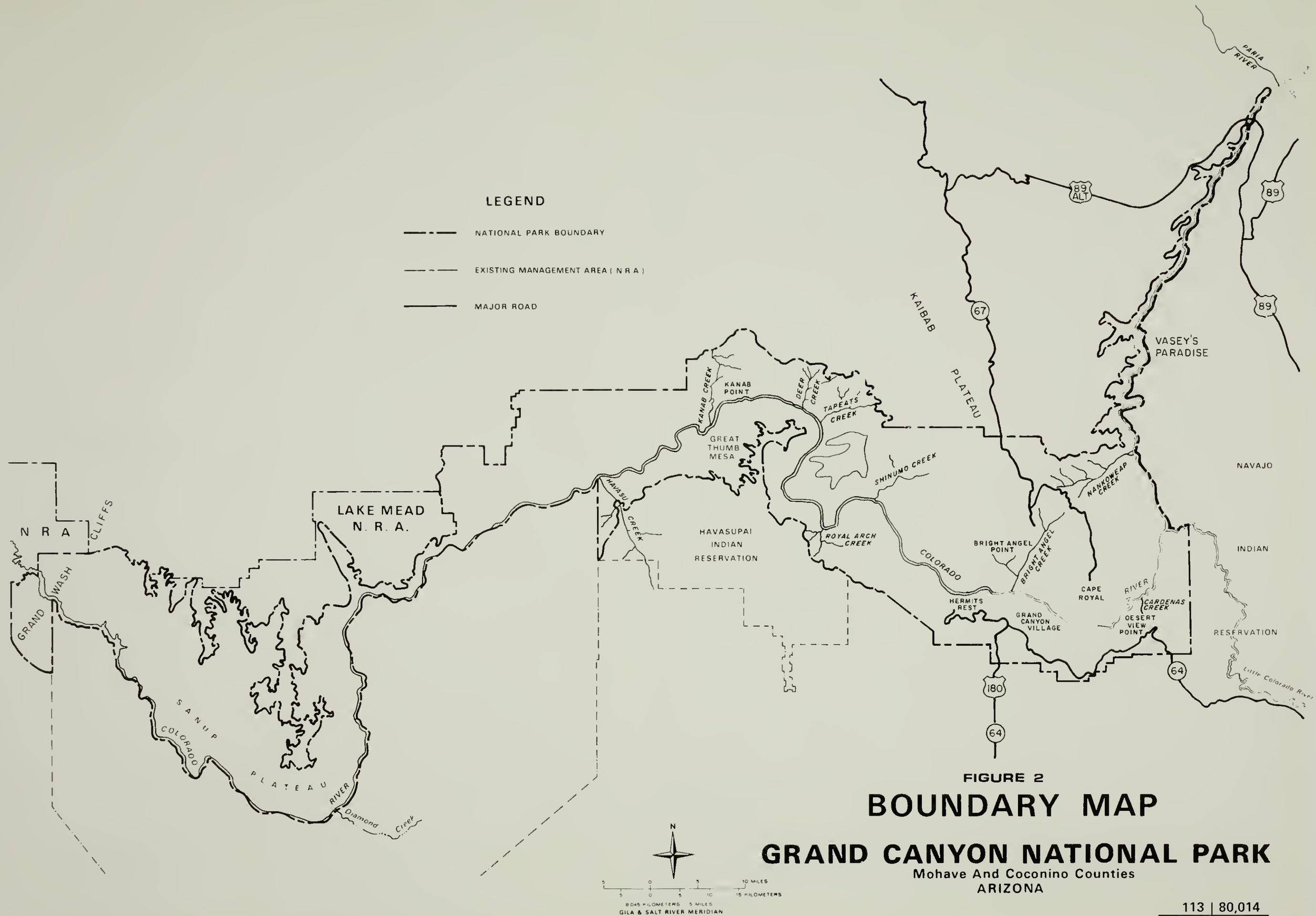

FIGURE 2

BOUNDARY MAP

GRAND CANYON NATIONAL PARK

Mohave And Coconino Counties
ARIZONA

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In addition, Public Law 93-620 authorizes the Secretary of the Interior to submit to the Federal Aviation Administration, the Environmental Protection Agency or other responsible agencies his recommendations for regulations concerning the use of aircraft in Grand Canyon National Park, if he believes such aircraft to be threatening the welfare of the public or the park (including the visitor's experience and the park's natural quiet).

Additional legislation influencing planning activities in the park includes the National Park Service Organic Act of 1916, the Archaeological Resources Protection Act of 1979, the American Indian Religious Freedom Act of 1978, the National Historic Preservation Act of 1966 and as amended in 1980, Executive Order 11593, Executive Order 11987, the Wilderness Act of 1964, the Federal Water Pollution Control Act Amendments of 1972, the Endangered Species Act of 1973, Public Law 94-429, and the Clean Air Act Amendments of 1977.

The Organic Act of 1916 directs the National Park Service (NPS) to regulate park use and promote enjoyment of park lands in a manner consistent with the conservation of park scenery, natural and historic objects, and wildlife. In order to fulfill these mandates, all resource planning activities must insure that public use facilities do not disrupt or damage resources to a degree whereby their ability to serve future visitors is reduced, that appropriate non-destructive public use and enjoyment of resources is made possible, and that conscious care and protection are provided to conserve natural and cultural park resources.

The Wilderness Act of 1964 requires all Federal land-managing agencies to re-examine their resources for possible wilderness classification. The lands within the former boundaries of the park and the two monuments have been studied and evaluated for placement in the National Wilderness Preservation System. A draft proposal and draft environmental impact statement (DES-76-28) have been prepared, based on these evaluations.

The Endangered Species Act of 1973 requires all Federal agencies to consult with the Secretary of the Interior on all projects and programs having potential impact on endangered flora and fauna. The legislation further requires Federal agencies to take ". . . such action necessary to insure that actions authorized, funded, or carried out by them do not jeopardize the continued existence of such endangered species and threatened species or result in the destruction or modification of habitat of such species which is determined . . . to be critical."

Executive Order 11987 states that "executive agencies shall, to the extent permitted by law, restrict the introduction of exotic species into the natural ecosystems on lands and waters which they own, lease, or hold for purposes of administration; and, shall encourage the States, local governments, and private citizens to prevent the introduction of exotic species into natural ecosystems of the United States."

Section 208 of the Federal Water Pollution Control Act Amendments of 1972 dictates that Federal areas are subject to State and local water quality regulations. Thus, Grand Canyon National Park must meet Arizona State water quality standards.

The Clean Air Act Amendments of 1977 designated Grand Canyon National Park as a Federal Class I area. This means that visibility within the park is not to be impaired by any man-made source, and that methods must be devised to monitor such visibility.

Public Law 94-429 (September 28, 1976) closed the park to new mining claim locations and placed existing claims under strict regulations. Under this law, all mining claims were presumed abandoned if they were not recorded with the Secretary of the Interior by September 28, 1977.

The National Historic Preservation Act of 1966 requires all Federal agencies to inform the Advisory Council on Historic Preservation of the effect of any undertaking on any district, site, building, structure, or object that is proposed for, or included in, the National Register and to afford the council a reasonable opportunity to comment. This Act was amended in 1980 to expand elements of cultural resources protection which will apply to Grand Canyon National Park.

Executive Order 11593 (1971) directs Federal agencies to survey all properties under their administration that might qualify for listing in the National Register of Historic Places, and nominate them to the Secretary of the Interior to take measures which would result in the "protection and enhancement of the cultural environment."

The Archaeological Resources Protection Act of 1979 (P.L. 96-95), supersedes the Antiquities Act of 1906. This act: (1) established that archaeological resources on public and Indian lands are protected, (2) established the permit requirements for resource excavation or removal and (3) established civil and criminal penalties for their illegal removal.

The American Indian Religious Freedom Act of 1978 (P.L. 95-341) mandates that Federal agencies ". . . protect and preserve American Indian religious cultural rights and practices." Each Federal agency must undertake consultation vis a vis "its missions, statutes, regulations and policies with traditional Native American religious leaders (A64 (WR) RC, June 5, 1979, from Regional Director, Western Region)."

B. Management Objectives

The 1978 edition of the National Park Service Management Policies Handbook forms the basis for planning activities and administration of Grand Canyon National Park. Natural and cultural resources management planning is also based on management objectives which provide the park manager with a context

for evaluation of preservation and use and a framework that enables management to satisfy the specific purposes for which the park was established. Overall objectives outlined in the management handbook relating to the park's natural and cultural resources management proposals include:

To conduct and support research programs pertaining to natural and cultural resources, and to social science.

To perpetuate unimpaired the cultural resources of the National Park System.

To prevent adverse effects on these resources by development, visitor use, or resources management activities.

To prohibit vandalism or unauthorized excavation, collection, or appropriation of cultural resources.

To eliminate grazing and mining where possible and appropriate.

To perpetuate the native animal life for its essential role in the natural ecosystems.

To reintroduce native plants and animals to their original range.

To identify all threatened and endangered species and their critical habitat requirements.

To manipulate population numbers of exotic plant and animal species, up to and including total eradication, whenever such species threaten protection or interpretation of resources being preserved.

To allow populations of native insects and the incidence of native diseases to function unimpeded except where control is essential.

To allow management fires to burn except where control is essential.

To maintain the quality of all waters.

To control, mitigate or eliminate adverse alteration of the air quality by industrial or mechanical sources.

To monitor activities causing excessive or unnecessary noise in and adjacent to parks and to take action to avoid or minimize noise which detracts from the visitor's enjoyment of park values, unduly disturbs the peace of adjacent neighborhoods, or adversely affects park resources.

To manipulate terrain and vegetative cover in order to restore natural conditions on lands altered by human activity.

To manage caves for the perpetuation of their natural, geological and ecological conditions, and historic associations.

C. Interrelationships With Other Projects

1. Park Suitability Study (1976)

The Park Suitability Study called for by P.L. 93-620, was instigated to determine if the areas of Jensen Tank, Tuckup Point and Slide Mountain were suitable for retention in the national park. The determination of the study team was that these areas were suitable for retention. Therefore, the Natural and Cultural Resources Management Plan includes action that affects these lands.

2. Grand Canyon Wilderness Recommendation (1976)

The lands within the former boundaries of the park and the two monuments have been studied and evaluated for placement in the National Wilderness Preservation System; the remainder of the park is yet to be studied. A draft environmental statement (DES 76-28) was prepared in 1976. A final environmental impact statement has not been prepared since a final tact for handling wilderness recommendations has not been developed by the NPS. All elements of the Natural and Cultural Resources Management Plan are in keeping with the objectives of the wilderness designation. The proposals can be carried out in full compliance with legislation regulating wilderness use. This includes the Fire Management Plan and Colorado River Management Plan.

3. Grand Canyon National Park Master Plan (1976)

The Master Plan, Final Environmental Statement, (FES 75-97) and park Statement for Management (1979) have been completed and reviewed by the public and other agencies. The Natural Resources Management Plan was developed in conjunction with the Master Plan proposals and takes into consideration access, visitor protection, interpretive facilities, resources management, and general development needs. Special attention must be paid to the identification in the Master Plan of five Research Natural Areas and two Environmental Study Areas. Resources management actions will not jeopardize the status of these units. The Research Natural Areas are Neal Springs, Mount Emma, Powell Plateau, Swamp Point and "Wayside" (near the Tusayan Museum). The Environmental Study Areas are along the Hermit Trail and in the Grandview Point area.

4. Grand Canyon Village Development Concept Plan (1977)

The Development Concept Plan and Final Environmental Statement (FES 76-9) was approved in 1976 and forms the design for the development of Grand Canyon Village. Coordination of this document with the Natural Resources Management Plan was necessary in projects pertaining to unused roads and structures, visitor impact on Mather Campground, feral dogs and cats, exotic birds, and South Rim small mammals.

5. Colorado River Management Plan (1981)

The Colorado River Management Plan and Final Environmental Statement (FES 79-30) provides for certain measures (such as changes in river trip schedules and the development of single trails to interest points) to mitigate the effects of Glen Canyon Dam and of increased visitor use on the river ecosystem. The plan is essentially a part of the Natural and Cultural Resources Management Plan although, because of its size and scope, it is covered in a separate document. After final public review, the plan is expected to be completed by January 1982 and implementation of most of the provisions will begin immediately. The Natural and Cultural Resources Management Plan contains a project which calls for continued monitoring of impacts caused by operation of Glen Canyon Dam and visitor use.

6. Feral Burro Management and Ecosystem Restoration Plan (1980)

The Feral Burro Management and Ecosytem Restoration Plan and Final Environmental Statement (FES 80-7) called for the live removal by the public, and removal by shooting if necessary, of feral burros from Grand Canyon National Park. Because of its size and scope this plan was also covered in a separate document. The plan was approved in January 1980 and the last burro was removed from the park in September 1981. As prescribed in the burro plan, the Natural and Cultural Resources Management Plan contains a proposal to monitor established feral burro impact plots after the removal of the burros to ascertain the rate and nature of recovery of the ecosystem and to remove any stray burros remaining in the park after completion of public live removal efforts.

7. Backcountry Management Plan (Draft 1981)

The purpose of this plan, still in draft form, is to set objectives for public use and management of roadless areas of Grand Canyon National Park. The emphasis of the plan is directed almost exclusively at visitor use of the backcountry accessible by river, trail, primitive roads, or air. The plan bases decisions on legislative mandates, park regulations, policies, management zones, and resource sensitivity.

8. Secretarial Land Use Plan for the Havasupai Indian Reservation (1979)

Pulic Law 93-620 required that a study be made by the Secretary of the Interior in consultation with the Havasupai Tribal Council to develop a plan for the use of 185,000 acres of land included in the Havasupai Reservation. The land may be used for traditional religious purposes, for the hunting and gathering of native foods, for agricultural and grazing purposes, and for the development of tribal small business enterprises. The plan includes the selection of areas which may be used for residential, educational and other community purposes for members of

the tribe, and which are not inconsistent with or do not detract from park uses and values. The Bureau of Indian Affairs was the lead agency in the development of this plan. A draft of the plan plus Draft Environmental Statement (DES 79-42) has been completed, reviewed by the public, and is now awaiting approval by the Secretary of the Interior.

Havasupai Reservation lands adjacent to the boundary in proximity to the Great Thumb area are virtually surrounded by the park. Housing, intensive grazing, road development or irrigation could affect the Natural and Cultural Resources Management Plan proposals if these developments require access across park lands and if park access requires travel across reservation lands. Any pertinent resources management proposals will be developed in conjunction with the Havasupai Tribe to assure understanding and continuity.

10. Glen Canyon National Recreation Area General Management Plan (1979)

Glen Canyon National Recreation Area's General Management Plan calls for the continued stocking of fish by the Arizona Game and Fish Department in the Colorado River directly below Glen Canyon Dam. This is a continuation of existing policy and is in general keeping with the area's enabling legislation. However, this activity does conflict with Grand Canyon National Park's stated management objectives relating to endangered fish species and maintenance of a natural habitat. This conflict has yet to be resolved.

11. Lake Mead National Recreation Area Natural Resources Management Plan (1975)

The contiguous boundary of the Lake Mead National Recreation Area and Grand Canyon National Park along the northwest portion of the park has been considered in the development of Grand Canyon's Natural Resources Management Plan. The interrelationships of wilderness proposals, mining and mineral leases, and stock grazing have been and will continue to be considered in this plan.

12. Several other proposals and projects potentially affect, or will be affected by, the Natural and Cultural Resources Management Plan. These include:

- Glen Canyon Dam operations
- Grand Canyon National Park Airport expansion proposals
- Arizona State Fish and Game Department proposals
- Tusayan growth and water sales
- U.S. Forest Service land management proposals
- Bureau of Indian Affairs and individual tribal plans on adjacent lands
- Bureau of Land Management policies and management of adjacent lands

II. RESOURCES MANAGEMENT PROGRAM

A. Natural Resources Management Program:

1. Overview

Since the completion of the 1977 Natural Resources Management Plan and Environmental Assessment, the park has been engaged in implementing project elements identified in that document. The Colorado River Management Plan and the Feral Burro Management and Ecosystem Restoration Plan were developed under separate environmental impact statements. Except for follow-up monitoring efforts identified in the Natural and Cultural Resources Management Plan, both of these projects have essentially been completed.

Progress on other elements of the 1977 Natural Resources Management Plan include:

Resources Base Inventory. The vegetation mapping phase of this comprehensive inventory project was completed in 1981. This involved the identification and mapping of over 100 vegetation types throughout the national park.

Further resource inventory projects were initiated through separate air and water quality monitoring projects.

Threatened and Endangered Species. The Kaibab Squirrel research effort was concluded in 1979 and a population monitoring effort was implemented in 1981. This project is being conducted in cooperation with the U.S. Forest Service, the Bureau of Land Management and the Arizona Game & Fish Department.

The park developed a draft Fish Management Plan and special regulation proposals intended to protect native fish species. Both these documents are still pending and are considered in the Natural and Cultural Resources Management Plan.

In 1981, the Museum of Northern Arizona, under contract to the U.S. Fish and Wildlife Service, completed an inventory of ten plants recommended for inclusion on the List of Endangered and Threatened Wildlife and Plants. These recommendations are pending.

Exotic and Pest Species. In addition to completing the feral burro project, the park implemented an ongoing tamarisk eradication program at tributary stream sources. Exotic birds, as well as dogs and cats, were eradicated as time permitted.

Human Use and Carrying Capacities. The Colorado River Management Plan is scheduled for completion in January

1982. Draft action plans concerning aircraft noise management and backcountry use management were completed in 1980. The park also completed an Aircraft Management Plan Study Task Directive the same year. All of these programs are pending.

The park continued to administer seven grazing permits as required under Public Law 93-620 and closed approximately 15 miles of unused roads for the purpose of rehabilitation.

Geologic Features and Disturbances. A Cave Management Plan was completed and implemented in 1978. This action plan is updated annually.

Wildlife Management. A survey of desert bighorn on the South Tonto Plateau was completed in 1978. The park also established permanent deer pellet group transects as a population monitoring effort for this species.

Fire Management. The park developed a Fire Management Plan and implemented its first prescribed burn in 1979. This document is updated annually. Since initial implementation of the fire manangement program, the park has conducted prescribed burns on both the North and South rims totalling 2,500 acres.

2. Natural Resources Management Needs and Project Statements

The following natural resources proposals are part of a composite plan based upon legislative edicts, policy statements and park management objectives. Each "needs" statement is followed by one or more individual project statements. Priorities for determining the significance of projects and the individual ranking of these projects in the five-year management program were made after considering specific evaluation factors, including:

Threats to endangered species or critical habitats.

The uniqueness or rarity of resource.

Violations to the Grand Canyon National Park enabling legislation.

Compliance with the Federal Water Pollution Control Act of 1971 and the Clean Air Act as amended in 1977.

Threats to the health and safety of the park visitor.

A consideration of the ecological principles regulating the resources of the park.

Threats to the overall visitor enjoyment of the park.

A consideration of established National Park Service policies and laws.

Natural Resources Project Statements marked with an asterisk are those projects which were included in the park's 1977 Natural Resources Management Plan and Environmental Assessment. These project statements have been updated and modified to reflect current budget needs and other administrative changes.

a) RESOURCES INVENTORY PROJECTS.

(1) Resources Base Inventory (RBI).

The basic resources of Grand Canyon National Park remain largely unknown. A program was initiated in 1978 to tabulate and computerize eight resource elements including vegetation and soils mapping, water resources, mammals, flora, reptiles, fish, and insects. The prioritization of these elements are based upon a consideration of: (1) the importance of the element itself; (2) the land use potential; (3) the geographic area within the park; (4) the status of the resource element in terms of rarity, economics, and political sensitivity. While a combination of the resource elements and their priority factors give rise to numerous varieties of research, the basic intent of the park will be to accomplish inventory investigations of individual elements rather than piecemeal investigations of all elements.

The first phase of the Resources Base Inventory, a vegetation mapping project, was completed in December 1981. This project resulted in the identification and mapping of 104 vegetation types throughout the national park. The usefulness of these maps has already been demonstrated in other resources management projects including fire and grazing management.

The next two phases of the RBI will involve the inventory of water and soils resources. The water inventory will dovetail with programs developed under the Water Resources Management Plan, an addendum to the Natural and Cultural Resources Management Plan.

Following the completion of the water and soils surveys, the park will continue the resources inventory by initiating studies of mammals and reptiles. Funds will be used to contract this research work through established research institutions or through the NPS Cooperative Research Studies Units.

The need for the RBI project is supported by general edicts to "preserve and protect" natural resources in the park enabling legislation and the Grand Canyon Enlargement Act (PL 93-620). Further impetus to protect individual resource elements is provided under the Federal Water Pollution Control Act, the Clean Water Act, and the Endangered Species Act.

NATURAL RESOURCES PROJECT STATEMENT *

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-16-Resources Base Inventory

3. STATEMENT OF PROBLEM: Many resources management problems in Grand Canyon National Park pre-dated the establishment of the park in 1919. By then, the basic layout and physical facilities of the park were fixed and a number of adverse uses were well-established. With the exception of the work done by the Civilian Conservation Corps in the 1930's, little information has been collected on the park's natural resources. The efforts of the Resources Management and Research divisions in the park have been largely directed toward the solving of immediate high priority crisis problems, such as feral burro and river management problems.

   During the 1970's, pressure on the park increased because of the expansion of visitor services and access and the decision to export water outside the park. Appropriate research data is unavailable for use in documentation of threats to park resources and development of necessary general management plans, development concept plans, environmental impact statements, and construction contracts. For these reasons, the park is unable to successfully meet the challenge of defending the long-established and ratified principles of resources management at Grand Canyon. Therefore, basic resource information is urgently needed.

4. WHAT HAS BEEN DONE: In the past, scattered and sporadic attempts have been made to gather resource information. Until recently, there has been no unified effort to pull these scattered fragments together. Because Grand Canyon National Park was established some time ago, and because it is an area of considerable scientific interest, there is information available, but it is rather spotty and scattered. The U.S. Forest Service, U.S. Geological Survey, U.S. Fish and Wildlife Service, and several other Federal agencies have conducted some scientific work in the park from time to time, usually on very specific problems. In most cases, this work was very confined geographically. Private or university researchers have undertaken work in the park, again, in very limited geographical areas. A synopsis of past and ongoing work follows:

   a. Vegetation. Considerable work has been done concerning the vegetation of Grand Canyon, but much of the work was done before there was adequate transportation in the region. Plant collection was therefore limited to areas easily reached. Recent work in the riparian zone along the Colorado River has uncovered three taxa of plants new to science and 30 species not previously known in the park. These discoveries have all been related to the ease of access of river raft trips. Large areas of the Grand Canyon proper and the North Rim have not been intensively collected. The park study collection contains a rather large number of specimens from Grand Canyon but many are

old and disintegrating. There are now two flora texts that cover the Grand Canyon, simplifying plant identification.

In 1936, the Civilian Conservation Corps completed a vegetation map of the park, identifying dominant species in various areas of the canyon. However, it only included areas within the old park boundaries, did not include community descriptions and was not as complete as aerial photography and modern techniques allow. In 1977, the Office of Arid Lands Studies at the University of Arizona was contracted to provide a vegetation map of the entire park using up-to-date techniques. Final maps from this project, at a scale of 1:62,500, were submitted in December 1981. As part of the field work needed to develop these maps, plant specimens were collected throughout the park. These specimens have been added to the park's herbarium.

b. Water Resources. Previous research in the Grand Canyon region, while providing a wealth of information on various topics pertaining to the availability and location of local water sources, has not produced an organized system of information on regional hydrology. In 1979, a comprehensive inventory of the surface waters in the central portion of the park was completed. This was done primarily as part of the Water Resources Management Plan project. Data were gathered on the location, history, permanence and quality of 537 water sources (57 perennial) in or adjacent to the park between lower Marble Canyon and Kanab Creek. These sources were classified according to a system designed specifically for the project. Emphasis was placed on the importance of water to backcountry hikers and wildlife.

c. Vertebrates. Most of our knowledge about vertebrates present in the park comes from sight observation records, most of which are old, with relatively few recent additions. The park has a small collection of mammal and bird specimens which are largely the result of accidental road kills. Reptiles, amphibians and fish are mostly unrepresented in the collection. There is available a semi-popular book on Grand Canyon mammals, an annotated bird checklist, and checklists of mammals, birds, and reptiles and amphibians. Mammal, bird, reptile and amphibian, and fish studies that were done in connection with the Colorado River Research Program have added new information about these animals along the river. During Resources Base Inventory field work vertebrate sightings were recorded from many areas. In addition, small mammal trapping was conducted on the North Rim and Kanab Plateau, and species with unusual distributions were collected.

d. Invertebrates. Sporadic efforts in the past have resulted in a small insect collection for the park. This collection emphasizes butterflies, at the expense of other taxa. The first comprehensive collection of insects was made in 1976 during the Colorado River Research Program. It contains nearly 2,000 taxa new to the park and is housed at the Museum of Northern Arizona. The relative diversities and densities of insects on some plant

species along the river was also studied at that time. Insect collections have been made as part of Resources Base Inventory field work on the North Rim and Kanab Plateau, but these need to be identified before they can be placed in the study collection. Aquatic invertebrates have been studied as part of a report on fish in Phantom, Bright Angel and Pipe Creeks, but they remain largely unknown for the rest of the park. In the past there have been a few publications on the insects of Grand Canyon.

e. Soils. Little information on the soils of Grand Canyon exists, with the exception of a few studies and very broad publications. This lack of information has led to structural failures in the Shrine of the Ages Chapel and the new cabins at the South Rim Motor Lodge, frequent problems with sewer and water lines, and inadequate reclamation of disturbed parklands.

f. Geology. Because the Grand Canyon is the premier geological show cases of the world, geological studies are quite advanced. The stratigraphy is generally well known, although in some cases not in detail. Stratigraphic studies are too numerous to even cite the more important publications. Most of the park has been geologically mapped and several of these maps are currently undergoing further revision. A map of the central portion of the park has been published at a scale of 1:62,500; maps of the western portion will be published in the next several years.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: Additional information needs to be collected, in priority order as follows:

a. Vegetation. Critical habitat necessary for the assured survival of threatened and endangered plant species needs to be identified. A comprehensive collection of all the plant species in the park, from different locations, needs to be accomplished.

b. Water Resources. The water resources inventory begun in 1979 needs to be continued so as to cover the entire park. This would be done primarily as part of the Water Resources Management Plan project.

c. Soils. A comprehensive soils report and map of the entire park needs to be prepared.

d. Mammals. A comprehensive survey of all the mammals in different locations and habitats of the park needs to be conducted. Special attention will be directed toward the bighorn and predatory mammal populations and toward the distribution of threatened, endangered, and endemic species.

e. Invertebrates. A comprehensive collection of the invertebrates from different locations and habitats of the park needs to be prepared.

f. Reptiles. The species, distribution, and density of all reptiles should be accomplished to monitor the status of these

animals. Critical areas of concern include the Havasupai Traditional Use Lands and unfenced grazing areas on the Sanup Plateau.

6. LENGTH OF TIME NEEDED: Begun in Fiscal Year 1977, this project is planned to continue through Fiscal Year 1986. In that time span, and at the current level of funding, the vegetation map, the water resource inventory, and possibly portions of the plant, vertebrate, and invertebrate collections should be completed. Other portions of the project not completed would have to be deferred. An additional three years would be required to complete the project in its entirety.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: Appropriate data will continue to be unavailable for input into the planning process. Resources management and research investigations in the park will still be directed largely toward immediate high priority crisis problems. This will result in inefficient and possibly inappropriate planning and management actions. Pressure groups, political decisions, or court actions will eventually force the park to conduct these inventories to support planning documents.

8. WHAT ARE THE ALTERNATIVES:

   a. Complete only those elements considered "most critical", i.e., water inventories and endangered and threatened species work.

   b. Increase funding and time allotted to the project in order to complete it as originally designed.

9. PERSONNEL: This project will be coordinated by the Cooperative National Park Resources Studies Unit at the University of Arizona in Tucson. Some work, as in the past, will undoubtedly be performed by National Park Service personnel from the Studies Unit. This might include the plant, vertebrate and invertebrate collecting. Other work, such as the vegetation and soil maps, would in all likelihood be performed by research contractors. Grand Canyon National Park personnel from the Division of Resources Management will assist, if necessary, with the field work.

10. ADMINISTRATION AND LOGISTICS: The Cooperative National Park Resources Studies Unit at the University of Arizona in Tucson will administer this project and provide limited logistical support. The research contractors will provide the remainder of the logistical support. Grand Canyon National Park will assist in arranging logistical support.

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	0	0	0	0	0
Other Than Personnel Services	55	55	55	55	55
TOTAL	55	55	55	55	55
Funds Available in Park Base	0.2	0.2	0.2	0.2	0.2
Funds Requested From Regional Office	55	55	55	55	55

On Form		Date Submitted
10-237	[X]	March 1975
10-238	[ ]	
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS:

a. May, Larry A., and James E. Walters, Division of Resources Management, Grand Canyon National Park.

b. Roy R. Johnson, Unit Leader, Cooperative National Park Research Studies Unit, University of Arizona, Tucson.

12. DATE OF SUBMISSION: September 1981.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- N -16 - Resources Base Inventory

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Research Actions:	
a. Initiate Soils Inventory	30.0
b. Initiate Mammals Inventory	25.0
Total	55.0
2. Fiscal Year 83	
Research Actions;	
a. Continue Soils Inventory	30.0
b. Continue Mammals Inventory	25.0
Total	55.0
3. Fiscal Year 84	
Research Actions:	
a. Continue Mammals Inventory	25.0
b. Complete Soils Inventory	30.0
Total	55.0
4. Fiscal Year 85	
Research Actions:	
a. Continue Mammals Inventory	25.0
b. Initiate Water Inventory	30.0
Total	55.0
5. Fiscal Year 86	
Research Actions:	
a. Complete Water Inventory	30.0
b. Initiate Reptiles Inventory	25.0
Total	55.0

(2) Air Quality Monitoring.

The quality of air in and around Grand Canyon National Park is increasingly threatened by regional and local emission sources. These sources include metropolitan areas as far away as Las Vegas, Nevada and Los Angeles, California; existing and proposed power generating facilities; several distant smelters; and burning activity resulting from Forest Service and Grand Canyon National Park fire management programs. The net effect of emissions from such sources has been a measurable reduction in visibility, an Air Quality Related Value (An AQRV is a park resource, biotic or abiotic, that is affected by changes in air quality.) of paramount importance to visitor appreciation of the canyon and its environs. Presently, it is not known whether other park resources, including biotic and cultural elements are adversely affected by changes in air quality, or what levels of potential pollutants will cause significant resource damage.

Efforts should be initiated to identify existing air quality, trends in air quality, sensitivity of park resources to changes in air quality, the importance of AQRV, micro and synoptic weather patterns affecting air quality, and the source and nature of existing and potential pollution sources. If these programs are not initiated in Grand Canyon National Park, a designated air quality class I area, the National Park Service will: (1) fail to act on its affirmative responsibilities identified in the amended Clean Air Act and in the National Park Service Organic Act; (2) fail to obtain basic information on changes in air quality and its environmental consequences; (3) lessen its ability to prevent significant air quality deterioration and to provide defense in litigation which may be necessary to protect park resources; (4) fail to provide information fundamental to fire management and to sound management of endangered and threatened flora and fauna; (5) fail to provide information on air quality changes which could cause human discomfort and health hazard.

National Park Service management policies set the responsiblity for the protection of all park resources, including "often taken for granted" air quality. Such policies are further supported by legislative mandates of sections 160, 162 and 169(a) of the Clean Air Act as amended.

The National Park Service operates air quality sampling stations at Hopi Point and the Visitor Center in Grand Canyon Village. The 24-hour air samples, taken periodically since 1977, are analyzed by the State of Arizona for particulate matter, sulphur dioxide, nitrogen oxides, and heavy metals. Available information indicates that dustfalls and sulfation rates, as well as levels of ozone, sulfur dioxide, nitrogen oxides, lead, benzene organics, and total oxidents are all low to very low. When compared to the national standards of air quality set by the Environmental Protection Agency, the data indicate that the air quality of the canyon is excellent but deteriorating.

Because of its almost pristine quality, the air in Grand Canyon can be degraded by introducing pollutants at levels considered negligible

in metropolitan areas. Visible ranges often exceed 190 kilometers (118 miles) in the exceptionally clean air above the canyon. Very small increases in atmospheric pollutants can significantly decrease visibility through air of this purity and thus degrade the aesthetic values of the park. Movements of air in the canyon are primarily up and down at very low velocities, making the potential for removal of air pollutants very low. Most of the higher wind velocities encountered in the canyon are not due to the exchange of canyon air with air above the rims, but rather a sloshing of the local air back and forth within the canyon. The slow circulation of air and low dispersive capabilities increase toward the level of the Colorado River. Inversion layers develop each night within the canyon, further restricting air circulation.

Pursuant to the Clean Air Act as amended in 1977, the Environmental Protection Agency developed regulations to prevent significant deterioration of air quality in the United States. Three air shed classes were established by the law in which different incremental increases were allowed in total suspended particulates (TSP), and sulphur dioxide (SO^2) (see Table 1). In Class I air quality areas very little deterioration in air quality is allowed; Class II applies to areas where the air quality deterioration which normally accompanies planned industrial growth or energy development would be allowed; and Class III applies to areas in which air quality deterioration up to the national ambient air quality standards would be allowed. Initially, all areas in the country which were not designated Class I were designated as Class II with provisions for future reclassification of an area to accommodate the social, economic, and environmental needs and desires of the public. To give added protection to areas of unique scenic value, such as those of the National Park System, certain of these areas were designated as Class I air quality areas by 1977 amendments to the Clean Air Act.

TABLE 1

AIR QUALITY AREA

CLASSIFICATION AND DETERIORATION INCREMENTS

Pollutant	Class I (ug/m^3)*	Class II (ug/m^3)
Particulate Matter (TSP)		
Annual Geometric Mean	5	19
24-hour Maximum	10	37
Sulphur Dioxide (SO^2)		
Annual Arithmetic Mean	2	20
24-hour Maximum	5	91
3-hour Maximum	25	512

*micrograms per cubic meter

Major portions of the Grand Canyon seen by park visitors, and major portions of the park being proposed for wilderness designation, are well within 160 km (100 miles) of proposed coal-fired power plants in Utah and within 120 km (75 miles) of the coal-fired Navajo power plant in operation at Page, Arizona. Collectively or individually, these plants can cause changes in air quality which would be significant and could compromise Class I designation for the Grand Canyon. The view of Navajo Mountain from Desert View in the park has been obscured by a brown haze on most days for five years. In fact, it is now unusual to see this mountain from viewpoints at Grand Canyon.

The national primary and secondary ambiant air quality standard for ozone is 0.12 parts per million (ppm) sampled over a 1-hour period. The city of Flagstaff, Arizona reached .09 ppm during 1980. The park is concerned that increasing ozone concentrations may be impacting tree seedlings and other vegetation on both the North and South Rims.

Resources management actions required include: (1) the identification of Grand Canyon National Park resources (AQRV's) that may be sensitive to air quality changes or existing pollution levels; (2) continued monitoring of visibility, sulphur dioxide, nitrogen oxide, ozone, particulate and acid precipitation levels within the park; (3) an analysis of existing and proposed emission sources, their pollutant composition and concentration; and emission levels that may affect park resources identified as AQRV's (Research will be needed to determine pollutant levels which will adversely affect AQRV's and identify "indicator species" which may be quickly and inexpensively monitored to measure changing air quality.); and (4) development of improved methods of forecasting weather conditions conducive to smoke dispersal and inversion breakup.

1. GRCA-N-2-AIR QUALITY MONITORING.

2. STATEMENT OF ISSUE OR PROBLEM:

Legislative and Administrative Constraints. The Clean Air Act as amended in 1977 was established by Congress after determination that the nation's air quality was rapidly deteriorating, and that Federal leadership and financial assistance were needed to cope with the problem. The stated purpose of the act is to protect and enhance the nation's air quality. The primary Federal responsibility is to provide technical and financial assistance to State and local governments, which have the responsibility to develop and execute air pollution prevention and control programs.

Section 118 of the Act indicates that all Federal facilities must comply with all Federal, State, interstate, and local requirements in the same manner and to the same extent as any non-governmental entity.

Part C of the Clean Air Act Amendments is entitled "Prevention of Significant Deterioration of Air Quality." Among the stated purposes of this section is the mandate "to preserve, protect and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreational, scenic, or historic value. . .."

As part of this preservation effort, the Clean Air Act Amendments created three classifications with varying degrees of restriction of allowable air quality deterioration. Under the terms of this classification Grand Canyon National Park was designated Class I. This is a mandatory designation, and may not be changed. Under this designation, the maximum allowable increase of particulate matter and sulfur dioxide has been established as follows:

Pollutant	Maximum allowable increase (micrograms per cubic meter)
Particulate matter:	
Annual geometric mean	5
Twenty-four hour maximum	10
Sulfur dioxide:	
Annual arithmetic mean	2
Twenty-four hour maximum	5
Three-hour maximum	25

Another stated goal of the Clean Air Act (Section 169A) is "the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I Federal areas in which impairment results from man-made air pollution." The EPA is in the process of determining methods and rules to accomplish this.

Section 165, paragraph (d)(2)(C)(ii) of the Clean Air Act reads as follows: "In any case where the Federal Land Manager demonstrates to the satisfaction of the State that the emissions from such (major emitting) facility will have an adverse impact on the air quality-related values (including visibility) of such lands, not withstanding the fact that the change in air quality resulting from emission from such facility will not cause or contribute to concentrations which exceed the maximum allowable increases for Class I area, a permit (for construction) shall not be issued."

Section 165 of the Clean Air Act also indicates that the National Park Service has an affirmative responsibility to protect the air quality related values of the park, and in the opinion of the Solicitor for the Department of the Interior, the park may be subject to civil litigation for failure to execute this responsibility.

Past Management History. Since 1965, a number of air quality monitoring projects have been initiated at Grand Canyon National Park. Some were pursued for only a short time, including the measuring of visibility from Yavapai Museum with a laser device and the monitoring of natural background radiation. Others have operated for longer periods. Between 1975 and 1978, the visibility perception of the view of Navajo Mountain from Desert View was recorded daily.

From 1969 to 1972, rainwater was collected at the Visitor's Center for pollutant analysis in cooperation with the National Weather Bureau. During 1980, rainwater was collected at Grand Canyon Clinic as a continuation of the weather bureau project.

From 1965 to 1979 a high volume particulate sampler and a chemical absorbtion "bubbler" (which tests for SO^2 and NO^2) operated near the Visitor Center; first running for 24 hours once every two weeks, then once every six days. The particulate sampler is still in operation.

In 1979, two high volume particulate samplers and a "bubbler" unit were established near Hopi Fire Tower on West Rim Drive.

In 1978 a telephotometer was established on the fire tower. Read three times a day, this device measures the photo-contrast of five selected targets. In order to correlate the telephotometer reading with actual visibility, photographs of three of these targets have been taken twice a day since the fall of 1979.

In 1979, a nephelometer was also established at Hopi Fire Tower. Recording constantly, it measured the amount of light scattered by airborne particles. This measurement was discontinued in late 1980 due to the difficulty of maintaining this piece of equipment.

Preliminary results of all of the above monitoring projects indicate that the air in the vicinity of Grand Canyon National Park is at present usually very clean and of exceptionally high quality, but is becoming increasingly impacted by man-caused pollutants from down-wind sources, including urban development and smelting operations.

During the summer of 1980, a Visibility Perception Study was initiated, investigating the visitors' perception of changes in the visual air quality in the park. This study used many of the photographs taken in conjunction with the telephotometer work. Preliminary interpretation of the results of this study indicates that American visitors are willing to pay the cost of maintaining the quality of air within the National Park.

Current Management Action. The current air quality management program monitors acidity and chemical composition of precipitation; ozone levels; visibility; and particulate levels of sulphur dioxide, nitrogen dioxide, lead, nitrates, sulphates, hydrocarbons, and dust. This program is being conducted in cooperation with the Environmental Protection Agency, the National Atmospheric Deposition Program, and State of Arizona Bureau of Air Quality. Cooperating agencies provide monitoring equipment, perform data analysis and incorporate findings into annual or monthly reports documenting pollution trends for the state and the nation. The information is used to establish standards for visibility and air quality for this Class I area, and to monitor air pollutants and eventually their effects on air quality related values at Grand Canyon.

3. Alternative Actions and Their Probable Impacts:

a. No Action. Discontinue the present monitoring program.

Impacts. If this program is discontinued it will result in the loss of data needed to: (1) establish air quality standards for the Grand Canyon as a designated Class I area; and (2) monitor changes in air quality. Information will not be available for use in national and statewide analysis of short and long-range pollution trends for acid rain, ozone, and other airborne pollutants. Without this monitoring program it would be difficult if not impossible to determine the degree of degradation in air quality at Grand Canyon caused by the development of new sources of pollution. The park would be unable to offer knowledgeable arguments against threats to air quality stemming from new power generating facilities or other sources of pollution.

b. Continue Present Management Action. The current monitoring program will continue to provide baseline information on visibility, levels of acid deposition, ozone concentrations, and other pollutants.

Impacts. Information derived from air quality monitoring is being used by the Environmental Protection Agency to establish air standards for the Grand Canyon and other Class I areas and to monitor changes in visibility and the concentration, composition, and origin of air pollutants. This information will also provide managers with

data needed for determining probable impacts of new pollutant sources. The information is also used by other State and Federal agencies as part of the data base in analyzing and predicting long and short-term trends in pollution levels.

4. Recommended Course of Action:

Continue the present air quality monitoring program. This program includes: (1) operation of an acid rain station; (2) operation of two high volume particulate samples; (3) a bubbler unit; (4) telephotometer readings three times per day accompanied by photographs taken twice daily; (5) operation of two membrane filter particulate samplers; and (6) continuous ozone samples taken during the summer months when concentrations peak.

NATURAL RESOURCES PROJECT STATEMENT

1. GRCA-N-14-Air Quality Monitoring, Air Quality Related Value Identification and Smoke Management.

2. Statement of Issue or Problem: Grand Canyon National Park has an affirmative responsibility to identify the Air Quality Related Values (AQRV's) of the park (an AQRV is a park resource, biotic or abiotic, that is affected by changes in air quality) and to protect those values from the negative impacts of air pollution. In the opinion of the Solicitor for the Department of the Interior, the park may be subject to civil litigation for failure to execute this responsibility. See GRCA-N-2 for legislative and administrative constraints. Intermittent air quality and visibility monitoring has addressed park values other than visibility. It is possible that park resources such as aquatic flora and fauna, terrestrial vegetation, soil micro fauna, etc., may be affected presently or in the future by sources of pollution located "upwind" of Grand Canyon National Park.

   The park is required to comply with all Federal, State, interstate, and local air pollution requirements. In order to comply with State of Arizona smoke management regulations and be successful in achieving the goals of the parks Fire Management Plan, the park must develop an adequate smoke management program. Research is needed to identify the effect of weather patterns over and air movement within Grand Canyon and its relationship to successful smoke management.

3. Alternative Actions and Their Probable Impacts

   A. No Action. The park would initiate no research to identify AQRV's, and no attempt would be made to research smoke dispersal models for the Grand Canyon.

      Impacts. If no research is initiated, park managers will (1) be unable to adequately assess the effects of pollutants on AQRV's because these values, with the exception of visibility, will remain unknown and the park will be unable to adequately formulate management designed to protect these park AQRV's, and (2) the successful implementation of the park Fire Management Program will be placed in jeopardy as a result of insufficient smoke dispersal information for Grand Canyon.

   4. Recommended Course of Action:

      Initiate research to inventory the parks AQRV's and prioritize the significance of those values.

      Install, collect, and analize data from three telemetry meteorological stations. Weather data will be gathered from within the canyon and on both rims and will provide the basis for a Grand Canyon complex terrain model for use in prediction and management of smoke dispersal.

NATURAL RESOURCES PROJECT STATEMENT

1. GRCA-N-21-Air Quality Monitoring - Air Quality Related Values, Sensitivity, and Smoke Dispersal.

2. Statement of Issue or Problem: Grand Canyon National Park has the responsibility for the protection of park resources identified as Air Quality Related Values (AQRV's) from the impacts of potential and existing air pollutants. Research is necessary to quantify the sensitivity of those values (Proposed for inventory under GRCA-N-14. See GRCA-N-2 for legislative and administrative constraints) to various air pollutants occurring at Certain frequencys and concentrations.

   With the results of GRCA-N-14 basic data will be available for the development of a complex terrain model for smoke dispersal and management at Grand Canyon. The development of such a model and its application at Grand Canyon is essential for the successful implementation of Grand Canyon's Fire Management Plan.

3. Alternative Actions and Their Probable Impacts:

   A. No Action. No research is initiated to identify the relationship between pollutant type, concentration and frequency and impacts to park AQRV's; no development of a Grand Canyon complex terrain and smoke dispersal model.

   Impacts. Without this research, park management will be unable to adequately assess the threat to park AQRV's from existing and proposed air pollution emitting facilities near Grand Canyon. Thus the park will be unable to protect these resources from possible negative impacts resulting from the effects of air pollution.

   Without an adequate complex terrain and smoke dispersal model, the park will be unable to effectively implement the Fire Management Plan.

4. Recommended Course of Action

   Research will be initiated to quantify the effects of air pollution on the parks AQRV's. Meteorological data and data on pollution source, concentration, type, frequency of occurrance and seasonal characteristics will be collected and analyzed through ongoing air quality monitoring (GRCA-N-14, N-21) which will examine the relationship between park values and possible harm from air pollution, and would address the potential for and extent of impact to the parks AQRV's resulting from air pollution at Grand Canyon. Ecological, geomorphogical, and meteorological relationships will be investigated in order to identify synergistic effects. Biological indicators of changes in air quality will be identified and tested.

   A smoke dispersal model for Grand Canyon will be developed based upon meteorological data collected through GRCA-N-14 and applied to the parks Fire Management Plan.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: Air Quality Monitoring and Research
(Includes Project Statement No's. N-2, N-14, and N-21)

ACCOMPLISHMENTS (IN Priority Order)	AMOUNT (In Thousands)
Fiscal Year 82	
Monitoring Actions: (N-2)	
- Continue Air Quality and Acid Rain Monitoring	3.0
- Analyze 58 Acid Rain Samples	.5
- Personnel	8.0
Total	11.5
Fiscal Year 83	
1. Monitoring Actions:	
- Continue Air Quality and Acid Rain Monitoring	3.0
- Analyze 58 Acid Rain Samples	.5
- Personnel	8.0
2. Resources Management Actions: (N-14)	
- Establish AQRV's	12.0
3. Research Actions: (N-21)	
- Develop Smoke Dispersal Model	60.0
Total	83.5
Fiscal Year 84	
Monitoring Actions:	
- Continue Air Quality and Acid Rain Monitoring	3.0
- Analyze 58 Acid Rain Samples	.5
- Personnel	18.9
- Identify biological indicators of air pollution and quantify their sensitivity and response (N-21)	15.0
- Complete AQRV survey (N-14)	12.0
- Continue Smoke Dispersal Modelling (N-21)	60.0
Total	109.4

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- Air Quality Monitoring and Research
(Includes Project Statement No's. N-2, N-14, and N-21)

ACCOMPLISHMENTS (IN Priority Order)	AMOUNT (In Thousands)
Fiscal Year 85	
Monitoring Actions:	
- Continue Air Quality and Acid Rain Monitoring	3.0
- Analyze 58 Acid Rain Samples	4.0
- Personnel	18.9
Total	25.9
Fiscal Year 86	
Monitoring Actions:	
- Continue Air Quality and Acid Rain Monitoring	3.0
- Analyze 58 Acid Rain Samples	4.0
- Personnel	18.9
Total	25.9

(3) Water Resources Management.

Backcountry water resources in the park, including the Colorado River, are continuously threatened by various organic and inorganic pollutants. The Colorado River, Kanab Creek, and Little Colorado River drainages originate outside the park, and are exposed to a variety of pollutant sources including pulp mills, mining operations, urban sewage, and uranium milling facilities. All are suspected of transporting industrial and urban pollutants into the Grand Canyon. In addition, a recent investigation of bottom sediments, sampled along the length of the Colorado River within the park, indicates unacceptably high levels of fecal coliform bacteria in many locations. Researchers suspect that these same sediments may also contain unknown levels of biocides, heavy metals and other waste products. Glen Canyon Dam flow levels and release patterns agitate the river bottom and bring such pollutants, usually trapped in bottom sediments, to the surface adjacent to river bank campsites where contaminated water may be used for drinking and domestic purposes by the river recreationists.

Heavy summer use of backcountry springs by hikers and wildlife, combined with limited water availability, creates a health hazard from contaminated water. Instances of hikers becoming ill from what are assumed to be water-borne diseases or other water contaminants occur annually. The park recommends that all backcountry water be treated before drinking.

Increasing visitation, combined with expanding industrial and energy development, raises the probability of water pollution problems within the Grand Canyon.

Broad edicts to "preserve and protect" the park water resources are contained in 16 U.S.C. 1; the park enabling legislation and the Grand Canyon Enlargement Act (P.L. 93-620). Further impetus toward improved water resources management is identified in specific documents including the National Park Service Management Policies, the General Management Plan, and the Natural and Cultural Resources Management Plan. Sections 208 and 303 of the Federal Water Pollution Control Act amendments and the Clean Water Act call for Federal land managers to insure future and present protection of the quality of waters within their areas. These legislative mandates also require Federal land managers to "comply as expeditiously as possible" with State water quality standards.

The park must develop and implement a Water Resources Management Plan which will provide managers with the data needed to assess the quality of backcountry waters and subsequently develop backcountry management plans to protect the health and safety of visitors to Grand Canyon's backcountry and river corridor, as well as provide managers with park-specific objectives for management of all water resources; specifically addressing floodplain management, water quality, water quantity, park ecosystems, and water rights issues as outlined in the Instruction for Preparation of Water Resources Management Plans, distributed to the park by the Regional Director's

memorandum of February 24, 1980. This document will be included as an addendum to the Natural and Cultural Resources Management Plan.

As an interim measure, a year-round monitoring program will be implemented to measure the bacteriological and chemical content of approximately 80 water sources including the Colorado River and its major tributaries. Tests performed will include measurement of: temperature, pH, dissolved oxygen, alkalinity, turbidity, nitrate, phosphate, and radionuclide levels. Chemical analyses will identify cations and anions present with emphasis on heavy metals. Fecal coliform and fecal streptococcus concentrations will be tested at surface and sediment levels. Selected backcountry water sources used by backcountry hikers will be tested four times per year at three month intervals.

1. GRCA-N-4- Backcountry Water Quality Monitoring.
GRCA-N-11 Backcountry Water Management Plan.

2. STATEMENT OF ISSUE OR PROBLEM: A coordinated parkwide study of the water resources of Grand Canyon National Park has never been completed. Section 208 of the Federal Water Pollution Control Acts Amendment of 1972 (Public Law 92-500), however, dictates that Federal areas are subject to State and local water quality regulations. The Northern Arizona Council of Governments has been concerned that hikers and inadequate sewage treatment facilities might be contaminating surface waters in the park. Thus, the council requested that the park begin a program to monitor water quality throughout its backcountry areas.

Past Management History. Between 1951 and 1979, at least 9 different groups of researchers collected water samples from the park for chemical analysis. Most of these samples were taken from the Colorado River and the mouths of its tributaries. While many of these water sources did not meet public health standards, especially for salts, there was no indication of pollution from human causes.

Between 1975 and 1979, three researchers tested park water for bacteriological content. The samples were usually of high quality. Isolated incidents of bacterial contamination, exceeding health standards for full or partial body contact, were usually the result of the suspension of contaminated bottom sediments by aquatic recreation, or an influx of contaminated sediments from storm runoff.

In 1979 the park, in cooperation with the Northern Arizona Council of Governments, developed a mutually acceptable program to monitor the quality of the park's backcountry water. Between April and September, 1979, approximately 30 backcountry water sources were tested on a regular basis for bacteriological content (usually every two to four weeks, depending on the site). Twenty of the sites were again tested once in August 1980. The sites tested included: (1) Red Canyon; (2) Bass Creek; (3) Hance Canyon Spring (eliminated as a sample site 4/17/79); (4) Cottonwood Creek; (5) Grapevine Creek; (6) Boulder Creek; (7) Cremation Canyon Spring; (8) Burro Springs; (9) Pipe Creek; (10) Garden Creek; (11) Salt Creek; (12) Cedar Spring; (13) Monument Creek; (14) Hermit Camp; (15) Hermit Creek; (16) Boucher Creek; (17) Clear Creek; (18) Cottonwood Camp; (19) the Transept; (20) Bright Angel Camp; (21) Long Creek Canyon; (22) Crystal Creek; (23) Slate Creek; (24) Sapphire Creek; (25) Turquoise Canyon; (26) Ruby Canyon; (27) Serpentine Canyon; (28) Shinumo Creek; (29) Dripping Springs; (30) Phantom Creek; (31) Santa Maria Springs; and (32) Cremation Creek.

These sites were selected based upon their accessibility and use by backcountry hikers. The samples were collected by helicopter, since it was necessary to ensure that specimens reached the South Rim in

time to be transported to the microbiology laboratory in Flagstaff within a six hour time limit. At the lab, the samples were cultured for total coliforms, fecal coliforms and fecal streptococci. Preliminary results indicate that most of the sites are usually free from bacterial contamination. Three sites exhibited a ratio of fecal coliform and fecal streptococcus during continued testing that suggested that human waste contamination might be occurring. These three sites are Cottonwood Creek, Monument Creek, and Serpentine Canyon. Three other sites exhibited an occasional high ratio. These sites were Boulder Creek, Cremation Canyon Spring and Cremation Creek. These latter sites were shallow, slow flowing and contained sediment at the time of sampling. This data indicates that, while park water is normally free of human contamination (with the exception of Garden Creek), isolated instances of contamination do occur.

In April 1979 the park began an inventory of its water resources. The locations of surface water sources in and around the central portion of the park (between lower Marble Canyon and Kanab Creek) were documented and information recorded concerning water flow, associated soil types, associated vegetation, etc. (see copy of Inventory Form in Figure 3). Data was gathered in the field and by searching relevant literature. All the water sources were then classified according to dependability, flow rate, use, water quality, etc. (See copy of Classification System in Figure 4). Of the 537 water sources documented, 57 were determined to be perennial.

During the summer of 1979 a bibliography of the park's water resources was prepared as part of the "208" project.

3. Alternative Actions and Their Probable Impacts:

a. No Action. This action would involve simply failing to implement either the biological analysis work or a water inventory program.

Impacts. The park will not comply with Section 208 of the Federal Water Pollution Control Act of 1972 (Public Law 92-500). Increasing numbers of backcountry visitors will be exposed to unknown levels of water pollution. A large portion of the park will remain uninventoried. The park will be unable to respond to threats concerning the quality of water resources.

b. Continue the Present Monitoring Program. This alternative involves the continuation of the park's three-phase water management program. The program includes: (1) The completion of the Water Resources Management Plan; (2) the continuation of periodic biological and chemical analysis; and (3) the implementation of a research project to determine biological indicators of water quality.

Impacts. The completion of the inventory and analysis work will allow the park to understand the nature of its water resources and monitor water quality trends through comparisons with baseline data. Water resources will be protected through timely management actions

intended to maintain the quality and quantity of naturally occurring water sources.

4. Recommended Course of Action:

To ensure the natural quality of backcountry water resources, the park needs to implement the three-phased management program. The Water Resources Management Plan will be completed in FY 1982. Testing of bacteriological and chemical parameters should be carried out quarterly. When chemical analysis work establishes yearly trends, this phase of the monitoring project should be reduced to sampling only once a year. Bacteriological analysis must continue quarterly to ensure that contamination from human backcountry use will not go undetected for long periods of time.

A research project identifying other biological indicators of water quality will enable the park staff to assess water resources without the need for costly laboratory analysis work. This project is intended to allow field staff to assess water quality, and make management recommendations to correct problem areas.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA-Backcountry Water Management Program
(Includes Project Statement No's. N-4 and N-11)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
1. Resources Management Actions:	
-Develop and Implement a Water Management Plan (N-11)	5.0
-Inventory Inner Canyon Water Sources (N-4)	35.0
2. Monitoring Actions:	
-Continue monitoring 80 inner canyon water sources for bacteria and chemical content	20.0
Total	60.0
2. Fiscal Year 83	
Monitoring Actions:	
-Continue monitoring backcountry water sources for bacteria and chemical content	20.0
	20.0
Total	
3. Fiscal Year 84	
Monitoring Actions:	
-Continue monitoring backcountry water sources for bacteria and chemical content	20.0
Total	20.0
4. Fiscal Year 85	
Monitoring Actions:	
-Continue monitoring of backcountry water sources for bacteria and chemical content	20.0
Total	20.0
5. Fiscal Year 86	
Monitoring Actions:	
-Continue monitoring of backcountry water sources for bacteria and chemical content	20.0
Total	20.0

Figure 3

GRAND CANYON NATIONAL PARK WATER RESOURCE INVENTORY

SITE No:_____
SITE LOCATION: _____ DATE:_____
_____ TIME: _____
ASPECT OF FLOW: SW S SE E NE N NW W NAME: _____
PHOTO: YES NO ELEVATION:_____ DATA SOURCE: _____

STREAM	Avg. depth	inches	site vegetation PROM HT COVER
SPRING	Width	inches	
SEEP	Flow rate	ft/sec	
WELL	Water temp. °F	°C	
	Relation to space: Cont.	Inter.	
	Deepest Pool	inches	
POTHOLE	Avg. depth	inches	
LAKE	Avg. diameter	inches	
TANK	Water temp. °F	°C	
CIENEGAS	# of potholes present		

SOIL: Formation (site)
Formation (source)
Drainage substrate:
%sand %gravel %rock

NOTES: (presence of salt, wildlife, sanitation problems, weather)

_____
E N
UMG/10: x

Site#: Card#: CFS:

CLASSIFICATION:

_____

DEFINITIONS:

Continuous: uninterrupted flow in space
Interrupted: alternating dry and wet stretches
Vegetation Prominence:
1- species not readily seen, possibly only 1 present
2- species readily observable, not uniformly distributed
3- species distributed uniformly, possibly co-dominant
4- species dominates its habitat
5- monoculture; single species dominates habitat

Height: (m)	Cover: (%)
1-1 to 0.1	1- 0 to 1
2- 0.1 to 0.5	2- 1 to 5
4- 2 to 5	4- 15 to 35
5- 5 to 10	5- 35 to 50
6- 10 to 20	6- 50 to 75
7- 20 to 35	7- 75 to 95
8- 35 and up	8- 95 and up

METHODS:

To calculate stream flow rate, place a wood chip in the center of stream flow, and time the footage traveled in seconds. This must be done at the SITE LOCATION described on the front of card and must be the same site at which depth and width are measured.

Figure 4

Proposed Water Resource Inventory Classification

```
10000     Perennial Water Source
20000     Intermittent Water Source
30000     Ephemeral Water Source
40000     Inactive Water Source (dry for at least 5 years)
     1000 Continuous Water Supply/Single Source
     2000 Continuous Water Supply/Multiple Source
     3000 Interrupted Water Supply/Single Source
     4000 Interrupted Water Supply/Multiple Source
     5000 Not Applicable (i.e. standing water source)
          100  Natural Water Source
            10 Flowing Water (  50 CFS)
            20 Flowing Water (  10 - 49 CFS)
            30 Flowing Water (  1 - 9.99 CFS)
            40 Flowing Water (  .1 - 0.99 CFS)
            50 Flowing Water (  .01 - .099 CFS)
            60 Flowing Water (  less than .01 CFS or 4.488 gpm)
            70 Pond/Lake (  .1 AC/FT or 4,356 ft3)
            80 Pothole (  .1 AC/FT)
            90 Playa Lake
          200  Man-Altered/Artificial Water Source
            10 Developed Spring
            20 Ditch
            30 Well
            40 Storage Tank
            50 Cistern
            60 Stock Tank
               1    more than 8 mi. to Next Perennial Source
               2    7 -  8 mi. to Next Perennial
               3    6 -  6.99 mi. to Next Perennial
               4    5 -  5.99 mi. to Next Perennial
               5    4 -  4.99 mi. to Next Perennial
               6    3 -  3.99 mi. to Next Perennial
               7    2 -  2.99 mi. to Next Perennial
               8    1 -  1.99 mi. to Next Perennial
               9    less than 1 mi to Next Perennial Source
                 .1 Endangered Plant Species
                 .2 Threatened Plant Species
                 .3 Endangered Animal Species
                 .4 Threatened Animal Species
                 .5 Does not Support Endangered or Threatened Species
                 .6 Insufficient Information Available on the Site
                    .01  Ceremonial/Religious
                    .02  Domestic Use, developed or undeveloped
                    .03  Recreational Use, Swimming, Bathing, & Drinking
                    .04  Agriculture and Livestock Use
                    .05  Fishing
                    .06  Aesthetics
                    .07  Outstanding Scientific Value
                    .08  Supports Riparian Vegetation
```

.09 Sediment Transport
- .001 Ceremonial/Religious
- .002 Domestic Use, developed or undeveloped
- .003 Recreational Use, Swimming & Bathing
- .004 Agriculture and Livestock Use
- .005 Fishing
- .006 Aesthetics
- .007 Outstanding Scientific Value
- .008 Supports Riparian Vegetation
- .009 Only One Main Use
  - .0001 Water Quality Problem (Public-health)
  - .0002 Water Quality Problem (non-Public health)
  - .0003 No Water Quality Problem
  - .0004 Insufficient Information Available on Site
    - .00001 Problem Source Outside Park
    - .00002 Problem Source Within Park
    - .00003 Problem Source Within & Outside Park
    - .00004 Problem Source Undefined
      - .000001 Biological Problem
      - .000002 Chemical Problem
      - .000003 Biological & Chemical Problem
      - .000004 Sedimentation Problem
      - .000005 Thermal Problem
      - .000006 Other Problem

b) THREATENED AND ENDANGERED SPECIES.

(1) Fish Management Plan.

The 1980 U.S. Fish and Wildlife Service List of Endangered and Threatened Wildlife and Plants lists the humpback chub (*Gila cypha*), the Colorado River squawfish (*Ptychocheilus lucius*), and the boney-tail chub (*Gila elegans*) as "endangered." The razorback sucker (*Xyrauchen texanus*), now rare in park waters, was recently proposed for placement on the list of "threatened" wildlife but was not granted this status.

Impoundment of the Colorado River by the Glen Canyon Dam, and subsequent unnatural releases of cold bottom water, has had a devastating effect on native fish populations, especially the *Gila* species. The ecological relationships of native fish species with the present river regime is largely unknown. Retention of the Little Colorado River tributary in its present natural state remains critical to the maintenance of remaining native species populations in the park.

Additional fish management problems arise from the popular sport fishery generated by the past stocking of non-native species, such as trout (*Salmo sp.*), directly into park waters and the current practice of stocking these fish in waters flowing into the park. In 1980, 150,000 fingerling trout were stocked into the river at Lees Ferry. Known and suspected impacts of sport fishing in the park include: direct destruction of native fish by fisherman and predation by introduced species including striped bass; possible competition between native and exotic fish for habitat and food; use of food items as bait; disturbance of stream side environment through trampling and digging for bait; and problems of fish-entrail disposal.

In response to these problems, the National Park Service in 1979 temporarily closed the confluence of the Colorado River and the Little Colorado River to all fishing as a protective measure for the humpback chub. In addition, a Fish Management Plan was prepared and is now ready for implementation. This plan includes a recommendation to develop special regulations to: (1) restrict fishing to the use of artificial lures or flies only; (2) allow the disposal of fish entrails directly into the Colorado River; and (3) permanently close the Little Colorado River area of the park to all fishing.

The park's intent to manage fish species and to resolve aquatic ecosystem problems through special regulation proposals was identified in the 1977 Natural Resources Management Plan and Environmental Assessment. This document was released for a 30-day public review period on November 15, 1977. A news release, circulated to 40 Regional, State, and local newspapers, invited public review and comment on this plan. Four hundred informational copies of the

document were mailed to various Federal and State agencies, plus organizations and individuals on the park's general mailing list. Since that time, the park has distributed an additional 400 documents to various groups and individuals interested in general resources management problems at Grand Canyon National Park. The fish management aspects of the Natural Resources Management Plan were discussed at a Northern Arizona Council of Governments, A-95 (Public Review) meeting held January 1978 at Flagstaff, Arizona and a multi-agency meeting held at the Grand Canyon in March 1978. The latter meeting was attended by representatives of: (1) Grand Canyon National Park; (2) Glen Canyon National Recreation Area; (3) the Arizona Game and Fish Department; (4) the U.S. Bureau of Reclamation; (5) the U.S. Fish and Wildlife Service (Office of Endangered Species); and (6) the Museum of Northern Arizona. The result of these meetings, plus other input from the public, indicated that the adoption of a fly-fishing only policy would have no real benefit toward the preservation of native fish species. Input from professional wildlife managers attending the March 1978 meeting, and comments received from the public, indicated that: (1) from an ecological standpoint, the best method of fishing waste-products disposal would be to place this material into the Colorado River; and (2) the adoption of an artificial lure policy would have the effect of allowing continued recreational fishing for trout while mitigating impacts on native wildlife species.

During this time, the park has received a total of ten letters and one petition responding to the fish management proposal identified in the 1977 Natural Resources Management Plan. Seven letters expressed concern that the park intended to "eliminate" trout from the park, and three persons were concerned with catch limits and fishing techniques (fly fishing versus bait fishing) currently allowed in the park. The petition, circulated in Flagstaff, opposed any proposal that would compromise the Colorado River trout fishery. This petition was signed by 85 persons.

Final special regulation proposals identified in the Fish Management Plan will be accompanied by separate environmental assessments which will be made available to the public. Management efforts for this resource problem will include the final implementation of the Fish Management Plan and the implementation of a Fish Ecology Study to determine the environmental needs of remaining native species.

NATURAL RESOURCES PROJECT STATEMENT *

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-10-Fish Management Plan.
GRCA-N-27-Fish Ecology Study.

3. STATEMENT OF PROBLEM: Presently, three native species of fish found in the park are on the U.S. Fish and Wildlife Service's list of endangered wildlife and plants. These are the humpback chub (*Gila cypha*), the Colorado River squawfish (*Ptychocheilus lucius*) and the bonytail chub (*Gila elegans*). The razorback sucker (*Xyrauchen texanus*) was proposed for placement on the list as a "threatened species", but it has been dropped from further consideration. The radical changes in the Colorado River ecosystem caused by Glen Canyon Dam have eliminated nearly all natural habitat and have resulted in the current critical condition of these populations. In addition, the past stocking of non-native species directly into park waters, and the current stocking into adjacent waters, has an unknown effect on these native fish species.

The stocking of non-native trout has also created a popular sports fishery with resultant impacts on the natural ecosystem. These impacts include: direct destruction of native species by fishermen and introduced fish; competition with native species for habitat and food; the use of roe as bait; the disturbance of the streamside environment through trampling and digging for bait; the building of check dams across side streams; and problems of fish entrail disposal.

4. WHAT HAS BEEN DONE: Basic population trends for the endangered species were determined as part of the Colorado River Research Project, completed in 1976. Management recommendations were made as part of this research. In 1978, consultation with the public and various State and Federal agencies was undertaken to explore options for the various fish management problems at Grand Canyon. In 1979, the confluence of the Little Colorado River with the mainstream was closed to all fishing. Further research was also deemed necessary, and some of this work is being pursued as part of an interagency Peaking Power Study to determine the impacts of increased power generation, and subsequent water flows, from Glen Canyon Dam.

The park has prepared a Fish Management Plan and has followed the standard procedures required in the implementation of such a document. The plan includes the following provisions:

The park will cooperate with other agencies in conducting fish research in the park, including the U.S. Fish and Wildlife Service and its study on the effects of Peaking Power proposals on the humpback chub.

A public education program will be implemented to explain to fishermen the need to protect native fish and to proper handling of fish returned to the water.

A regulation will be implemented to restrict fishing to the use of artificial lures or flies only.

Another regulation will allow the disposal of fish entrails into the Colorado River.

A third regulation will permanently close the Little Colorado River confluence to all fishing.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: The Fish Mangement Plan must be finalized and implemented. This includes the completion of the three-part special regulations package and the implementation of a Fish Ecology Study. The Fish Ecology Study is intended to quantify the numbers and habitat requirements of all remaining native fish and develop management recommendations to insure their existence in park waters. Whenever possible, this study will also assess the magnitude and significance of the impacts of increased water flows resulting from Bureau of Reclamation "Peaking Power" proposals.

   The finalization of the Fish Management Plan will be the responsibility of the park staff. The Fish Ecology Study will be contracted to qualified researchers through the offices of the NPS Cooperative Research Studies Unit.

6. LENGTH OF TIME NEEDED: The monitoring and management of fish populations is continuing. The Fish Ecology Study will require three years to complete.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: Pressures will continue on existing native fish populations, possibly resulting in their elimination from the park. The park will violate the 1973 Endangered Species Act.

8. WHAT ARE THE ALTERNATIVES:

   a. Do nothing.

   b. Arbitrarily limit numbers of non-native fish stocked in the Colorado River.

   c. Limit management actions to the Little Colorado River closure.

9. PERSONNEL: Research contractors and park staff.

10. ADMINISTRATION AND FUNDING:

FUNDING		YEAR IN PROGRAM SEQUENCE				
	F.Y.	82	83	84	85	86
Personnel Services		(to be handled through existing funds plus Increase No. 239)				
Other than Personnel Services		.5	.5	50.5	50.5	50.5
	TOTAL	.5	.5	50.5	50.5	50.5
Funds Available In Park Base		0	0	0	0	0
Funds Requested From Region		.5	.5	50.5	50.5	50.5

On Form	Date Submitted
10-237	September 1981

11. REFERENCES AND CONTACTS

a. Johnson, R. Roy, Unit Leader, Cooperative National Park Resources Studies Unit, University of Arizona, Tucson.

b. Walters, James E., Resources Management Specialist, Grand Canyon National Park.

c. Minckley, C.O. and Dean W. Blinn. 1976. Summer distribution and reproductive status of fish of the Colorado River in Grand Canyon National Park and vicinity. Colorado River Research Program Technical Report No. 14. U.S. Department of the Interior, National Park Service.

d. Suttkus, Royal D. and Glenn H. Clemmer. 1976. Survey of fishes, mammals and herpetofauna of Colorado River in Grand Canyon. 1976. Colorado River Research Program Technical Report No. 5. U.S. Department of the Interior, National Park Service.

e. May, Larry A., Chief, Division Resources Management, Grand Canyon National Park.

12. DATE OF SUBMISSION: September 1981.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: Fish Management Plan
(Includes Project Statement No's. N-10 and N-27)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Resources Management Actions:	
- Finalize Fish Management Plan and Special Regulations Package (N-10)	.5
- Continue Creel Census	
Total	.5
2. Fiscal Year 83	
Resources Management Actions:	
- Implement Fish Management Plan (N-27)	.5
- Continue Creel Census	
Total	.5
3. Fiscal Year 84	
1. Research Actions:	
- Develop and Implement Fish Ecology Study	50.0
2. Resources Management Actions:	
- Continue Creel Census	.5
Total	50.5
4. Fiscal Year 85	
1. Research Actions:	
- Continue Fish Ecology Study	50.0
2. Resources Management Actions:	
- Continue Creel Census	.5
Total	50.5
5. Fiscal Year 86	
1. Research Actions:	
- Continue Fish Ecology Study	50.0
2. Resources Management Actions:	
- Continue Creel Census	.5
Total	50.5

(2) Other Threatened and Endangered Species Projects.

(a) Identification of Threatened and Endangered Plant Habitats. Approximately 25 species of plants which are listed by the State of Arizona as "threatened or endangered" occur in the park; an additional five species may occur, judging from their known distribution. One species, the Brady pincushion cactus, (*Pediocatus bradyi*) is on the U.S. Fish and Wildlife Service list of endangered species. Ten additional species found in the park are presently being proposed for inclusion on this list. Little is known concerning the ecology of any of these plants. The park is therefore handicapped in its ability to manage these species and prevent impacts from human activity and development.

The action plan calls for the identification of habitat requirements and distribution of these plants, and the possible closure of all areas where visitor impacts may threaten the existence of these species in the park. Where species can exist in harmony with recreational use of the park, management will consist of close monitoring of these plants to alleviate potential threats.

(b) Status and Ecology of Peregrine Falcon and Golden Eagle Populations. The peregrine falcon (*Falco peregrinus*) currently on the U.S. Fish and Wildlife Service list of endangered species, is a rare permanent resident of the Grand Canyon. Pesticides have been attributed as a major cause of the decline of the bird throughout its range. The golden eagle (*Aguila chrysoetos*), protected under the Eagle Act of 1962 and amendments, is an uncommon permanent resident of the area. Large numbers of eagles migrate through the region in the fall. Population trends of eagles are unknown. Control measures were implemented prior to the establishment of the park, and incidents of illegal trapping and shooting continue to occur.

Little beyond the recording of sightings and nest locations has been accomplished concerning peregrine falcons and golden eagles in the park. Work proposed for the future will include a review of historical data and a literature search. Field studies will determine nesting density, breeding ecology, food preferences, seasonal movements, influx of migrants, sensitivity to disturbance by visitor use activities, and exact habitat requirements. Fledglings and adults will be tagged to reveal local movement patterns. When possible peregrine falcon body tissue, eggshells, and prey species should be tested for pesticide residues.

(c) Monitor Kaibab Squirrel Populations . The Kaibab squirrel (*Sciurus kaibabensis*) is an uncommon inhabitant of the Kaibab Plateau. This particular subspecies of the tufted-eared squirrel is found only on the Kaibab Plateau and is closely related to its more plentiful counterpart on the South Rim, the Abert squirrel. Its reclusive nature and limited geographic range account for the fact that it is seldom seen by visitors or by scientists. Because of

this, studies of the habitats and life history of this squirrel during the past 20 years have failed to reveal the reasons for its declining population.

While it is not listed on the U.S. Fish and Wildlife Service List of Endangered and Threatened Wildlife and Plants, the Kaibab squirrel is the subject of a continuing cooperative research program combining the efforts of the Arizona and Utah Game and Fish Departments, the U.S. Forest Service; the U.S. Fish and Wildlife Service, the National Park Service and the Bureau of Land Management. Through this study agreement, the National Park Service will continue a program of monitoring squirrel population trends on the North Rim. This work will involve a trap, mark, and release type survey and will continue until population stability is affirmed.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-23-Identification of Threatened/ Endangered Plant Habitats.

3. STATEMENT OF PROBLEM: Approximately 25 species of plants which are listed by the State of Arizona as threatened or endangered occur in the park. An additional five species may occur, judging from their known distribution. One species, the Brady pincushion cactus (*Pediocactus bradyi*), is presently on the U.S. Fish and Wildlife Service list of endangered species. Ten more plants, known to occur in the park, are being proposed for inclusion on this list. Beyond this knowledge of their existence (or possible existence) little is known concerning the habitat requirements and distribution of these plants within the park. More information is necessary to ensure the continued survival of these species, and to ensure that the park fire, backcountry, and grazing management programs are not adversely impacting these species.

4. WHAT HAS BEEN DONE: In 1980 and 1981, the Museum of Northern Arizona, under contract to the U.S. Fish and Wildlife Service, surveyed the park for the ten plants proposed for listing on the List of Endangered and Threatened Wildlife and Plants. Some information on habitat locations may be available through analysis of vegetation maps developed as part of the 4-year Resources Base Inventory Vegetation Mapping Project.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: Gather habitat and distribution information through the Resources Base Inventory (RBI) and independent studies and propose appropriate management action to ensure the survival of these plant species. Travertine deposits will be investigated in particular due to the unique flora they often contain. Management actions may include: elimination or instigation of controlled burning, water development, and area closures. All information will be integrated into the RBI.

6. LENGTH OF TIME NEEDED: Two years.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: The park will continue in its present inability to adequately protect these plants. Populations may receive adverse impacts and disappear.

8. WHAT ARE THE ALTERNATIVES:

   a. Do nothing.

9. PERSONNEL: RBI contractors and personnel from the Cooperative National Park Research Studies Unit at the University of Arizona in Tucson.

10. ADMINISTRATION AND LOGISTICS:

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	0	0	0	0	0
Other than Personnel Services	0	2	2	0	0
TOTAL	0	2	2	0	0
Funds Available in Park Base	0	0	0	0	0
Funds Requested from Regional Office	0	2	2	0	0

On Form		Date Submitted
10-237	[X]	March 1976
10-238	[ ]	(Also included in Increase No. 239)
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS

a. Johnson, R. Roy, Unit Leader, Cooperative National Park Resources Studies Unit, University of Arizona, Tucson.

b. Carothers, Steven W., Curator of Biology, Museum of Northern Arizona, Flagstaff, Arizona.

c. Fenn, Dennis, Regional Chief Scientist, National Park Service, San Francisco.

d. Walters, James E., and May, Larry A., Resources Management Division, Grand Canyon National Park.

12. DATE OF SUBMISSION: September 1981.

1. GRCA-N-28- Status and Ecology of Peregrine Falcon and Golden Eagle Populations.

2. Statement of Issue or Problem:

The peregrine falcon (*Falco peregrinus*) and golden eagle (*Aguila chrysaetos*) are uncommon permanent residents of Grand Canyon National Park. The peregrine falcon is protected under the Endangered Species Act of 1973; the golden eagle is protected under the Eagle Act of 1962. Under these laws, the National Park Service is required to be aware of the effects of proposed management action on the species; however, at the present time, very little is known about the population, habitat and ecology of these two raptors within Grand Canyon National Park. Studies in other areas have shown that population decline in some instances is caused by pesticides entering their food chain. Threats to the park's resident population may come from aircraft noise, poaching, and increased recreational use of the birds' habitat. In order for the park to respond to real and/or potential threats to these raptor populations, more information is needed on their numbers, and the ecological dynamics affecting them.

Past and Current Management Actions. A general study of the peregrine falcon in Grand Canyon was conducted by Dr. David Ellis of the U.S. Fish and Wildlife Service in the mid-1970's; the results of this study have not been readily available to park officials. A preliminary study has been done by the multi-agency Peregrine Falcon Recovery Team to determine the feasibility of recovering eggs from local nest sites to supplement their foster parents/captive breeding program.

Park biologists and management personnel have been compiling data on sightings and nest locations of both golden eagles and peregrine falcons within the park this past decade. A large amount of general information about both birds is currently available, along with detailed studies of their life cycle and habits, though no such studies exist for the local area of Grand Canyon National Park.

3. Alternative Actions and Their Probable Impacts:

a. No Action. The park will not make specific attempts to study the population dynamics or ecology of peregrine falcons or golden eagles. Most of what is known of these birds will continue to be of a general nature.

Impacts. If no action is taken, the population status and ecology of these two protected species will remain unknown. Without this baseline data it will be impossible to monitor population trends. The effects of park and outside agencies management actions on the raptor populations will remain unknown. Through ignorance, park management may allow or promote extinction of peregrine falcons and golden eagles from the park. The effects of human impacts such as aircraft

noise and recreational use of their preferred habitat will remain unknown. Park managers will not have the information they need to maintain and/or possibly restore native populations.

b. Initiate a Study of Eagle and Falcon Populations in the Grand Canyon Region. This alternative consists of several research actions. First, the thorough search for pertinent general information will be undertaken. Second, intensive field studies of both birds would be initiated at Grand Canyon. These studies will determine nesting density, breeding ecology, diet, seasonal movements, habitat requirements, and population dynamics for birds in Grand Canyon National Park and adjacent habitats.

Impacts. This action will be in compliance will all Federal laws including park protection of peregrine falcons and golden eagles. The presence of researchers studying the birds near their nesting sites will result in stressful conditions for the birds, possibly disrupting nesting. Increased aircraft noise near nesting sites associated with the study, may also cause some disturbance. Information resulting from the study will benefit both species by providing a greater understanding of their needs at Grand Canyon. Management decisions on actions possibly affecting the two species would be based upon the findings of this study. Subsequent monitoring action would establish population trends so that park managers could be kept advised of the birds' status.

4. Recommended Course of Action:

The park recommends the second alternative mentioned above. This alternative consists of two types of action. The first action is a literature research to obtain general life cycle information of the two raptors with field research to determine the specific population dynamics and ecology of the local population. The second action is a monitoring program, which would provide park managers with ongoing information about any changes in the status of either species. These research and monitoring efforts will provide the park with the information necessary to mitigate adverse impacts to raptor populations and, if appropriate, assist their recovery.

1. GRCA-N-40-Monitor Kaibab Squirrel Population Trends.

2. Statement of Issue or Problem:

The Kaibab squirrel,(*Sciurus aberti kaibabensis*) is found only in a restricted area of the ponderosa pine forest of the Kaibab Plateau in northern Arizona. This particular subspecies of the tufted-earred squirrel is found only on the Kaibab Plateau and is closely related to the more plentiful subspecies on the South Rim, the Abert squirrel. The squirrel is well known because of its beauty and because of its fame as an example of a species that developed as a result of isolation due to the creation of the Grand Canyon. At one time the animal was on the Federal list of threatened species. Later it was removed from the list. A population trend study conducted since 1960 indicates that the population is declining. The cause of this decline is unknown. A sharp drop in the squirrel population occurred in the winter of 1972. Since that time the animal is seldom seen and may be on the brink of extirpation from the park.

Past Management History. Since 1960, the population trends of the Kaibab squirrel in the park have been monitored annually by independent researchers and park personnel. In 1971, an interagency committee was formed including representatives of the National Park Service, U.S. Forest Service, Bureau of Land Management, Utah and Arizona Fish and Game representatives, and independent researchers. The committee meets once a year to pool research information. A considerable amount of research is being done on the Kaibab squirrel and the closely related Abert squirrel.

3. Alternatives and Their Probable Impacts:

a. No Action. No research or monitoring will be performed by the park.

Impacts. Park managers will have to rely on monitoring and research performed by other agencies for information on the status of the park's Kaibab squirrel population. The park would fail to meet commitments to the interagency committee. The park would not take affirmative action to protect this species and the animal may become extinct within the park from unknown causes.

4. Recommended Course of Action:

The Kaibab squirrel population in the park needs to be monitored each year to determine population trends. The ongoing annual population survey based on the number of terminal pine clusters the squirrels leave from their feeding on pine trees during the winter months should be continued. In addition, a trap, mark and release type survey should be instituted.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- Other Threatened/Endangered Species Projects (Includes Project Statements No's. N-23, N-28 and N-40)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Monitoring Actions:	
- Initiate Kaibab Squirrel Monitoring Project (N-40)	.3
Total	.3
2. Fiscal Year 83	
1. Research Actions:	
- Initiate E/T Plant Species Habitat Identification Study (N-23)	2.0
2. Monitoring Actions:	
- Continue Kaibab Squirrel Monitoring Project	.3
Total	2.3
3. Fiscal Year 84	
1. Research Actions:	
- Initiate Peregrine Falcon and Golden Eagle Status & Ecology Study (N-28)	10.0
- Continue E/T Plant Habitat Identification Study	2.0
2. Monitoring Actions:	
- Continue Kaibab Squirrel Monitoring	.3
Total	12.3
4. Fiscal Year 85	
1. Research Actions:	
- Complete Peregrine Falcon and Golden Eagle Status & Ecology Study	10.0
2. Monitoring Actions:	
- Continue Kaibab Squirrel Monitoring	.3
Total	10.3
5. Fiscal Year 86	
1. Research Actions:	
- Complete Peregrine Falcon and Golden Eagle Status & Ecology Study	10.0
2. Monitoring Actions:	
- Continue Kaibab Squirrel Monitoring	.3
Total	10.3

c) EXOTIC SPECIES AND DISEASE CONTROL.

(1) Feral Burro Impact Monitoring.

The Feral Burro Management and Ecosystem Restoration Plan was implemented in July 1980. Under the public live-removal program identified in this document, over 570 burros were removed from the Grand Canyon by September 1981. While it is the intention of the management plan to allow the public an opportunity to remove all burros from the park, it is also anticipated that a few (estimate 5 to 20) burros will elude live capture efforts and will need to be dispatched directly by NPS personnel.

The environmental impact statement accompanying the management plan quantified burro damage to park resources in terms of impact to vegetation, wildlife, and soils. Forty-one transects measuring impacts to vegetation, soils, and small mammals were established in three separate habitat types by private researchers under contract to the National Park Service. Comparative but qualitative data was also gathered concerning the interaction of burros with the park's population of desert bighorn and mule deer.

The re-reading of the impact transects to quantify the extent and rate of ecosystem recovery is intended as a mitigation measure for the implementation of the final management plan. This information is intended to measure the success of the park's own removal project and to provide data to other National Park Service areas experiencing problems with burros and other exotic species.

The management action for the burro problem followup will be: (1) re-read the vegetation, soil, and wildlife impact transects established during development of the burro management plan; (2) prepare a study design and initiate the study to quantify the bighorn response to feral burro removal; and (3) eliminate any stray burros left after termination of live-removal efforts. The park will contract research work to a qualified research institution and coordinate this work through the NPS Cooperative Research Studies Unit at the University of Arizona. The two-year project will quantify species diversity, frequency, and density at each transect site. Conclusions will be submitted in a final report at the end of the contract period.

Stray burros located in the park after live removal efforts have ceased will be located and destroyed by trained NPS personnel. It is expected that this program will continue over a period of six months until the last burro has been removed.

1. GRCA-N-5 -Feral Burro Management and Ecosystem Restoration Program.

2. Statement of Issue or Problem:

Statement of Condition. The park implemented its Feral Burro Management and Ecosystem Restoration Plan in the summer of 1980. The project ended September 1981 following the removal of approximately 570 burros. The completion of the public live removal portion of the program left approximately five to seven burros remaining in the park.

As a "mitigating measure" in the Environmental Impact Statement supporting the management plan, a resources recovery program was identified. Monitoring needs include the determination of the rate and extent of vegetation, soil, and small mammals recovery as well as the response of desert bighorn to feral burro removal.

Current Management Action. The park is currently conducting reconnaissance flights in an attempt to locate any remaining burros. This information will be used to finalize either public live removal efforts or the direct reduction efforts carried out by the National Park Service. While the park intends to offer the public every reasonable opportunity to find and remove all burros from the park, it is anticipated that some animals will remain regardless of live-removal efforts.

3. Alternative Actions and Their Probable Impacts:

a. No Action. This proposal would involve letting the remaining burros live and propagate at their will. This alternative would reverse the decision made in the Feral Burro Management and Ecosystem Restoration Plan Final Environmental Impact Statement. It also places the park in the same position it occupied in 1969 when a decision to stop controlling burros was made. Unlike the present situation, however, managers during that period thought they had rid the park of all burros, not realizing that a few animals remained in each herd area.

Impacts. The burros remaining in the park would reproduce at a rate of approximately 11% to 17% annually and repopulate all herd areas within 10 to 15 years. Recovery of park ecosystems would be reversed and the same damage described in the Final Environmental Impact Statement concerning the present management proposals would continue. Essentially, the park stands to repeat the entire burro management episode.

b. Fully Implement the Feral Burro Management and Ecosystem Plan. This alternative involves the final removal of burros by a public live-removal effort and/or shooting by NPS personnel, and the implementation of a three-year monitoring effort intended to evaluate

ecosystem recovery. Since final management decisions were made after the completion of the full National Environmental Policy Act (NEPA) process and full public involvement, the public live-removal and reduction projects will be implemented as written in those documents.

Impacts. All feral burros will be removed from Grand Canyon. Topographic barriers and boundary fencing will prevent their reintroduction. Soils, vegetation and native wildlife communities will begin to return to a natural condition. A study of this recovery will provide valuable knowledge applicable to many other areas with feral burro management problems. The probability of hikers contracting enteric diseases by drinking from contaminated water sources will decrease. Helicopter surveys of former burro ranges in remote areas of the park will disturb some backcountry users.

4. Recommended Course of Action:

Because of demonstrated environmental impacts and because all reasonable alternatives have been evaluated in a full environmental impact statement, the park will complete the public live removal and shooting programs to remove all burros from Grand Canyon and institute a two-year program to monitor resource recovery. Reduction work will be carried out by trained NPS personnel. Resource monitoring will be contracted to established research institutions.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- N - 5 - Feral Burro Management/Ecosystem Restoration Monitoring

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
1. Resources Management Actions:	
-Remove remaining burros by direct reduction	11.9
2. Research Actions:	
-Design and implement a bighorn recovery study	10.0
3. Monitoring Actions:	
-Re-examine Established Impact Transects	5.0
Total	26.9
2. Fiscal Year 83	
1. Resources Management Action:	
-Remove remaining burros by direct reduction	5.0
2. Research Action:	
-Continue Bighorn Recovery Study	10.0
3. Monitoring Actions:	
-Re-examine Established Impact Transects	5.0
Total	20.0
3. Fiscal Year 84	
Monitoring Actions:	
-Continue Bighorn Recovery Study	10.0
-Re-examine established Impact Transects	5.0
Total	15.0
4. Fiscal Year 85	
Monitoring Action:	
-Continue Bighorn Recovery Study	10.0
Total	10.0
5. Fiscal Year 86	
Monitoring Action:	
-Continue Bighorn Recovery Study	10.0
Total	10.0

(2) Insect and Disease Control.

(a) Forest Insect Disease Monitoring. The pinyon-juniper, ponderosa pine and mixed conifer forests of Grand Canyon National Park are hosts for several insect, fungal, bacterial, and parasitic plant species. Most infestations of these species occur naturally, slightly lowering productivity and contributing to the death of some trees. Occasionally population eruptions of these species will occur, and result in the death of a large number of trees.

Significant infestations of three insect species and one parasitic plant species, dwarf mistletoe (Phoradendron juniperinum), are currently occurring in Grand Canyon National Park and the adjacent Kaibab National Forest. Spruce budworm (Coristoneura occidentalis) infests approximately 30,000 acres of mixed conifer forest on the North Rim, and mountain pine beetle (Dendroctonus donderosae) infests most of the approximately 50,000 acres of ponderosa pine forest in this same area. The mountain pine beetle also occurs occasionally on the South Rim. Lesser infestations of pandora moth (Colorado pandora) on the North Rim, and dwarf mistletoe (Arceuthobium sp.) on both rims occasionally occur.

The objectives of forest insect and disease management on park lands differs considerably from those on lands administered by the U.S. Forest Service. As a natural phenomenon, the park prefers to allow these infestations to run their course without intervention. However, these infestations also occur on adjacent Kaibab National Forest lands. Since maintaining the maximum timber harvest is obviously an important part of multiple-use management of U.S. Forest Services lands, these insect infestations have led to problems in developing management solutions acceptable to both agencies. Where infestations have become severe, the U.S. Forest Service has proposed the initiation of active control measures, including in some cases aerial spraying of insecticides. The effectiveness of such spraying would be doubtful if park lands were not also treated. By design, insecticide spraying causes severe alterations of natural insect populations. Non-target species would be adversely affected by the interruption of a portion of the food chain, the introduction of pesticide residues, and direct mortality from acute toxicity. Therefore, the National Park Service has opposed some USFS insect management proposals.

To avoid the use of undesirable control measures within Grand Canyon National Park, the park must be able to assess the severity of insect and disease problems, and knowledgeably discuss possible control measures with the Kaibab National Forest. The Forest Service has conducted annual ground and aerial surveys of both USFS and NPS lands for insect infestations since the late 1960's. Periodic dwarf mistletoe surveys and control efforts have been conducted since 1949. Through monitoring programs on the Kaibab Plateau and elsewhere, the Forest Service has developed considerable expertise in the detection, monitoring, and control of forest insect and disease problems. The park has taken advantage of this expertise by participating in the

monitoring of park lands through financial support, by providing personnel for field surveys and by consulting with Kaibab National Forest personnel regarding the monitoring program and possible control measures. To protect its forest resources, the park must continue to obtain current information on forest insect and disease dynamics and to discuss the threats posed by those infestations, and possible control measures, with all agencies involved.

(b) Biocide Use Program. The protection of human health and property, and the park's native biota, necessitates the periodic use of chemical biocides. Within Grand Canyon National Park biocides are used, or proposed for use, to control several plant and animal pests. House flies, bed-bugs, cockroaches, silverfish, and small rodents can contaminate food, transmit disease, and degrade aesthetics in all areas of human and livestock habitation. In the past, these pest species have been controlled by the use of chemical sprays, poisoned bait and mechanical traps. On the North Rim, fleas from ground squirrels were found to carry relapsing fever after several visitors contracted the disease. The fleas were controlled through the use of insecticide spraying and the use of tick traps. Termite damage to wooden buildings in the park has been controlled by injecting insecticides under building foundations. Plants growing in cracks can hasten the deterioration of asphalt roadways, trails, and concrete sidewalks. Chemical herbicides are proposed for use to control these problem plants. A combination of mechanical and chemical measures will be used to control the spread of exotic species in the park.

In the past the park has reviewed proposals for biocide use and monitored applications to assure that all biocide use conforms with Department of Interior and Environmental Protection Agency (EPA) regulations. However, the park efforts fall short of a complete assessment of each pest problem. Such an assessment, including effectiveness, need, alternatives and potential for environmental contamination, would maximize the control of pest problems while minimizing environmental hazards. Some low level environmental contamination will occur whenever chemical biocides are used. This can be minimized through a comprehensive pest management program. A variety of solutions will be explored for each pest problem including tolerating the problem, mechanical control, biological control, and minimal chemical application. If chemical applications are necessary, the variety of biocides available will be examined to determine the treatment, or combination of treatments, most effective against the target species while causing a minimum of disruption to park ecosystems.

(c) Hazard Tree Program. Throughout the park, many trees or limbs damaged by insects, disease or visitors may become weakened to the point of hazard. Such defective trees or limbs become hazardous when their failure could result in damage to something of value, such as life and property. In order to protect life and property, in concert with the Federal Tort Claim Act of 1946, the National Park Service has a legal responsibility to discover and correct "unreasonable" dangerous conditions. Accordingly, the park staff will develop a Hazard Tree Action Plan.

Tree Hazard Risk Zones, hazardous trees and potential targets will be defined and documented, corrective action prescribed and then taken. Trees will be evaluated individually. Defects will be considered in relation to factors such as prevailing winds and vulnerability to windthrow, snow loads, location with respect to other trees, vigor, and distance and direction from a potential target. Our goal will be to preserve the greatest number of trees in recreation use areas consistent with safety requirements and due consideration for aesthetics.

1. GRCA-N-39-Forest Insect and Disease Monitoring.

2. Statement of Issue or Problem:

Statement of Condition. Approximately 210,000 acres of park lands are covered with ponderosa pine and mixed conifer forests. Recent infestations of several forest insects and diseases have occurred in the conifer forests of both the North and South rims. Spruce budworm (*Choristoneura occidentalis*) currently infest approximately 30,000 acres of mixed conifer forest on the North Rim and mountain pine beetle (*Dendroctonus ponderosae*) infest most of the approximately 50,000 acres of ponderosa pine forest in this same area. The mountain pine beetle also has limited occurrences on the South Rim. Lesser infestations of Pandora's moth (*Colorado pandora*) on the North Rim and dwarf mistletoe (*Arceuthobium sp.*) on both rims also occasionally occur.

Periodic infestations of forest insects and diseases occur naturally in the forests of the Kaibab Plateau. While loss of some trees can be expected, and indeed has occurred in the past from one, or a combination of these insects or diseases, the threat to park forest is not seen as critical by the National Park Service. These infestations are considered as "natural phenomenon." The Kaibab National Forest, however, is also experiencing infestations of these pests, and sees them as a very real threat to the timber production and scenic quality of the forest.

Since the late 1960's, when insect problems were first perceived as a problem on the Kaibab Plateau, annual aerial surveys have been made of park and forest lands in an effort to map and monitor major outbreaks of "detrimental" insects and/or diseases. Ground surveys were conducted by the park and U.S. Forest Service personnel until 1973. Some dwarf mistletoe (Phoradendron juniperinum) control work was conducted by the park on the South Rim from 1949 to 1973, but has since been discontinued. U.S. Forest Service personnel continue to periodically survey areas of mistletoe infestation. The last inspection was made in 1980.

The park's past participation in forest insect and disease monitoring has included; financial support to control infestations, limited personnel to assist in field monitoring, and consultation with Kaibab National Forest regarding the monitoring program and possible control measures.

Current Management Action. The park continues to participate in the forest insect test and disease monitoring program in cooperation with the U.S. Forest Service. This participation includes providing limited services and personnel for aerial and ground surveys, and liaison activities with Forest Service personnel concerning forest insect and disease management problems.

Results of Current Action. Through participation in this monitoring program, the park has remained aware of the extent and rate of spread of insect and disease infestations. This has allowed the park to accurately assess the potential threat to its forest and vegetation resources and provide timely and knowledgeable input into U.S. Forest Service proposals for controlling these infestations.

3. Alternative Actions and Their Probable Impacts:

a. Continue present management. Under this alternative, the park would continue its cooperation with the U.S. Forest Service in the current monitoring program. This includes taking advantage of special entomological expertise provided by the U.S. Forest Service at their Office of Forest Pest Species in Albuquerque, New Mexico.

Impacts. With current insect and disease population and trend information, the park will be able to make informed and timely decisions regarding possible control measures on park lands and provide valuable input toward decisions on U.S. Forest Service lands which might impact the National Park. Knowledge gained through this monitoring program will be useful in predicting the dynamics of future infestations in Grand Canyon National Park and other NPS areas.

b. No action. Under this alternative, the park will not monitor forest insects or diseases, nor participate with the U.S. Forest Service in such a program. As a natural occurrence, insect and disease infestations would simply be allowed to run their course unmonitored.

Impacts. Without participation in a monitoring program, park personnel would not be able to ascertain the extent of exotic or natural insect and disease infestations and what steps might be needed in managing potential insect problems. Despite the fact that some infestations might be natural occurrences, they may erupt to a point where major control effort is deemed necessary by either the National Park Service or U.S. Forest Service. Little data would be available to implement such a management program.

A lack of a cooperative effort with the U.S. Forest Service would also handicap the park's ability to cooperate with Forest Service efforts to control infestations on their own lands. In the past, proposed control efforts on U.S. Forest Service lands have had the potential of impacting natural resources in the National Park. Proposed spraying programs on U.S. Forest Service lands could have potential impacts on park insect populations and water quality. The disruption of natural balances of these resources could adversely affect the food chains of various park ecosystems. Active participation with the U.S. Forest Service in the past has avoided these kinds of conflicts.

c. Use NPS personnel for Monitoring. The park would begin a monitoring program independent of the U.S. Forest Service. This would allow the park to obtain and assess data without relying on U.S. Forest Service manpower or funding resources.

Impacts. A significant increase in expenditures would be expected as a trained entomologist would need to be brought in for ground and aerial surveys and data analyses. In fiscal year 1981, Kaibab National Forest allocated approximately $125,000 to forest insect pest and disease monitoring on the Kaibab Plateau including Grand Canyon National Park. Were the park to institute an independent monitoring program, costs for all work conducted in the National Park would have to be borne by the National Park Service.

4. Recommended Course of Action:

The park will continue to participate with the U.S. Forest Service in a cooperative forest insect and disease monitoring program. Data obtained from this monitoring effort will be used by the National Park Service to actively participate in management decisions made by the U.S. Forest Service in areas which might impact the National Park. Failure to implement a full cooperative program with the U.S. Forest Service would compromise the park's ability to influence control efforts when such actions are determined necessary by the National Park Service. This cooperative effort will include: assisting with logistical support where and when practical, maintaining an open line of communication with pertinent U.S. Forest Service offices, assisting with field data collections when practical, and working with the U.S. Forest Service during the management decision making process.

PROJECT TITLE: GRCA- N - 39 - Forest Insect and Disease Monitoring

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Monitoring Actions:	
- Continue participation in USFS monitoring program	.5
Total	.5
2. Fiscal Year 83	
Monitoring Actions:	
- Continue participation in USFS monitoring program	.5
Total	.5
3. Fiscal Year 84	
Monitoring Actions:	
- Continue participation in USFS monitoring program	.5
Total	.5
4. Fiscal Year 85	
Monitoring Actions:	
- Continue participation in USFS monitoring program	.5
Total	.5
5. Fiscal Year 86	
Monitoring Actions:	
- Continue participation in USFS monitoring program	.5
Total	.5

NATURAL RESOURCES PROJECT STATEMENT

1. GRCA-N-20-Biocide Use Program.

2. Statement of Issue or Problem:

Statement of Condition. A number of insect, mammal, and plant species present problem conditions requiring periodic or continuous control measures, including the use of biocides. This group includes: household insect pests, small rodents, ticks, termites, roadside weeds, and tamarisk.

Household insect pests, including house flies, cockroaches, bed bugs, and silver fish have the potential to transmit disease, contaminate food, and disturb the aesthetics of a park visit. These insects are present in almost every area of human or livestock habitation. Current control measures include the use of malathion at rim visitor facilities and Phantom Ranch, and the use of diazinon, pyrethrum powder, Ficam -W, and New Purge II in less frequented areas, including corrals, sheds, attics and shelves.

Small rodents consume and contaminate food, disturb aesthetics and potentially carry diseases. They also become nuisances in all areas of human habitation. In addition to improved food handling and mechanical traps, chemical rodenticides have been used to control mice and rats. The following rodenticides have been approved for use in the park: Diphacin 120 in concession buildings, mule barns, and the North Rim Lodge; Pitch Pack Tag-M in North Rim cabins; and Warfram bait in the South Rim school and concession houses.

In 1973 an outbreak of relapsing fever occurred among North Rim visitors. Soft-bodied ticks from rodents were tested by the Communicable Disease Center in Boulder, Colorado, and were found positive for the disease organism, *Borrelia hermsi*. A tick monitoring and control program was undertaken to prevent a reoccurrence of this problem. Areas in the North Rim Village frequented by rock squirrels and golden-mantled ground squirrels were sprayed with Baygon 1.5 and tick traps were placed in and around squirrel nests.

Most buildings in the park are constructed of wood, making them susceptible to termite damage. To protect these buildings, many of which have historic significance, Chlorodane has been injected under the building foundations.

Annual and perennial plants become troublesome when they grow in cracks in concrete and asphalt roadways and trails. Supplemental runoff from surfaced areas and limited competition creates a microenvironment where plants thrive. These plants cause a progressive widening of cracks in the asphalt and accelerate deterioration of the roadways necessitating frequent and expensive repairs. Plants growing in sidewalk cracks and expansion joints can cause shifting of the concrete sections and further cracking. These plants also create obstacles to walking on paved and concrete walkways and give the walks and trails a poorly maintained appearance. Hand clipping and grubbing has not been entirely

successful because of the substantial labor involved and the difficulty of removing roots. Limited use of the herbicide "Roundup" is proposed beginning in FY 82. The use of this herbicide, which kills the entire plant, should substantially reduce the damage caused by plant nuisance species and the amount and frequency of needed hand control.

Tamarisk is an exotic tree which grows vigorously along waterways. When the annual floods of the Colorado River were controlled by Glen Canyon Dam, tamarisk so completely colonized the beaches and gravel bars adjacent to the river that mechanical control is not feasible. To a lesser extent, tamarisk has begun to invade many of the tributary canyons within Grand Canyon. Past control efforts involving hand chopping of trees and treatment of the stumps with "Silvex" (active ingredient 2,4-D) to prevent regrowth, were confined to these tributary canyons. All use of herbicides containing 2,4-D has since been prohibited by the Environmental Protection Agency. Future control efforts will probably involve hand chopping followed by hand treatment of stumps with approved herbicides to prevent regrowth. Herbicides under consideration are "Tardon-RTU," "Garlon 3A", and "Garlon 4."

Current Management Action. The Division of Resources Management is responsible for reviewing all biocide use proposals in the park. When a division or concessioner proposes a pest control program, the Resources Management Division evalutes the necessity of the proposal and explores alternative control measures. If a control action is found to be necessary and involves the use of a biocide, a use application is submitted to the Washington Office through Western Region. If approval is granted, the Resources Management Division is responsible for keeping accurate records of actual biocide applications.

Results of Current Action. The use of chemical and non-chemical biocides has helped control many disease carrying organisms. This has created a safer environment for both visitors and residents at all rim facilities. Substantial economic benefits have been realized by the reduction of damage to buildings, sidewalks, roadways and trails by nuisance species. The environment has also been restored to a more natural condition by the partial removal of tamarisk.

Current restrictions governing biocide use in the park have been sufficient to prevent acute contamination of the environment. However, chronic contamination from long-term and/or improper biocide use is a very real possiblity.

Through ignorance of viable alternatives, or lack of manpower to fully explore these alternatives, some less desirable nuisance species management actions may have been implemented in the past.

3. Alternative Actions and Their Probable Impacts:

a. Continue Present Management. Biocide use proposals will be reviewed by the park for environmental impacts, necessity, effectiveness, and safety. If the review is favorable, a request will be submitted for biocide use. Accurate records of applications will be kept.

Impacts. The most serious nuisance species and/or threats to health, safety or property, will be adequately controlled. Where feasible, invading plant species will be controlled or will be eliminated.

Application of biocides will be carefully monitored by the National Park Service. Each proposal will be evaluated and approved if it is demonstrated to be effective against target species, and personal and environmental safeguards are adhered to. This will reduce, though not eliminate the possiblity of environmental contamination. Some low-level chronic contamination will occur as the result of any biocide use.

b. Augment the Present Action with a Comprehensive Nuisance Species Management Program. In addition to the review and regulatory measures identified in alternative 1, the park will make a more in-depth study of nuisance species management problems and explore a wider variety of possible solutions. Non-chemical treatments including tolerating the problem, mechanical control, and biological control will be explored for each problem. Application techniques will be examined and improved where possible. An effort will be made to find safer, more effective biocides.

Impacts. The most serious nuisance species will be controlled with a minimum of chemical application. A broader knowledge of nuisance species management may increase the feasibility of managing some exotic pest species (i.e., tamarisk). The opportunity for chemical contamination of the environment will be minimized though not eliminated.

The cost of using non-chemical or non-conventional control methods will probably increase over conventional methods.

c. No Action. The park will stop reviewing, monitoring or controlling biocide use.

Impacts: Concessioners, residents, and park divisions will use their own discretion in choosing a method of control and implementing a control effort. With less control of the biocide use program treatments can be expected to be less effective, sometimes excessive, and with a greater potential for spills and environmental contamination. Many non-target species may be directly or indirectly affected. Birds of prey may be particularly susceptible to contamination with biocides.

4. Recommended Course of Action: The augmentation of the present biocide management effort with a comprehensive management program will best assure effective control while minimizing hazards to the environment. Though some of the analysis may occur even if present management continues, a comprehensive management program will assure pest controls are accomplished in an efficient and safe manner. Implementation of a comprehensive nuisance species management plan will require an in-depth examination of all biocide alternatives.

The no action alternative is rejected as its potential for environmental contamination is unacceptable, and violates the intent of Environmental Protection Agency regulations and the policies of park management.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- N -20 - Biocide Use Program

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Resources Management Actions:	
- Initiate a Comprehensive Nuisance Species Management Program	.3
Total	.3
2. Fiscal Year 83	
Resources Management Actions:	
- Continue Comprehensive Nuisance Species Management Program	.3
Total	.3
3. Fiscal Year 84	
Resource Management Actions:	
- Continue Comprehensive Nuisance Species Management Program	.3
Total	.3
4. Fiscal Year 85	
Resources Management Actions:	
- Continue Comprehensive Nuisance Species Management Program	.3
Total	.3
5. Fiscal Year 86	
Resources Management	
- Continue Comprehensive Nuisance Species Management Program	.3
Total	.3

NATURAL RESOURCES PROJECT STATEMENT

1. GRCA-N-49- Hazard Tree Program:

2. Statment of Issue or Problem:
Statement of Condition. A large but unquantified number of trees in areas of concentrated visitor use on the North Rim, South Rim and the Inner Canyon have died and become snags, or have become defective due to insect or parasite infestation, fires, root or basal rot, frost checking, etc. Such trees which may cause property damage or loss of life should they fall are hazard trees. Each year the park has 4 to 10 accidents where limbs or entire trees fall and cause damage to NPS or visitor property. Presently, the park has no systematic procedure to follow in documenting hazards and averting disaster.

Current Management Action. The Resources Management and Visitor Services Divisions, in consultation with the park Safety Officer, are preparing a Hazard Tree Plan. The plan defines responsibilities, the need for hazard zone identification and staff training, types of hazardous conditions we are concerned about and procedures for documenting them.

Results of Current Action. The plan will provide basic guidance in hazard documentation and formulation of action plans to eliminate hazards that are severe. However, implementation of the plan must follow.

3. Alternative Actions and Their Probable Impacts:

A. Continue Present Management (No Action) Complete the Hazard Tree Management Plan, but do not implement the plan. Continue to respond after hazard tree incidents occurs, cleaning up debris, repairing picnic tables and on occasion administering first aid to injured visitors.

Impacts. The park will have 4 to 10 incidents of damage to property each year. Because overstory vegetation in the vicinity of campgrounds, established structures and along some powerline connectors is overmature, weakened, or subject to windthrow, the number of these incidents is expected to increase 10 to 30 percent annually. With these increases, there may be greater likelihood that incidents will cause loss of life or injury as well as damage to property.

B. Implement Hazard Tree Plan. Identify and document hazardous trees in all areas of intensive visitor use (in vicinity of North Rim, South Rim and Inner Canyon developments, campgrounds, roadways, picnic areas, etc.) and in the vicinity of NPS facilities (along secondary powerlines, vicinity of structures, parking lots, etc.). Remedial action should follow as soon as possible after hazards are documented. Remedial action can include any of a variety of actions varying from placement of

warning signs, moving vulnerable facilities (i.e., picnic table) a safe distance away, monitoring of marginally hazardous trees to be sure their risk of failure remains within acceptable limits, pruning dangerous limbs, stimulating tree vigor to felling extremely hazardous individual trees.

Impacts. Documented safety inspections on a regular basis and remedial action will reduce hazards to the public and to property. Tort claim costs will decrease significantly, often to the extent that the cost to perform tree hazard inspection and maintenance are offset (A court in Wyoming awarded over $43,000 for the death of a man in an NPS campground struck by a tree with obvious defects that failed in the absence of unusual weather conditions). Minor habitat loss and disruption to nutrient cycling processes will occur. It is not expected that impacts of major significance will occur as a result of hazard tree plan implementation. However, just as hazard must be evaluated on an individual tree basis, the impacts of hazard reduction will also have to take place on a case-by-case basis.

4. Recommended Course of Action: Complete Hazard Tree Management Plan and see that it is implemented. The Continue Present Management (No Action) alternative is rejected: we have a responsibility to act with reasonable care to discover and correct any unreasonably dangerous conditions on our lands or warn the visitor of the danger and risk involved in use of park lands.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA-N-49-Hazard Tree Program

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Resources Management Actions:	
- Complete Hazard Tree Plan	.5
- Equipment Purchase (harnesses, rope, saws, safety belts, etc.)	2.0
- Personnel	5.5
Total	8.0
2. Fiscal Year 83	
Equipment	.5
Personnel	5.5
Total	6.0
3. Fiscal Year 84	
Equipment	.5
Personnel	5.5
Total	6.0
4. Fiscal Year 85	
Equipment	.5
Personnel	5.5
Total	6.0
5. Fiscal Year 86	
Equipment	.5
Personnel	5.5
Total	6.0

(3) Control of Exotic and Nuisance Species.

The park is presently inhabitated by a variety of exotic and nuisance species in visitor use areas, residential areas, and backcountry locations. These organisms include both plant and animal species.

(a) Control of Nuisance Rock Squirrels and Skunks. Rock squirrels (*Spermophilus variegatus*) and skunks (*Mephitis mephitis*) are attracted by food and loose grain and congregate in abnormally large numbers at popular visitor use areas and residential areas throughout the park. This results in nuisance populations of squirrels and skunks which pose a potential public health hazard through the transmittal of diseases such as rabies, bubonic plague, and relapsing fever. During 1980 and 1981, the Arizona Public Health Service circulated warnings cautioning all persons that these diseases were endemic to native wildlife populations and could be easily transmitted through high populations of rodents and other mammals.

Plague has been found in the Arizona Strip just north of the park and near the town of Valle, 25 miles south of Grand Canyon Village. Several coyotes collected on the North Rim in 1973 were found to be "positive" carriers of plague-infected ticks and fleas. Fleas collected from North Rim rock squirrels every other year since 1973 have tested "negative." Rock squirrels collected from Indian Gardens and Phantom Ranch were tested in 1980 and 1981 and found to be negative carriers of bubonic plague. However, rock squirrels recently tested in areas to the south and east of the park have proven to be positive. Fleas from skunks have not been tested but pose potentially as serious a risk.

Future management actions for this problem will involve the continuation of past trapping programs intended to reduce high squirrel and skunk populations to "normal" levels at visitor use areas. Rangers and Division of Resources Management personnel will determine the need for, and the extent of, reduction operations on a case-by-case and year-to-year basis. Live trapped animals will be disposed of by humane methods only, i.e. shooting or asphyxiation of squirrels and possible relocation in the case of skunks.

The park will also undertake a project to monitor skunks in keeping with public health and nuisance considerations of these animals. As determined on a case by case basis, an approved chemical skunk repellent, available on the open market, may be used to remove skunks from various park buildings and visitor facilities.

(b) Control of Exotic Plants. Three main exotic plant species have established themselves in the Grand Canyon and significantly impacted the natural environment. These plants include: tamarisk, Russian olive, and camelthorn. Regardless of treatment applied, monitoring is required to assess control effectiveness and scheduling of maintenance followup.

Tamarisk: The introduction of the exotic tamarisk, or salt-cedar (*Tamarix sp.*), in various portions of the western and southwestern states has resulted in serious habitat alteration. While control of

this exotic plant along the Colorado River would be a massive and possibly an undesirable task, because of possible food chain links in today's riparian habitat, its elimination at isolated water sources and tributary streams is highly desirable. The tamarisk is capable of completely drying up small springs and seeps, thereby eliminating not only native plants, but bird and animal populations that are dependent upon stable water sources. Its encroachment upon tributary springs results in the ultimate usurpation and destruction of native habitat as evidenced by the area in and around Phantom Ranch.

The action plan for control of tamarisk will be to identify critical water sources and eradicate the plants by cutting them at ground level and applying an Environmental Protection Agency approved chemical treatment to the stumps. Smaller plants can be simply pulled up by hand. Plants encroaching upstream along the Colorado River tributaries will be treated accordingly. All treatment sites have not yet been defined, but they will emerge with the Resources Base Inventory study. It will not be the goal of the park to try to eliminate trees growing along the Colorado River.

Camelthorn: Camelthorn (*Alhagi camelorum*) is an introduced exotic from Middle Eastern countries which is invading many beaches along the Colorado River. The thorny nature of this plant, plus its crowding effect upon native plants, renders it an undesirable plant from both aesthetic and biological perspectives.

Management actions will include the encouragement of the physical removal of plants by boating parties using the beaches. Further action by National Park Service personnel will involve both physical removal at campsites, and possibly herbicidal treatment of individual plants located away from the beaches. A suitable herbicide has not yet been identified. Complete removal of the species from the park would be ideal. However, a strict maintenance program is more realistic.

Russian-olive: Because of its dense growing nature, introduction of the Russian-olive (*Elaeagnus angustifolia*) has the effect of replacing native plant species wherever it grows. Only recently has it demonstrated this capacity to crowd, but individual plants are observed to be spreading along higher elevations of the park. Particular problem areas include stands along the Colorado River below Lees Ferry and individual trees growing along the South Rim roadways.

The management of this problem will involve the cutting of individual plants wherever they are found. Possible treatment with a suitable herbicide or perhaps prescribed fire will be undertaken if it is shown to prevent regrowth.

(c) Control of Feral Dogs and Cats. Feral dogs and cats commonly roam park residential areas and are suspected of radically impacting the populations of native wildlife in these areas. While no technical data exist, the park staff does note fewer observations of

deer, small mammals, and reptiles in wooded areas near residential sites.

While a few of these feral dogs and cats are the escaped pets of park visitors, most feral animals in the park belong to park residents. Pets are noted to be deliberately allowed to roam free by some concessioner and NPS employees. An estimated 10 to 20 dogs and 50 to 75 cats are roaming free in the park at any given time.

The park will implement an accelerated control program involving the trapping and removing of all unclaimed animals through implementation of a more stringent pet policy. In recognition of the probable adverse impacts caused by these animals, <u>any</u> free roaming pet in the park will be considered as "feral."

(d) <u>Control of Exotic Birds</u>. English sparrows, pigeons, and starlings are increasingly common around concession and NPS stock use areas. These species adjust well to man-made structures and find a ready food supply from livestock feed and manure piles. Problems with these species arise when they compete with native bird species for available food and habitat space. Both the English sparrow and the starling are known to usurp less aggressive native birds when competing for available nest sites. These exotics also enjoy the advantage of being able to utilize the relatively coarse food items comprising livestock feeds whereas native wildlife species cannot.

The management action for this problem will involve the continued control of pest species by destroying nest sites and disposing of individuals as they appear. This program will be particularly effective in more remote areas of the park such as Phantom Ranch, Cottonwood, Indian Gardens, and other areas where exotic species have only recently gained a foothold. Established populations on the North and South Rims will require a more concerted effort of destroying nesting sites and limiting available food in living sites when those actions will not adversely affect native species. This program will especially include concessioner and NPS stable areas.

1. GRCA-N-32-Control of Nuisance Rock Squirrels and Skunks.

2. Statement of Issue or Problem:

Because of an abundance of food items at rim attraction sites, campgrounds, stables, and residential areas the populations of rock squirrels (*Spermophilus variegatus*) and skunks (*Mephitis mephitis*) periodically reach artificially high levels. With squirrels these populations can reach concentrations of 40 to 50 animals per acre as compared with normal densities of 2 to 3 squirrels per acre. The high population levels have resulted in: (1) an increased threat to human health and safety through the possible contact with disease organisms; (2) an increase in the number of incidents of bites and scratches and the damage of camping gear by squirrels and skunks foraging for food; (3) stress to the populations themselves, as animals are forced to exist in crowded conditions without a proper supply of natural food items; and (4) offensive conditions created by garbage can raids and animal refuse in public places.

In 1973, as a result of a small epidemic of relapsing fever (*Treponemataceae borrelia*) among North Rim visitors, the U.S. Public Health Service began a program of testing soft-bodied ticks, commonly found on small mammals, for this disease. Several of the small mammals tested proved to be carriers of relapsing fever.

During 1981 the Arizona Department of Public Health found bubonic plague organisms (*Yersinia pestis*) in small mammal species on the Arizona Strip (north of the canyon) and near the town of Valle (south of the canyon). The same year the park submitted blood samples from 100 rock squirrels from Indian Gardens and Phantom Ranch for testing for the plague virus. None of these samples proved positive, but the Arizona Department of Public Health has requested further sampling and has cautioned Federal and State agencies to monitor this disease problem. Skunks are also considered potential plague carriers.

The increase of squirrels at rim facilities and backcountry campsites has resulted in an increased number of the incidents of bites and scratches from these animals. Although the Grand Canyon Clinic documented 38 bite and scratch incidents in 1980, the majority of such incidents go unreported. Over 30 complaints concerning damaged hiking and camping gear were submitted during this same year. It is suspected that a considerable number of other incidents go unreported.

Current Management Actions. Because the above problems were evident at Phantom Ranch and Indian Gardens, an interim squirrel reduction program was implemented in 1980. Approximately 100 rock squirrels were captured and destroyed by National Park Service personnel. Sex and ages of all these animals were recorded, and blood samples were submitted for disease analysis.

The population was reduced to a "normal" level as estimated by area managers. The immediate result of this action was a cessation of nuisance incidents and the establishment of basic information concerning the disease status of these animals. In addition to the direct reduction effort, a program of visitor education and food source elimination was implemented. This included the installation of backpack tie-bars and the stringent enforcement of regulations prohibiting feeding of the squirrels.

Current management actions involving skunks have included removing individual animals on a case by case basis. Except in instances where the animal was injured during the removal process, the skunks were relocated to areas on the South Rim, but distant from the Village area.

3. Alternative Actions and Their Probable Impacts:

a. No Action. Under this alternative, squirrels and skunks would be allowed to propagate until natural control factors, most likely diseases, begin to take effect. It has been demonstrated by past observations that natural predators are unable to control rock squirrel populations at any of the problem sites. It is estimated that natural control processes would be implemented only after squirrel and skunk populations have reached extreme proportions.

Impacts. The number of squirrels and skunks at rim and inner canyon visitor sites will increase each year. Vegetation and soil resources at Phantom Ranch, Cottonwood Camp, and Indian Gardens would be impacted by the excess population of squirrels and skunks foraging for food and digging shelters. Soils impacted by vegetation removal and burrow "construction" and collapse would become susceptible to accelerated wind and water erosion. An estimated 12 acres of park vegetation and soils would be affected.

Incidents of equipment damage and bites and scratches from squirrels and skunks would increase at all sites. At the same time, the public would be exposed to an increased disease threat caused by high populations of both squirrels and skunks. The health of both these animals may be adversely impacted by high population numbers. While no exact physiological data is available, both these animals appear malnourished and generally stressed (haggard) during high population periods.

b. Control Squirrel and Skunk Populations by Direct Reduction. This alternative would involve the continuation of past trapping and killing projects. Rangers and Resources Management Division personnel would determine the need for, and the extent of, reduction operations on a case-by-case and year-to-year basis. Live trapped animals would be disposed by humane methods only, i.e. shooting or asphixiation. Carcasses would be disposed of by burying or by being hauled out during routine trash and sewage disposal operations.

Impacts. Environmental impacts of this alternative include the adverse aesthetic impacts associated with the killing of park wildlife and impacts to the squirrel and skunk populations. Persons opposed to any form of killing would be offended by the proposal implementation. Persons recognizing the need for a practical, economically feasible way of controlling squirrel and skunk populations would support the proposal.

Since the intent of the reduction is only to lower squirrel and skunk numbers to natural levels, there will be no long-term impacts on this mammal species. An estimated 30 to 40 squirrels will need to be removed from the park annually during high population years.

c. Relocate Excess Squirrel and Skunk Populations. This alternative involves the live trapping and relocating of nuisance squirrels and skunks to other locations within the park.

Impacts: Vegetation and soil resources within the areas of high squirrel populations would be spared the process of denuding and erosion caused by excess animals.

The park would need to carefully consider the impacts of relocating either of these animals. Most areas of the park already have resident populations of rock squirrels and skunks in ecological balance with their physical environment. The introduction of even small numbers of squirrels and skunks relocated from other areas of the park may have the effect of upsetting this balance.

The transporting of one population of squirrels and skunks into another area may also have the effect of irrevocably mixing natural gene pools created by natural behavioral or physical barriers. The greatest problem would occur where animals would be transported across the Colorado River.

d. Remove Food Sources. This alternative would involve an attempt by the park to eliminate all artificial food sources for the squirrels and skunks. This would include a program of totally eliminating livestock feed supplies, removing access to concession garbage, preventing illegal feeding, and eliminating all other unnatural sources of food for the animals.

Impacts. Since it has been shown to be nearly impossible to prevent at least some spillage of stock feed at mule corrals, the elimination of this food source would require the elimination of mules from the inner canyon area. This would deprive the visiting public of the aesthetic pleasures associated with riding a mule into the Grand Canyon. Also, mules are used almost exclusively for transport of supplies and refuse to populated areas of the inner canyon, i.e., Phantom Ranch, Indian Gardens.

Since the park is now making an active effort to eliminate all other artificial food sources, and the problem still persists, an accelerated program of control would create a decrease in the social environ-

ment of the National Park by the stricter enforcement of existing rules. Limited manpower would be directed towards policing unlawful feeding activities and would therefore lessen the time NPS personnel could spend on other visitor activities, i.e. interpretation and visitor protection.

4. Recommended Course of Action:

The park recommends the management action of controlling rock squirrels by direct reduction, and the live removal (if possible) of skunks on a case by case basis, as the best course of action for this problem. This recommendation is based upon a consideration of the ecological, economical, and practical aspects of this problem. The decision also appraises the realities of present visitor use patterns in the park and the probability of changing these use patterns to accommodate the scope and nature of the rock squirrel and skunk problem.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-33-Control of Exotic Plants. (Tamarisk, Camelthorn, Russian-olive)

3. STATEMENT OF THE PROBLEM: The above species of exotic plants are replacing native species, drying water sources, eliminating beach camping, and changing native habitat.

4. WHAT HAS BEEN DONE: The park has attempted control of camelthorn through the use of volunteer high school students hand grubbing the plants. Tamarisk control was attempted in one small drainage in the inner canyon (Phantom Creek) in the spring of 1979 by similar methods. Neither effort met with significant success.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: Individual tamarisk plants at critical water sources, camelthorn along Colorado River beaches, and Russian-olive plants will be hand cut or grubbed and treated with an appropriate, approved herbicide.

6. LENGTH OF TIME NEEDED: 5 years (continuing).

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: Exotic plants will continue to alter the park's native ecosystem. Water holes critical to wildlife will dry through the invasion of tamarisk. Colorado River beaches will continue to be rendered unusable through invasion of camelthorn.

8. WHAT ARE THE ALTERNATIVES:

   a. Do nothing.

9. PERSONNEL: Existing park staff and volunteers.

10. ADMINISTRATION AND LOGISTICS:

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	0	0	0	0	0
Other than Personnel Services	.5	.5	.5	.5	.5
TOTAL	$.5	.5	.5	.5	.5
Funds Available in Park Base	0	0	0	0	0
Funds Requested from Regional Office	$.5	.5	.5	.5	.5

On Form		Date Submitted
10-237	[X]	October 1976
10-238	[ ]	(Program to be supported by Increase Nos. 162 and 239).
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS:

a. Johnson, R. Roy, Unit Leader, Cooperative National Park Research Studies Unit, University of Arizona, Tucson.

b. Walters, James E. and Larry A. May, Division Resources Management, Grand Canyon National Park.

12. DATE OF SUBMISSION: September 1981.

1. GRCA-N-34-Control of Feral Dogs and Cats.

2. Statement of Issue or Problem:

Feral dogs and cats, as well as those allowed to run loose, cause a presently unknown impact on native wildlife in the park. Little or no control is exercised against these animals at this time.

Past Management History: Park regulations and enforcement procedures regarding pets have been established. Residents and visitors are permitted to keep pets, but these animals must always be under physical restraint when outdoors, and must never be left unattended.

3. Alternatives and Their Probable Impacts:

a. No action. No attempt would be made to control feral animals in the park.

Impacts. Impacts on native wildlife in and around the park's developed areas will continue. Grand Canyon will stand in violation of feral animal policies developed by the National Park Service.

b. Eliminate pets from the park.

Impacts. Visitors would be inconvenienced by such strict regulations. This regulation would be costly and difficult to enforce.

4. Recommended Course of Action:
Implement an intensive program of trapping and removal of unclaimed dogs and cats in conjunction with the enforcement of present policies. An intensive program of public relations and pet control measures will be directed toward all park visitors and residents.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-48-Control of Exotic Birds

3. STATEMENT OF PROBLEM: Exotic bird species (house sparrows, pigeons, and starlings) are invading all areas of the park and are competing with native species for feeding, nesting, and roosting sites. Visitor and stock facilities provide artificial food and habitat beneficial to these exotics. Control measures are needed.

4. WHAT HAS BEEN DONE: Some trapping and netting of house sparrows (followed by destruction) has been done in the village and at Phantom Ranch. Success was limited, due largely to the sporadic nature of the effort.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: Control exotic bird species populations by nest destruction and direct reduction by shooting and trapping.

6. LENGTH OF TIME NEEDED: 5 years (continuing).

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: Populations of these exotics will continue to increase and compete with native species. The park will stand in violation of exotic animal edicts in the 1978 Management Policies handbook.

8. WHAT ARE THE ALTERNATIVES:

   a. Do nothing.

   b. Trap and remove these pest species.

9. PERSONNEL: Existing park staff.

10. ADMINISTRATION AND LOGISTICS:

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	(Project to be conducted within existing budget)				
Other than Personnel Services	.1	.1	.1	.1	.1
TOTAL	.1	.1	.1	.1	.1
Funds Available in Park Base	0	0	0	0	0
Funds Requested from Regional Office	.1	.1	.1	.1	.1

On Form	Date Submitted
10-237 [X]	October 1976
10-238 [ ]	(Program to be supported by Increase No. 239)
10-250 [ ]	
10-451 [ ]	

11. REFERENCES AND CONTACTS:

a. Walters, James E., Resources Management Specialist, Grand Canyon National Park.

12. DATE OF SUBMISSION: August 1981

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: Control of Exotic and Nuisance Species
(Project Statement No's. N-32, N-33, N-34 and N-48)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Resources Management Actions:	
- Control of Exotic Plants (N-33)	.5
- Control of Nusiance Rock Squirrels, and Skunks (N-32)	.5
- Control of Feral Dogs and Cats (N-34)	.2
- Control of Exotic Birds (N-48)	.1
Total	1.3
2. Fiscal Year 83	
Resources Management Actions:	
- Control of Exotic Plants	.5
- Control of Nusiance Rock Squirrels and Skunks	.5
- Control of Feral Dogs and Cats	.2
- Control of Exotic Birds	.1
Total	1.3
3. Fiscal Year 84	
Resources Management Actions:	
- Control of Exotic Plants	.5
- Control of Nusiance Rock Squirrels and Skunks	.5
- Control of Feral Dogs and Cats	.2
- Control of Exotic Birds	.1
Total	1.3
4. Fiscal Year 85	
Resources Management Actions:	
- Control of Exotic Plants	.5
- Control of Nusiance Rock Squirrels and Skunks	.5
- Control of Feral Dogs and Cats	.2
- Control of Exotic Birds	.1
Total	1.3
5. Fiscal Year 86	
Resources Management Actions	
- Control of Exotic Plants	.5
- Control of Nusiance Rock Squirrels and Skunks	.5
- Control of Feral Dogs and Cats	.2
- Control of Exotic Birds	.1
Total	1.3

d) Human Use and Carrying Capacity.

(1) Colorado River Use and Impact Monitoring.

Glen Canyon Dam, located above the upper end of Grand Canyon, was completed in 1963. Hoover Dam, built in 1935, is at the western boundary of the Grand Canyon. These dams have resulted in changes to the Colorado River and riparian habitat in Grand Canyon National Park including: reduction in river sediment load and water temperatures; more rapid and frequent fluctuations in river levels; increases in the severity of rapids; and changes to the ecology of the riparian and aquatic flora and fauna associated with the Colorado River. In addition to changes caused by the dams, recreational use of the river has increased dramatically (from 547 individuals in 1965 to more than 17,000 individuals in 1981). This increase has resulted in deterioration of the cultural and natural resources found along the Colorado River including: destruction and vandalism of cultural resource artifacts; soil compaction and erosion; loss of and damage to riparian vegetation; distruption of wildlife; accumulation of trash, charcoal, and human feces; and lowering of river and tributary water quality.

The Colorado River Management Plan states that the goals for management of the Colorado River in the Grand Canyon will be to ". . . perpetuate the wilderness river running experience and to attempt to mitigate the influences of man's manipulation of the river", and to protect the riparian ecosystem through careful management of river use. Quantitative data are needed to: (1) identify the critical elements of the river corridor's aquatic, riparian resources; (2) identify their sensitivity to visitor use and changes in those elements acceptible to management; (3) identify trends in impacts to these resources; (4) identify trends in recreational use of the river; (5) take management action to mitigate or eliminate adverse impacts to cultural and natural resources and improve conditions for recreational enjoyment; and (6) to assess whether changes are needed in the program design to increase its effectiveness and management utility.

From 1973 to 1976 the Colorado River Research Program sponsored research to identify the basic resource elements (ecological and recreational) of the river corridor. The results of this research guided the development of the 1980 Colorado River Management Plan and Draft Environmental Impact Statement. This plan directs the management of the river resources and governs: (1) the level of recreational use on the river; (2) river trip launch schedules; and (3) the management of cultural and natural resources along the river. The plan calls for a monitoring program to measure the success of management efforts in accomplishing the goals of resource protection while providing for recreational enjoyment of the river. Specifically, the monitoring program is designed to analyze and quantify impacts caused by visitor use and to predict impacts to natural and cultural resources and recreational use caused by changes in management policy, recreational use levels, and boat launch schedules.

The Colorado River Monitoring Program is in direct response to the park's need to comply with: the NPS Organic Act (1916), which calls for the conservation of the park's natural values and the enjoyment of those values; Executive Order 11987, restricting the introduction of exotic species into natural areas; the 1973 Endangered Species Act requiring the park to ensure that its management activities do not jeopardize threatened or endangered species or their habitats; and the 1975 Grand Canyon Enlargement Act (P.L. 93-620), which recognizes that the entire Grand Canyon, including tributary side canyons, is of national and international significance and that further protection is in accordance with its true significance.

1. GRCA-N-1- Colorado River Use and Impact Monitoring.

2. Statement of Issue or Problem:

As identified in the Colorado River Management Plan and Environmental Impact Statement, future research and monitoring are needed to measure the ecological responses brought about by changing management procedures and environmental conditions, and to measure the effects of management actions on visitor satisfaction. The aim of the Colorado River Use and Impact Monitoring Project will be to continue to monitor impacts to the river related resources. Resource alterations could take place over a period of sustained use (15 to 20 years) are unknown and can only be determined by careful and consistent monitoring of the system.

The monitoring effort is viewed as a long term project to be carried out by park staff as well as by research contractors. Work involves: determining impacts on vegetation, wildlife and soils; mapping of study sites; digitizing of site photographs to determine changes in vegetative cover and increases in surface disturbance; point-quarter sampling to detect changes in the presence of litter, human feces, charcoal accumulations, vegetation damage, trail frequency and frequency of red ant hills; analysis of recreational use at selected river camp and attraction sites; monitoring of water quality trends; and monitoring of damage to archaeological sites along the river.

The results of the monitoring effort will be summarized annually to provide management with a continuing picture of river resource and recreational trends.

3. Alternative Actions and Their Probable Impacts:

a. No action. The park will make no effort to monitor trends in use and impacts occurring in the river corridor. Necessary research will not take place.

Impacts. Human impacts such as trailing and loss of soil, congestion and crowding at beaches and attraction sites, the accumulation of human waste and other litter, damage to vegetation and disruption of wildlife will continue at rates determined by visitor use levels.

Without monitoring, park managers will be unable to measure the environmental health of river campsites and popular attraction sites. Management could be unable to support, justify, or propose changes in recreational practices or use levels in the river corridor, including increases in the number of river trips or the shifting of use to less impacted campsites. Management decisions, if made, would be made without firm data and without a method of measuring the success of the protection of cultural and natural resources along the river. No data would be available to determine maximum visitor use levels compatible with protecting area resources and with providing the highest level of enjoyment for the visiting public.

b. Partial Implementation. Under this alternative some monitoring could take place, i.e. water quality but not beach monitoring or beach monitoring but not recreational use levels.

Impacts. The park would be remiss in carrying out its fundamental responsibilities. Management actions, if taken, would be based on incomplete information. Costly decisions affecting management of the river corridor may be made without any assurance that they will achieve stated goals.

4. Recommended Course of Action:

It is recommended that the Colorado River Management Plan be fully implemented. This includes an aggressive and comprehensive river monitoring program and options for management action as identified in the Plan and including the following:

A. Monitoring Actions.

1. The following monitoring actions will be accomplished by NPS river trips on an annual basis.

a. Read vegetation transects and plots at sample sites along the river for species cover, frequency, and competition.

b. Map vegetation enclosed by the study plots at each sample site.

c. Through the use of the point-quarter method, measure vegetation damage, accumulation of charcoal, human feces and litter, and frequency of red ant hills at each study plot.

d. Photographically document the status of cultural resources affected by river recreational use.

2. The following monitoring actions will be accomplished on routine patrol trips by river rangers.

a. Collect sociological data on river recreation including crowding and congestion at popular attraction sites, frequency of contacts between boat parties on the river, and use levels at various locations along the river corridor.

b. Collect wildlife observation data.

c. Record health and safety problems encountered by river recreationists.

3. Low level, high resolution, aerial photographs will be taken annually of each sample site and digitized for computer measurement of gross geomorphological changes, changes in percentages of vegetation cover, and frequency of trailing. These photos will also be used to assist field personnel in mapping vegetation and in locating transects and point quarters.

4. Water quality of the Colorado River and selected tributaries will be assessed annually for levels of fecal streptococcus and fecal coliform bacteria as indicators of the presence of disease carrying pathogens, and for radionuclide contamination which may result from mining activity outside the park.

5. Recreational use levels will be assessed annually for selected river sites through the use of river trip log forms and NPS aerial overflights.

6. Periodically, the incorporation of human debris into the beach substrate will be measured by analysis of sand coloration and texture at selected sample sites.

7. Small mammal species composition, density, and frequency will be evaluated periodically.

B. Research Action. At present no research actions are identified. Results of monitoring will identify new areas where research is a necessity.

In addition, the need of Federal Land Managers to address the consequences of water and power development proposals will influence future river research needs. At this time the Glen Canyon Dam Peaking Power Proposal calls for impact assessment and appropriate research. Although past and present research efforts have helped in evaluating the effects of peaking power, additional information should be assembled and assessed if we are to recognize this proposal's environmental costs. Such information should include further analysis in the following areas:

1. Longer periods of low flows will make rapids such as Horn Creek, Dubendorff, Badger, 25-Mile, and Hance extremely hazardous or impassible, and will possibly (a) limit continued use of large motorized rubber rafts and wooden dories; (b) cause trip delays, "stacking up," or congestion at difficult rapids and principal campsites; (c) cause increased landscape scarring and disturbance to vegetation and wildlife in areas of congestion; (d) cause changes in itineraries that could affect duration of trips or cause the passing up of significant river attractions; (e) cause more accidents that may result in injury, loss of life, and damage or destruction of property; (f) restrict boat access to prime trout fishing areas adjacent to Lees Ferry; and (g) cause economic loss to commercial boat companies unable or unwilling to adapt their operations to new flow conditions.

2. Low flows will cause a rise in the temperature of Colorado River water, especially as the water travels downstream. This rise in temperature may: (a) permit up-river migration of striped bass now inhabiting Lake Mead, thereby increasing predation of native fish species by exotics; (b) facilitate the spread throughout the park of an introduced fish parasite (*Lernaea cyprinaceae*) known to cause considerable mortality to native fishes; (c) increase hardships on native species during trout spawning runs when large numbers of adult trout move into available native fish habitat, which in tributary

confluence areas will be expanding or compressing as river water levels rise and fall; and d) increase the occurrence of undesirable phytoplankton blooms.

3. At the low flows proposed, possible contamination from human and animal feces will be more concentrated and therefore increase the probability of river users contracting enteric diseases such as Shigella, Salmonella, and Giardia.

4. Flow fluctuations may trigger a series of long-term and short-term channel responses that would have far-reaching, irreversibile effects on erosional/depositional patterns of beach sediments. Accelerated erosion of beach sediments will decrease the size and number of available campsites for river parties. Also, these sediments provide the substrate for riparian vegetation. Increased erosion or instability of these soils will reduce the amount of riparian habitat and the associated wildlife species.

5. As a result of lost riparian habitat, proposal implementation may cause eventual reductions in species diversity and population numbers. The riparian zone supports approximately 89 of the 283 species of birds, 36 of the 93 species of mammals, and 19 of the 55 species of reptiles and amphibians found in the park. Loss of riparian habitat is a direct loss of food sources, feeding areas, cover and nesting habitat for canyon birdlife. Little attention has been given to the importance of the Colorado River as a migratory corridor for songbirds. It is likely that a river corridor, such as that of the Colorado River, even though its alignment may be east-west, is especially important to migrating birds in arid country. The park is concerned about the effects on birds and other wildlife that the loss of riparian habitat will cause.

6. Extreme flow fluctuations may adversely affect waterfowl habitat on the river, especially that section between the dam and River Mile 10. That section of the river is extensively used by ducks, perhaps geese, and other waterfowl during their seasonal migrations.

7. Grand Canyon National Park contains one of the largest populations of beaver now existing in the Southwest. Riparian vegetation, primarily willows (*Salix spp.*), provides these animals with forage. River banks also provide beaver with habitat for denning. Extreme flow fluctuations and resulting inundation and/or destruction of riparian vegetation may significantly reduce the food sources for these animals and even cause the drowning of young in dens. Slumping of river banks and washing away of sediments will cause direct loss of denning habitat for these animals.

8. The southwestern river otter (*Lutra canadensis sonora*), protected by the State of Arizona, is considered extremely rare along the Colorado in Grand Canyon National Park as well as in historical habitat on the Green River and other areas. It is believed that the more stable flow of the river as it is now, may provide suitable habitat for the reintroduction of this particular subspecies. Extreme flow fluctuations may preclude successful reintroduction of

this threatened subspecies of otter to Colorado River waters below the dam, as called for in the Grand Canyon National Park Natural and Cultural Resources Management Plan.

9. Flow fluctuations may adversely affect the endangered humpback chub. The mixing zones at the confluence of the Colorado River and a few tributaries such as the Little Colorado River seem to be favored, if not critical, habitat for the humpback chub. If any reproduction of this species does occur, it is usually in these confluence zones. Extreme flow fluctuations may shift the location of suitable spawning grounds, may wash eggs away, and may expose eggs laid at higher water levels to stress caused by different water temperatures and by water quality changes.

10. Flow fluctuations may have adverse effects on mainstream invertebrates (Simuliids, Chironomids, etc.) and consequent effects on the native and non-native fishes of the Colorado River. The young of all the native fishes in the park feed on aquatic invertebrate larvae, planktonic crustaceans, and algae. In addition, anticipated water level fluctuations may also affect aquatic larval stages of terrestrial insects such as mayflies, midges, caddisflies, etc., with consquent effects upon related food chains.

11. Rapid fluctuations of water level may also affect invertebrates that play a role in the food chain for the endangered peregrine falcon. This predator feeds for the most part (95 %) on avian species, including the white-throated swift which, in turn, feeds on midges hatched from waters of the Colorado River and its tributaries. Because the Grand Canyon may be one of the most important peregrine falcon breeding areas in the contiguous United States, the park is concerned about how this and other important food chains may be affected.

12. Rapidly fluctuating water levels and resulting cold, swift currents may pose a potential hazard to recreation boaters and fishermen, especially above Lees Ferry. In addition, at low flows recreation boaters and fishermen may be unable to navigate more than two or three miles up-river, significantly reducing the amount of river available for recreation. Lees Ferry is a nationally recognized fishing area noted for its trophy-sized trout.

C. Resources Management Actions. The River Management Plan identifies options for management including: changes in trip scheduling and visitor use levels; closure of campsites and archaeological sites for stabilization or resource recovery; institution of regulations or operating guidelines aimed at modifying recreational behavior to reduce resource damage; rehabilitation of denuded areas and multiple trailing; institution of interpretive programs; and distribution of information concerning low impact camping and appropriate water purification methods and other health and safety information.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA-N-1- Colorado River Use and Glen Canyon Dam Operations, Impact Monitoring and Research

ACCOMPLISHMENTS (IN Priority Order)	AMOUNT (In Thousands)
Fiscal Year 82	
River Monitoring Actions:	
- Contracted botanical work and data analysis	14.0
- USGS Photo Digitization, FY81 & 82 data	10.8
- Aerial Photography	5.0
- Recreational use analysis: overflight, data reduction	5.0
- Sociological monitoring	10.0
- Personnel	21.2
- Water quality analysis	10.0
Total	76.0
Fiscal Year 83	
River Monitoring Actions:	
- Contracted botanical work and data analysis	19.4
- USGS Photo Digitization	5.4
- Aerial Photography	5.0
- Recreational use analysis: overflights, data reduction	5.0
- Sociological monitoring	10.0
- Personnel	21.2
- Water quality analysis	10.0
Total	76.0
Fiscal Year 84	
River Monitoring Actions:	
- Contracted botanical work and data analysis	34.2
- USGS Photo digitization,	5.4
- Aerial Photography	5.0
- Recreational use analysis: overflights, data reduction	4.5
- Sociological monitoring	10.0
- Personnel	34.1
- Water quality analysis	15.0
Total	108.2

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA-N-1- Colorado River Use and Impact Monitoring (Cont'd)

ACCOMPLISHMENTS (IN Priority Order)	AMOUNT (In Thousands)
Fiscal Year 85	
1. River Monitoring Actions:	
- Contracted botanical work and data analysis	34.2
- USGS photo digitization	5.4
- Aerial photography	5.0
- Recreational use analysis: overflights data reduction	4.5
- Sociological monitoring	10.0
- Personnel	34.1
- Water quality analysis	15.0
Total	108.2
Fiscal Year 86	
1. River Monitoring Actions:	
- Contracted botanical work and data analysis	34.2
- USGS photo digitation	5.4
- Aerial photography	5.0
- Recreational use analysis: overflights, data reduction	4.5
- Sociological monitoring	10.0
- Personnel	34.1
- Water quality analysis	15.0
Total	108.2

(2) Analysis of Roaring Springs Water Withdrawal Impacts.

In 1978 Congress passed P.L. 95-586, permitting the sale of "excess" water to the town of Tusayan, Arizona. A provision of this act states that this sale must not be "detrimental" to the natural resources of the park. Responding to this condition, the National Park Service initiated a two year study entitled "A Survey of Present and Future Impacts of Water Depletions and Additions on the Aquatic and Terrestrial Habitats of Roaring Springs, Bright Angel, Garden and Pipe Creeks, Grand Canyon National Park." This study will: (1) provide baseline data concerning aquatic and terrestrial communities; (2) determine the effects of water withdrawal on the aquatic ecosystem at Bright Angel Creek; and (3) determine the chemical effects of mixing Roaring Springs water with Garden Creek water. A final report is due December 31, 1981.

The park has several legislative edicts to preserve and protect its aquatic and terrestrial habitats. These include: 16 U.S.C.1; the park's enabling legislation (Act of February 25, 1919); the National Park Service Act of 1916; and the Grand Canyon Enlargement Act (P.L. 93-620). Further impetus is identified in specific National Park Service and park management documents including: the National Park Service Management Policies, the General Management Plan, and the Natural and Cultural Resources Management Plan.

P.L. 95-586 conditionally provides for the sale of park water to the town of Tusayan. A memorandum of agreement between Grand Canyon National Park and the Tusayan Water Development Association dated December 1980 placed the sale-transfer of Roaring Springs water into effect until such time it is determined that this action is detrimental to park resources.

Meanwhile, present water sales are based totally on an interpretation of what is "excess" to park needs. However, water is a vital part of the park's environment and a natural resource which the park is committed to protect. Currently there are no plans or proposals to monitor the Bright Angel and Garden Creek ecosystems beyond the present study. Consequently, a monitoring program is needed for definition of flow levels required for maintenance of the ecosystem and to assess possible changes to these stream systems resulting from future water sales. The data resulting from this monitoring project will be used as documentation for possible water sales and use adjustments or denials. Without this data, interpretation of damage to park resources is purely subjective and easily challenged.

This monitoring program will: (1) allow the timely assessment of possible damage to stream ecosystems at alternative withdrawal rates; and (2) provide data which documents this damage. This monitoring program must supplement the present research study. The sample frequency and schedule can probably be reduced to summer and fall sampling periods only. However, a final sample schedule must await the findings of the present research study. Based upon study findings, a decision can be made as to whether monitoring should be conducted by contractors or trained National Park Service personnel.

All research will be coordinated through the Cooperative National Park Research Studies Unit at the University of Arizona.

1. GRCA-N-3-Analysis of Roaring Springs Water Withdrawal Impacts.

2. Statement of Issue or Problem:

Water for National Park Service and concession usage in Grand Canyon National Park is currently provided for both the North and South Rims by a single source, Roaring Springs. This large spring originates at an elevation of 5,225 feet, approximately two miles southeast of, and 3,000 feet below, North Rim Ranger Station. Roaring Springs contributes one third to one half of the water which flows eight miles down Bright Angel Creek to the Colorado River.

Prior to the completion of the transcanyon pipeline in 1971, water was supplied to the South Rim from Indian Gardens. Thus, the Indian Gardens aquatic and riparian ecosystems were originally impacted by a loss of water, withdrawn for the South Rim. Now, the Bright Angel Creek aquatic and riparian ecosystems are affected by water withdrawal to supply potable water to both South and North Rim developed areas. In addition, the Garden Creek and Pipe Springs ecosystems are impacted by the overflow of Roaring Springs water from the Indian Gardens pump station. In 1978 Public Law 95-586 was passed permitting ". . .the Secretary. . .to sell by contract water located within Grand Canyon National Park for the use of customers within Tusayan, Arizona. . .upon his determination that such sale is not detrimental to the protection of the resources of Grand Canyon National Park. . ." Passage of this law has increased further demand for water from the Roaring Springs system.

Past Management History: The Museum of Northern Arizona was contracted in September 1979, to perform research on the ecology of Roaring Springs, Bright Angel Creek, Garden Creek and Pipe Creek, all of which are effected by the potable water supply system for Grand Canyon National Park. This study will provide: (1) baseline data concerning aquatic and terrestrial communities; (2) determine effects of water withdrawal from the aquatic ecosystems at Bright Angel Creek; and (3) determine the chemical effects of mixing Roaring springs water with Garden Creek water. This research is meant to provide baseline data, and includes studies on water chemistry, periphyton, benthic invertebrates, fisheries, riparian vegetation, riparian mammals, and riparian birds. Also, hydraulic simulation models will be utilized to determine the effects of water depletion on the trout fishery of Bright Angel Creek. This two-year study on the impacts of water withdrawal from the Roaring Springs ecosystem is scheduled for completion in December 1981.

A monitoring program is needed to define flow levels required for maintenance of the ecosytem and to assess possible changes to this spring system resulting from future water sales. The monitoring program will: (1) allow the timely assessment of possible damage to stream ecosytems at alternative withdrawal rates; and (2) provide data which documents damages caused by excessive water withdrawal.

3. Alternative Actions and Their Probable Impacts:

a. No action. Upon completion of the current study, no further monitoring of water depletion or associated impacts will be undertaken. Decisions on future water withdrawals will be based on knowledge gained through this study and general knowledge of impacts in other areas.

Impacts. If this monitoring program is not initiated, park managers will not have sufficient data to manage and protect the riparian ecosystem. Future water sales will be based on subjective determination of what water is "in excess" of ecosystem needs. Managers will also not have sufficient data to document their decisions concerning future water withdrawal demand as the surrounding communities continue to grow.

b. Establish a Monitoring Program. A monitoring program based on the results of the impact study will be established to: (1) define water flow rates needed to maintain riparian ecosystems; (2) monitor ecosystems for possible damage resulting from established flow rates; and (3) develop a data base which documents the damages of water withdrawal.

Impacts. The long-term environmental impacts of this action would be the prevention of "excessive" water depletion from the Roaring Springs/Bright Angel Creek ecosystems. Vegetation and wildlife dependent on natural flow rates within the riparian ecosystem would be maintained at natural balances with their environment. Exotic fish species would continue to use the Bright Angel Creek as a breeding ground and continue their presently unknown interaction with native wildlife.

Information gained from the monitoring project will ultimately be used to make management recommendations concerning the availability of water for sale to the town of Tusayan. Recommendations to eliminate or reduce water sales may have a direct effect on the availability and price of water used to support local residents and the tourist industry. A decrease in the availability of park water will mean an increased dependence on water trucked from Williams and Flagstaff.

4. Recommended Course of Action:

In keeping with the legislative and policy edicts to "preserve and protect" the natural resources of the Grand Canyon, the park will implement an annual monitoring program to assess the impacts of water withdrawal from Roaring Springs.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA-N - 3 - Analysis of Roaring Springs Water Withdrawal Impacts

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Monitoring Actions:	
- Initiate monitoring program based upon results of 2-year water withdrawal research project. Assess water withdrawal impacts to Bright Angel and Garden Creek	20.0
Total	20.0
2. Fiscal Year 83	
Monitoring Actions:	
- Continue monitoring and inventory of Roaring Springs/ Bright Angel ecosystems	20.0
Total	20.0
3. Fiscal Year 84	
Monitoring Actions:	
- Continue monitoring and inventory of Roaring Springs/ Bright Angel ecosystems	20.0
Total	20.0
4. Fiscal Year 85	
Monitoring Actions:	
- Continue monitoring and inventory of Roaring Springs/ Bright Angel ecosystems	20.0
Total	20.0
5. Fiscal Year 86	
Monitoring Actions:	
- Continue monitoring and inventory of Roaring Springs/ Bright Angel ecosystems	20.0
Total	20.0

(3) Backcountry Management Plan.

The impacts of visitor use levels and patterns in the Grand Canyon backcountry are not well known. Increasing pressure from higher levels of visitation is apparent. In 1980, backcountry use totaled 560,000 visitors, with approximately 60,000 visitors using trails outside the cross-canyon corridor. In addition, 35,600 visitors spent nearly 82,000 user nights in Grand Canyon's backcountry during 1980. Since 1965, overnight use on backcountry trails has increased dramatically to the 1980 level. It is anticipated that this increase will continue at a rate which will not drop below an average of eight percent per year. To meet the needs of the public for enjoyment of the park's backcountry and to prevent significant and/or irreparable resource damage, the park's Backcountry Management Plan calls for quantification and evaluation of backcountry visitor use and the impacts caused by such use, assessment of the backcountry's ability to sustain various use levels and patterns without irreparable damage, and establishment of appropriate site and zone carrying capacities and user guidelines to minimize adverse impacts.

The National Park Service Organic Act, reaffirmed by the Grand Canyon Enlargement Act, requires the protection of the outstanding scenic, natural and scientific values of Grand Canyon for public use and enjoyment. The need for protection and preservation of this resource is also delineated in the park's General Management and Cultural Resources Management Plans, the draft Backcountry Management Plan and National Park Service Management Policies. It should be noted that the draft Backcountry Plan requires that future adjustment of use levels be supported by environmental monitoring data, ensuring that the Grand Canyon backcountry will be used, but not abused, and preserved for future public enjoyment. The final version of the Backcountry Management Plan will be accompanied by its own environmental assessment and will be made available for public review.

Past physical and biotic inventories have aided in pointing out subject areas where future research and monitoring are needed. Monitoring of sociological perceptions of crowding on trails and backcountry camping areas is essential. Natural and cultural resource alterations taking place over the next 10 to 20 years need to be carefully monitored and considered when establishing visitor use levels. Research is to be undertaken to evaluate and quantify the rate and mode of impact by visitors on the vegetation and soils in selected backcountry areas and sites in the park. The major emphasis of the study will be directed toward the determination of changes taking place in the plant communities involved, with only minor attention given to changes in fauna. Further research will be directed towards finding an efficient, feasible, and rapid method of restoration of damaged areas. Recommendations for future management to minimize impact will be made. Investigations will also be undertaken to determine the need for toilet facilities in the backcountry; appropriate types and locations will be suggested.

Meanwhile, monitoring efforts will provide an assessment of the environmental health of present and potential campsites and unmain-

tained trails. With the use of aerial photography of selected back-country sites, gross geomorphological changes and trends in vegetation loss or recovery can be identified. In addition, field surveys will provide a quantitative assessment of changes in vegetation and wildlife communities, soil erosion and deposition patterns, conditions of cultural resources, and accumulation of trash and human feces.

NATURAL RESOURCES PROJECT STATEMENT *

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-6-Backcountry Management Plan.
GRCA-N-13-Backcountry Carrying Capacity Impact Study.
GRCA-N-15-Backcountry Use Impact Monitoring.

3. STATEMENT OF THE PROBLEM: The impact of visitors in the backcountry areas of Grand Canyon National Park is virtually unknown. Casual observations show marked visual evidence of considerable impact along streams and near springs. The Bright Angel and Kaibab Trails are heavily used by mule riders and day hikers in addition to overnight backpackers. Increasing numbers of visitors are now entering the remotest parts of the canyon. The demand to enter the backcountry is increasing at exponential rates. Scientific data on the impact of visitors on the biota of the backcountry is necessary to properly manage visitor use and the natural resources they expect to experience.

4. WHAT HAS BEEN DONE: Little research has been accomplished in this area. A simulation study of recreation use in the park's backcountry has been completed and records of use are available for the last several years. Management implications were included in the park's Wilderness Proposal of 1976 and its accompanying draft environmental statement. At the present time, arbitrary recreation use limitations have been imposed for the park backcountry and a reservation/registration system instituted. A Backcountry Management Plan is currently being drafted by the park staff.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: A Backcountry Carrying Capacity Study is to be undertaken to evaluate and quantify the rate and mode of impact by visitors on the vegetation and soils in selected backcountry areas and sites in Grand Canyon National Park. The major emphasis of the study will be directed toward the determination of changes taking place in the plant communities involved, with only minor attention given to changes in fauna. Further research will be directed toward finding an efficient, feasible, and rapid method of restoration of damaged areas. Recommendations for future management to minimize impact will be made. Investigations will also be undertaken to determine the need for, location of, and appropriate types of toilet facilities for use in the backcountry.

The goals of this study go beyond simple identification of problems and solutions. The ultimate objective is to obtain information suitable for long-range planning of carrying capacities, desirable physical arrangement of campgrounds, and suitable sites for studying ecological relationships. Such results should find wide use in future master planning and in current operations management.

In addition to initiating the Backcountry Carrying Capacity Study, the park must complete the Backcountry Management Plan and continue the interim monitoring of present backcountry use levels. The

Backcountry Management Plan will be completed in FY 82 and released to the public with its own environmental assessment. As the three-year research effort is completed, the park will continue or modify its monitoring efforts and will assess carrying capacity levels now in force, based upon the findings of that project. Monitoring efforts will then continue indefinitely.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: Park managers will be forced to continue making arbitrary decisions based on casual observations of recreation use impact on natural resources. Visitor experience and the resource may seriously degrade.

8. WHAT ARE THE ALTERNATIVES:

   a. Do nothing.

   b. Severely limit recreation use without benefit of concrete rationale.

   c. Permit unlimited recreation use.

   d. Exclude all public use from backcountry because of impact on natural ecosystems.

   e. Provide sufficient public use facilities to mitigate all long-term impacts.

9. PERSONNEL: Research contractors will perform the bulk of the work.

10. ADMINISTRATION AND LOGISTICS: The Cooperative National Park Resources Studies Unit at the Univeristy of Arizona in Tucson will administer this project and provide limited logistical support.

FUNDING (In Thousands)		YEAR IN PROGRAM SEQUENCE			
	F.Y.82	83	84	85	86
Personnel Services	0	0	0	0	0
Other than Personnel Services	60	55	55	5	5
TOTAL	60	55	55	5	5
Funds Available in Park Base	0	0	0	0	0
Funds Requested from Regional Office	60	55	55	5	5

On Form		Date Submitted
10-237	[X]	October 1976
10-238	[ ]	
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS:

a. May, Larry A., and James E. Walters, Resources Management Division, Grand Canyon National Park.

b. Paul Anderson, Division of Visitor Services, Grand Canyon National Park.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: Backcountry Management Plan
(Includes Project Statement No's. N-6, N-13 and N-15)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
Fiscal Year 82	
1. Resources Management Actions: (N-6)	
- Complete Backcountry Management Plan	5.0
2. Monitoring Actions: (N-15)	
- Monitor impacts of present use levels	2.0
- Continue aerial photo project	3.0
3. Research Actions: (N-13)	
- Initiate Backcountry Carrying Capacity Study, i.e., determine biological and sociological carrying capacity at inner canyon areas	50.0
Total	60.0
Fiscal Year 83	
1. Monitoring Actions:	
- Continue aerial photo project	3.0
- Continue monitoring present use levels	2.0
2. Research Actions:	
- Continue Backcountry Carrying Capacity Study	50.0
Total	55.0
Fiscal Year 84	
1. Monitoring Actions:	
- Continue aerial photo project	3.0
- Continue monitoring present use levels	2.0
2. Research Actions:	
- Complete Backcountry Carrying Capacity Study	50.0
Total	55.0

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: Backcountry Management Plan Cont'd. (page 2)
(Includes Project Statement No's. N-6, N-13 and N-15)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
Fiscal Year 85	
Monitoring Actions:	
- Continue aerial photo project	3.0
- Implement monitoring program based upon Backcountry Carrying Capacity Study	2.0
Total	5.0
Fiscal Year 86	
Monitoring Actions:	
- Continue monitoring backcountry use	5.0
Total	5.0
Fiscal Year	
Total	

(4) Aircraft Noise Management Program

Noise is simply defined as any unwanted sound. The concept of noise adversely affecting the quality of life is easily understood by persons living in high population and industrial areas. The intent of new laws regulating noise levels in such areas testifies that noise can and does adversely affect the emotional and even physical well-being of people. Noise has become a tangible pollutant factor that can be measured in terms of both decible levels and its effect on people. Noise has assumed its place along with smog, congestion, and litter as a major source of pollution in the nation's environment. A notable source of noise pollution throughout the United States, and in Grand Canyon National Park, is aircraft.

An airport for scenic flights through the canyon was developed near Red Butte, 16 miles from the South Rim during the late 1920's. Beginning in 1931, this facility was operated by Grand Canyon Airlines. A modern airport was completed less than 10 miles south of Grand Canyon Village in 1962. Since that time, air travel over the canyon has increased greatly with the availability of convenient commercial services, including a major jet aircarrier, air-taxi operators, helicopter flight services, privately owned aircraft, military aircraft, and government contract fixed-wing and helicopter services. Forty-three air tour companies operate from various communities surrounding the park. Table 2 summarises the increase in aircraft traffic at Grand Canyon National Park Airport over the last five years.

TABLE 2

AIRCRAFT USE FIGURES FROM GRAND CANYON AIRPORT
1974 - 1980

(Number of Flights - May through September)

	1974	1975	1976	1977	1978	1979	1980*
Air Carrier	1453	1237	1424	1282	913	1617	1136
Air Taxi	9520	13027	16676	15597	24977	65436	46825
Gen. Aviation	6806	7617	8498	8212	7934	18115	9729
Military	127	112	103	145	135	410	443
TOTAL	17906	21993	26701	25236	33959	85578	58133

(* as of August 1980. February Air Carrier and Air-Taxi Data missing)

It is estimated by airport authorities that Grand Canyon National Park Airport is now the third busiest transient airport in the State of Arizona, based upon the number of arrivals and departures. In 1978 the State of Arizona requested permission to extend the runway to a length capable of receiving four-engine jet aircraft. This request was subsequently withdrawn, due partially to opposition from the National Park Service.

Current expansion plans for Grand Canyon National Park Airport call for the addition for a new main terminal, a new operation building for commercial aircraft, and an enlarged aircraft parking area. A second helicopter tour company began operation in the town of Tusayan in 1979.

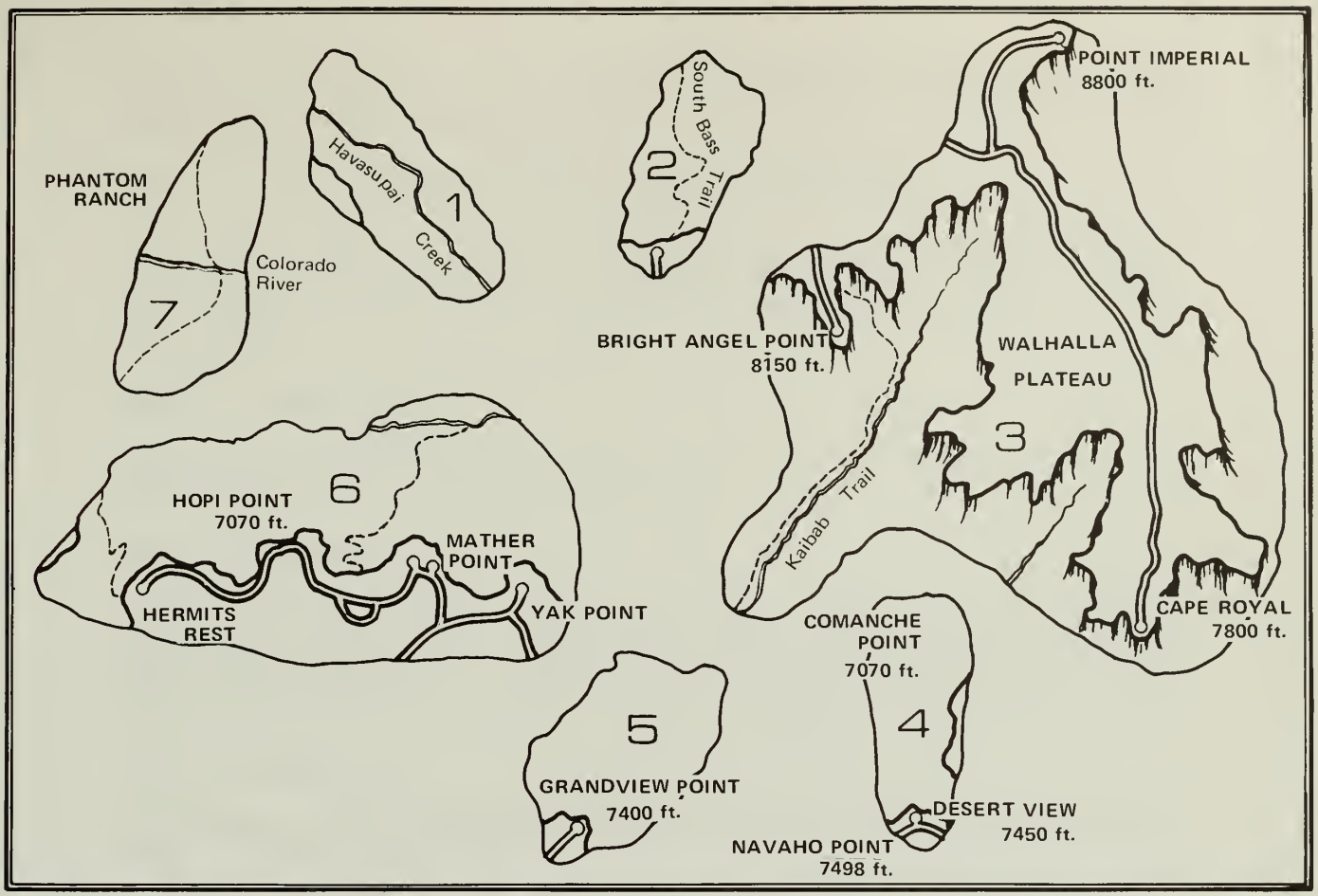
All aircraft use combines to disrupt the natural quiet of the park, imposes visual impact, compromises the intent of wilderness proposals for certain sections of the park, and poses potential safety problems.

Attempts to regulate aircraft are complicated by the commercial importance of these operations and the service they provide to the public. Proponents of aircraft use argue that persons viewing the canyon from the air are numerous (estimated 500,000 in 1980), thus relieving impacts on the backcountry and concentrated Grand Canyon Village area, and offer an opportunity to view the Grand Canyon to persons who otherwise might not be able to do so. Those objecting to aircraft use argue that most people visit the park via automobile and that persons who do fly into the park are using canyon facilities as part of their tour anyway.

At present, few laws regulate aircraft use in the park. Since most of Grand Canyon National Park is sparsely populated, Federal Aviation Administration (F.A.A.) regulations only require that aircraft fly a minimum of 500 feet from any person, vehicle, vessel or structure. Congested areas such as Grand Canyon Village require that an aircraft maintain an altitude of 1000 feet above the highest obstacle. The F.A.A. does, however, request that pilots maintain altitudes of 2000 feet above the surface and avoid flying below the canyon rim. It also requests that pilots maintain a distance of 1500 feet vertically and horizontally from all scenic overlooks, parks, and trails.

A 1972 letter of agreement between the National Park Service and air tour operators in the Grand Canyon area outlined recommended flight patterns over the park. This letter contains the following information concerning flight procedures in the park:

> AREAS AND PROCEDURES. Unless specifically authorized by the Superintendent of Grand Canyon National Park to operate to the contrary in the areas of concern, flights shall be conducted in the areas depicted in Figure 5 as follows:
>
> Area 1 - Havasu Creek
>
> All aircraft, fixed-wing and helicopters, shall not operate at an altitude below 5,000 feet Mean Sea Level (M.S.L.) over this area. Helicopters landing or taking off from the Havasupai Reservation are exempt from this restriction. (The area in and around Havasupai Canyon has since been excluded from National Park Service administration by P.L. 93-620.)
>
> Area 2 - Bass Trail
>
> No flights shall be conducted by either fixed-wing aircraft or helicopters within this area. When it is necessary to overfly the area, aircraft shall not operate below an altitude of 6,500 feet M.S.L.



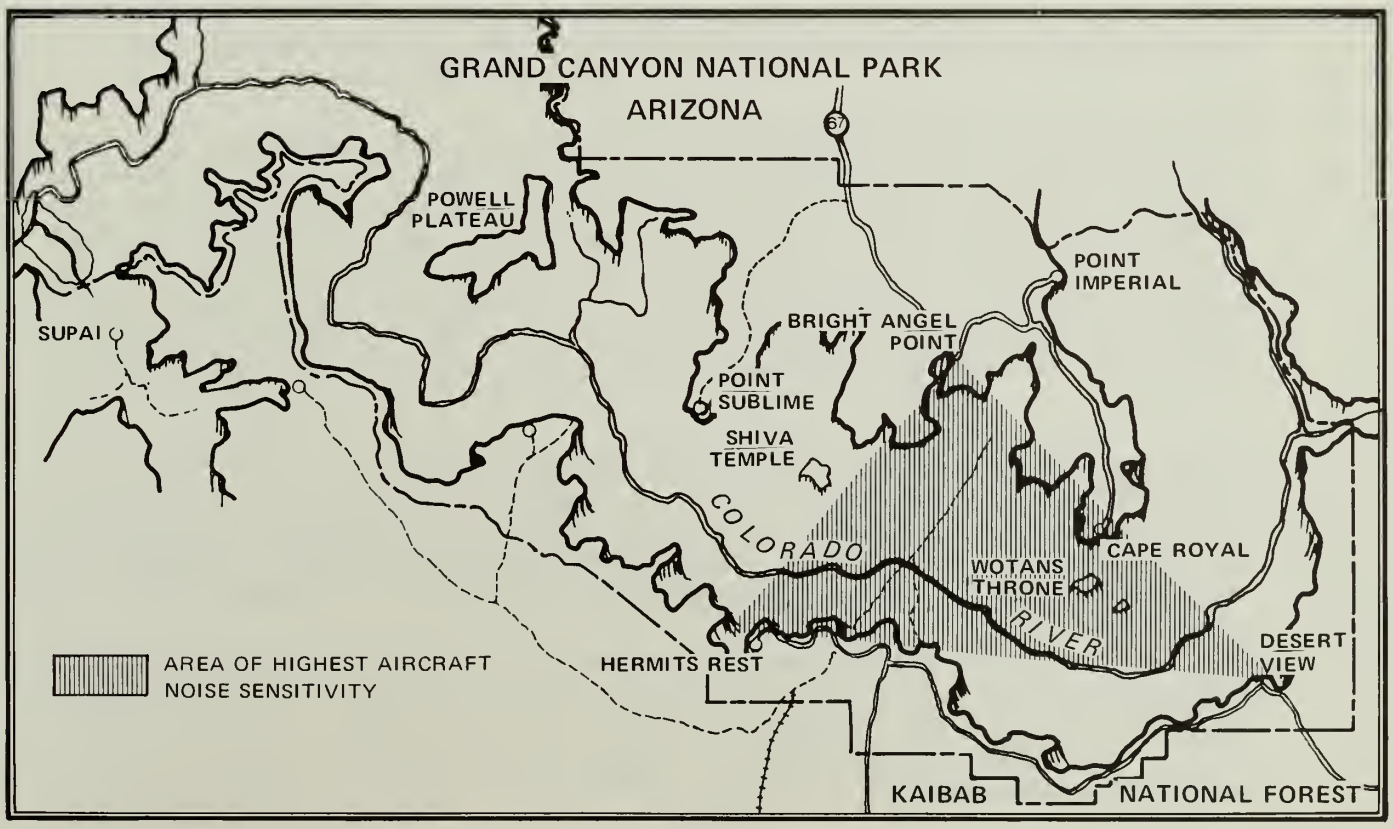


FIGURE 5
AIRCRAFT USE AREAS IN THE PARK

within the confines of the canyon and not below an altitude of 8,500 feet M.S.L. while over the rim.

Area 3 - North Rim, Cape Royal, and North Kaibab Trail

No flights shall be conducted within this area by either fixed-wing aircraft or helicopters. When circumstances do not permit avoiding these areas, aircraft shall not operate below an altitude of 10,000 feet M.S.L..

Area 4 - Desert View

Helicopters and fixed-wing aircraft shall not operate over this area below an altitude of 8,500 feet M.S.L..

Area 5 - Grandview

Fixed-wing aircraft shall not operate below an altitude of 8,500 feet M.S.L. within this area. Helicopters shall operate at an altitude not below 8,500 feet M.S.L. when flying over the rim areas and not below 5,000 feet M.S.L. when flying within the canyon.

Area 6 - South Rim

Helicopters and fixed-wing aircraft shall not operate over this area below an altitude of 8,500 feet M.S.L..

Area 7 - Phantom Corridor

Helicopters and fixed-wing aircraft shall not operate over this area below 6,500 feet M.S.L..

The 1972 agreement is both outdated and ignored by some elements of the aircraft community. This fact, plus radical increases in the number of tour operators and the number of aircraft they fly, required a renewed look at flight operations over the park. Since 1971, several studies on aircraft noise have been conducted in the park. These studies have indicated, among other findings, that aircraft could typically be heard approximately 50% of the time and that approximately 70% of the backcountry users felt that aircraft flying overhead detracted from the enjoyment of the park.

On May 4, 1981 the park staff met with representatives of the aircraft community to discuss the problem of aircraft noise at the Grand Canyon. The park Superintendent outlined the concern the NPS has for preserving the natural sounds of park and the park's willingness to work with the aircraft community in developing an acceptable aircraft managment program.

During this same workshop, the park staff emphasized that the greatest concentrations of noise complaints coincided with the area of heaviest visitor use and roughly outlined within a triangle drawn from Desert View to Hermits Rest to Bright Angel Lodge on the North Rim (Figure 5). This zone represents the area of immediate concern to park managers developing the management plan.

The park's attempt to minimize the use of its own management aircraft is identified in the Draft Aircraft Use Mitigation Plan for Grand Canyon National Park. This document is presently undergoing review within the park. This plan, if approved by the Superintendent, will minimize or eliminate park helicopter and fixed-wing aircraft operations which are unnecessary, inefficient, or cause excessive visitor disturbance.

In April 1980, a Draft Task Directive for an Aircraft Management Plan Study for the park was completed and approved by the Director of the National Park Service, Western Regional Office. This directive outlines the steps necessary for the development of a general Aircraft Management Plan which will attempt to work with the public, including the aircraft community, in developing a compromise program for the aircraft noise problem. The program will include public workshops, monitoring work, noise studies, and cooperation with the Environmental Protection Agency and the Federal Aviation Administration in developing the draft plan. The Aircraft Management Plan will include its own environmental assessment and undergo public review before final implementation. Meanwhile, the park intends to continue its noise monitoring effort and maintain an open line of communication with the aircraft community. Other projects needed include: 1) new monitoring equipment to cover wider areas of the park; and 2) a sociological study to assess the tolerance levels of park visitors to noise pollution.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region,

2. PROJECT NAME AND NUMBER: GRCA-N-9-Aircraft Noise Management Plan.
GRCA-N-22-Aircraft Noise Sociological Study.

3. STATEMENT OF PROBLEM: The natural peace and quiet of the park is currently being compromised by aircraft noise. Many persons report what they consider to be intolerable levels and duration of noise in both backcountry and rim areas of the park. In addition, the numbers of aircraft using the park impose visual impacts, compromise those areas of the park that have been recommended for inclusion in the National Wilderness Preservation System, and may create safety problems. However, these aircraft do provide a service to the public and the rights of individuals to use airspace over the park is an issue that complicates management in this area. Plans to expand all aircraft-related facilities outside the park further intensify this problem.

4. WHAT HAS BEEN DONE: In 1971, C.H. Black of Northern Arizona University conducted a study for the Environmental Protection Agency in which he found that in Grand Canyon National Park "aircraft... provide almost continuous intrusion at all sites." E. Bowman, in 1975, conducted an 18-day aircraft monitoring program during which aircraft noise was heard 48% of the 8 a.m. to 4 p.m. day. In 1977, W. Fowler conducted a sociological survey of hiker responses to aircraft noise in the park backcountry as part of his thesis work at the University of Arizona. The report indicated that 71% of those questioned felt that aircraft noise detracted from their enjoyment of the park. In 1978, the park continued monitoring aircraft noise patterned after Bowman's study. Comments and complaints are frequently received from visitors (150 written complaints in 1980) and are currently being summarized on a regular basis. Data on numbers of aircraft using Grand Canyon National Park Airport are available for the last several years.

The park is currently elaborating its noise-monitoring program to involve numerous volunteers and employees in a multi-faceted survey. A public contact program on the issue has been initiated and includes the first public workshop held May 4, 1981. A Task Directive has been prepared and now awaits approval by the Director of the National Park Service, Western Regional Office. An in-park mitigation plan for NPS management of aircraft use is also being prepared.

4. DESCRIPTION OF WORK TO BE UNDERTAKEN: The park plans to implement the Task Directive with the purpose of developing an Aircraft Management Plan and an in-park mitigation plan. This will involve: continued monitoring and quantification of aircraft use; creation of standards for decible level; the implementation of a sociological study; the investigation of various alternatives to mitigate aircraft use-related problems; the establishment of open communication with

the aircraft community impacting Grand Canyon; and the solicitation and collation of public response to the various issues involved. A media program and liaison with aircraft operators will be established, public meetings held, and contact with local military bases reactivated. The development and implementation of the Plan will involve the standard public review procedures obliged by such an undertaking.

5. LENGTH OF TIME NEEDED: Final implementation of the Aircraft Management Plan will require two years. Noise monitoring will continue indefinitely.

6. WHAT WILL HAPPEN IF NOT UNDERTAKEN: The park will continue to be subjected to the adverse impacts of aircraft disturbances. It will also stand in violation of the 1975 Management Policies, the 1975 Grand Canyon Enlargement Act and the Park Service Organic Act.

7. WHAT ARE THE ALTERNATIVES:

   a. Do nothing.

   b. Limit management efforts to restricting present aircraft to present limits and routes.

   c. Stop all flights over the park.

8. PERSONNEL: Park staff.

9. ADMINISTRATION AND LOGISTICS:

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	0	0	0	0	0
Other than Personnel Services	21	4	.5	.5	.5
TOTAL	21	4	.5	.5	.5
Funds Available in Park Base	0	0	0	0	0
Funds Requested from Regional Office	21	4	.5	.5	.5

On Form		Date Submitted
10-237	[X]	March 1980
10-238	[ ]	
10-250	[ ]	
10-451	[ ]	

10. REFERENCES AND CONTACTS:

a. Walters, James E., Resources Management Specialist, and Larry A. May, Chief, Resources Management Division, Grand Canyon National Park.

b. Farabee, Charles R., Jr., Assistant Chief Ranger, Grand Canyon National Park.

c. Bowman, Eldon, Northern Arizona University.

d. Bowman, E. 1975. Aircraft Noise Evaluation, Grand Canyon, May-August 1975. Report to NPS in Resources Management files.

e. Black, C.H. 1971. Report of Preliminary Survey of Noise Levels in Grand Canyon National Park. Northern Arizona University, Flagstaff, AZ., Report to NPS in Resources Management files.

f. Fowler, W. 1977. Graduate Thesis. University of Arizona, Tucson.

11. DATE OF SUBMISSION: September 1981.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: Aircraft Noise Management
(Includes Project Statement No's. N-9 and N-22)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
1. Resources Management Actions:	
- Continue Noise/Disturbance Monitoring	5.0
- Continue Public Relations Work With Aircraft Community	15.0
2. Research Actions:	
- Implement and Complete Sociological Study	6.0
Total	26.0
2. Fiscal Year 83	
Resources Management Actions;	
- Continue Noise/Disturbance Monitoring	1.0
- Complete Aircraft Management Plan; Hold Public Workshops	3.0
Total	4.0
3. Fiscal Year 84	
Resources Management Actions;	
- Continue Noise/Disturbance Monitoring	.5
Total	.5
4. Fiscal Year 85	
Resources Management Actions:	
- Continue Noise/Disturbance Monitoring	.5
Total	.5
5. Fiscal Year 86	
Resources Management Actions;	
- Continue Noise/Disturbance Monitoring	.5
Total	.5

(5) Livestock Use and Boundary Management.

The Grand Canyon National Park Enlargement Act of 1975 added to the park some lands on which grazing was occurring at the time of passage of the act. Seven persons held permits to graze livestock on these lands at that time. Two of these individuals held three life-tenure permits (permits which expire upon the death of the permittee) for grazing in the Tuweep District of the park. One person holding one life-tenure permit has since died. These life-tenure allotments are administered directly by Grand Canyon National Park as Special Use Permits. The remaining five individuals hold 10-year allotment permits, totaling 28,200 acres, that are administered under a Memorandum of Agreement with the Bureau of Land Management offices in St. George, Utah and Kingman, Arizona. These grazing permits expire January 2, 1985. Four of the allotments are located in the Shivwits Plateau area; one is in the Grand Wash Cliffs area on the south side of the Colorado River. An additional short-term permit, involving the grazing of 40 horses, was terminated in 1976. Approximately 1,200 cattle and/or horses are legally permitted to graze within park boundaries at the present time. No domestic sheep are permitted to graze within the park, but trespass grazing in the area of the east boundary occurs frequently.

The land being grazed by domestic livestock within the park does not provide a bountiful harvest according to criteria set forth in the U.S. Forest Service Allotment Analysis Handbook. The lack of naturally occurring surface water combined with the low productivity and slow regrowth of vegetation, and shallow, infertile soils make this land "poor" under most grazing classifications. Numerous stock roads, trails, and scattered stock tanks are the main evidence that these areas are being used for grazing. As permits expire, the majority of these roads and trails will be abandoned and the stock tanks removed and restored to a natural state. The National Park Service recognizes that the current use of park lands for grazing of domestic livestock (domestic cattle, sheep, and horses are all exotic species) is contrary to the established policies and goals for which these areas have been preserved and plans to terminate these grazing permits once the various tenure periods have expired.

Until 1975, the Havasupai Tribe held grazing privileges on 56,000 acres of Grand Canyon National Park and Grand Canyon National Monument. A 1976 livestock count indicated fewer than 500 cattle and horses grazing on this land. The Grand Canyon National Park Enlargement Act of 1975 deleted 83,809 acres from the park and monument for addition to the Havasupai Reservation and provided for special grazing privileges on approximately 95,300 acres of park land in the Great Thumb area. Although grazing carrying capacities for this Havasupai Use Lands (HUL) have not yet been established, they appear low. Stock water is minimal, the forage is of low quality, and the soils are of such low fertility that range "improvements" would result in little additional yield. The U.S. Forest Service Allotment Analysis Handbook indicates lands similar to those found on the Havasupai Traditional Use Area have low capacities for maintenance of livestock. Preliminary information obtained from the draft

Secretarial Land Use Plan for the Addition to the Havasupai Indian Reservation and Environmental Statement indicates this is indeed true. The Havasupai Tribe has expressed a desire to increase the amount of livestock grazing in the Havasupai Use Lands. To comply with the Enlargement Act, the Secretary of the Interior must determine appropriate grazing carrying capacities for the area. Monitoring of grazing impact on the HUL will continue indefinitely.

Desert bighorn exist on northern portions of the Great Thumb and Tenderfoot Plateaus within the Havasupai Indian Reservation. In these two areas, livestock may compete directly with desert bighorn for food and water. Preservation of bighorn habitat in these areas is essential to the continued existence of bighorn within adjacent portions of the park. Similar competition may exist on the Sanup Plateau. The only known competition north of the Colorado River between domestic livestock grazing and wildlife is with a small herd of pronghorn antelope in the Tuweep District, and this competition is minor.

Grazing stock belonging to individuals of the Navajo Tribe trespass the southeast corner of Grand Canyon National Park. Thin soils and moisture deficits make the land and vegetation vulnerable to grazing damage, and "nuisance" species such as Russian thistle (*Salsola kali*) readily replace native plants. Significant livestock trespass also occurs within the park on the Kanab Plateau from adjacent lands. Occasional trespass occurs along the Kaibab Plateau boundary on the North Rim and along the south boundary of the park. Management actions to resolve grazing problems within the park will include the following: (1) establishment of grazing carrying capacities for the H.U.L.; (2) continuation of a monitoring program for insuring that carrying capacities are not exceeded on park lands (including those capacities established by B.L.M. for permit grazing in the park); (3) boundary fencing to eliminate trespass grazing along the Desert View, Pasture Wash, North Rim and Tuweep areas of the park; and (4) an investigation of concession and NPS stock use impacts. Monitoring of the carrying capacities will involve field inspection of all grazed lands at least once each year and cooperation with the Bureau of Indian Affairs as the lead agency in dealing with the Havasupai. Boundary fencing will involve 13 miles of new fence along the Desert View boundary and approximately 62 miles along the north boundary. Forty-eight miles of old fence will be rebuilt. All boundary fencing will necessarily be coordinated with the projected grazing permit program and various wilderness proposals.

Priorities for fence construction will be based upon: (1) the existence of trespass grazing; (2) legislation allowing the continuation of grazing on park lands; and (3) the existence of an established boundary line.

An additional research proposal will involve investigating the impact of concession and National Park Service horses and mules in the park with emphasis on developing plans to minimize impacts. This project

will be conducted by park staff. The need exists for this investigation because of water contamination, exotic species (feed grains, English sparrows, etc.) associated with stock and stables, trail erosion and widening, and visitor/stock conflicts. Approximately 130 animals are currently kept by the National Park Service and the park concessioners.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-17-H.U.L. Grazing Carrying Capacity Study.
GRCA-N-18-Grazing Monitoring Program.

3. STATEMENT OF PROBLEM: Public Law 93-620, the Grand Canyon National Park Enlargement Act, enacted on January 3, 1975, authorized that 185,000 acres at park and U.S. Forest Service lands be added to the Havasupai Indian Reservation and an additional 95,300 acres of park lands be available to the tribe for "traditional" uses, including the grazing of domestic livestock. The Secretary of the Interior must determine the grazing carrying capacity of the Havasupai Use Lands (HUL) which extends west along the Esplanade from Royal Arch Canyon to the boundary of the Haulapai Indian Reservation at National Canyon. The Havasupai wish to increase the number of animals grazing in the area although similar lands on the Colorado Plateau have been found to have low carrying capacities.

P.L. 93-620 also extended grazing privileges to five permittees using lands previously administered by Lake Mead National Recreation Area until January 2, 1985, and gave two additional permittees life-time grazing privileges on old Grand Canyon National Monument lands. As a result of this action, the park has as many as 1,200 head of cattle or horses grazing in various parts of the park during various times of the year.

4. WHAT HAS BEEN DONE: Nothing has been done directly related to the establishment of a grazing carrying capacity on the H.U.L.. In 1979, the Office of Arid Lands Studies at the University of Arizona completed a draft vegetation map of the H.U.L. at a scale of 1:62,500. This map may be of limited assistance in establishing the carrying capacity. The mapping was completed as part of the Resources Base Inventory; a final map of the entire park is anticipated at the end of 1981.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN; The carrying capacity of the Havasupai Use Lands for the grazing of domestic livestock will be determined using commonly accepted methods under contract to an established research institution or under a cooperative agreement with another agency. Monitoring of the grazing impacts will then be initiated and will continue as long as grazing is permitted. Grazing use on seven areas of the park administered under Special Use Permits will continue to be monitored in cooperation with the Bureau of Land Management. As grazing is phased out of the park, developments and range improvements on these lands will be allowed to revert to a natural state or will be removed by the National Park Service.

6. LENGTH OF TIME NEEDED: A minimum of three years is needed to determine the H.U.L. carrying capacity. The monitoring of grazing impact

on the H.U.L. will continue indefinitely. Grazing monitoring on other lands will be terminated as permits are terminated and boundary fences are constructed.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: The park will not meet the dictates of Public Law 93-620 which require it to determine the grazing carrying capacity of the Havasupai Traditional Use Lands. Livestock will be placed on this area with no control as to their numbers or types. In other areas of the park, livestock will be allowed to graze with little or no control. Grazing dates and animal unit months (A.U.M.) allotments could be exceeded with resultant impacts to the vegetation and soil communities of the park.

8. WHAT ARE THE ALTERNATIVES:

a. Establish a carrying capacity without performing any research in the area, by comparing with areas of similar vegetation and climate.

b. Do nothing and allow the Havasupai Tribe to determine the number of domestic animals to be grazed in the Havasupai Use Lands.

9. PERSONNEL: Park staff and research contractors or other Federal agencies.

10. ADMINISTRATION AND LOGISTICS: This project will be administered by the Resources Management Division, Grand Canyon National Park. If the work is performed by park staff, the park will provide logistical support. If it is done under contract or by another agency then the contractor or agency will provide logistics.

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
	F.Y. 82	83	84	85	86
Personnel Services	0	0	0	0	0
Other than Personnel Services	$22	22	22	2	2
TOTAL	$22	22	22	2	2
Funds Available in Park Base	0	0	0	0	0
Funds Requested From Regional Office	$22	22	22	2	2

On Form		Date Submitted
10-237	[X]	January 1980
10-238	[ ]	
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS:

a. Walters, James E., Resources Management Specialist, Grand Canyon National Park.

b. May, Larry A., Chief, Resources Management Division, Grand Canyon National Park.

12. DATE OF SUBMISSION: September 1981.

1. GRCA-N-38-Impacts of Stock Use in the Inner Canyon.

2. Statement of Issue or Problem:

The National Park Service and park concessioners currently maintain approximately 130 horses and mules. These animals are used for transportation and packing on Inner Canyon trails. Stock animals are housed in five corrals on the North and South Rims, and in five corrals in the Inner Canyon. Obvious impacts of this stock use include trail widening, objectionable odors, trail and water contamination from liquid and solid waste, the introduction of exotic grain species, and conflicts with hikers. Present knowledge is insufficient to quantify these impacts or to support forced changes in stock use aimed at mitigating adverse impacts.

3. Alternative Actions and Their Proposed Impacts:

a. Study Stock Use Impacts and Develop Measures to Mitigate Them. A study will be initiated to identify the impacts of stock use in the park, determine the extent of such impacts, and, with the cooperation of National Park Service and concessioner stock personnel, develop measures to mitigate them.

Impacts. Some conflicts between stock use and park visitors and resources will be mitigated. This will be particularly true where health hazards are identified. Short of complete elimination of stock use in the park, some adverse impacts are inevitible. Other alternatives to be considered for mitigating impacts include reductions in stock use, closure of trails to stock use, diversion of runoff from trails and corrals, changing feed grains, change trail construction and maintenance techniques, relocate corrals, and improve visitor education. More alternatives will be developed during this study.

b. No Action. The park will not study this problem in its entirety, though some particular segments may be addressed, if they become critical.

Impacts. The present but unknown impacts to park resources will continue. The Indian Gardens and Plateau Point areas will continue to experience trail widening and soil erosion. Conditions will be conducive to the introduction of exotic species. Hikers will continue to be offended by the presence of feces and urine on the trails and will be exposed to possible contamination of Garden, Pipe, and Bright Angel Creeks.

1. GRCA-N-12-Desert View Boundary Fence.

2. Statement of Issue or Problem:

Approximately 13 miles of the eastern boundary between the park and the Navajo Indian Reservation has not been fenced. Members of the Navajo Tribe graze cattle, sheep, goats, and horses on reservation and unintentionally on park lands. This trespass grazing creates competition between livestock and native wildlife for forage and water supplies. Plant vigor and species composition has been altered allowing an increase in invader plant species. Soil disturbance has encouraged the establishment of exotic species and increased erosion.

The boundary was surveyed in 1975 by private contractors to verify its alignment. A search of park records revealed no indication of inholdings along the eastern boundary of the South Rim which would be isolated by a boundary fence.

3. Alternative Actions and Their Probable Impacts:

a. Fence the Eastern Boundary. A boundary fence will be constructed along the eastern boundary of the South Rim. This fence will be constructed of a combination of hog wire and barbed wire to exclude sheep and goats. There are no wildlife species in the vicinity of this boundary which would be excluded to a significant extent by this type of fence.

Impacts. Deteriorated range conditions will begin to recover. Plant vigor and soil surface conditions would begin favoring native species over exotic species. The increase in ground cover will create conditions conducive to the spread of natural fire, which will in turn hasten the recovery of native plant communities. Fence construction activities will disturb soils and vegetation along the fence line.

b. Fence Only the Most Frequently Trespassed Portions of the Boundary. The five miles of boundary south of Straight Canyon, which is the area most frequently trespassed, will be fenced. Navajo hogans, corrals, and water developments are very near the boundary in this area.

Impacts. Fencing this portion of the boundary would discourage most trespass grazing. This will protect the canyon bottoms and pinyon juniper areas which are currently being heavily impacted. The exclusion of Navajo livestock from this portion of the park, and the poor condition of range lands on the adjacent reservation, may force Navajo ranchers to move their stock northward to take advantage of the remaining unfenced park lands, thereby increasing impacts there. Soil and vegetation disturbances will occur along the fence line during construction.

c. Establish a Grazing Agreement with Navajo Ranchers. An agreement not to graze park lands will be established with Navajo ranchers in the area. Such an agreement would be difficult to reach, as most Navajo ranchers do not recognize the current park boundary and claim historic grazing rights to park lands. There would be little incentive for Navajo's to enter into such an agreement, and if such an agreement were made it would probably be ineffective; because most, if not all, of the productive range land in the area is inside the park.

Impacts. Such an agreement, if it could be reached, would be ineffective in reducing grazing impacts to park lands.

d. No Action. The east boundary between the park and Navajo Reservation would not be fenced.

Impacts. The degradation of park resources would continue. Irreversible changes in vegetation composition and soil profiles will occur, if they have not already. Continued use by the Navajo's of park lands for grazing would support their claim of a historic grazing right.

4. RECOMMENDED COURSE OF ACTION: The entire 13 miles of boundary fence should be constructed. Short of this, the most frequently trespassed portion, south of Straight Canyon, should be fenced immediately, and the remainder completed at a later date. This completion of a boundary fence should occur before a shift in grazing pressures to the north, severely impacts what is now a relatively pristine area.

An attempt to reach a non-trespass agreement with the Navajo ranchers would be as effective as No Action. Both would result in an unacceptable degredation of park resources.

1. GRCA-N-19-Kanab Plateau Boundary Fence.

2. Statement of Issue or Problem:

Only two miles of the 24 mile park boundary fence on the Kanab Plateau has been fenced. This was accomplished in 1979 by members of the Young Adult Conservation Corps (YACC). Years of continual trespass grazing, hunting, and motor vehicle traffic occurring in this portion of the park has caused significant alterations of the soils, vegetation, and wildlife habitat.

3. Alternative Actions and Their Probable Impacts:

a. Complete the Boundary Fence. Twenty-two miles of four-strand barbed wire fence will be constructed along the park boundary on Kanab Plateau. This fence will be constructed with sufficient posts, guys, and stays to withstand snow loads up to five feet. Helvic type construction will allow safe passage of bighorn and deer.

Impacts. Recovery of the natural soils, flora and fauna, will begin with the exclusion of trespass livestock and hunters. It will be possible to close and rehabilitate some unnecessary roads in the area. Wildlife travel across the boundary will be somewhat impeded.

b. Continue to Construct Portions of the Fence as In-Park Materials and Personnel are Available. Personnel from YACC or other sources will be used to construct short segments of boundary fence as the personnel and materials are available.

Impacts. The impacts would be the same as for a boundary fence constructed in one season, however, it will be delayed considerably.

c. No Action. A boundary fence on the Kanab Plateau will not be completed.

Impacts. Changes in the soil, native wildlife, and vegetation will continue to progress. Loss of some native plant species through overgrazing and competition with invading species and the loss of soil as a result of accelerated erosion will be permanent. Trespass grazing, hunting, and the ingress of motor vehicles will continue.

4. Recommended Course of Action: The Kanab Plateau boundary fence should be completed as soon as possible and certainly by the time grazing permits expire. The continued degradation of park resources is unacceptable and completing the fence with available resources could take many years.

1. GRCA-N-30-North Rim Fence Repair.

2. Statement of Issue or Problem:

The park's boundary on the Kaibab Plateau was originally fenced by the Civilian Conservation Corps and is now in a state of disrepair. Heavy snows have damaged much of the original barbed wire fence, and a newer barbed wire fence was constructed in 1965 to replace one mile of rail fence. Additionally, the new boundary created by the Grand Canyon Enlargement Act of 1975 remains unfenced.

Park lands that are bounded by ineffective fences, or that are unfenced, are subject to trespass grazing and hunter ingress from adjacent U.S. Forest Service and Bureau of Land Management lands.

3. Alternative Actions and Their Probable Impacts:

a. Fence Entire Boundary. Twenty-six miles of boundary fence will be built or rebuilt to standards which will withstand the heavy snow common at the higher elevations of the North Rim. The fence will also be constructed so as to cause a minimal disruption of wildlife travel.

Impacts. Trespass grazing and inadvertant hunter ingress will cease. Occasional damage to the fence by falling trees will allow limited livestock trespass until repairs are made. Intentional hunter ingress may still occur. There will be some minor disturbance of wildlife migration patterns. Soils and vegetation will be disturbed during the fence project.

b. Fence Frequently Trespassed Portions of the Boundary. Portions of the boundary experiencing the most frequent trespasses by livestock and hunters will be fenced. Fences will be constructed to withstand heavy snows and cause minimal restriction to wildlife passage.

Impacts. Impacts from trespass grazing will be much reduced. The possibility will exist for livestock to go around a portion of the fence and be unable to find a way back across to water. The disruption of wildlife travel will be only slightly less than for a completely fenced boundary as wildlife travel in much the same patterns as livestock. Inadvertant hunter ingress will be effectively eliminated. A partial fence will be subject to the same periodic maintenance as a complete fence. Impacts to soils and vegetation during construction will be proportionately less than for a complete fence, depending on the length of fence constructed.

c. Construct no Fence. No new boundary fence will be constructed.

Impacts. Trespass grazing will continue at an extent dependent on stocking rates and range condition on adjacent lands. Hunter ingress will continue to have adverse impacts on park wildlife. Downed wires from the existing fence will present a hazard to both wildlife and livestock.

4. Recommended Course of Action:

The entire 26 mile boundary should be fenced. Short of this, as funds are available, the first priority for fencing will be portions most frequently trespassed by livestock and hunters.

The no action alternative will result in a continued unacceptable degredation of park resources.

1. GRCA-N-26-Pasture Wash Fence Repair.

2. Statement of Issue or Problem:

The 22 miles of boundary fence from the South Entrance Road to east of Pasture Wash is in a state of disrepair. Cattle and horses from adjacent Kaibab National Forest and Havasupai Indian Reservation lands are perpetually grazing on park lands. Hunters can unknowingly cross downed fence lines into the park.

Occasional repairs done in a haphazard manner have failed to keep pace with the rate of deterioration. The only concerted effort to repair this fence occurred in 1977 when the park's Youth Conservation Corps trainees repaired approximately two miles.

3. Alternative Actions and Their Probable Impacts:

a. Repair the Entire 22 Miles of Fence. The wire will be tightened and where necessary replaced. Rotted wooden fence posts will be replaced with metal posts. In areas identified as possible bighorn habitat the wire spacing will be changed to a Helvic style to allow their passage. Brush will be cleared from an eight foot easement on either side of the fence to prevent trees from falling across the fence.

Impacts. Most livestock and hunter trespass will be eliminated. Soils and vegetation disturbance will occur during repair activities, but will be reduced by the fact that the fence line is easily accessible by road in most places. There may be a minor disturbance of wildlife travel across the boundary.

b. Continue the Existing Haphazard Repair Efforts. The park will repair obvious bad spots when trespass livestock become a nuisance.

Impacts. Trespass, grazing, and hunting on park lands along this boundary will continue to be regular occurrences. As it is now constructed, bighorn may not be able to cross this fence safely. Impacts to soils and vegetation caused by trespass grazing will continue. Occasionally livestock and wildlife will be injured or killed when they become entangled in downed wire.

c. Discontinue Current Repair Efforts. The park will not attempt to repair downed or ineffective fence.

Impacts. Livestock and hunter trespass and their associated impacts will increase. The cost of eventual repairs will increase. Incidences of injury or death of livestock and wildlife will become numerous. Even where it is in good condition, this fence will be a hazard to bighorn.

4. Recommended Course of Action:

The park should make a concerted effort to repair and maintain this fence. Additionally, in the Pasture Wash area, where bighorn are occasionally found, the fence should be modified to a Helvic style.

Short of a complete fence repair project, the park should make an effort to identify and repair portions of the fence subject to frequent trespass.

The no action alternative was rejected, as it would result in unacceptable and possibly permanent alterations of wildlife habitat, vegetation and soils in the park. Injuries and death to livestock and wildlife from downed wire will be unacceptable and possibly malfeasant.

1. GRCA-N-45-Sanup Plateau Boundary Survey.
GRCA-N-46-Sanup Plateau Boundary Fence.

2. Statement of Issue or Problem:

The addition of Bureau of Land Management and Lake Mead National Recreation Area lands greatly increased the size of Grand Canyon National Park in the Sanup Plateau Area. Included in these new park lands was a portion of a grazing allotment which was extended for 10 years on park lands. Though this allotment will expire in 1984, livestock will continue to have free access to park lands across the unfenced boundary.

The Grand Canyon National Park Enlargement Act of 1975 does not identify the boundary location clearly. Hunter ingress, and in the future, trespass grazing, will occur across this unmarked boundary.

3. Alternative Actions and Their Probable Impacts:

a. Fence the Sanup Plateau Boundary. The 30 mile park boundary on the Sanup Plateau will be surveyed and fenced. A five-strand barbed wire fence will be built in compliance with Arizona's "fence out" law and will be able to withstand two feet of snow.

Impacts. Vegetation, soils and wildlife habitat in the park will begin to recover from past grazing. Park wildlife will be protected from unintentional hunter ingress. Some soils and vegetation will be disturbed during surveying and fence construction.

b. Fence Only Critical Areas. Major avenues of livestock travel and hunter ingress will be identified, surveyed, and fenced.

Impacts. The majority of livestock trespass and hunter ingress will be stopped. Soils, flora and fauna will begin to recover, however, this recovery will be slowed by periodic trespass grazing. Disturbances caused by fence construction will be proportional to the length and location of fence constructed.

c. No Action. The park boundary on the Sanup Plateau will not be fenced.

Impacts. The condition of park resources on the Sanup Plateau will, as they have in the past, be dependent on the weather, stocking rates and condition of adjacent grazing land. So long as grazing by domestic livestock continues, the condition of park resources will never approach a natural state, and most probably will continue to deteriorate.

4. Recommended Course of Action: The park boundary in the Sanup Plateau area should be surveyed and fenced by 1984, when the temporary grazing allotment on park lands expires.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: Livestock Use and Boundary Management
(Includes Project Statement No's. N-12, N-17, N-18, N-19, N-26, N-30, N-38, N-45 and N-46)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
Fiscal Year 82	
1 Resources Management Actions:	
- Complete Desert View Boundary Fence (N-12)	35.0
- Complete Kanab Plateau Fence (N-19)	21.0
2. Monitoring Actions:	
- Continue permittee monitoring (N-13)	2.0
3. Research Actions	
- Initiate H.U.L. Carrying Capacity Study (N-17)	20.0
Total	78.0
Fiscal Year 83	
1. Monitoring Actions:	
- Continue permittee monitoring	2.0
2. Research Actions	
- Continue H.U.L. Carrying Capacity Study	20.0
- Initiate Inner Canyon Stock Use Study (N-38)	4.0
3. Resources Management Actions:	
- Complete Pasture Wash Fence (N-26)	45.0
- Complete North Rim boundary fence (N-30)	25.0
Total	96.0
Fiscal Year 84	
1. Monitoring Actions:	
- Continue permittee monitoring	2.0
2. Research Actions:	
- Complete H.U.L. Carrying Capacity Study	20.0
- Continue Inner Canyon Stock Use Impact Study	4.0
Total	26.0

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: Livestock Use and Boundary Management Cont'd. (Page 2)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
Fiscal Year 85	
1. Monitoring Actions:	
- Continue monitoring permittees - grazing phase-out	2.0
2. Research Actions:	
- Complete Inner Canyon Stock Use Impact Study	4.0
Total	6.0
Fiscal Year 86	
1. Monitoring Actions:	
- Continue monitoring permittees (life tenure)	2.0
2. Resources Management Actions:	
- Sanup Plateau Boundary Survey (N-45)	50.0
- Sanup Plateau Boundary Fence (N-46)	385.0
Total	437.0
Fiscal Year	
Total	

(6) Rehabilitation of Impacted Areas.

Several areas throughout the park have been impacted by high levels of visitor use and the inability of the park to take immediate corrective actions. Other areas, impacted by past administrative use, continue to impact the natural environment, even though they are no longer needed by park administration. These areas include backcountry trails, barrow pits, campsites, and assorted roads and structures scattered throughout the park.

The need to rehabilitate these areas is in keeping with the park's enabling legislation and NPS policies. Specific problem areas include the following:

Trails: Four backcountry areas require immediate trail rehabilitation efforts. These areas include the Nankoweap Ruin river docking area, the upper Deer Creek Falls and Thunder River area, the Whitmore Canyon trailhead, and the Cross-canyon corridor.

The Nankoweap Ruin area contains a major archaeological site visited by river parties. As a result of activities of approximately 17,000 persons visiting this site annually, a network of trails has developed on the beach terrace and talus slope below the ruin. This trail network has resulted in trampled soils and the destruction of the cryptogamic lichen crust covering the fragile soil. The park intends to consolidate this network of trails into a single system which allows the rehabilitation of unneeded trails. Approximately 1.5 miles of trails will be closed and will be allowed to revert to a natural state.

The upper Deer Creek Falls and Thunder River area is used by approximately 14,000 visitors, including 4,000 backcountry hikers, annually. This area is impacted by numerous trails used as access routes to these attraction sites by river parties and backcountry hikers. This trail network has resulted in trampling and destruction of both the soil and riparian vegetation communities in these drainages. The park intends to consolidate the existing network of trails and close approximately three miles of secondary trails in these two drainages.

The Whitmore Canyon trail is used by approximately 15,000 visitors annually, most of whom are terminating river trips. Most of this traffic is carried by mules to the canyon rim. This use has resulted in drainage scars, switchback cutting, and gully erosion between the river docking area and the trailhead. Drainage-capture, landslides, and gully erosion have created situations which are both an eyesore and a safety hazard as mules attempt to lunge over these obstacles. Approximately one mile of trail will be rehabilitated.

Rehabilitation efforts on the cross-canyon trails are intended to correct environmental problems resulting from gully erosion, switchback cutting, landslides, and siltation. These impacts have resulted in the loss or reduction of native vegetation, the loss of soil stability, and the reduction of water quality along this corridor. The park intends to rehabilitate approximately 5,000 feet of the worst areas impacted along the trails. Work will involve the stabili-

zation of slide areas, bordering trails, and the revegetation of scars.

Campsites: Three backcountry camping areas are in need of immediate rehabilitation efforts. These areas include Horseshoe Mesa, Clear Creek, and the Deer Creek-Thunder River camping area.

Horseshoe Mesa is frequented by 4,200 overnight hikers and 6,000 day hikers annually. This use has resulted in scattered campsites throughout the area and has accelerated damage to local historic structures as campers use these walls and fallen materials for shelters. All structures on the mesa are listed on the National Register of Historic Places.

The park will close and revegetate all campsites scattered within the relics of the Last Chance Mine and associated buildings. Designated campsites will be delineated among remaining sites and routes to camping areas will be consolidated into a single trail.

In the Clear Creek area, 2,500 annual visitors have created a series of scattered campsites and trails in the riparian vegetation bordering the creek. The park will establish a single trail system, designate a specific campground, and re-establish native vegetation in impacted areas. Approximately two miles of multiple trails will be closed along with unneeded campsites totalling an area of approximately ½ acre.

Visitors using the Thunder River area have created a scattered assortment of campsites in the vegetation adjoining the falls and along the river itself. This has resulted in near total removal of vegetation at these sites and a sanitation problem as campers use nearby areas for human waste disposal. Multiple trails in this area have been obliterated, and a single established trail has been more clearly defined. Heavily impacted areas and scattered campsites have been covered with brush and rocks. A containerized pit toilet has been installed at Upper Tapeats Campground to reduce the impacts of human waste disposal.

Roads and Structures: Many unused barrow pits and several miles of abandoned roads exist within the park. These areas once served as access routes, fire trails, construction sites, shortcuts, supply depots, and other uses no longer needed. The roads invite illegal use from visitors and exist as an impact on the natural scene. An inventory of these roads, completed by the park, indicates that 350 acres of surface area are involved.

Also existing within the park are numerous obsolete or unused buildings, housing, phone and fence lines, etc.. These structures all present eyesores, and some pose safety hazards to both people and wildlife. Several desert bighorn, for example, have been killed by becoming entangled in old phone and fence lines.

Management actions for solving these problems will be: (1) to complete the inventory of all such roads and structures in the park, (2) to ascertain if there is a need for maintaining these manmade features, and (3) to determine or if they possess historical significance. If not, they will be closed permanently. A program of scarification and restoration will be undertaken where necessary. Before any action is taken with respect to roads or structures which possess potential historical significance, consultation under the provisions of Section 106 of the National Historic Preservation Act will be made.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-29-Rehabilitation of Impacted Areas.
GRCA-N-25-Stock Tank Abandonment/ Rehabilitation Study.

3. STATEMENT OF PROBLEM: The entire park, especially Grand Canyon Village, has sustained high use impact for many years, both from concessions and National Park Service developments. Little effort has been made to restore these impacted areas to desirable park environmental and aesthetic standards.

Structures and roads exist which neither serve useful purposes nor conform to established park standards. Some of these structures pose health and safety hazards to both man and wildlife. Examples are stock tanks located in old grazing areas, obsolete phone and fence lines, and obsolete buildings. Additionally, unused roads, power and sewer line right-of-ways and old barrow pits invite illegal visitor use, are denuded of vegetation and require restoration.

4. WHAT HAS BEEN DONE: Occasional litter clean-up campaigns have been initiated in the past, and sporadic junk removal carried out. In the early 1950's, a small amount of unsuccessful revegetation work was carried out along certain road right-of-ways. An inventory of roads to be restored to a natural state, totaling 350 acres of surface area, was prepared. In 1980, the park mapped stock tanks on old grazing permit lands which are slated to be rehabilitated.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: The inventory of roads and barrow pits to be restored needs to be expanded to include abandoned structures, phone lines, fences, etc.. The work anticipated at the present time includes the following:

The houses at Supai Camp will be managed under conditions identified in a Special Use Permit issued by the Park Superintendent in February 1982. Work should be undertaken to remove obsolete fences and phone lines around the Pasture Wash and inner canyon areas, and to remove old tires, auto parts, and assorted junk from the old sewer plant area at Grand Canyon Village, and from the drainage running from the old dumpsite at Trailer Village to Rowe Well Road. Secondly, various road, sewer, and powerline right-of-ways should be barricaded (consistent with NPS-Arizona Public Service agreements) to prevent further visitor use impact by vehicles, and then vegetatively screened to encourage natural vegetative regeneration.

The Desert View dump was phased out in 1975. Heavy equipment filled and rough graded this site. This site now needs to be planted with native species and restored to a natural condition. Old road scars need barricades to prevent further damage by visitors

driving in these areas. Vegetation screens should also be planted to naturalize these areas. Unneeded fencing and obsolete utilities need to be removed. Some old material sites and stock tanks need to be naturalized and have vehicular access blocked.

Before any alterations are performed to existing structures or roads, their historical significance will be determined and, if necessary, the appropriate procedures will be followed under Executive Order 11593 or Section 106 of the National Historic Preservation Act.

Backcountry campsites and trail networks need to be consolidated into designated campgrounds and pathways. Areas slated for rehabilitation include: Upper Deer Creek Falls and Thunder River; Whitmore Canyon; the Cross-canyon corridor; Clear Creek; and Horseshoe Mesa.

As grazing is phased out of the park, range improvements, such as stock tanks and line sheds, will be removed and/or allowed to return to a natural condition. In the case of stock tanks on the Kanab and Shivwits Plateaus, the park will first initiate a two-year research study intended to assess the relationship these water sources may have on native wildlife species and the impacts of water source removal. This study will be entitled a "Stock Tank Abandonment and Rehabilitation Study" and will be coordinated through the NPS Cooperative Research Studies Unit.

6. LENGTH OF TIME NEEDED: This work should be accomplished within two years.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: Public Law 93-620, Section 10, paragraph f declares those lands not held in Havasupai Tribal Trust are to be removed from tribal jurisdiction. Supai Camp falls within the parameters of this paragraph in that this particular area is not in Tribal Trust, but is part of the park itself. The obsolete phone lines and barbed wire fencing pose hazards to wildlife, notably bighorn and deer, and restrict their natural ranging tendencies. The old road, sewer and power line right-of-ways, if not barricaded and rehabilitated, will be continuously used by visitors for illegal camping and pull-offs, posing further law enforcement and fire hazard problems. The scars from these sites and remaining junk in other areas will continue to be eyesores to visitors.

The network of trails at inner canyon locations will widen as visitor use and erosion increase. Gradually this network will erode to the point that access to the attraction sites will be difficult and visitors will create additional trails to these sites.

Old stock tanks will continue to fill with water for several more years and continue to attract trespass cattle onto park lands. Vegetation and soils impacts resulting from this trespass use will prevent the recovery of the land to a natural state.

8. WHAT ARE THE ALTERNATIVES:

a. Stock tanks could be allowed to fill in through the slow processes of erosion, or, they could all be breached quickly during a wet season or during winter months. Wildlife would subsequently have the seasonal change from winter to spring to locate new (natural) water sources.

b. Trail use at heavily impacted areas could be restricted by use limits in keeping with the ability of the soil and vegetation communities to withstand the pressure, i.e., carrying capacities for individual sites would be established. Use would be reduced at each of the impacted sites and an enforcement system would need to be developed to ensure compliance.

c. Old buildings and structures at Supai Camp could be removed as present occupants vacate the premises and the entire camp would be phased out gradually over a period of 10 to 13 years.

9. PERSONNEL: Most of the project (removing phone and fence lines, barricading and fertilizing road, sewer and power line right-of-ways, and junk cleanup) can be accomplished with Young Adult Conservation Corps personnel in the summer. Removal of Supai Camp may be accomplished by park personnel and heavy equipment. Trail rehabilitation work will be accomplished by the park trail crew. Stock tank rehabilitation will be coordinated through the Resources Management Division.

10. ADMINISTRATION AND LOGISTICS:

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	0	0	0	0	0
Other then Personnel Services	40	30	24	15	5
TOTAL	$40	$30	$24	$15	$5
Funds Available in Park Base	0	0	0	0	0
Funds Requested from Regional Office	40	30	24	15	5

On Form		Date Submitted
10-237	[X]	December 1976
10-238	[ ]	
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS:

a. Clancy, Edmund J., Chief of Maintenance, Grand Canyon National Park.

b. Burns, Jennifer, Resources Managment Specialist, Grand Canyon National Park.

c. Walters, James E., and Larry A. May, Resources Management Division, Grand Canyon National Park.

d. Sloat, Harry, Landscape Architect, Western Regional Office, Memo to Edmund J. Clancy, Landscape Architect, Grand Canyon National Park, File D30.

e. Site and Acreage List: Areas to be Rehabilitated, Landscape Architect files, Grand Canyon National Park.

12. DATE OF SUBMISSION: September 1981.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: Rehabilitation of Impacted Areas
(Includes Project Statement No's. N-25 and N-29)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
1. Resources Management Actions:	
- Repair Cross-Canyon Corridor Trails	25.0
2. Research Actions:	
- Initiate Stocktank Rehabilitation Study	15.0
Total	40.0
2. Fiscal Year 83	
1. Resources Management Actions: (N-29)	
- Nankoweap Ruin and River Docking Area	4.0
- Upper Deer Creek Falls and Thunder River	5.0
- Whitmore Canyon Trailhead	6.0
2. Research Actions:	
- Continue Stocktank Rehabilitation Study (N-25)	15.0
Total	30.0
3. Fiscal Year 84	
1. Resources Management Actions;	
- Rehabilitate Horseshoe Mesa	4.0
- Rehabilitate Clear Creek	5.0
2. Research Actions;	
- Complete Stocktank Rehabilitation Study	15.0
Total	24.0
4. Fiscal Year 85	
Resources Management Actions;	
- Rehabilitate North and South Rim Roads and Barrow Pits	5.0
- Rehabilitate South Rim Structures	5.0
- Rehabilitate Kanab Plateau Stocktanks	5.0
Total	15.0
5. Fiscal Year 86	
Resources Management Actions:	
- Rehabilitate Shivwitz Plateau Stocktanks	5.0
Total	5.0

(7) Mining and Mineral File System

Public Law 94-429 (Sept. 28, 1976) requires that existing mining claims within any area of the National Park Service be recorded with the Secretary of the Interior by September 28, 1977, or they will be considered abandoned. Only the Orphan Mine, a uranium operation along the rim just west of Grand Canyon Village is still held in private ownership within Grand Canyon National Park. Although no actual mining is currently taking place, the owners of the mine, Republic Mining Enterprises, Inc., are appraising the uranium price market to evaluate the possibility of renewing operations. Current ore prices and transportation costs render immediate operations unfeasible.

The Orphan Mine originally opened in the 1890's before the Grand Canyon became a national park. It closed in 1968 as the uranium market weakened. The National Park Service owns the property, but mining rights on the land will not expire until 1987.

Although the mine is closed, it still presents a potential health hazard in that it is known to contain high working levels of radon gas. The present chainlink fence surrounding the mine property eliminates danger to the passing public, but the problem will persist in the mine until it is completely sealed.

Tailings from the mine were used as fill in and around the South Rim development area. It is suspected that traces of radon gas may still be detected, although in minute levels. The park has implemented a monitoring program to access levels of emission.

No oil or coal-bearing strata are known to exist within the Grand Canyon. Exploration for petroleum and natural gas has not occurred within the park, but extensive claim location activity is occurring up to the park boundary along the Kanab and Shivwits Plateaus. Mining development in these areas offer the possibility of threatening water quality as all drainages eventually lead into the Grand Canyon.

It is assumed by geologists that as the Colorado River cuts through to the base of the metamorphic rocks, any hydrocarbon resources that may have existed have long since drained from the strata adjacent to the Canyon. Two wells have been drilled far back from the canyon on both the North and South Rims in an effort to find oil. Both wells were dry holes. There are no geothermal resources present in the Grand Canyon. Lands enlarged under the 1975 Grand Canyon Enlargement Act are not open to mineral entry. This means that lands added to the park from Lake Mead National Recreation Area are no longer subject to mineral leasing. The mineral reservations on the Sanup Plateau and Shivwits Plateau are based upon ownership of mineral rights rather than on actual mineral discovery and mineral claims.

Mining and mineral activity in the park and on lands adjacent to park boundaries will be regulated or tracked to ensure protection of

Federal property and private interests by developing a filing and monitoring program administered by the Resources Management Division. This program will insure that the park possesses knowledge of the status of potential operations that may affect park lands.

Immediate action will include the physical closure for safety reasons of entrances to mines located on Horseshoe Mesa. Prior to closure, the historical significance will be evaluated by suitable professional personnel and if found significant, their closure will be preceeded by either consultation under the provisions of Executive Order 11593, or Section 106 of National Historic Preservation Act, whichever is appropriate. If found to be historically significant, closure may be accomplished by non-destructive means such as a metal grill, rather than by blasting or filling or other means of sealing. These mines are also suspected of being a source for persons unlawfully removing mineral specimens for commercial sale.

NATURAL RESOURCES PROJECT STATEMENT

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-47-Mining and Mineral File System.

3. STATMENT OF PROBLEM: Public Law 94-429 (September 28, 1976) requires that existing mining claims within any area of the National Park Service be recorded with the Secretary of the Interior by September 28, 1977, or they will be considered abandoned. Only the Orphan Mine, a uranium operation along the rim just west of Grand Canyon Village, is still held in private ownership. No actual mining, however, is currently taking place there. In 1987 the ownership of the mine will revert to the National Park Service. Although the mineral development potential for the park is low, rising costs of uranium products warrants close watch on existing mineral inholdings and on lands adjacent to the park open to location under the 1872 Mining Law and Mineral Leasing Act authorities. Gas and oil leases on the Shivwits and Sanup Plateau sections also present a potential for development, since they involve subsurface claims.

   The park is also concerned about possible public health problems resulting from radon gas emissions originating within the mine and from tailing material used as landfill in the South Rim development area.

4. WHAT HAS BEEN DONE: Problems have been handled on a crisis basis by whichever division possessed files and records. No previous monitoring program has existed.

   DESCRIPTION OF WORK TO BE UNDERTAKEN: Consolidate all records and documents into a central file to be administered by the Division of Resources Management. Establish a monitoring program to insure that the park possesses knowledge of the exact status, both on record and in the field, of potential development sites. Entrances of mines on Horseshoe Mesa will be closed for public safety and to prevent the removal of mineral specimens.

6. LENGTH OF TIME NEEDED: Continuing.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: The park will continue to operate its mining and mineral program on a crisis basis. No centralization of data will exist. The park will continue to depend on regional staff to ascertain its position on these issues.

8. WHAT ARE THE ALTERNATIVES:

   a. Continue under current administration policies.

   b. Assign responsibility to a different division.

9. PERSONNEL: Existing park staff.

10. ADMINISTRATION AND LOGISTICS:

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
FY	82	83	84	85	86
Personnel Services	(Program to be funded within existing programs)				
Other than Personnel Services	2.5	2.5	.5	.5	.5
TOTAL	2.5	2.5	.5	.5	.5
Funds Available in Park Base	0	0	0	0	0
Funds Requested From Regional Office	2.5	2.5	.5	.5	.5

On Form	Date Submitted
10-237 [X]	October 1976
10-238 [ ]	(Program to be instigated within existing operation, plus support from Increase No.s 162 and 239)
10-250 [ ]	
10-451 [ ]	

REFERENCES AND CONTACTS:

a. Walters, James E., Resources Management Specialist, Grand Canyon National Park.

b. May, Larry A., Chief, Division Resources Management, Grand Canyon National Park.

11. DATE OF SUBMISSION: September 1981.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- N - 47- Mining and Mineral File System

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Resources Management Actions:	
- Develop and implement a minerals file and monitoring system	.5
- Close hazardous mine entrances on Horseshoe Mesa	2.0
Total	2.5
2. Fiscal Year 83	
Resources Management Actions:	
- Continue mineral files and monitoring system	.5
- Close hazardous mine entrances on Horseshoe Mesa	2.0
Total	2.5
3. Fiscal Year 84	
Resources Management Actions:	
- Continue mineral files and monitoring system	.5
Total	.5
4. Fiscal Year 85	
Resources Management Actions:	
- Continue mineral files and monitoring system	.5
Total	.5
5. Fiscal Year 86	
Resources Management Actions:	
- Continue mineral files and monitoring system	.5
Total	.5

(8) Study of Visitor Impact on Mather Campground.

The Mather Campground in Grand Canyon Village is used by over 300,000 people annually. Damage to vegetation and soils is obvious in and around the camping complex. Trees are being impacted by persons hanging equipment on them or through the illegal gathering of branches for firewood. Natural ground litter is almost non-existent, as campers scour the area for available fuel. The fragile soils within the campground are compacted by constant trampling and scorched by proliferation of ground fires. This area of the park has lost much of its rustic appeal through this damage, and it has been described by many park managers as "a sacrifice area."

Management needs for this problem include a research project designed to: (1) evaluate and quantify the rate and character of resource impacts; and (2) find an efficient, practical method of resource restoration. Some data has already been gathered on visitor use patterns, tree growth, soil characteristics, and vertebrate populations. The goal of research and monitoring efforts will be to restore Mather Campground to a more "natural" state.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-43-Study of Visitor Impact on Mather Campground.

3. STATEMENT OF PROBLEM: Mather Campground in Grand Canyon Village is heavily used by visitors throughout the year. The resulting impact on vegetation is great. Research is needed to determine practical means for maintaining a semblance of natural conditions in the campground. Vegetation does not rejuvenate naturally for many years under semi-arid conditions.

4. WHAT HAS BEEN DONE: Data has been gathered on visitor use at Mather Campground. In addition, use information has been gathered on types and uses of camping equipment, what sites are favored by people with particular kinds of equipment, whether they camp with children, and whether they cook out-of-doors. The types and intensity of use have been correlated with ecosystems, and the effects compared to nearby "natural" control areas. Four representative sites have been mapped in detail, and gross changes noted since the study began. Data has been gathered about tree growth by the use of tree ring analysis. A large number of soil samples have been analyzed for physical, chemical and micro-biological parameters. Populations of vertebrates have been determined for comparison with the control plots.

5. DESCRIPTION OF THE WORK TO BE UNDERTAKEN: Research is to be undertaken to evaluate and quantify the rate and mode of impact by visitors on the vegetation and soils of Grand Canyon National Park. The major emphasis of the study will be directed toward the determination of changes taking place in the plant communities involved with only minor attention given to faunistic changes. Further research will be directed toward finding an efficient, feasible and rapid method of restoration of damaged areas. Recommendations for future management will be made to minimize impact.

   The goals of this study go beyond simple identification of problems and solutions. The ultimate objective is to obtain information suitable for long-range planning. Data about carrying capacities, desirable physical arrangement of campgrounds, and suitable sites for development from an ecological point of view will become available.

6. LENGTH OF TIME NEEDED: With adequate funding, this project can be completed in three years.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: Mather Campground will probably continue to deteriorate and become aesthetically unpleasant and biologically depleted. Attempts to restore a semblance of natural conditions may be uneconomical and ineffective without a proper data base.

8. WHAT ARE THE ALTERNATIVES:

a. Move the campground when the present one is severely depleted.

b. Close portions of the campground in rotation for several years duration.

c. Attempt reseeding and revegetation by trial-and-error methods.

d. Severely reduce the number of times a camping site can be used during the travel season.

9. PERSONNEL: Research contractors and park staff.

10. ADMINISTRATION AND LOGISTICS: The Cooperative National Park Resource Studies Unit at the University of Arizona in Tucson will administer this project.

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	0	0	0	0	0
Other than Personnel Service	0	0	$7	$7	$7
TOTAL	0	0	$7	$7	$7
Funds Available in Park Base	0	0	0	0	0
Funds Requested from Regional Office	0	0	$7	$7	$7

On Form		Date Submitted
10-237	[X]	October 1976
10-238	[ ]	(Program to be supported by Increase No. 156.)
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS:

a. May, Larry A., and James E. Walters, Resources Management Division, Grand Canyon National Park.

b. Harvey, H. T., R. J. Hartesveldt, and J. T. Stanley. 1972. Wilderness Impact Study Report. Sierra Club Outing Committee, San Francisco, California. 87 pp.

12. DATE OF SUBMISSION: September 1981.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- N -43 - Study of Visitor Impact on Mather Campground

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
NA	
Total	
2. Fiscal Year 83	
NA	
Total	
3. Fiscal Year 84	
Research Actions:	
- Initiate Mather Campground Impact Study	7.0
Total	7.0
4. Fiscal Year 85	
Research Actions:	
- Continue Mather Campground Impact Study	7.0
Total	7.0
5. Fiscal Year 86	
Research Actions:	
- Complete Mather Campground Impact Study	7.0
Total	7.0

(9) Foreign Visitation.

The number of foreign visitors to the Grand Canyon has increased significantly over the past decade. While exact statistics are unavailable, concession facilities within and surrounding the park estimate that as much as 30 to 40 percent of the park's annual visitation is composed of foreign visitors. While informal observation would seem to indicate a predominance of Japanese, German, and French visitors, closer observation shows that the visiting public to the Grand Canyon actually represents a much wider variety of nationalities and races.

Currently, the park has limited facilities to provide for the non-English speaking visitor. General information handouts in German, Japanese, Spanish, and French are available at the main Visitor Center. While the National Park Service does attempt to develop a cadre of foreign language speaking uniformed interpreters during the main visitor season, there is actually little or no interpretive, safety, or general information available for the foreign visitor once he or she leaves the Visitor Center.

Because of the increase in requests for assistance and information by foreign visitors at hotels, restaurants, stores, etc., and the increasing number of foreign visitors requiring medical attention in the backcountry, it is felt that this category of park visitor is receiving inadequate visitor orientation.

The park is also interested in understanding the relationship of money and manhours spent in providing services to foreign visitors versus the amount spent in servicing U.S. citizens. It is also important that park management understand special needs and interests foreign visitors might have when visiting Grand Canyon. A better understanding of specific transportation needs and problems (aircraft, bus tours, shuttle bus services, mule rides) in and around the park is also necessary if the park is to adequately serve visitors.

To accomplish these goals, the park is proposing a two year foreign visitor study to evaluate the origin, number, and needs of non-English speaking persons visiting the park. It is important to note that these concerns also extend to the total of Grand Canyon visitors. For that reason, we propose a component of this effort will include preparation of a Social Science Research Plan. It is anticipated that this project will be conducted through contract with a qualified research institution and will be coordinated through the Cooperative Park Research Studies Unit at the University of Arizona.

1. GRCA-N-24 Foreign Visitor Study.

2. Statement of Issue or Problem.

An estimated 30% to 40% of total park visitation at Grand Canyon National Park is composed of foreign visitors. In order for park management to respond to their needs, information is needed on the demographic characteristics of these groups, and their visitation and park use patterns.

Past Management History: A one year demographic study of foreign visitors was conducted in the park from October 1980 to September 1981. The purpose of the study was to gather information on the number of foreign visitors to the canyon, the countries they represented, their interests, activities and method of travel to the park. A final report from this study is pending as of this writing.

3. Alternative Actions and Their Probable Impacts:

a. No Action: Without specific information on foreign visitors, their activities, and distribution within Grand Canyon National Park, the park will not provide necessary services including: 1) interpretive programs designed for the foreign visitor; 2) effective utilization of multi-lingual interpreters; 3) effective information services; and 4) an effective law enforcement and safety program.

Impacts. Impacts of this alternative will be: 1) inadequate service to foreign visitors; 2) possible economic impact as visitors seek other areas of interest with better service; 3) minor impacts to natural resources through carelessness and ignorance on the part of visitors, e.g. fires, picking flowers, switchback cutting, etc..

b. Conduct a Two-Year Study of Visitation to Grand Canyon. This will be an in-depth study of foreign visitation based upon the findings of the park project conducted in 1981. Its purpose will be to identify foreign visitation patterns throughout the year and to develop management recommendations to improve services for foreign visitors.

Impacts. Impacts of this research effort will include: 1) improved benefits to foreign visitors; 2) perhaps increases in foreign visitation; 3) better understanding of and consideration for park aesthetics and resources on the part of the visitor; 4) adverse impacts to foreign visitors who do not like to be questioned or fill out survey forms; 5) decreased time and manpower spent in law enforcement and emergencies involving foreign visitors.

4. Recommended Course of Action: The preferred action is to conduct a two-year study of the demographic characteristics of foreign visitors, the visitation and park-use patterns, and their needs. The study will provide information needed by park managers to adequately

respond to the needs of these visitor groups in areas of interpretation, visitor services, park maintenance, safety, and protection of the park's natural resources.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA-N - 24 - Foreign Visitor Study

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Research Actions:	
-Initiate a demographic study of foreign visitors to Grand Canyon National Park.	10.0
Total	10.0
2. Fiscal Year 83	
Research Actions:	
-Complete study of foreign visitation to Grand Canyon National Park	10.0
Total	10.0
3. Fiscal Year 84	
NA	
Total	
4. Fiscal Year 85	
NA	
Total	
5. Fiscal Year 86	
NA	
Total	

e) GEOLOGIC FEATURES AND DISTURBANCES.

(1) Cave Monitoring Program

The caves found in the Redwall limestone formation throughout the Grand Canyon provide a unique recreational opportunity for park visitors. Over 30 caves have been recorded and mapped. There is a potential for locating dozens more as spelunkers explore the more remote sections of the park. Approximately 1,500 people visit park caves annually.

In addition to providing a unique recreation experience, caves can be used for basic and applied, non-destructive research. Because of their simplicity, underground environments are easily defined, and then ecology, evolution and mineralogy studied. Cave studies also provide information on geology, karst topography, hydrology, paleontology, and archeology.

Caves are fragile resources which can be endangered by both overuse and intentional vandalism. The contents of a cave - its formations, biota, and floor deposits - are essential for its enjoyment and complete interpretation. Once these resources are removed, they cannot be recovered. With few exceptions, caves in the park are classified as outstanding natural areas, and are managed primarily for their wilderness exploration values.

Bat Cave, near River Mile 265, has lost much of its wilderness character because of past guano mining in its entrance portions. The historical significance of the mining operations at Bat Cave will be evaluated by suitable professionals, and if any such significance is found, the provisions of Executive Order 11593 and the procedures of the Advisory Council for the National Register of Historic Places will be followed.

Roaring Springs Cave, in the cross-canyon corridor, is closed to public entry, because it supplies water for the North and South Rim developed areas. Stanton's Cave near Vasey's Paradise in Marble Canyon, and Rampart Cave in the Grand Wash Cliffs near the Colorado River, have been gated to protect archeological and paleontological material from disturbance. Other caves which have special restrictions upon entry are: Muav Cave, near the Colorado River in the extreme western portion of the park, because of its archeological content; and nearby Vulture Cave for its paleontological evidence of use by the Shasta ground sloth.

Tsean Bida Cave has been physically closed as a shortcut route used by hikers in their progress down the Hance Trail. Cave of the Domes, on Horseshoe Mesa, will be managed as an "open" cave and will be accessible to persons with only minimal knowledge of cave etiquette and safety.

A Cave Management Plan has been prepared in recognition of the unique recreational and scientific value of these resources. Management actions will include the close regulation of total annual visitation, party sizes, and length of stay. Individual carrying capacities have been established for each cave and permits are issued accordingly, with length of stay limited to two days. Permits are issued by park personnel familiar with cave techniques and safety precautions for protection of both the visitor and the resource.

All caves not specifically restricted are open to the public. Cavers are required to demonstrate sufficient cave knowledge and technical expertise to insure the well-being of themselves and the resource. The Cave Management Plan also requires that spelunkers possess minimal caving gear in accordance with standards set forth by the National Speleological Society.

The exception to the above policy will be those caves possessing recognized archeological or paleontological material. All such caves will be closed to the public until scientific investigation proves recreational use will not hinder or destroy its value.

Scientific collection shall be professional, selective and minimal. Because they are part of the delicately balanced cave ecosystem, specimens may not be collected for display or study collections even if the specimens are previously broken or dead. Funding for cave management will be used to: (1) update the Cave Management Plan as needed; (2) monitor visitor use levels; (3) complete annual photo impact transects; and (4) continue liaison with the caving community by attending state caving organization meetings.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-36-Cave Use Impact Monitoring.

3. STATEMENT OF PROBLEM: An unknown number of natural caves having paleontological, archeological, biological, mineralogical, historical, and recreational value exist within the park. These sites also present a definite safety hazard. Sport caving is fast increasing as a park recreation activity. Because of a general lack of knowledge, the park stands to lose both the scientific and aesthetic values of this resource through public misuse. New sites are constantly being located, adding to the management load.

4. WHAT HAS BEEN DONE: Preliminary surveys have been made of several caves by private sport spelunkers and by members of the Cave Research Foundation. These sites include only a few of the total number of caves in the park. Fairly extensive paleontological and archeological research has been conducted in Rampart Cave and Stanton's Cave, with other sites receiving only salvage investigation, if any at all. Monitoring of radon gas in several of the most heavily used caves indicates relatively low levels of radiation. A Cave Management Plan was completed by the park in 1979, and implemented that year.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: Continue implementing the Cave Management Plan. Continue an inventory of all caves to include information on location, accessibility, scientific value, etc.. Monitor carrying capacities for recreation caves and continue the management program aimed at preserving these sites. Close all caves having scientific value until they can be evaluated by qualified personnel. Continue the cave use permit system in conjunction with the management plan; this includes regulations on required equipment and techniques. Provide for the protection (closure) of caves having extreme scientific value.

6. LENGTH OF TIME NEEDED: Continuing.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: The park will continue to lose these sites through destruction by vandals and pressures from recreational users. Irreplaceable scientific data in the fields of archeology, mineralogy, and paleontology will be lost.

8. WHAT ARE THE ALTERNATIVES:

   a. Do nothing.

   b. Close all caves immediately until research can be funded.

9. PERSONNEL: Existing park staff, contract personnel, Cave Research Foundation, and sport caving organizations' volunteers.

10. ADMINISTRATION AND LOGISTICS:

FUNDING	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	0	0	0	0	0
Other than Personnel Services	$500	500	500	500	500
TOTAL	$500	500	500	500	500
Funds Available in Park Base	0	0	0	0	0
Funds Requested from Regional Office	$500	500	500	500	500

On Form		Date Submitted
10-237	[X]	August 1981
10-238	[ ]	(Program will be executed within operational base and as funds become available with support from Increase No. 239)
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS:

a. Arizona Grotto Chapters.
b. Cave Research Foundation, Tucson, Arizona.
c. National Speleological Society.
d. Walters, James E., Resources Management Specialist, Grand Canyon National Park.

12. DATE OF SUBMISSION: September 1981.

PROJECT TITLE: GRCA-N -36 - Cave Use Impact Monitoring

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
1. Monitoring Actions:	
- Continue annual photo transects and monitoring established use limits.	
2. Resources Management Actions:	
- Update Cave Management Plan as needed and continue liaison with caving community.	
Total	.5
2. Fiscal Year 83	
1. Monitoring Actions:	
- Continue annual photo transects and monitoring established use limits.	
2. Resources Management Actions:	
- Update Cave Management Plan as needed and continue liaison with caving community.	
Total	.5
3. Fiscal Year 84	
1. Monitoring Actions:	
- Continue annual photo transects and monitoring established use limits.	
2. Resources Management Actions:	
- Update Cave Management Plan as needed and continue liaison with caving community.	
Total	.5
4. Fiscal Year 85	
1. Monitoring Actions:	
- Continue annual photo transects and monitoring established use limits.	
2. Resources Management Actions:	
- Update Cave Management Plan as needed and continue liaison with caving community.	
Total	.5
5. Fiscal Year 86	
1. Monitoring Actions:	
- Continue annual photo transects and monitoring established use limits.	
2. Resources Management Actions:	
- Update Cave Management Plan as needed and continue liaison with caving community.	
Total	.5

(2) Meadow Restoration and Ecology Study.

Meadows on the North Rim of the Grand Canyon represent a distinct plant and animal community. The park contains approximately four square miles of North Rim meadows. Informal observations and records have documented what appears to be a slow encroachment of these areas by surrounding forests. Whether or not this encroachment will gradually cover the meadows, or whether there is a natural control mechanism to maintain these clearings, is unknown. However, it is reasonable to assume natural fire plays an important role in meadow ecology as evidenced by fire scars and the presence of several plant species in and around these meadows.

Existing unpaved roads on the North Rim include approximately 15 miles through park meadowlands. Some of these roads exceed management needs and mar scenic grasslands, altering the natural drainage patterns of the meadows and cause severe erosion problems. Nine miles of roads were closed in recent years in an attempt to promote rehabilitation of meadowlands.

Management efforts for this problem will include: (1) the continued closure and scarification of unnecessary roads crossing meadowlands; and (2) the initiation of a research and monitoring projects investigating meadow ecology. Management work will be carried out by the park staff. Research efforts will be coordinated through the Cooperative Park Research Studies Unit at the University of Arizona. Research work may be contracted to an established research institution.

1. GRCA-N-41-Meadow Restoration and Ecology Study.

2. Statement of Issue or Problem:

Although meadows make up a small percentage of the North Rim acreage, they contribute greatly to the overall scenic beauty of the area. They enhance visitor experiences in the park and constitute an important ecological biome containing a wide variety of grasses, wildflowers and animals. The North Rim contains approximately 90 miles of backcountry road, 15 miles of which traverse meadowlands. Most of these roads follow drainage bottoms which upset the natural flow regime of the meadows and cause considerable erosion. Deep meadow soils are particularly susceptible to erosion and are slow to recover. Erosion scars from vehicle traffic across meadows are very noticeable, unsightly, and encourage further use.

One road crossing a meadow on the North Rim was closed in 1979. More closures are planned.

3. Alternative Actions and Their Probable Impacts:

a. Study Meadow Ecology. A meadow ecology study will be contracted to a research institution prior to any extensive rehabilitation efforts. This study will explore run-off patterns, soils, plant succession, role of fire in meadow evolution, natural and artificial revegetation, erosion control techniques and structures, and visitor perceptions of meadow erosion.

Impacts. Knowledge gained through this study will be useful in several aspects of meadow restoration. The most severely impacted areas can be identified and given top priority for rehabilitation. Rehabilitation can be accomplished with a minimum of adverse impacts to the meadow ecosystems. Where roads are allowed to remain, measures can also be taken to effectively mitigate adverse impacts.

b. Close and Rehabilitate Roads Without A Study. Road closures and rehabilitation efforts would begin as soon as manpower and funds are available. A literature search would be made to determine the best available methods.

Impacts. Active erosion from meadows would be reduced greatly. Visual impacts would also be reduced although more slowly. A reduction in downslope sedimentation problems would parallel the stabilization of active erosion. Current techniques of meadow gully stabilization will cause a substantial, though temporary, disturbance of soil and vegetation.

c. Close or Relocate Roads and Allow Natural Rehabilitation to Occur. Actively eroding meadow roads will be physically closed and allowed to stabilize and revegetate through natural succession.

Impacts. Active gully erosion will continue to occur until a new channel slope equilibrium is reached. Revegetation will be very slow, taking many decades. Natural gully widening will result in the loss of substantial amounts of soil and vegetation. The recovering gullies will be obvious for decades and noticeable for centuries.

d. No Action. Roads through meadows will continue to be used until erosion makes them impassable, in which case motorists will develop a parallel road adjacent to the impassable one.

Impacts. Roads will become a permanent blight on the meadow landscape. Active gully erosion in the roads will spread, involving all drainages in the meadow which connect with the lowering base level of the roadway. Substantial amounts of soil will be permanently lost, lowering the productivity of the meadow ecosystem. The continued presence of roads through meadows will encourage motorists to travel across previously unscarred meadows.

4. Recommended Course of Action:

A study should be initiated to explore meadow ecology and recommend the most economical and environmentally sound methods of meadow restoration. Roads through meadows should be closed as soon as it is determined that they are unnecessary or funds are available to relocate them. Road closures should proceed with or without restoration efforts, as natural rehabilitation, though slow, is far better than continued degradation. At the very least, a thorough investigation of the literature on meadow restoration, and consultation with Kaibab National Forest regarding restoration projects on U.S. Forest Service lands should be accomplished before restoration efforts begin on park lands. Active gully erosion in meadows is one of the most obvious and unsightly indicators of improper land management.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- N - 41 - Meadow Restoration and Ecology

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Resources Management Actions;	
- Continue Closure of Unneeded Roads	1.0
Total	1.0
2. Fiscal Year 83	
Resources Management Actions;	
- Continue Closure of Unneeded Roads	1.0
Total	1.0
3. Fiscal Year 84	
Research Actions:	
- Initiate Meadow Ecology Study	7.0
Total	7.0
4. Fiscal Year 85	
Research Actions:	
- Continue Meadow Ecology Study	7.0
Total	7.0
5. Fiscal Year 86	
Research Actions:	
- Complete Meadow Ecology Study	7.0
Total	7.0

f) WILDLIFE MANAGEMENT.

(1) Desert Bighorn Population Study.

It is suspected that the Grand Canyon contains a significant percentage of the remaining desert bighorn (*Ovis canadensis mexicanus*) found in the United States. However, while these animals are commonly seen and admired, extremely little is known about their population and ecology in the Grand Canyon.

In 1970, a park biologist initiated a river user observation project intended to generate basic population data. These data were to have been integrated into a punch-card inventory system and keyed to a Mercator Grid sighting system. However, river observations proved to be relatively infrequent, and this project was not fully implemented.

In 1978 and 1981, the park conducted helicopter survey flights as part of its feral burro management program. Observations of bighorn and other wildlife were made during these flights. The resultant data, combined with backcountry hiker observations, enabled the park to estimate the approximate herd size inhabiting the South Tonto Plateau. A comparison of the 1978 data size with data generated during 1981 survey flights indicates a reduction in the overall herd size in this section of the National Park.

Several factors may be having unknown detrimental effects on bighorn populations. These factors include: (1) a dramatic increase in backcountry use; (2) competition with the park's feral burro herds; and (3) diseases which infect bighorn.

Legal grazing on park lands could also be impacting this native wildlife species. Proposals to increase the present grazing levels on the Havasupai Indian Reservation, and especially the Havasupai Traditional Use Lands, are a concern to the park.

A comprehensive ecological survey of the park's entire bighorn population needs to be undertaken to ensure the continued existence of this animal. The actual numbers and movements of these animals needs to be determined and monitored. The general condition of the herd and the interaction of sheep with present backcountry use patterns needs to be evaluated in order to determine possible competitive situations. Data will be collected through the use of radio-collar monitors, field observations, and aircraft surveys.

It is proposed that a three-year research project be implemented. This work will be coordinated through the NPS Cooperative Research Studies Unit and may be contracted to other research institutions.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-8-Desert Bighorn Population and Ecology Study-Havasupai Use Lands and Burro Impact Areas.

3. STATEMENT OF PROBLEM: The number, movement, and ecology of desert bighorns within Grand Canyon National Park are virtually unknown. Such information is needed in order to ensure the continued presence in the park of stable, healthy herds of this native animal. At this time, there are several factors which may be having unseen detrimental effects on the sheep within the park: recent, dramatic increases in backcountry use; past competition with the park's feral burro population; grazing of domestic livestock in and adjacent to the park; the hunting of desert bighorn on the adjoining Hualapai Indian Reservation; and population instability and disease, such as affects many herds of desert bighorn in the Southwest. Of particular and immediate concern are the effects of present and proposed grazing of domestic and feral livestock in the Havasupai Use Lands of the park.

4. WHAT HAS BEEN DONE: Between 1972 and 1975, the park conducted a survey of the desert bighorn along the Colorado River, gathering data from past records as well as from new observations. Information was collected on distribution, herd movements, age/sex ratios, etc. In 1977 desert bighorn fecal pellets from four different locations along the Tonto Plateau were analyzed for food content. During 1977 and 1978, the park conducted a study which compared hiker observations of desert bighorn with helicopter surveys and determined the total number of sheep between Red Canyon and Fossil Canyon. All of the studies undertaken to date have been limited both in scope and geographic area.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: A comprehensive survey of the entire desert bighorn population of Grand Canyon National Park needs to be performed. The actual number of animals needs to be determined and information needs to be gathered on sheep movements, the age/sex structure of the population, general condition of the herds, desert bighorn-feral burro interactions, foods eaten and habitat preference. Such means as radio collaring, field observations, and aircraft surveys will be employed to collect the data. A method to monitor population trends must be developed so that any change in numbers can be detected.

6. LENGTH OF TIME NEEDED: With adequate funding, this project can probably be completed in three years. Actual progress in realizing interim goals may dictate the final amount of time needed.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: The park will not have enough knowledge to properly manage adverse impacts that might affect the future existence and welfare of desert bighorn at Grand Canyon.

8. WHAT ARE THE ALTERNATIVES:

a. Do nothing.

b. Undertake a desert bighorn study more limited in scope and covering a smaller geographic area.

c. Make arbitrary decisions on bighorn management based on inadequate knowledge.

d. Attempt to correlate bighorn studies in other desert areas to the bighorn situation at Grand Canyon.

9. PERSONNEL: Research contractors will perform the bulk of the work. Qualified National Park Service personnel from University Cooperative Studies Units may assist.

10. ADMINISTRATION AND LOGISTICS:

The Cooperative National Park Research Studies Unit at the University of Arizona in Tucson will administer this project and provide limited logistical support.

FUNDING (In thousands)	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	0	0	0	0	0
Other Services	70	70	70	0	0
TOTAL	$70	70	70	0	0
Funds Available from Park Base	0	0	0	0	0
Funds Requested from Regional	$70	70	70	0	0

On Form		Date Submitted
10-237	[X]	January 1981
10-238	[ ]	_____ 1979
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS:

a. Walters, James E., Resources Management Specialist, Grand Canyon National Park.

b. Douglas, Charles, University of Nevada at Las Vegas.

c. Guse, Neal G., Jr. 1975. Notes and observations compiled as the park biologist. Grand Canyon National Park, Arizona.

d. Walters, James E. 1979. Bighorn sheep population estimate for the south Tonto Plateau - Grand Canyon. Unpublished manuscript, National Park Service, Grand Canyon National Park, Arizona. 12pp.

e. Walters, James E., and Richard M. Hansen. 1978. Evidence of feral burro competition with desert bighorn sheep in Grand Canyon National Park. Desert Bighorn Council Trans. 1978: 10-16.

12. DATE OF SUBMISSION: September 1981.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- N - 8 - Desert Bighorn Population and Ecology Study - Havasupai Use Lands and Burro Impact Areas

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Research Actions:	
-Initiate a Comprehensive Ecology Study of the park's Bighorn Populations, i.e., determine population numbers, trends and movements	70.0
Total	70.0
2. Fiscal Year 83	
Research Actions:	
-Continue Ecological Investigations of Bighorn populations	70.0
Total	70.0
3. Fiscal Year 84	
Research Actions:	
-Continue Ecological Investigations of Bighorn Populations	70.0
Total	70.0
4. Fiscal Year 85	
NA	
Total	
5. Fiscal Year 86	
NA	
Total	

(2) Other Wildlife Projects.

(a) Monitor Deer Population Trend: Prior to the establishment of Grand Canyon National Park in 1919, livestock grazing in the area kept deer populations small through competition for forage and water. When livestock grazing was reduced, deer populations began to increase rapidly. Increased forage, transplanted individuals, construction of watering tanks, and boundary fencing to exclude cattle further bolstered the population size. Deer also migrated into the park where competition was non-existent and began to utilize water from the sewage disposal systems. South Rim populations began to exceed the carrying capacity of the range, resulting in destruction of park vegetation. In addition, deer began to frequent developed areas and roadsides creating public safety hazards.

From the 1940's to the 1960's on the South Rim, deer were live-trapped and relocated to nearby Indian reservations or, as a last resort, killed by park rangers. Direct reductions were limited to deer in isolated areas and those ailing or crippled by park motorists.

Deer on the North Rim were historically hunted by the Southern Paiute Indian Tribe during the summer, and their hides were traded with the Navajo and other nearby tribes. This ancient process of eliminating about 800 deer annually probably aided in stabilizing the deer population.

Records clearly indicate that the Kaibab (North Rim) deer range began to deteriorate with the introduction of extensive herds of livestock. By 1887, at least 200,000 sheep, 20,000 cattle, and "many" horses were using land formerly occupied only by mule deer, pronghorn antelope, and other native wildlife.

The purported "unlimited" supply of forage rapidly declined and led to the establishment of the Kaibab Deer Preserve. One objective was to preserve the mule deer, whose numbers were decreasing at an alarming rate. The action was, however, the first step in the long line of mistakes which degraded the native wildlife and its habitat. Deer hunting was prohibited, followed by intensive predator elimination. The wolf was exterminated and many thousands of cougars, coyotes, and bobcats were taken over a 30-year period. A deer population explosion resulted, and by 1924 an estimated 100,000 deer had devastated their range. The inevitable population decline began in which malnutrition and disease killed an estimated 60 percent of the herd. Regulated hunting and a deer reduction program by government hunters in the Kaibab National Forest began in 1924. Public hunting continues today outside the park, where a herd of about 10,000 to 12,000 deer exists.

Deer control programs within the park have not been recommended nor carried out since the winter of 1963-64. However, population levels on both rims appear to be declining as indicated by pellet-group transects read by the park and the Arizona Game & Fish Department. Park control efforts are now limited to dispatching ailing or injured animals along park roadways.

Meanwhile the park's deer herds continue to be subject to pressures exerted from outside the park including; grazing, hunting, and predator depredation hunts. If the park is to protect the natural balance of deer populations within its boundaries, it must continue a program of population monitoring in order to provide sound management recommendations to neighboring Federal and State agencies.

To effect this monitoring program, management efforts will include the continued reading of pellet group and browse transects. A tagging program will also be initiated in order to monitor deer movements in and out of the park. These programs will be coordinated with on-going Arizona Game & Fish Department projects.

(b) Predatory Mammals Study. Only broad ecological relationships of predator and prey species within the park are known. Research is complicated by predator movement out of the park and the protection the park offers. The effect of depredation hunts, conducted outside the park, have on predator populations inside the park, is unknown.

A four-year management study will identify the population status and trends of park predators, critical habitat requirements, relationship with prey species, and impacts of off-park control measures. This increased understanding of predator roles will allow recommendations for the management of predator populations, and will supply knowledge needed to negotiate agreements with other agencies to manage predators occasionally resident to the park. All work will be coordinated through the NPS Cooperative Research Studies Unit.

(c) Monitor Elk, Antelope and Turkey Populations: The park has representative numbers of elk and turkey but little is known about them. Because these animals are hunted on adjoining U.S. Forest Service lands, it is important that basic information on numbers and distribution be established. This data is critical if the park expects to maintain these populations and develop a cooperative management program with State and Sederal agencies. Management will consist of research to determine the numbers, distribution, and ecology of elk and turkey in the park as well as the effects of outside hunting pressures. This study will include re-establishing turkey transects on the North Rim and initiating an elk monitoring program.

Pronghorn antelope were at one time abundant in the pinyon woodlands and flat, open grass and brushland between the San Francisco Peaks and the South Rim, as well as on the Kanab Plateau between the Vermillion Cliffs and the Colorado River. Pronghorns were never especially numerous within the park because of the nature of the terrain, forest vegetation, and the limited free water. A small herd maintains itself in Toroweap Valley in the Tuweep District and obtains water from small stock tanks. Transplanting has been done on the Coconino Plateau south of the park and antelope are sometimes seen south of Red Butte and along the primitive road to Hualapai Hilltop.

Pronghorn antelope are fleet-footed animals of open grass and brushlands. They use a wide variety of food, eating both grass and brush. Some of the preferred foods include sagebrush, squawbush, squirreltail, and cheat grass. Range conditions, rainfall and time of year greatly influence what a particular pronghorn eats, as it wanders over its normal 20 to 40 square-mile range. A herd of 12 animals planted at Indian Gardens in 1924 sustained itself for nearly 30 years on a diet of catclaw, blackbrush, wild grape, cottonwood, grasses, and the succulent stalks of the yucca and agave. What became of these animals is unknown.

With the 1975 expansion of the park, vast areas were included that may be conducive to antelope and therefore fall within recognized National Park Service policies of re-establishing native wildlife. Specific resources management proposals include: (1) a survey of the park to ascertain historic habitation of pronghorn; (2) a reintroduction program in cooperation with State and Federal agencies based on the ecological desirability of doing so; and (3) the monitoring of present populations.

(d) South Rim Small Mammal Study: Visitor use and human habitation have an undetermined effect on small wildlife in developed areas of the park. Implications of artificial feeding near lodges, harassment by feral cats and dogs, and an abundance of artificial watering sources must be evaluated to effectively measure trends in small mammal populations. This baseline information can be used to determine future management actions.

The study will require surveys of small mammal populations in and around the Grand Canyon Village area. Standard scientific techniques of trapping, marking, and site records will be used.

(e) Feasibility Study for Reintroduction of River Otter: Though historically listed in park files as "uncommon," the Southwestern river otter (*Lutra canadensis sonora*) was once found along the Colorado River in greater abundance than it is found today. Current population estimates for this animal, as of 1981, are one or two pairs along the entire 280 miles of the Colorado River in Grand Canyon National Park. Researchers feel that the river environment, stabilized as it is today by Glen Canyon Dam, may make an ideal habitat to attempt a reintroduction program. The U.S. Fish and Wildlife Service at one time reviewed the status of the river otter for possible inclusion on its List of Endangered and Threatened Wildlife and Plants.

A literature search to compile all available information has been completed. Next, the Utah Game and Fish Department must determine the number of pairs of otters, if any, which can safely be removed from the Green River without jeopardizing the remaining otter population. The Green River in Utah is the last known stronghold for the particular subspecies concerned. Five to ten pairs are needed for release in the park; these could be bred in captivity from two to three pairs if that is the largest number which can be removed from the Green River.

1. GRCA-N-37-Monitor Deer Population Trends.

2. Statement of Issue or Problem:

Prior to the establishment of Grand Canyon National Park in 1919, livestock grazing in the area kept deer populations small. When grazing was reduced, hunting prohibited, and predators controlled, the number of deer rose sharply. Approximately 60 percent of the North Rim herd died from the effects of overpopulation, largely malnutrition and disease. From the 1940's to the 1960's, deer numbers on the South Rim were controlled by shooting and trapping. Public hunting continues today outside the park. This hunting, plus predator control on adjacent lands, has an unknown effect on park herds. Impacts of the deer on the park are also unknown. A knowledge of population status and trends is needed to properly manage the herds. Presently the park depends largely on outside agencies to gather this information.

Past Management History. In the 1930's, deer exclosures were established and studied on both the North and South Rims of the park. During the 1950's and 1960's, deer browse and pellet group transects were established on both rims and read annually. Also, animals were counted along deer survey routes. The pellet group transects on the South Rim were relocated in 1977, and have been read annually since then. The Arizona Game and Fish Department continues to operate deer transects adjacent to and within the North Rim of the park. Since cessation of population control activities in the mid-1960's, deer numbers have declined on the North and South Rims.

3. Alternative Actions and Their Probable Impacts:

a. No Action. No data collection nor analysis of park deer populations will be performed.

Impacts. The park will continue to depend on outside agencies for deer herd information. This information may not be directly applicable to park herd management. Regulation of herds on adjacent lands will continue, including hunting and predator control. The park will have no way to assess the effects of this regulation on park deer herds. Damage to the ecosystem resulting from possible herd overpopulation will continue and be undocumented.

b. Restricted Monitoring. Restrict monitoring to areas suspected of receiving direct impact from hunting and predator control pressures on adjacent lands.

Impacts. This action will provide some answers to questions concerning the effects on park herds of management actions taken outside the park. Basic questions concerning herd dynamics and ecology will only be partially answered.

4. Recommended Course of Action:

Continue monitoring the deer populations on the South Rim with pellet group transects. Reinstitute the use of the pellet group transects on the North Rim, as well as the browse transects, survey routes and exclosures on both rims. Begin a deer tagging program. Continue coordinating the park's monitoring and control efforts with Arizona Game and Fish Department programs.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-31-Predatory Mammal Study.

3. STATEMENT OF PROBLEM: The status of all major predators in the park is unknown. Predatory mammals are notoriously wide-ranging within their habitats, often utilizing ten to one hundred square miles each. In the course of their activities, they often spend part of the time within the park and part on lands administered by other agencies. Prey species tend to be much less mobile. Therefore, predators may have important effects on the park ecosystem even though they are not confined within the park. Most of the lands surrounding this park are open to stock grazing as well as to hunting, and are thus subjected to predator control programs.

4. WHAT HAS BEEN DONE: Few records of large predators exist in park files. Little or no field research work has been conducted. The Arizona Game and Fish Department has recently conducted a mountion lion study on adjacent Forest Service lands and verified the fact these animals do move on to and off of park lands.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: Evolve a contract research program of mountain lion and coyote ecology. This includes population status and trends, critical habitat requirements, relationship with prey species, and impacts of off-park control measures. This study will identify the importance of predators in park ecosystems, and geographical areas where predators are important and where they are affected by outside factors. It will make possible increased understanding of predator roles, recommendations for the management of predator populations, and contribute to the knowledge needed in negotiating agreements with other agencies to manage predators partially resident in the park and perpetuate park ecosystems.

6. LENGTH OF TIME NEEDED: Four years.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: Without this information, the park will not meet stated responsibilities for maintenance of natural ecosystems. The management policies of adjoining land management agencies will continue to exert major influences on the ecology of the lands within the park.

8. ALTERNATIVES:

   a. Do nothing.

   b. Limit studies to influences only within the park.

9. PERSONNEL: Research contractors and park staff.

10. ADMINISTRATION AND LOGISTICS:

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	0	0	0	0	0
Other than Personnel Services	0	50	50	50	50
TOTAL	0	50	50	50	50
Funds Available in Park Base	0	0	0	0	0
Funds Requested from Regional Office	0	50	50	50	50

On Form		Date Submitted
10-237	[X]	January 1981
10-238	[ ]	(This project will be supported by Increase No. 239)
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS:

a. Johnson, R. Roy, Unit Leader, Cooperative National Park Research Studies Unit, University of Arizona, Tucson.

b. Walters, James E., Resources Management Specialist, Grand Canyon National Park.

c. Burns, Jennifer, Resources Management Specialist, Grand Canyon National Park.

12. DATE OF SUBMISSION: September 1981.

1. GRCA-N-42-Monitor Elk, Antelope, and Turkey Populations.

2. Statement of Issue or Problem:

The park has unknown populations of elk, pronghorn antelope, and turkey. Elk occur in small numbers on the South Rim, antelope in small numbers on the South Rim and in Toroweap Valley, and turkeys in moderate numbers on both the North and South Rims. Little is known about these species in reference to population trends, influence of outside hunting and predator control measures, critical habitat, and ecology. These species are subject to hunting pressures on nearby U.S. Forest Service lands. The park presently has no means for measuring impacts on populations from this pressure.

Past Management History. Until the early 1970's, the park read annual turkey transects on the North Rim in cooperation with Arizona Game and Fish Department researchers. The Arizona Game and Fish Department currently reads annual transects on, and adjacent to, park lands on the North Rim. Little previous antelope or elk research has been done in the park.

3. Alternative Actions and Their Probable Impacts:

a. No Action. No monitoring of population trends and ecology will be done.

Impacts. Basic information will be unavailable to properly manage these wildlife populations. Impacts to these populations from outside influences or park developments will be undetected and difficult to avoid.

b. Monitor Population Trends on a Sight Record Basis Only.

Impacts. Data will show trends only. Impacts may be detected too late for adequate management response. Information will be unreliable and may cause management to take inappropriate action.

4. Recommended Course of Action:

Re-establish turkey transects on the North Rim and initiate a monitoring program for antelope and elk. Also investigate the possibility of reintroducing antelope to areas of the park which were historically inhabited by that species. Establish a cooperative program with Arizona Game and Fish Department to initiate and continue these projects.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region.

2. PROJECT NAME AND NUMBER: GRCA-N-35-Monitor South Rim Small Mammal Populations.

3. STATEMENT OF PROBLEM: The influence of human development, increased visitation, feral dogs and cats, and artificial feeding has a currently unknown effect on small mammals within Grand Canyon Village. Information is needed to institute a resources management program.

4. WHAT HAS BEEN DONE: Little information on mammal populations within the village exists at present in park files.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: As part of the Resources Base Inventory, a small mammal census program will be conducted using accepted techniques of trapping, marking and site records. Whatever methods practical to gather needed basic population data will be used.

6. LENGTH OF TIME NEEDED: Three years.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: The impact of Grand Canyon Village on small mammals (a decline is suspected) will continue. Management measures will not be suitable due to a lack of information.

8. WHAT ARE THE ALTERNATIVES:

   a. Do nothing.

9. PERSONNEL: Resources Base Inventory research contractors and personnel from the Cooperative National Park Research Studies Unit at the University of Arizona in Tucson.

10. ADMINISTRATION AND LOGISTICS:

FUNDING (In Thousands)

	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	(To be conducted with existing Funds)				
Other than Personnel Services	.5	.5	.5	.5	.5
TOTAL	.5	.5	.5	.5	.5
Funds Available in Park Base	0	0	0	0	0
Funds Requested from Regional Office	.5	.5	.5	.5	.5

On Form		Date Submitted
10-237	[X]	October 1976
10-238	[ ]	(To be conducted within the existing program with support from Increase No. 239)
10-250	[ ]	
10-451	[ ]	

11. REFERENCES AND CONTACTS:

    a. May, Larry A., Chief, Resources Management Division, Grand Canyon National Park.

    b. Walters, James E., Resources Management Specialist, Grand Canyon National Park.

    c. Burns, Jennifer, Resources Management Specialist, Grand Canyon National Park.

12. DATE OF SUBMISSION: September 1981.

NATURAL RESOURCES PROJECT STATEMENT*

1. PARK AND REGION: Grand Canyon National Park, Western Region

2. PROJECT NAME AND NUMBER: GRCA-N-44-Feasibility Study for Reintroduction of River Otter.

3. STATEMENT OF PROBLEM: The Southwestern river otter (*Lutra canadensis sonora*) has apparently never been common in the Grand Canyon. Its numbers, however, have declined in historical times and the animal may now be extirpated from the park. Only two probable reports of otters have been recorded in the last decade (both in 1978, one from River Mile 10, and one from the mouth of the Paria River). The Green River in Utah is the last known stronghold for this particular subspecies. A study is needed to determine the feasibility of reintroducing the otter into the Colorado River in Grand Canyon National Park.

4. WHAT HAS BEEN DONE: A preliminary proposal has been submitted by a research biologist of the Museum of Northern Arizona which outlines the activities and time schedules that need to be undertaken to put this project into effect. A literature search to compile all available information has been completed.

5. DESCRIPTION OF WORK TO BE UNDERTAKEN: The Utah Game and Fish Department must determine the number of pairs of otters, if any, which can safely be removed from the Green River without jeopardizing the remaining otter population. Five to ten pairs are needed for release in Grand Canyon National Park; these could be bred in captivity from two or three pairs if that is the largest number which can be removed from the Green River. The park will assist with the release of the five to ten pairs into the Colorado River and with the subsequent monitoring of these animals to determine the success of the reintroduction attempt.

6. LENGTH OF TIME NEEDED: One year.

7. WHAT WILL HAPPEN IF NOT UNDERTAKEN: The park will possibly lose this native wildlife species and fail to follow the edicts of management addressing wildlife resources.

8. ALTERNATIVES:

   a. Do nothing.

   b. Attempt a transplanting program without background research.

9. PERSONNEL: Park staff and contract researchers.

10. ADMINISTRATION AND LOGISTICS:

FUNDING (In Thousands)	YEAR IN PROGRAM SEQUENCE				
F.Y.	82	83	84	85	86
Personnel Services	(The remainder of the fiscal program will be determined by the findings of the literature survey.)				
Other than Personnel Services	0	3	0	0	0
TOTAL	0	3	0	0	0
Funds Available in Park Base	0	0	0	0	0
Funds Requested From Regional Office	0	3	0	0	0

11. REFERENCES AND CONTACTS

a. Stevens, Lawrence E., Research Biologist, Museum of Northern Arizona, Flagstaff.

b. Walters, James E., Resources Management Specialist, Grand Canyon National Park.

c. Burns, Jennifer, Resources Management Specialist, Grand Canyon National Park.

12. DATE OF SUBMISSION: September 1981.

PROJECT TITLE: Other Wildlife Management Projects
(Includes Project Statement No's. N-31, N-35, N-37, N-42 and N-44

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Monitoring Actions:	
- Monitor Deer Population Trends (N-37)	.5
- Monitor South Rim Small Mammals (N-35)	.5
- Monitor Elk, Turkey, Antelope (N-42)	1.0
Total	2.0
2. Fiscal Year 83	
1. Monitoring Actions:	
- Monitor Deer Population Trends	.5
- Monitor Small Mammals	.5
- Monitor Elk, Turkey, Antelope	1.0
2. Research Actions:	
- River Otter Reintroduction Feasibility Study (N-44)	3.0
- Predatory Mammal Study (N-31)	50.0
Total	55.0
3. Fiscal Year 84	
1. Monitoring Actions:	
- Monitor Deer Population Trends	.5
- Monitor Elk, Turkey, Antelope	1.0
- Monitor South Rim Small Mammals	.5
2. Research Actions:	
- Predatory Mammal Study	50.0
Total	52.0
4. Fiscal Year 85	
1. Monitoring Actions:	
- Monitor Deer Population Trends	.5
- Monitor Elk, Turkey, Antelope	1.0
- Monitor South Rim Small Mammals	.5
2. Research Actions:	
- Predatory Mammal Study	50.0
Total	52.0
5. Fiscal Year 86	
1. Monitoring Actions:	
- Monitor Deer Population Trends	.5
- Monitor Elk, Turkey, Antelope	1.0
- Monitor South Rim Small Mammals	.5
2. Research Actions:	
- Predatory Mammal Study	50.0
Total	52.0

g) FIRE MANAGEMENT.

The presence or absence of natural fire within an ecosystem is one of the ecological factors which shape and perpetuate the plants and animals native to that ecosystem. Natural fires have coexisted with plant and animal communities for millions of years, and the considerable amount of scientific research on the role of fire in the natural environment indicates that it is an essential element in most plant communities. Human interference with the natural role of fire at Grand Canyon National Park over the last 70 years has brought about unnatural changes in the varied environments of the park.

In the absence of fire, thick stands of young pine, spruce, and fir have closed in upon the once open park-like stands of forest on the North Rim. The lack of natural burning allows tree crowns to close in and shade many forage plants which support much of the forest animal population. Dense stands of trees allow the rapid spread of such forest infestations as dwarf mistletoe, and the deep accumulation of forest litter improves habitat for some nuisance insects. The crowding of trees contributes to the general slowing of growth rates and the lowering of resistance to disease and insect infestations. The large quantities of forest fuels, which have accumulated because of fire suppression activities by the National Park Service, have made many of the park's forested areas unnaturally susceptable to holocaust forest fires.

Fire acts on the forest to reduce fuel accumulation, lessen fire hazards, and release nutrients into the soil. In fire-dependent forests such as ponderosa pine, fire burns away thick layers of duff, and prepares the substrate for pine seed germination. Fire also thins crowded stands of saplings and eliminates the less fire-resistent plants from the forest.

Between 1970 and 1975, the park investigated the ecological effects of fire in the ponderosa pine forest. The research information was used in the development of the 1977 Fire Management Plan, an addendum to the Natural and Cultural Resources Management Plan. The Fire Management Plan serves as an action plan for the fire management program and is updated annually in keeping with yearly progress and the development of new technical data and administrative edicts. The plan is coordinated with both the US Forest Service and the Arizona Department of Health Services, Bureau of Air Quality Control.

The management program outlined in the Fire Management Plan is intended to: (1) reintroduce fire as a natural force in park ecosystems; (2) maintain ecosystems in a naturally evolving state; and (3) reduce the probability of holocaust fires. Certain areas of the park will be treated with prescribed burns to reduce unnatural fuel loads. Other areas of the park will be allowed to burn when ignited by lightening or other natural forces. Over 121,000 acres of park land will eventually be treated by natural or prescribed fires over a 15-year period.

Prescribed burning guidelines are detailed in the the Fire Management Plan. It should be noted that all burning activities are in accordance with cultural resources preservation edicts.

1. GRCA-N-7-Fire Management Plan.

2. Statement of Issue or Problem:

The practice of fire suppression over the last 70 years has prevented fire from carrying out its natural role in shaping and maintaining the park's plant and animal communities. The ponderosa pine and mixed conifer forests totaling 121,000 acres have been the most affected by the suppression of fire. Fire scar analysis and historic fire reports indicate that, under natural conditions, the ponderosa pine forest has a fire frequency of three to ten years.

Fire is one of the most important environmental factors affecting the ecosystems of Grand Canyon National Park. Fire plays a variety of natural roles that include: (1) seed bed preparation; (2) recycling of nutrients; (3) re-establishment of plant succession; (4) provision of conditions favorable to wildlife; (5) reduction of fire hazards; (6) creation of mosaics of age class and vegetation types; and (7) reduction in the number of trees susceptible to attack by insects and disease.

The disruption of this natural force has resulted in many changes in the environment. The natural mosaic of vegetation type and age classes has been altered. Spruce and fir are invading the open stands of ponderosa pine, crowding out the fire-dependent ponderosa and replacing it with a more fire-susceptible forest. Fire is needed for ponderosa pine seed germination and to thin the thick stands of young seedlings for optimum growing conditions. Among the ponderosa and spruce-fir forests, woody fuel accumulations have reached abnormally high levels, choking out many of the small ground plants and also increasing potential for the occurrence of major fires.

Current Management Action. Between 1970 and 1975, the park researched the role of fire in the ecology of the ponderosa pine forest. The information gained from this study was incorporated into the Fire Management Plan approved and implemented in 1977. The objectives of this plan are: (1) to reintroduce fire as a natural force in the ecosystems of the park; (2) to maintain these ecosystems in a naturally evolving state; and (3) to reduce the forest's susceptibility to holocaust wildfires. To accomplish these objectives, approximately 88% of the park lands with low fuel levels have been designated as "prescribed natural fire zones" wherein natural fires are allowed to burn under given conditions.

In accordance with National Park Service policy guidelines, prescribed burning will be used to create fuel breaks, to reduce high fuel levels, and to restore fire to the ponderosa pine and mixed conifer habitats. From 1978 through 1980, 27 natural fires have been allowed to burn. These fires burned an estimated 3,526 acres. An additional 2,218 acres were prescribe burned in the ponderosa pine habitat.

Approximately 55,000 additional acres of ponderosa pine habitat need to be prescribe burned to restore fire to the environment and to prepare the areas for inclusion into the natural fire zones of the park. Because of the exceptionally high fuel loading and dense understory, much of this acreage will have to be prescribe burned twice before conditions will allow the areas to be categorized as Natural Fire Zones.

3. Recommended Course of Action: In keeping with research findings and an assessment of impacts identified in the 1977 Natural Resources Management Plan and Environmental Assessment, the park will continue to implement its fire management program. The exact nature of the park's fire management activities will be identified in an annual Fire Management Plan. This document will be updated annually.

Impacts of the Fire Management Program

Water: The major effects of the Fire Management Plan on water resources will be increased surface runoff, erosion rates, and snowmelt. Surface run-off following a fire may be temporarily increased as much as eight times the normal rate due to removal of vegetation and forest floor litter and by the reduction of soil infiltration rates. The removal of ground cover also increases run-off and reduces protection from wind erosion. Removal of parts of the forest canopy by fire will reduce shade cover over winter snows and increase snow melt in these areas.

Soil moisture storage will also be affected by fire. As the growing season progresses, water stored in the soil by winter snows and spring rains is greatly reduced by growing plants. Vegetation subsequently removed by fires will reduce this water consumption and will provide more soil moisture at the end of the growing season for use by perennial plants such as pine, fir, and spruce.

Immediately following a fire, rains will bring temporary increases in nitrates, bicarbonates, phosphates and calcium levels to surface streams. Studies have shown that this increase does not exceed 10 ppm for nitrates. The aquatic habitat is little affected by these chemical changes, but it is impacted by increased levels of sediment and turbidity. Since Grand Canyon surface streams periodically experience high levels of sediment and turbidity during spring runoff and flash floods, effects on aquatic habitats from management fires will be minimal. All impacts to water resources will be less than those caused by the holocaust fires which will result if the described fire management program is not implemented.

Soils: Several changes will take place in the chemical and physical properties of soils following a fire. Phosphorus, calcium, potassium, magnesium, and nitrogen concentrations will increase as chemicals locked up in forest debris are released during the combustion process. Soil alkalinity will increase. Some nitrogen will be lost through volatilization. This loss will be compensated for by increases in levels of ammonia nitrogen resulting from organic decay. Soil bacteria, especially nitrogen fixing populations, will increase

and be more active following fires. Soil productivity will increase due to increased availability of nutrients. Chemicals released by the fire and the combustion process will reduce soil aeration and absorption capacities. Fire effects on soils will vary greatly depending on burn intensity. The more severe the fire the greater the reduction in infiltration and aeration capacity and the greater the loss of nitrogen. Each year the soils on 5,000 to 10,000 acres of park land will be affected by either natural or prescribed fire.

Air: The type and amount of pollutants emitted into the air will vary greatly depending on the amount of fuel moisture present, fire intensity, and other physical characteristics of the environment.

Head fires (those moving with the wind) will move quickly over the fuels leaving a large zone of smoldering fuels behind. Back fires (those moving against the wind) move slowly and have a higher combustion efficiency, producing one third the pollutants emitted by heading fires. Combustion products emitted by prescribed fires will include: (1) carbon dioxide emissions of 2,000 to 3,500 lbs. per ton of fuel comsumed; (2) carbon monoxide emissions will range from 200 ppm close to flames to less than 10 ppm 100 feet from fires; and (3) sulfur oxides will be produced in negligible quantities. Information on nitrogen oxides from forest fires is scanty and inconclusive. Formation of nitric oxide normally occurs in the combustion zone at temperatures above 1,540° C.. This is above temperatures normally achieved in prescribed burning. Hydrocarbons, a diverse class of organic compounds and acids, will make up approximately five pounds of each ton of pollutants emitted.

Smoke effects on plants will be varied. Effects will range from temporary influences on photosynthetic efficiency to toxicity. For some plants, the results may be to increase photosynthetic rates when higher CO_2 concentrations are sustained. Recent studies indicate that smoke may reduce the growth, spore germination, and infectivity of several fungal pathogens.

Canyon visibility will be reduced an estimated 14 days per year by poor smoke dispersal conditions. Grand Canyon is designated a Class I area under Environmental Protection Agency standards for air quality. Emissions from forest fires may exceed Class I standards for 21 days of the year. The park will attempt to mitigate this impact by computer smoke management modeling and weather service smoke dispersal prediction, which will be used to determine best times of smoke dispersal.

Wildlife: Fire provides a long-term beneficial effect for wildlife in re-establishing natural fire succession. In the plant community, stimulated growth creates mosaic patterns which improve food production and nutritional quality. The resultant diversity of habitat benefits all wildlife. Deer find better access in burned areas with removal of dead and down debris and thinning of the forest understory. Opening up the forest also allows predator-prey relationships to proceed normally among bobcat, coyote, fox, raptors, and other species. It is fire which causes ponderosa pine seeds to germinate,

thereby creating the Kaibab squirrel's favorite environment. In the warmer, dryer burn areas of the North Rim grow habitat sought by Blue Grouse for its increased early spring vegetation and accompanying insects. Fire thus serves many purposes.

Vegetation: Fire stimulates plant growth and productivity through elimination of competing plants and release of nutrients held by dead and down vegetation debris. Mosaic fire patterns and varying fire intensities will increase the diversity of plant community and species. Those plant communities that are maintained by fire are favored over those intolerant to fires. Fire in the sagebrush grasslands re-establishes predominately the grassland community and reduces the encroachment of the pinyon-juniper forest. Desert shrub communities revert to a grass community following a fire. Fire removes understory vegetation and maintains open ponderosa pine forest habitat. Fire removes forest litter and duff layers providing bare mineral soil and nutrients needed for the germination of ponderosa pine and other plant seeds. Each year 5,000 to 10,000 acres of vegetation are affected by natural fires or prescribed burning.

Endangered and Threatened Plant and Animal Species: Research is needed to determine whether fire and the ecosystem could increase populations of certain species. Fire suppression may be a significant factor in the decline of these species. While not listed on the U.S. Fish and Wildlife's List of Endangered and Threatened Wildlife, the Kaibab squirrel is considered "restricted" in its range. It is the focus of concern by several State and Federal wildlife agencies. The population decline of the Kaibab squirrel may be related to a fire suppression altered habitat. The squirrel relies on an open ponderosa pine forest for both food and shelter. Fire suppression has allowed a dense understory to develop in this forest thereby changing considerably the preferred squirrel habitat. Fire creates a diversification of habitat and stimulates plant growth. This variety of habitats is expected to have long-term benefits to all native wildlife species.

Social Impacts: Some views of the canyon may be obscured by smoke for approximately 14 days of the year. Persons may be delayed 5 to 10 minutes along portions of park roads when natural fires and prescribed burning activities are in progress. Two to three miles of roadside views of the forest will be impacted by the presence of fire-killed trees, scorched tree trunks, and blackened ground cover each year. Evidence of the fire will remain for approximately two to five years, but will be reduced with the first rain on the area. Long-range fire effects on roadside views will be to enhance the visitor's perspective by opening the forest, and improving forest vistas. The creation of a forest mosaic will increase the opportunity to observe wildlife.

Cultural Resources: The natural fire frequency of the ponderosa pine and mixed conifer forests is three to ten years. Under these conditions, countless fires have burned over archeological sites in the past. Prescribed burning will reduce the possibility of high intensity (holocaust) wildfires, resulting from past fire suppression

efforts, burning over many sites and causing severe damage. Holocaust fires impact sites by discoloring surface artifacts and by burning perishable materials. Archaeomagnetic dates and pollen counts may also be altered by these high intensity fires. Rock walls may be weakened or cracked. Fire suppression activities may destroy artifact context and stratigraphy. Natural and prescribed burns may inadvertently destroy backcountry historic resources, such as pioneer cabins, corrals, fences, and other such uninventoried historic resources. To evaluate impacts on cultural resources, archeological clearance will be obtained on all prescribed fires, and the park archeologist will be consulted on all wildfires or prescribed natural fires.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA-N - 7 - Fire Management Plan

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
Fiscal Year 82	
1. Resources Management Actions:	
- Prescribe burn 7,589 acres of ponderosa pine and mixed conifer habitat to: create a fuel break along a portion of the north park boundary; reduce fuel levels and stand densities of white pine understory prior to designation of Point Sublime as a natural fire zone.	21.0
2. Monitoring Actions:	
- Monitor management fires in prescribed natural fire zones by aircraft in remote areas and by on-site observers when fires are in accessible areas. Photo and vegetation transects will be used for monitoring effects of prescribed burns.	1.5
Total	22.5
Fiscal Year 83	
1. Resources Management Actions:	
- Prescribe burn a total of 7,320 acres. Prescribed burning would be used to: create a fuel break along 11 miles of park boundary on the north rim and across Walhalla Plateau.	25.0
2. Monitoring Actions:	
- Monitor management fires in prescribed natural fire zones by aircraft in remote areas and by on-site observers when fires are in accessible areas. Photo and vegetation transects will be used for monitoring effects of prescribed burns.	1.5
Total	26.5
Fiscal Year 84	
1. Resources Management Actions:	
- Prescribe burn a total of 4,605 acres. Create fuel breaks at Muav Saddles and three miles of park boundary. Reduce fuel levels and thin out white fir understory in preparation to including Tiyo Point area in natural fire zone.	21.0
2. Monitoring Actions:	
- Monitor management fires in prescribed natural fire zones by aircraft in remote areas and by on-site observers when fires are in accessible areas. Photo and vegetation transects will be used for monitoring effects of prescribed burns.	1.5
Total	22.5

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA-N - 7 - Fire Management Plan Cont'd. (Page 2)

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
Fiscal Year 85	
1. Resources Management Actions:	
- Prescribe burn a total of 5,600 acres, to reduce fuel levels, thin out white fir understory in preparation to include Swamp Point area in natural fire zone.	20.0
2. Monitoring Actions:	
- Monitor management fires in prescribed natural fire zones by aircraft in remote areas and by on-site observers when fires are in accessible areas. Photo and vegetation transects will be used for monitoring effects of prescribed burns.	1.5
Total	21.5
Fiscal Year 86	
1. Resources Management Actions:	
- Prescribe burn 6,540 acres to reduce fuel levels thin out white fir understory in preparation for establishing all of Walhalla as natural fire zone.	20.0
2. Monitoring Actions:	
- Monitor management fires in prescribed natural fire zones by aircraft in remote areas and by on-site observers when fires are in accessible areas. Photo and vegetation transects will be used for monitoring effects of prescribed burns.	1.5
Total	21.5
Fiscal Year	
Total	

B. Cultural Resources Management Program:

The Cultural Resources Management Program for Grand Canyon National Park is a long-term plan to be used as a guide in managing the park's cultural resources. Although presented separately, projects in the Cultural Resources Program are also of permanent importance to the success of other natural resources management, interpretation, maintenance and construction, and visitor protection programs. The accompanying project statements describe recommended projects and the environmental impacts of the proposals.

Proposed Actions. The proposed actions for the management of Grand Canyon National Park cultural resources include: 1) cultural resources compliance surveys; 2) sample data recovery of six fragile and heavily impacted archeological ruins; 3) stabilization of selected structures including one of the above; 4) cyclic maintenance of the previously stabilized ruins (Tusayan Ruin, Walhalla Glades Ruin and Bright Angel Pueblo) as well as other ruins slated for stabilization under this plan; 5) monitoring of cultural resources, particularly in high visitor use areas, and the List of Classified Structures (LCS); 6) assessing the effects of management fires on archeological resources; 7) liaison with the five neighboring American Indian Tribes; and 8) maintenance of the park's study collection.

Impacts. The survey, excavation, and monitoring projects will result in expansion of the cultural resources data base while having little or no adverse impact to natural or cultural resources. Stabilization, cyclic maintenance, and monitoring of actions affecting all resources on the List of Classified Structures will promote the preservation of the structures and other physical remains of historic and prehistoric resources. These actions may also alter some structures or portions of structures causing unavoidable adverse effects to the resource. Pre-stabilization research and planning should minimize the dangers of significant adverse effects. Excavation will destroy parts of the resource but will preserve data that would be lost through inaction. Data recovery has been recommended only for those sites with deeply stratified deposits (middens) and fragile walls located in heavily impacted areas, and where other alterations to protect and preserve them are not feasible or economical. Research into the effects of management fires on surficial, as well as buried archeological resources, may result in the destruction of portions of park resources, but will shed light on how to minimize or perhaps avoid significant adverse effects by using the correct fire prescriptions. If accomplished insensitively, liaison with the five Indian tribes can decrease rather than increase the ease of communicating with tribal members involved in park/Indian issues, and can severely hamper or even set the park back in terms of progress made on principal issues.

Alternatives. The alternative of no action was considered for all proposals. Sample data recovery alternatives included stabilization, "stop-gap" preservation techniques or emergency stabilization and avoidance or mitigation through other methods. All would result in partial loss of the resource, non-retrieval of information necessary to assess values and management needs and/or increased costs for cyclic and routine maintenance. Alternatives to the stabilization of ruins where

data recovery would not add to the present data base are the same as for excavation. Alternatives to the proposed liaison with neighboring American Indian tribes include liaison by park officials other than the Anthropologist and visits to tribes scheduled only when problems arise. These may adversely affect relations with all tribes.

Conclusion. All of the proposed actions have been chosen as the best alternatives available to minimize or eliminate significant adverse environmental impacts. However, as new data retrieved during monitoring and research become available, solutions to these management problems will be reassessed and updated.

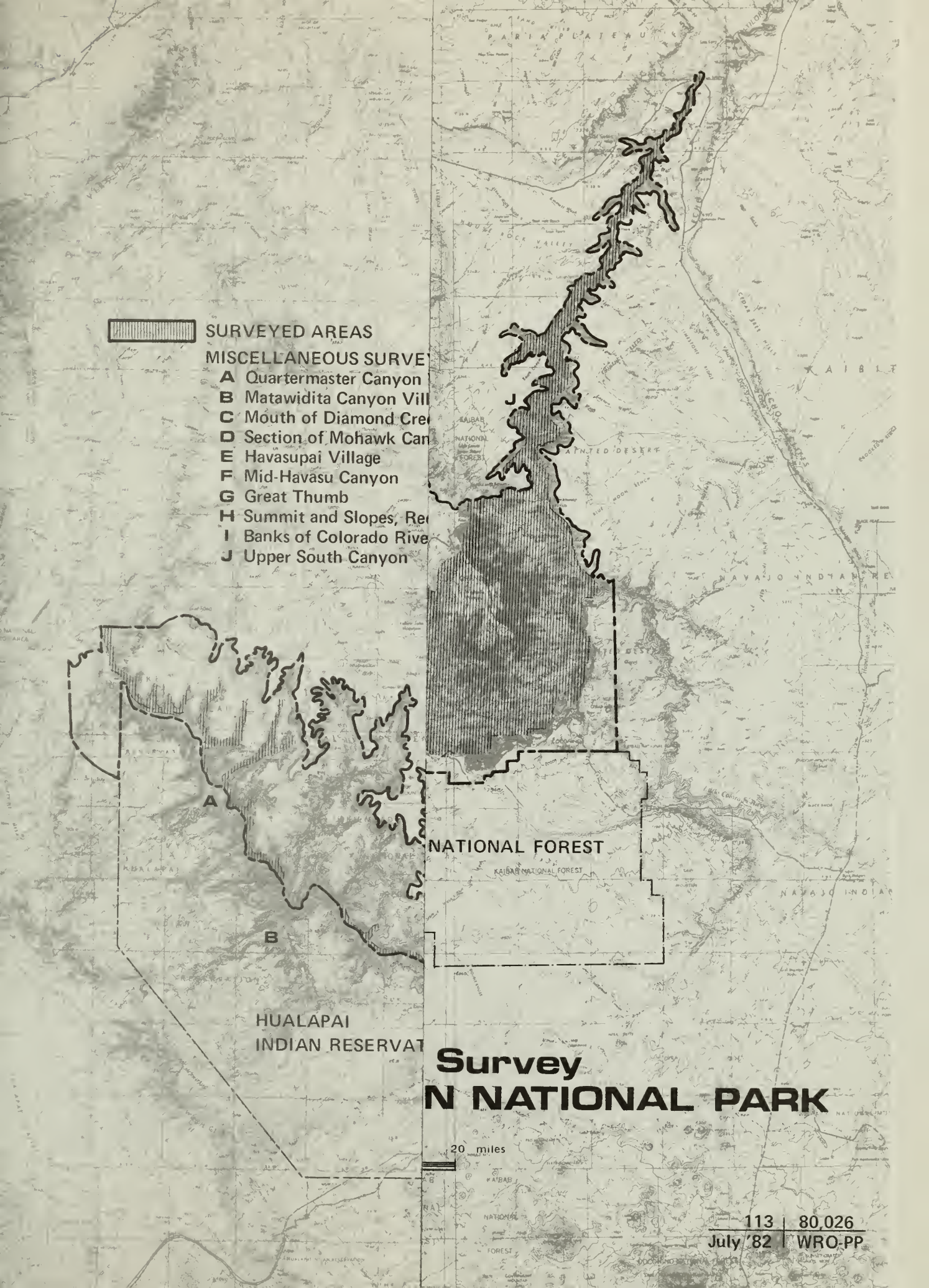
1. Overview

Grand Canyon National Park is rich in cultural resources. The cultural history of the area began three to four thousand years ago. Resource categories described below are prehistoric resources, ethnic and ethnohistoric groups, historic resources, research collections, and the research library. Cross-cutting several of these categories are the List of Classified Structures (Appendix F) and the National Register Properties, management tools used for the active monitoring and preservation of the resources. Knowledge about Grand Canyon's cultural resources has come from research and reporting begun in A.D. 1540 during a trip by Spaniards to the canyon rim. However, most has been learned in the last few decades. Areas where inventories of archeological resources have been accomplished are shaded in Figure 6. Documentation of the architecture and history of presently standing structures was done mainly in 1976 by Western Region and Denver Service Center historical architects and historians as part of a commitment by the National Park Service to complete inventories for the LCS. In addition to periodic updates, only small scale historic and architectural studies need to be completed for North Rim backcountry ranching sites and a few Inner Canyon sites.

Prehistoric Resources. The earliest evidence of the utilization of the Grand Canyon is found in caves developed in the Mississippian-age Redwall Limestone and dates 3,000 to 4,000 years ago. At that time, Archaic hunters, possibly of the Pinto Basin Desert Culture, placed willow or cottonwood split-twig figurines in caches in the caves for the purpose of imitative magic. Dates are arrived at through radiocarbon analyses of the figurines. At this time, no diagnostic artifacts have been found in direct association with the figurines although Pinto Basin projectile points have been found in the vicinity.

The next tangible evidence of human use of the canyon was left by the people of the Kayenta Tradition of the Anasazi beginning around A.D. 500 or slightly earlier. Diagnostic Basketmaker projectile points have been found eroding from a few middens, and information from excavations of a cluster of pithouses in the Tuweep District attest to this presence (Thompson and Thompson 1974). The exploratory forays continued with minimal impact upon the canyon. Slab structures and circular pithouse-like dwellings along with early Kayenta ceramics and lithics are found in rockshelters and occasionally in the open.

Peak population and maximum utilization of the canyon appear to have occurred roughly between A.D. 1000 and A.D. 1150. Sites are found in almost every possible type of location from the river to both rims (see Figure 7). Riverine sites consist mainly of masonry pueblos of one to several rooms with occasional water/soil control features. The higher Pleistocene and other terraces are also characterized by open masonry pueblos. Granaries and small habitation sites are found on top of the talus of the Inner Gorge. The remains of single room sites and mescal pits dot the Tonto Plateau, and the Esplanade (a higher platform) has revealed a number of open masonry pueblos,


SURVEYED AREAS
MISCELLANEOUS SURVE
A Quartermaster Canyon
B Matawidita Canyon Vil
C Mouth of Diamond Cre
D Section of Mohawk Can
E Havasupai Village
F Mid-Havasu Canyon
G Great Thumb
H Summit and Slopes, Re
I Banks of Colorado Rive
J Upper South Canyon
A
B
J
NATIONAL FOREST
HUALAPAI
INDIAN RESERVAT
Survey
N NATIONAL PARK
20 miles
113 | 80,026
July '82 | WRO-PP

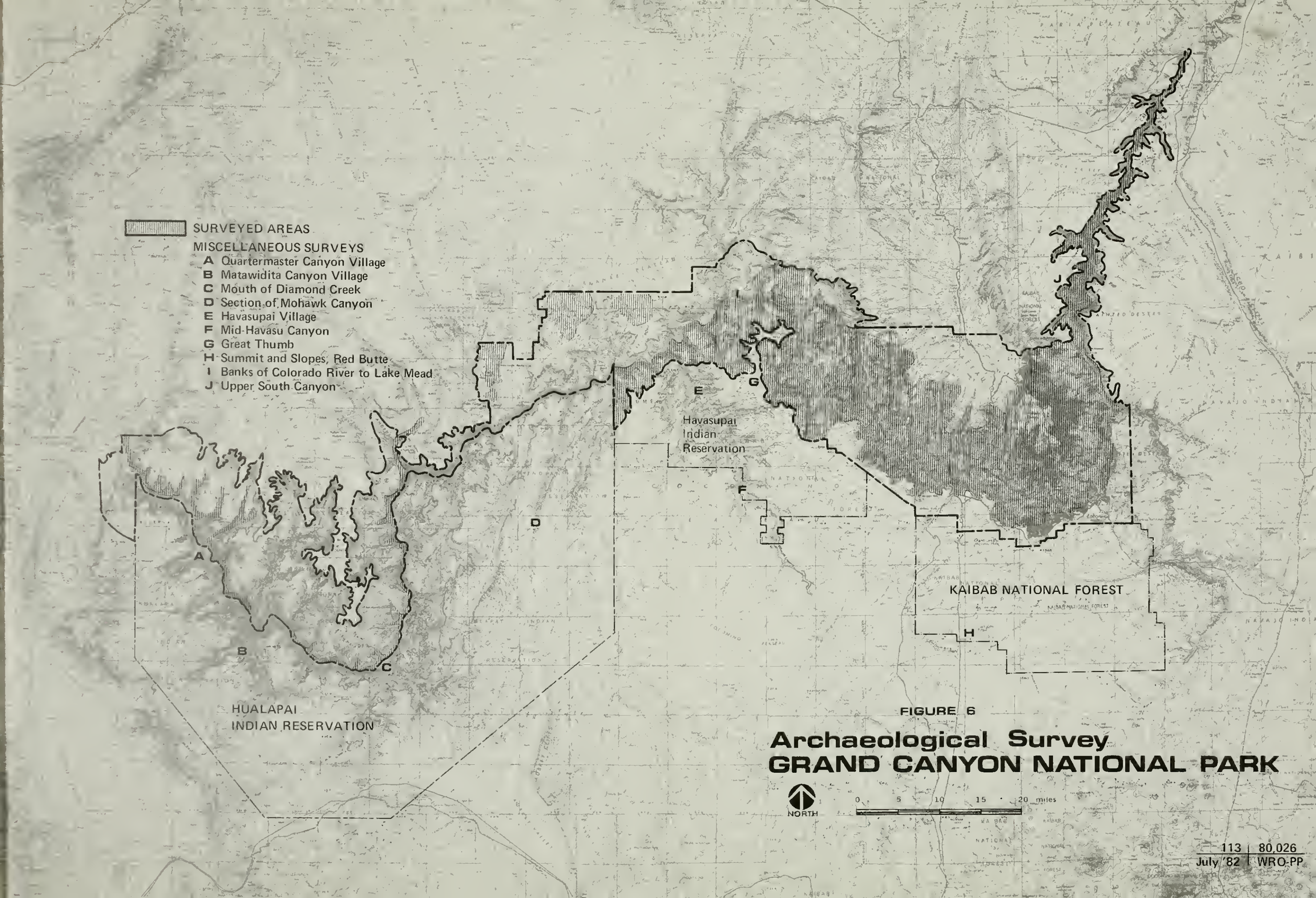


FIGURE 6

Archaeological Survey
GRAND CANYON NATIONAL PARK

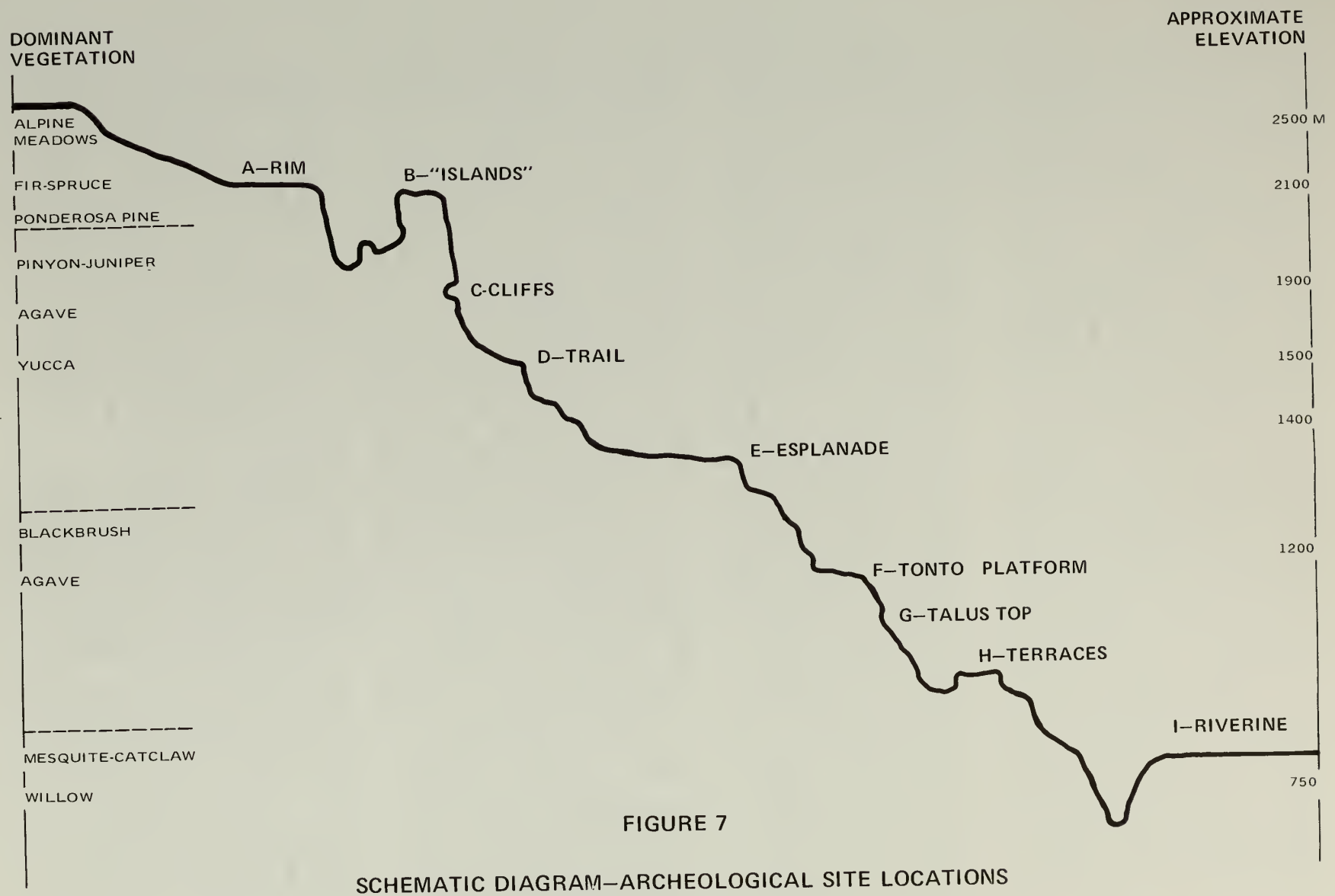


FIGURE 7

SCHEMATIC DIAGRAM–ARCHEOLOGICAL SITE LOCATIONS

Grand Canyon National Park

rockshelter sites and mescal pits. Other trailside sites, usually granaries, caches and small habitation sites, are found throughout the Supai formation. A few hundred meters higher may be found a series of small cliff dwellings, and rising to the rims, one again finds small open masonry sites of from one to a dozen rooms, many of which are accompanied by check dams and terraces (Euler and Chandler 1978). Single and multiroom dwellings, kivas and granaries were built of jacal and masonry, dry and wetlaid, coursed and uncoursed. These types of sites as well as the caches, water/soil control systems and more ephemeral sites such as artifact scatters and low masonry walls in rockshelters attest to the full use of the seasonal abundance of the canyon, and range in size from a single broken ceramic vessel to a 20-room masonry structure with associated kiva (up to $3000m^2$).

At about the same time, the members of another Anasazi group from the vicinity of the Virgin River were occupying the western part of the park north of the Colorado River. In addition, intensive use was made by the Cohonina of the South Rim, the Esplanade and Havasu Canyon. The activities of this occupation include similar intense utilization of the canyon's various microenvironments. However, there is more variability in types of structures and less emphasis on agriculture with a consequent increase in gathering. Hundreds of mescal roasting pits in protecting rockshelters and abundant lithics are scattered over the Esplanade (Euler 1976).

Climatic shifts apparently dictated the abandonment of Grand Canyon shortly after A.D. 1150 (Euler, et al. 1979). Tree ring analysis indicates that Tusayan Ruin on the South Rim was one of the last sites occupied. Around A.D. 1300, Southern Paiute Indians moved into the area north of the canyon and made occasional use of the resources below the rim. Rockshelters and other limited activity campsites are found on the North Rim where dense forest and alpine meadows created good habitat for wildlife such as deer, and below the rims where water and edible plants would have been more plentiful. Occasional Paiute ceramics found south of the river indicate contact with the population there. More research needs to be done to determine the nature and extent of this contact as well as that which existed between North and South Rim peoples prior to A.D. 1150.

At the same time, Indians of the Cerbat Branch moved from the Lower Colorado River Valley into abandoned Cohonina territory. Cerbat sites resemble those of the Paiute with the exception of ceramic types and the more intense exploitation of the abundant mescal growing on the Esplanade. Also, agriculture played a fairly important part in the economy, as shown by ethnographic analogy. Although theories as to the relationship between the Cerbat and the Pai who now inhabit the area differ, Euler's theory that the Pai are direct descendents of the Cerbat is well supported by the data (Euler 1958, 1975b). Little change seems to have occurred in the subsistence patterns and cultural traits from A.D. 1300 with the arrival of the Cerbat until the nineteenth century and the intrusion of the Anglo-American culture into the Havasupai way of life.

The historic period begins with Don Garcia Lopez de Cardenas' exploration in A.D. 1540 of the South Rim and its possible routes to the river. In three unfruitful days, he reached neither the river nor the Havasupai of whom he had been told by the Hopi. European contact with both Havasupai and Southern Paiute in their homelands occurred in 1776 with visits by the Franciscan priests, Francisco Garces and Silvestre Velez de Escalante, respectively. Both accounts of the Indians, although relatively brief, are the first descriptions of any type of cultural resource within this area.

Ethnic and Ethnohistoric Groups. Although the Anasazi abandoned the canyon area, their descendents, the Hopi, continue periodic visits. Trips are made to gather ceremonial salt from the salt deposits along the eastern section of the Colorado River and to the Sipapu, a mineral spring located just outside the park boundary on the Little Colorado River which is believed to be the place of origin for the Hopi. Jeddito Yellow Ware sherds are found at campsites and rockshelters along the routes. In addition, substantial trade between the Hopi and Havasupai as late as A.D. 1880 account for Hopi ceramics in temporarily occupied Havasupai and Hopi campsites.

Navajos also made limited use of the eastern portion of the canyon beginning in the 1880s. Evidence of this use consists of an occasional broken pot left along a route of access into or out of the canyon and campsites along the South Rim which were occupied seasonally in the fall for the purpose of gathering the abundant pinyon nut harvest (Effland and Green 1979). Hogans of the octagonal or three-forked pole types, tipi-like structures of poles and juniper bark, sweat houses, fire pits, trash and perhaps corrals are the usual components of these sites.

The elevation of the Grand Canyon to national park status in 1919 precludes the use of the park for any purpose contrary to park policies and goals. No camping is allowed in the rim areas of the park outside of established campgrounds, although pine nuts are still collected by both Indians and non-Indians. One small group of Havasupai continue to live about a mile west of Grand Canyon Village in Supai Camp. The first mention of Supai Camp in park records does not come until about 1926 (Hinchliffe 1976). Residence, at least on a seasonal basis, probably was established much earlier because this has been part of the traditional winter territory for the Havasupai since at least A.D. 1300.

The Grand Canyon National Park Enlargement Act (P.L. 93-620), effective in 1975, enlarged the Havasupai Reservation by 185,000 acres at which time the tribe relinquished any further rights within the park. The act also alloted them 95,300 acres of National Park Service land, termed the Havasupai Use Lands (HUL), "for grazing and other traditional purposes."

Thus, with the exception of park or concessions employees and their families and the small Havasupai group housed at Supai Camp, no Native Americans reside in the park. The Havasupai use the HUL; the Hopi continue to visit the salt mines. Those two groups, along with

the Navajos, and to some extent the Hualapai, utilize the pinyon nut harvest for private consumption. All, including the Southern Paiute, have a long history in the area, a part of which was inextricably entwined with Grand Canyon. This heritage remains of extreme interest to each tribe and must be preserved.

Historic Resources. Evidence of the interaction of the European with the canyon is another phase of cultural development within the park. For the Europeans, the immense chasm was a barrier from the beginning. Not until the arrival of John Hance and other prospectors was the economic or recreational potential of the canyon recognized. In the latter part of the nineteenth century, gold fever was spreading throughout the West. The exposure of so many rock formations and fault zones led a few to believe that precious metals could be easily found. In reality, some high grade asbestos, copper, silver, lead and more recently, uranium ores were located but the logistical problems of building and stocking mining camps and of transporting the ore to the rim made the attempts economically unfeasible. Before the park's inception in 1919, all mining except at the Orphan mine near Grand Canyon Village, had stopped. Evidence of these ventures is still very visible in the park. Examples are found in Asbestos Canyon, Copper Canyon, Shinumo Gardens, Point Sublime, Hakatai Canyon, Horseshoe Mesa and Red Canyon and consist of trailwork and masonry along access routes, mine adits and tailings, masonry and wooden cabins, tent floors, grinders, sawed-off shovels and other tools and human refuse.

Many of the prospectors turned to tourism as a more effective way to make money. John Hance's cabin near Grandview became the nucleus of a tent camp hotel, the first tourist facility at the Grand Canyon, built at the terminus of the Flagstaff-Grand Canyon stageline. This structure, along with the larger frame hotel built beside it by Martin Buggeln in 1906, was razed by the National Park Service in the 1960s. For the same reason, only the foundations remain of the first hotel on the rim. The Grandview Hotel was constructed in 1897, replacing a cabin used by miners from Horseshoe Mesa. For a time, these hotels and the Grandview Trail down to Horseshoe Mesa and the river were the center of activity.

A more remote but no less interesting area was that of Bass Camp established by W. W. Bass in 1890. He built a trail to the river and located several mineral claims, but his primary goal was to show the canyon to as many people as possible. He built a road from Ashfork and ran a stage guiding tourists from both there and Williams. The foundations of some of the buildings and the trash dumps of the camp are still visible.

The arrival of the Santa Fe Railroad in 1901 shifted the popular focus to the area of the South Rim near the Bright Angel Trailhead. The Santa Fe Railraod Station was unique among railraod stations in its rustic design. The Bright Angel Hotel was begun as a tent camp by J. W. Thurber, a stage operator who extended the stage route from Hance's Hotel to Bright Angel Canyon in 1895. Probably the first person to build in this area was "Bucky" O'Neill, the journalist,

mayor, sheriff, soldier and promoter who was also fond of the canyon. The structure believed to be his log cabin is the oldest surviving structure on the rim. Ralph Cameron, another early canyon entre preneur, moved a cabin to the area and added on a porch and second story in 1902, naming it the Cameron Hotel. Development of the tourist facilities by the Fred Harvey Company began during this time. El Tovar Hotel was completed in 1905. Mary Jane Colter was hired to design plans for the Hermit's Rest concession building and Lookout Studio. She later incorporated Cameron's Hotel and O'Neill's cabin into her plan for the present Bright Angel Lodge.

Because of its inaccessibility, the North Rim developed much more slowly. Cattle and sheep grazing were more successful here than on the South Rim until overgrazing depleted the denser vegetation. For the most part, the range was controlled by Mormons who were colonizing southern Utah and the Arizona Strip north of the canyon. Line shacks, corrals, and water control features such as tanks and troughs are the relics of this period. Grazing is still allowed on a lease basis in some areas of the park, notably the Tuweep District.

Grand Canyon became a forest reserve in 1893, proceeding through game reserve and national forest status along with development of the U.S. Forest Service. The passage of the Antiquities Act of 1906 gave the President the power to set aside areas as national monuments. In 1908, Theodore Roosevelt established Grand Canyon National Monument under the jurisdiction of the National Forest Service.

After the creation of Grand Canyon National Park in 1919, construction continued to flourish. The National Park Service buildings erected in these early days were patterned after the examples set by Mary Jane Colter. Most were built of native stone and wood to fit into the natural surroundings. This style, "NPS Rustic," was popular in the National Park Service until the 1940s, and is illustrated in the first and second NPS administration buildings and in the old post office. For more detail on the architecture of buildings within the park, see the National Register forms on file. Currently, National Register forms for the North Rim Headquarters Historic District, designed along similar lines in the 1920s and 1930s, are being prepared by the Denver Service Center and Western Region National Park Service personnel.

For a more comprehensive history of the Grand Canyon region, see Hughes (1967, 1978). Many historic photos are also reproduced in those volumes.

Research Collections. Grand Canyon research collections are composed of approximately 35,000 objects. Study collection materials are those which could not be studied *in situ* but which contribute to the understanding and interpretation of the park. Subjects covered include geology (40 percent of the collection); zoology (26 percent); botany (15 percent); history, including maps and photographs (13 percent); and anthropology/archeology (6 percent). Of these objects, 22,500 items have been catalogued into the National Catalog. For accountability purposes, some anthropological/archeological items

have been catalogued_ into the National Catalog. However, the majority of these have been catalogued using a system convenient for research. Copies of those forms are kept in the Study Collection with notations on the storage locations of the artifacts so that items are easily accessed. One thousand other items and 11,000 insect and plant specimens remain uncatalogued. The backlog occurred due to understaffing and is being cleared at a steady rate since the appointment of a permanent less-than-fulltime Museum Technician (GS-7).

The collection is accessible to park employees and to a limited number of other people according to their purpose and to the availability of the fulltime curator. A statement on collecting policy and scope of collections was compiled in 1978 and is updated by the curator periodically. In addition, the research collections are being managed according to a Collection Preservation Guide (Lewis 1980).

Research Library. The research library was established in the late 1920s. At present, it consists of more than 7100 catalogued items housed primarily in the Visitor Center and a branch location on the North Rim. The facilities are open at no extra fee to park staff and outside researchers.

Forty-five journals and newspapers are subscribed to annually. Extensive collections of other unbound periodicals, reprints, and news clippings about Grand Canyon, the park, and general park policy are not catalogued and are filed separately. Copies of Monthly Reports of the Superintendent and Monthly Report of the Park Naturalist are invaluable for research on the history of Grand Canyon National Park. Approximately 200 books are acquired annually by the permanent fulltime Library Technician (GS-7).

List of Classified Structures and National Register Properties. As an aid to planning, a number of prehistoric and historic structures with standing walls greater than one meter high have been evaluated and placed on the List of Classified Structures. The Western Archeological and Conservation Center (Sudderth, et al. 1976) prepared the list of 61 prehistoric structures with recommendations and estimates for treatment. Western Regional personnel prepared the reports for historic sites and buildings including 10 structures on the South Rim, 137 on the North Rim, 2 at Tuweep amd 17 in the Inner Canyon. The total for all structures is 220. Computer printouts of the list are sent periodically from Washington for review and updating. Time and staff permitting, the remaining standing structures which meet LCS criteria will be added.

At present, nine historic sites, one prehistoric site and one historic district are listed in the National Register. Two additional sites have been determined eligible for inclusion.

Properties listed in the National Register:

1. El Tovar Hotel (9-6-74)
2. El Tovar Stables (9-6-74)
3. Grand Canyon Railroad Station (9-6-74)
4. Grandview Mine (7-9-74)

5. Hermits Rest Concession Building (8-7-74)
6. O'Neill, Buckey, Cabin (10-29-75)
7. Ranger's Dormitory (9-5-75)
8. Superintendent's Residence (9-6-74)
9. Water Reclamation Plant (9-6-74)
10. Tusayan Ruins (7-10-74)
11. Grand Canyon Village Historic District, AZ (11-20-75)

Forms in process of preparation:

1. Grand Canyon Lodge
2. Grand Canyon Inn and Campground
3. NPS North Rim Headquarters
4. Bright Angel Lodge (and cabins)

Historic properties for which forms are needed:

1. Desert View Watchtower
2. Hermit's Rest
3. Greenland Lake Salt Cabin
4. Tuweep Ranger Station and Garage
5. North Rim Entrance Station Ranger Cabin and Garage
6. Uninventoried North Rim Ranching Structures
7. Uninventoried Inner Canyon historic resources
8. Kaibab Suspension Bridge

(Properties in the above categories may also require List of Classified Structures forms if not already entered in that listing.)

Properties determined eligible for inclusion in the National Register:

1. Old Post Office, Grand Canyon Village
2. Little Jug Site, Tuweep District, Grand Canyon National Park

In addition, a draft nomination to the National Register of Grand Canyon National Park in its entirety as an Archeological District or a Multiple Resources Area (partial listing) has been submitted to the Regional Director. In January 1980, it was accepted by the Arizona Historic Sites Review Committee as eligible for the National Register and of national level significance. Minor revisions are being made at their request.

Summary. The area which encompasses Grand Canyon National Park is known to have been inhabited from approximately 2500 B.C. to the present day. The original hunters and gatherers were supplanted in turn by Indian farmers, European explorers, scientists, prospectors, ranchers, and finally by those who come today for recreation and entertainment. Archeological and historic architectural sites number in the thousands. Over 2000 have been recorded by professional archeologists. Nearly 200 historic buildings, some representative of what later became known as "NPS Rustic," were designed and built after 1900. These varied cultural resources illustrate the general

historic development of the American West. More than that, they represent human exploitation, adaptation, and finally, recreation in an extremely rugged and diverse environment.

According to the National Register criteria for evaluation (36 CFR 1202.6), the cultural resources of Grand Canyon National Park are significant. This significance lies mainly in their value for study and the use of the resources to answer questions on: (1) culture history; (2) human adaptation to an arid and rugged physiographic environment and its numerous microenvironments; (3) subsistence and settlement patterns; and (4) trade and interaction. Both surface and subsurface evidence exists for a variety of prehistoric and historic, Native American and Anglo-American sites representing a wide range of cultures, ages and functions. Historic structures still in use today represent distinct architectural styles and historic periods and are no less important than archeological resources in defining the cultural resources of Grand Canyon National Park.

The integrity of the sites, and structures makes the area useful in interpreting the land use and history which is of local, regional, and national significance.

Conclusion. Knowledge of Grand Canyon cultural resources is based on incomplete, and in some cases, inaccurate data. Surveys to comply with E.O. 11593 and the National Historic Preservation Act as amended have not been completed. An historical and architectural inventory of the land on both rims is ninety percent complete. Based on research done by J. Donald Hughes (1967), Western Region personnel were able to study all areas of development on the rims except for ranching structures in the North Rim backcountry. Thus, while no major studies of historic resources are needed to comply with E.O. 11593, several National Register forms (mentioned above) should be filled out.

Inventories taken to provide archeological clearance for various projects within the park do add information, but in most cases, project areas are too small to appreciably augment the data base. Exceptions to this are large areas surveyed for the fire management plan (required by NPS-18:16-3) and survey done in the Cross-Canyon Corridor along the Bright Angel, North and South Kaibab Trails (Brooks 1974). Yet nearly 500,000 acres of the park remain a blank in regards to archeological resources. Interpretation based on current data may be inaccurate. Certainly, it is far from being as complete as it could be. Management decisions on the treatment of the resource may be outdated as well. Deterioration of some sites, especially along the Colorado River, is so rapid and monitoring so infrequent that no decisions on their preservation can be considered informed. Lack of action is resulting in the premature loss of irreplaceable resources. Thus, the present level of research is inadequate for interpretation, management and resource preservation.

2. Cultural Resources Management Needs and Project Statements

Current inadequacies in the cultural resource data base and in the treatment of individual sites must be corrected. The National Historic Preservation Act (NHPA) as amended and E.O. 11593 call for the location, evaluation and nomination to the National Register of all significant cultural resources on Federal lands. Sect. 106 of NHPA and Sect. 102 of the National Environmental Policy Act as well as the NPS Organic Act and the park's enabling legislation mandate that active protection measures be taken to preserve our cultural and historic heritage for future generations. The following projects have been designed to resolve data inadequacies and preservation problems.

The performance of compliance surveys (GRCA-C-3) will provide data for management, research and interpretive uses for areas where little or no work has been done or where ground disturbing projects are planned. For sites in areas which are surveyed in conjunction with the Fire Management Plan, a research design to determine the effects of management fires on the physical remains (GRCA-C-6) will be executed.

Where knowledge of an area exists, preservation is needed for heavily impacted sites and includes monitoring of particular sites (GRCA-C-7) to determine their rates of impact and deterioration. Sample data recovery (GRCA-C-1) has been recommended for six sites which have stratified middens. Such deposits are rare in the park and can provide valuable data useful for updating Grand Canyon culture history and culture change and for reconstructing the occupants' lifeways. This information is necessary to keep interpretation and public education accurate, and is the basis for effectively evaluating and planning future management actions. Stabilization techniques, developed primarily for standing structures, would not be feasible for these features. For heavily impacted sites where standing walls are present, stabilization (GRCA-C-5) is recommended to insure visitor safety and the long-term preservation of the physical remains and data potential of each site. Ruins which have been initially stabilized will be placed on a cyclic maintenance plan (GRCA-C-4). This will prevent further deterioration and the loss of funds and manpower already invested. The project, Curatorial Cyclic Maintenance (GRCA-C-8), will insure that archeological and historical, as well as natural, collections are properly curated. All collections previously collected or made in the course of any project in this plan need to be maintained according to present park and professional standards.

Liaison with adjacent Indian tribes (GRCA-C-2) is necessary to comply with the American Indian Religious Freedom Act (P.L. 95-341). Regular contact between tribal officials and park professionals is needed to help ease longstanding tensions and implement effective solutions to common issues.

Each of the above projects fills the need for the long-term preservation of cultural resources and for required compliance with

preservation legislation. Variation in recommended treatment is the result of the current knowledge about a site or area, site condition and previous treatment.

In addition to implementing the projects mentioned above, resource management personnel will need to develop several other project statements and Development/Study Package Proposals. More emphasis needs to be placed on the active preservation of the numerous historic park resources. Small historic resource studies are needed for ranching structures in the North Rim backcountry and for some Inner Canyon sites. LCS and National Register forms need to be completed for those structures which have already been studied. The compliance survey, monitoring and stabilization projects address needs for inventory and emergency preservation of structures or historic archeological sites where encountered. In some cases, recommendations on the treatment of historic structures still in use were made in the LCS report from Western Region. Based on this, a number of 10-237s and 10-238s have been prepared and are listed below.

Park Priority	No.	Title
15	I#15	Preserve Superintendent's House and Ranger Dorm
43	P#322	Rehab Operation Building
44	P#837	Preserve Old Post Office Building
45	P#340	Preserve Beamer's Cabin
62	P#124	Rehab Phantom Ranch and Indian Gardens Campgrounds
71	P#193	Rehab Tusayan Museum and Residence
76	P#422	Rehab Kolb Quarters

For these and other historic structures, more detailed Historic Structure Reports and/or Historic Structure Preservation Guides are needed. Because the park does not have a historian or historical architect, these will be prepared under the direction of the regional Historical Architect or qualified personnel in the Denver Service Center. Liaison with maintenance personnel who will perform the recommended treatment and monitoring of all maintenance projects are needs that will also be addressed.

The library is an important Grand Canyon resource. Planning documents will be developed to reflect the park's commitment to retain its present staffing and operation. A guide, similar to that written for the Study Collection, would also be useful.

Finally, rapidly inflating costs of labor and materials cause cost estimates to become outdated almost immediately. Thus, many of the figures will seem too low. To alleviate this problem, estimates will be reviewed and updated periodically.

1. GRCA-C-1-Excavation of Heavily Impacted Prehistoric Sites.

2. Statement of Issue or Problem:

Statement of Condition. Six prehistoric Indian ruins are being destroyed by heavy visitor use, vandalism and natural erosion. These sites are located at Tuna Creek, Whitmore Wash, Beamer's Cabin, 205-Mile Canyon, Deer Creek, and Granite Park.

1) Ariz. A:16:1. This is one of the most important stratified sites in the Grand Canyon. The deep midden, protected by the overhanging cliffs at Whitmore Wash, contains many normally perishable foodstuffs of the Virgin Anasazi. It is being badly vandalized due to the ease of accessibility from both the river and the Bundy (Whitmore) Trail. Also, two large gullies, one from human trailing, are cutting two exposures of the midden.

2) Ariz. B:15:7. This is a stratified rockshelter in Tuna Canyon, several kilometers from the river. Southern Paiute occupation, post-A.D. 1300, is evidenced on the surface. Below that are 20 centimeters of sterile, water-laid deposits. Below that a pre-A.D. 1150 Kayenta Anasazi occupation is evident. This is revealed in an erosional cut along the front of the shelter. Sample data recovery would provide significant data relative to the interface in time between the two cultural occupations.

3) Ariz. A:15:2. This site at 205-Mile Canyon is another deep, stratified midden. While it is seldom seen by river parties, it is in danger of being destroyed by flash floods. Past flooding is evidenced by sterile mud and gravel deposits capping the midden.

4) Ariz. C:13:4. This is the site of Beamer's cabin, constructed at the mouth of the Little Colorado River in 1890. Eroding from the terrace in front of the cabin is evidence of prehistoric use of the site by various groups of Indians over many centuries. It probably was a campsite for Native Americans on their way to the salt deposits about a mile down the Colorado River.

5) Ariz. B:10:4. This site at Deer Creek contains one Pueblo I Anasazi structure that is receiving heavy damage; at least one wall of the ruin has been totally dismantled by river parties. Due to the rarity of this type of site, especially this far west in the canyon, sample data recovery should be carried out before the site is totally destroyed.

6) Ariz. G:3:3. This is a rockshelter at Granite Park showing evidence of the intermingling of several cultures in western Grand Canyon. The site is being impacted due to its proximity to a heavily used camping beach.

Five of these sites are especially fragile because of the deep, stratified middens associated with them. Normally perishable materials such as basketry fragments and faunal and floral specimens have been preserved in undisturbed portions of the middens. These materials are rarely found in any quantities in archeological sites and are important in determining what subsistence activities were carried out, what was eaten or worn, and what time of year the site was occupied. In short, these data are important in trying to reconstruct the lifeways and behavior of the people.

The stratigraphic record represented by the midden deposits gives a broader time range and indicates culture change such as occupation of the same site by different cultural groups comtemporaneously or sequentially. For example, basal portions of the midden at Tuna Creek represent a Kayenta Anasazi occupation prior to A.D. 1150, while the upper portions indicate a Southern Paiute occupation. Controlled stratigraphic excavation is needed to document the relationship between the two and the postulated 200-year break in the habitation of the site.

The most visible impact on the middens is the development of pits and undermined areas caused by vandalism, pothunting and the scavenging of artifacts by hikers and river runners. Between 14,000 and 20,000 people visit these sites annually. The heavy traffic has also caused the formation of numerous trails on the middens which rainfall runoff has incised into deep trenches.

In addition, each of these sites constitutes an irreplaceable cultural resource. At the current rate of deterioration, the valuable scientific information embodied in the sites will be lost. All are included in the National Register nomination for the park's cultural resources, and are considered to be of national significance.

Current Management Actions. No direct actions have been taken to protect the selected ruins. Representatives of the various commercial river running companies are advised at annual boatman training sessions on the history and fragility of the structures, associated artifacts, and the physical context in which these are found. Hikers have received little or no briefing on cultural resources. The success of a recent article printed in the Grand Canyon Guide and a brochure, both written to educate the public on enjoying and preserving cultural resources, cannot be assessed yet. Backcountry hiking and river running permit systems involve quotas, but do not prevent visitation and further damage to the sites.

Monitoring efforts (Euler 1979) have produced photographs for comparison which document the increasing rate of destruction (See GRCA-C-7).

Results of Current Action. Quotas maintained through use of the permitting systems are not sufficiently stringent to prevent heavy visitor use. Current low levels of educational information and talks to hikers and boaters have been inadequate as evidenced by the continued degradation of these resources. This may even increase visitation by alerting visitors to the presence of the sites and lead to the illegal excavation and collecting of artifacts which are visible on midden surfaces. Monitoring projects have documented the deterioration, yet are too sporadic to help determine how often, when and by whom sites are being pothunted, or to pinpoint when emergency stabilization may be necessary.

A continuation of current management practices will result in continued deterioration and the eventual loss of the resource and the information it contains.

Another negative effect of the current management actions is non-compliance with cultural resources legislation. Preservation of these resources is mandated in the NPS Organic Act, the Natural Historic Preservation Act as amended, the National Environmental Policy Act and NPS Management Policies. In addition, enabling legislation for the park and the Grand Canyon National Park Enlargement Act (P.L. 93-620) call for the preservation and protection of cultural resources.

3. Alternative Actions and Their Probable Impacts:

a. No Action. Under this alternative, natural and man-caused erosional processes will be allowed to continue operating. Natural rates of erosion will be magnified by the foot-traffic and scavenging of thousands of visitors who have received only minimal education on the fragility of the sites and the scientific importance of preserving the physical relationships between objects and structures by leaving everything in place.

Impacts. This action will result in the damage to and eventual loss of the resource, the destruction of interpretive and research values, and may even endanger visitor safety. It will fail to address the non-renewable nature of the resource in violation of Federal legislation and regulations for their protection. Further, information necessary for wise management planning will continue to be inadequate.

b. Stabilization. These sites do not involve extensive structural components for which ruins stabilization techniques are designed. The major problem will be to build retaining walls or similar structures to prevent erosion of the soft midden areas, or to apply a chemical hardener to the cultural deposits.

Impacts. Stabilization may result in temporary disturbance of vegetation, visitation, and interpretive programs. The alteration of the appearance of the sites due to retaining walls or covering the midden will reduce the potential for on-site interpretation as well

as increase cyclic maintenance costs. The application of chemical hardeners will have a detrimental effect on cultural and paleoenvironmental data which could be collected.

The lack of scientific information available at only a few sites at Grand Canyon which is the basis for management decisions, the evaluation of resource significance, and research problem solving may be the greatest impact.

c. Use of "Stop-Gap" or Emergency Preservation Techniques. Such methods could include bracing, stabilizing only weakened, collapsed and eroded areas or covering the sites with soil or plastic to retard weathering.

Impacts. As opposed to complete stabilization, this action will result in the gradual loss of the resource and the information contained therein. Such measures may cure the visible symptoms but not the underlying problem of instability caused by continued erosion. Visitor safety may not be insured and aesthetic and interpretive values will be impaired. This alternative may be more costly in terms of labor and money which cannot be programmed in advance due to the nature of the action, and furthermore, management decisions will continue to be made on the basis of inadequate and inaccurate data.

d. Closure. All sites can be closed to visitation by the Park Superintendent under the Code of Federal Regulations (35 CFR 2.6). These sites are in heavily visited backcountry areas, accessible only by foot, mule, helicopter, or from the Colorado River. They would need to be signed to establish the closure, but under current budget and manpower limitations, patrols to help enforce the closure are unavailable.

Impacts. Closure by fencing is unsightly and has proven ineffective and expensive at Stanton's Cave where fencing of only one side, the cave entrance, was necessary. The decrease of access to the sites would also result in the loss of interpretive features and research value and the continued evaluation of the resource on the basis of incomplete or inaccurate information.

e. Continue Present Management. This alternative involves the continuation of the present monitoring and interpretive program. The deterioration of the selected sites has been monitored for nearly 20 years by the current park Anthropologist. Photographs, taken of the river sites in the early 1960's, were duplicated in 1978 and 1981. Comparisons of the photographs and descriptions document an increasing rate of destruction at each site.

Visitor safety will be endangered, and with the loss of the resource, on-site interpretive and research potential will disappear.

Impacts. Further monitoring will help document the progress of the destruction but does nothing to preserve the ruins or to bring the park into compliance with historic preservation legislation and mandates.

f. Increase Public Awareness. The public is poorly informed about the important scientific and cultural heritage represented by cultural resources, and yet these sites comprise some of the greatest attractions along trails and the river. The circulation of newspaper articles, brochures, and slide presentations or movies should be increased and studies implemented to evaluate their effectiveness.

Impacts. Increased briefing and public education may make the public more aware of the fragility of the ruins, and therefore help to preserve them. At the same time, it is not likely to decrease the visitation which is the main source of the problem. This may even increase instances of illegal digging and collection.

In addition, the scientific information available at only these few sites at Grand Canyon, which is important for interpretation and and public education, will not be available.

g. Sample Data Recovery. This alternative would involve the execution of a research design based on background research and prior complete surface collection and mapping. Controlled stratigraphic testing of less than twenty percent of the deposits will proceed according to professional standards, including screening of removed fill by natural and/or arbitrary provenience and the recovery of artifacts and floral and faunal specimens. Photographic and written documentation will be an integral part of this process. Following completion of the field work, collections will be analyzed and receive preliminary curation (cleaning, stabilization, and cataloguing). Data produced will be incorporated with the notes into a final report comprising recommendations for planning and future disposition of the site as well as research-oriented conclusions. Concurrently, stabilization of structural features and deposits (where possible) will be done.

Impacts. Natural plant cover may be altered and part of the resource will be removed from its original context. Visitor patterns and present interpretation may be altered, but guides should be able to take advantage of the excavations to educate the visitor about the nature of the archeologists' work and why data recovery is necessary in some cases. Preservation will be of the information from remote sites where only stabilization is not feasible or desirable. This information will augment the data base necessary for wise management, the evaluation of the significance of the resource and research problem solving.

4. Recommended Course of Action:

Sample data recovery accompanied by a broader public education program is advised. Data from these unusual sites is necessary for the evaluation of site and regional cultural significance and will augment inadequate or inaccurate information used for park planning. This alternative provides for the long-term preservation of most of each site which is valuable for on-site interpretation and compliance with Federal public archeology legislation.

Because public interest in the archeology of the park seems to be increasing, the interpretation and education will foster informed visitor use. This will allow the continued enjoyment and scientific value of the sites.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA-C -1 - Excavation of Heavily Impacted Prehistoric Sites and Resources Management Action

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Sample data recovery of six ruins in imminent danger of destruction	60.0
(If total funding is not forthcoming, at least 2 sites should be excavated each year. Whitmore Wash and Beamer's Cabin in FY 82 for a total of $20,000)	
Total	60.0 (or $20,000)
2. Fiscal Year 83	
Sample data recovery at 2 ruins, at Tuna Creek and 205-Mile Canyon	20.0
Total	20.0
3. Fiscal Year 84	
Sample data recovery at two ruins at Deer Creek and Granite Park	20.0
Total	20.0
4. Fiscal Year 85	
Total	
5. Fiscal Year 86	
Total	

1. GRCA-C-2-Liaison with Indian Tribes.

2. Statement of Issue or Problem:

Statement of Condition. Five Indian tribes adjacent to the park share concerns and problems with park management. These include the Kaibab Paiute, Hopi, Navajo, Havasupai, and Hualapai. The reservation boundaries of the latter three adjoin those of the park.

Where the boundaries are contiguous with the individual tribes, park officials would like to develop agreements for the regulation of fires which would permit wildfires to burn across park boundaries when prescription conditions prevail. Also, each tribe would like to continue collecting plants for religious purposes. This has been done often in the past and conforms with provisions of the American Indian Religious Freedom Act (P.L. 95-341). Other concerns are specific to individual tribes as follows.

Hopi concerns with the park include: 1) the protection of the sacred salt deposits located about one mile downstream from the confluence of the Colorado and Little Colorado rivers; and 2) the protection of another Hopi sacred place, the "Sipapu." This area is located on the Navajo Reservation on the Salt Trail, an access trail into the park. Where access can be controlled hikers and boaters should be informed of the restrictions.

The Navajo Reservation shares a 13-mile long unfenced boundary with the park. Several Navajo families have been grazing cattle, sheep and a few horses in the area since about 1890, almost 30 years prior to the establishment of the park. Misunderstandings are occurring now that park management has decided to enforce a "no grazing" policy. This issue is especially sensitive because it coincides with boundary disputes over the Bureau of Indian Affairs fencing of the new Hopi and Navajo boundaries.

A second major issue revolves around unauthorized bead selling within the park by Navajos from various parts of the reservation. An agreement could be worked out between the tribe, park officials, and concessioners for this to be permitted on a limited and controlled basis.

The contiguous boundary between the Hualapai tribe and the park follows the Colorado River from National Canyon to the Grand Wash Cliffs. The common concern here is the disembarkation of river trips at Diamond Creek. All parties pay a disembarkation fee. In addition, the NPS cleans up Hualapai beach campsites and notifies the tribal officials of the number of passengers intending to disembark at Diamond Creek.

The Havasupai have a special relationship with park management. The Grand Canyon National Park Enlargement Act (P.L. 93-620) provided for

95,300 acres of the park, known as the Havasupai Use Lands (HUL), to be used by the tribe ". . . for grazing and other traditional purposes." In 1977, consultation with the park Anthropologist was begun to develop a "Memorandum of Understanding" on the tribal use and park management of these lands. Central to this is the establishment of rights-of-way for hikers wishing to use the park boundary. Carrying capacities for park lands to be grazed must also be determined. The recent construction of four grazing exclosures and study transects will be used for this (See GRCA-N-17).

One mile west of Grand Canyon Village at Supai Camp, several Havasupai families are living on park lands. Because of frequent contact with the Park Anthropologist and rangers and a visit by the Superintendent which resulted in the construction of a shower, relations are taking a positive turn. However, alcohol abuse remains a problem.

The relationship with the Havasupai is perhaps one of the best due to frequent contacts between the park Superintendent, Visitor Services personnel, the Anthropologist, the tribal members and officials. Clearly, increased contact with all the tribes helps ease tensions and fosters better understanding and cooperation.

Current Management Action. Present liaison with the Indian tribes consists mainly of only one trip per year by the park Anthropologist to each reservation, and meetings between ranger personnel and tribal officials when specific problems arise. Meetings have been held with Navajo Chapter officials to resolve conflicts about the bead selling and trespass grazing within the park. Navajos from all parts of the reservation are engaging in the bead selling. Therefore, contact should be made with tribal officials at Window Rock.

Meetings between the park Anthropologist and Havasupai have been more frequent. The park Anthropologist has attended tribal council meetings and has worked on the terms of a "Memorandum of Understanding" regarding the Havasupai Use Lands, and has worked with the Federal veterinarian who has been studying abnormal deaths of Havasupai horses on reservation lands adjacent to the park. Also, the park Anthropologist is the only archeologist permitted to examine sites on the reservation at the present time. He has conducted limited archeological clearances for the Havasupai, and this information has given considerable insight into the occupation of the area by the Havasupai and their ancestors. This insight is valuable in establishing and maintaining smooth cross-cultural relations.

Results of Current Action. The park Anthropologist has been working to establish cooperative relations between the park and the five adjacent Indian tribes since 1975. He also has worked closely with the Hualapai, Havasupai, Navajo and Paiute tribes on a professional basis since the 1950's. Regular visits, not made to deal with a specific problem, provide continuity in the relationship and help establish smoother communication. Tension and antagonism towards NPS

managers is lessened, making it easier to effect solutions to particular problems when difficulties do arise. In addition, continual liaison contributes to compliance with the American Indian Religious Freedom Act.

3. Alternative Actions and Their Probable Impacts:

a. No Action: Under this alternative, current management would continue. The park Anthropologist would make one visit per year to each tribe except the Havasupai. Due to their close proximity, and due to the complexities arising from joint use of the Havasupai Use Lands, more meetings will be required with these tribal members and officials. Ranger personnel and the park Superintendent would attend at least one meeting annually and as needed when problems arise.

Impacts. In addition to contributing to compliance with the American Indian Religious Freedom Act, regular communication by a culturally sensitive anthropologist will decrease persistent tensions and antagonisms between park officials and tribal members. Involvement by other park staff will provide continuity and backup when the Anthropologist is not available.

b. Terminate Indian Liaison Activities. This alternative would involve cutting out all liaison between the park and adjacent Native American tribes.

Impacts. This ignores legislative and NPS mandates that "properly selected, sensitized and trained people shall serve as intermediaries between the Park Service and local groups" (NPS-28:2-18). Cooperative relations will continue to deteriorate, and the park will continue to be deluged with complaints from Indians, lawyers, advocates, congressmen, and the news media. More importantly, the character of Indian lifeways as these relate to the park and its resources will also deteriorate.

c. Liaison by Ranger Personnel Only. Liaison actions would be performed by rangers as problems arise.

Impacts. This alternative will not comply with Federal and NPS mandates to use specially selected and sensitized personnel for liaison and would be wasteful of the expertise and rapport of the park Anthropologist. Traditionally, antagonism towards park management has been high in all the tribes. This is aggravated by lack of training and sensitivity in ranger personnel about cross-cultural differences. Also, cooperation is not fostered by the establishment of communications only when a problem arises.

d. Liaison by Park Anthropologist Only. Regular contact between the park Anthropologist and tribal officials would be established. A minimum of two to three annual visits to each reservation, as well as trips scheduled as problems arise, will insure the interpretation of park managerial policies and the pinpointing of tribal concerns.

Impacts. These visits would help comply with Federal and NPS mandates in dealing with socio-cultural resources. Consultation should improve or at least maintain present cross-cultural relations which have been better than perhaps anytime in the past due to frequent contact by the park Anthropologist. However, it should be noted that time spent on liaison activities will detract from staff ability to inventory and assess the significance of other park cultural resources.

4. Recommended Course of Action:

The park recommends that liaison be performed on a regular basis by the park Anthropologist to establish continuity and rapport. Ranger personnel, including the Superintendent, will also attend at least one tribal council meeting annually to sensitize them to specific needs and problems. Rapport and familiarity established at these meetings will be beneficial for communications necessary when unforseen problems arise.

This alternative will result in compliance with Federal and NPS mandates. Further, the skills of the park Anthropologist will be wisely used to smooth relations and establish effective communications between park management and adjacent Indian tribes, thus insuring a more timely solution to common problems and concerns.

PROJECT TITLE: GRCA- C - 2 - Liaison With Indian Tribes
Resources Management Actions

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Thirteen trips to meet with tribal councils or other tribal leaders on five reservations	1.0
Total	1.0
2. Fiscal Year 83	
Thirteen trips to meet with tribal councils or other tribal leaders on five reservations	1.0
Total	1.0
3. Fiscal Year 84	
Thirteen trips to meet with tribal councils or other tribal leaders on five reservations	1.0
Total	1.0
4. Fiscal Year 85	
Thirteen trips to meet with tribal councils or other tribal leaders on five reservations	1.0
Total	1.0
5. Fiscal Year 86	
Thirteen trips to meet with tribal councils or other tribal leaders on five reservations	1.0
Total	1.0

1. GRCA-C-3-Conduct Cultural Resource Compliance Surveys.

2. Statement of Issue or Problem:

Statement of Condition. An estimated 475,000 to 500,000 acres of the park have not been inventoried for their cultural resources. These areas (Figure 6) include most of the 407,799 acres added to the park by P.L. 93-620, the Grand Canyon National Park Enlargement Act of 1975. Many areas along the North and South Rims, and in the Tuweep District, have been only partially inventoried.

The following priorities have been set based upon: clearance needed under the fire management plan; development and maintenance programs; reports of vandalism; other negative impacts in unsurveyed areas (such as response to grazing in Tuckup Canyon); and research gaps in the interpretation of the prehistory and history of Grand Canyon. These priorities include:

1) Areas proposed for management development, maintenance, or construction activities likely to result in ground disturbance

2) North Rim - Walhalla Plateau

3) South Rim - Desert View, Palisades of the Desert

4) South Rim - Bass Point

5) South Rim - Rim areas between Bass Point and Grandview excluding Grand Canyon Village

6) Tuweep District - Tuckup Canyon

7) Sanup Plateau

8) Area south of the Colorado River and west of the Hualapai Indian Reservation.

All prehistoric and historic sites and structures need to be recorded and photographed. To determine the age and cultural affiliation of sites, collections will be made and all objects curated according to professional standards.

The inventory and mapping of sites is essential to establishing a data base necessary for wise management and planning. It will provide data needed for an archeological and historical understanding of the nature of the resources, a projection of site density and for prediction of the types and degree of natural and man-caused impacts to sites. For historic resources, this preliminary investigation can help determine if Historic Structure Reports or Guides are needed. These will be referred to the Historical Architect, Western Region.

Inventories originally required by E.O. 11593 are now covered by the National Historic Preservation Act as amended in 1980. The National Park Service must "locate, inventory and nominate to the Secretary of the Interior all sites, buildings, districts and objects under [its] jurisdiction or control that appear to qualify for listing on the National Register of Historic Places" (E.O. 11593, Sect. 2a). The deadline for the inventory, December 1973, has passed, but this does not relieve Federal agents from those responsibilities. Further, compliance with Section 106 of the National Historic Preservation Act and Section 102 of the National Environmental Policy Act needs to be fulfilled. Failure to make progress toward this goal may result in the loss of these irreplaceable resources.

Current Management Action. The Park Anthropologist and Archeologist are able to perform only archeological surveys and clearances on a project-by-project basis. This has included inventory and blanket clearance for Inner Canyon campgrounds, Bright Angel Point and parts of the South Rim Village. Under a blanket clearance, an area slightly larger than the zone of direct project impact is surveyed and all sites located. Future projects within the clearance boundaries may be cleared quickly by comparing project specifications with a map which shows the location of previously recorded sites.

Additional clearance work has been done in yearly phases to fulfill cultural resources compliance requirements for the Fire Management Plan. Prescribed burn blocks to be used as fire breaks and prescribed natural fire zones are being surveyed first. Sampling fractions of between 5% and 20% based on the nature of the area to be affected and the expected density of sites have been agreed upon by Western Regional personnel as adequate. Of those sites located, several sites felt to be representative of those in each area are flagged by the Anthropologist or Archeologist and will be protected from burning by a fuel break or fire line. Five sites on Powell Plateau (Unit I of the Fire Management Plan) and three on Walhalla Glades (Units 3A and 3C) have been flagged; however, only three on Powell have had a fire line placed around them. All historic sites with aboveground structural remains that could be destroyed by fire are protected in the same way.

Areas which will be impacted directly by any ground disturbance, such as fire lines or trenching, are totally surveyed. Likewise, when any subsurface remains are located during a project, work will be stopped to allow inspection and assessment by the Anthropologist or Archeologist.

Results of Current Action. The present methods of inventory insure that the effects of park projects on cultural resources are assessed according to regulations promulgated by the Advisory Council on Historic Preservation (36 CFR 800). This constitutes compliance with Sect. 106 of the National Historic Preservation Act (NHPA) and Sect. 102 of the National Environmental Policy Act. However, the data base acquired in the past is not adequate for compliance with E.O. 11593

or NHPA as amended. For the nearly 500,000 acres added to the park in 1975, little data exist. Thus, not only is the park failing to comply with Federal mandates, but it is continuing to base management decisions on inadequate and out-dated information on the resources.

3. Alternative Actions and Their Probable Impacts:

a. No Action. A management decision to take no action will involve curtailing surveys of proposed park projects.

Impacts. Not conducting archeological surveys would be in violation of all Federal legislation and regulations mandating the preservation and evaluation of cultural resources. Park planning and interpretation will continue to be based on incomplete and perhaps inaccurate data. Finally, this alternative may result in the damage to and eventual loss of the resource.

b. Continue Present Management Actions. This action has been described above as a decision to conduct surveys within project boundaries as needed for Section 106 clearance. Additional sample surveys using between 5% and 20% sampling fractions are completed annually in block areas corresponding to fire breaks and prescribed natural fire zones described in the park Fire Management Plan.

Impacts. Current actions are fulfilling requirements for archeological clearance and the assessment of effects of various projects on cultural resources. Inventory of historic structures will be completed after Historic Resource Studies of North Rim ranching structures and some Inner Canyon structures can be programmed. Additional resource basic inventory work on archeological sites required by E.O. 11593 and the National Historic Preservation Act as amended in 1980 will not be done on a timely basis. Apart from lack of compliance, park planning and interpretation would be based on inadequate and incomplete data. This problem is especially acute for the nearly 500,000 acres which were added to the park by the Grand Canyon National Park Enlargement Act (P.L. 93-620). This alternative could possibly result in damage to or loss of archeological resources.

c. Complete Survey. This alternative would entail a 100% survey of all park areas. Surveys would be done on foot with access by helicopter or boat as needed. Mapping and surface collection of a representative sample of artifacts would be done for each site.

Impacts. This alternative would eventually bring the park into compliance with all NPS and Federal mandates and policies. The only direct effect would result from removal of artifacts from their original context. A representative collection is necessary for the correct identification and dating of each site and is not possible without prior washing of the artifacts. The effects of this would be mitigated by locating all sample units and diagnostic artifacts on accurate site maps. By preserving the proveniences, future studies on intra-site activity areas will not be hindered.

Present limitations on funding and manpower would preclude the timely completion of this project. This would result in the augmentation of the data base in certain geographic areas only. Thus, management would still be without adequate information for the planning and interpretation of large areas of the park. This could result in damage to or loss of resources in those parts of the park.

4. Recommended Course of Action:

Park management recommends a combination of the last two alternatives. Projects and broad areas of the park would be surveyed according to the list of priorities enumerated above. Highest priority has been assigned to ground-disturbing projects which need archeological clearance in the early stages of planning. Additional acreage (up to 40,000 acres annually) would be sample surveyed (5% to 20% sample fraction) to fulfill fire management and basic inventory requirements. Inventory and mapping would include partial and complete survey on foot with occasional access by helicopter or boat. When possible, sites will be revisited periodically to update site records (See GRCA-C-7).

The only direct effect of this on individual resources will be from surface collection of artifacts. A representative sample will be collected using stratified random sampling and judgmental collection of diagnostics. Accurate mapping will show the location of all sample units and isolated finds. The collections are necessary for the proper identification and dating of these sites. Complete analysis cannot be done in the field without prior washing.

The recommended surveys will begin compliance with National Park Service and other Federal cultural resource legislation. Complete coverage would not be achieved, but a representative and statistically valid sample of cultural resources in all areas could be obtained in a reasonable time period. Thus, management and planning decisions, as well as interpretation and research of the park's cultural resources, could be based on adequate data. In such a way, long term preservation of the scientific and educational value of the entire resource will be insured.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- C - 3 - Conduct Cultural Resources Compliance Surveys - Resources Management Actions

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Surveys of management development and construction projects, 5,000 acres of resource inventory near Desert View, Pasture Wash, Bass Point east to Eremita Mesa	30.0
Total	30.0
2. Fiscal Year 83	
Surveys of management development and construction projects. Resources inventory of Tuweep District	30.0
Total	30.0
3. Fiscal Year 84	
Surveys of management development and construction projects. Resources inventory of Tuweep District and extreme southwestern section of the park west of the Hualapai Indian Reservation	30.0
Total	30.0
4. Fiscal Year 85	
Surveys of management development and construction projects. Resources inventory of Tuckup Canyon and adjacent areas of the park	30.0
Total	30.0
5. Fiscal Year 86	
Surveys of management development and construction projects. Resources inventory of Sanup Plateau	30.0
Total	30.0

1. GRCA-C-4-Cyclic Maintenance of Archeological and Historic Structures.

2. Statement of Issue or Problem:

Statement of Condition. Four sites, Walhalla Glades Ruin (Ariz. C:13:81), Bright Angel Pueblo (Ariz. B:16:1) Tusayan Ruin and Museum (GC-1 and LCS HS-114) and Nankoweap Granaries (Ariz. C:9:1A), have been previously stabilized. A project (GRCA-C-5) has been designed to stabilize eight others. These sites must be placed on cyclic maintenance programs to maintain the present condition and to correct any deficiencies to bring them up to current National Park Service standards. The sites are visited by as many as 175,000 people annually. Visitation has caused loosening of rocks and wall sections creating safety hazards for the visitor. Faulty drainage and vegetation growth cause additional erosion.

Continued neglect will result in the deterioration and eventual loss of the resource as well as its historic, aesthetic and interpretive values. Further, these irreplaceable resources are protected under the National Historic Preservation Act (NHPA), National Environmental Policy Act (NEPA), National Park Service Organic Act and this park's enabling legislation as amended. Tusayan Ruin and Museum are on the National Register. The remaining sites are included in a nomination to the Register of all the park's cultural resources. NHPA and NPS regulations and guidelines place the responsiblity for evaluating project and natural effects on these resources and for actively planning for their preservation on National Park Service managers.

Current Management Action. Maintenance of the previously stabilized ruins has been minimal and irregular. Tusayan Ruins were last stabilized in 1965 with minor repairs in 1978. Inspection by the Preservation Supervisor, Western Archeological and Conservation Center, on May 27, 1981 led to an estimate that 18 person-days would be needed for recapping, repointing of walls and replacing the soil cement coating of the bench in Kiva A. Walhalla Glades Ruin was last stabilized in October 1978. In the report (Mayer 1978), cyclic maintenance is estimated to require 11 person-days every five years. Bright Angel Pueblo was stabilized after excavation in 1969. Inspection on May 27, 1981 revealed that the ruin was in relatively good condition and would need about six person-days to remove excess vegetation and replace loose cap stones. Nankoweap granaries were stabilized for the first time in November 1981 after a visitor pushed a fragile wall down.

Inspections are not regularly scheduled and have not been performed annually. Recommended repair has been done more infrequently due to lack of funding and trained personnel.

Result of Current Action. Present management actions do not insure the long-term preservation of these resources. Eventually, the

physical remains will be lost or displaced and the aesthetic and interpretive values depleted. Visitor safety may be endangered by loosened masonry and unstable wall sections. Funding previously spent on stabilization is being wasted if these ruins are allowed to further deteriorate. Ultimately National Park Service policy and guidelines and Federal legislation calling for cultural resource preservation are being violated.

3. Alternative Actions and Their Probable Impacts:

a. No Action. Choice of a no action alternative would mean allowing any natural and man-caused erosional problems to continue with no attempts at monitoring or mitigating the impacts. Natural rates of deterioration are accelerated by the trampling and scavenging of large numbers of visitors.

Impacts. This alternative fails to comply with public legislation or to address the non-renewable nature of the resources. It will result in the eventual loss of these resources and their aesthetic and interpretive qualities. Visitor safety will also be endangered.

b. Continue Present Management. Inspection and maintenance would be performed at irregular intervals. Rather than having cyclic maintenance, preservation would be done on an emergency basis or as surplus funds and manpower became available.

Impacts. This action will result in the gradual loss of the resources. Aesthetic and interpretive values may be retained, but the use of restoration techniques, after substantial damage and collapsing of walls, will result in a loss of resource integrity. This is in violation of NPS and other Federal compliance legislation and may also lead to tort claims against the park by visitors injured by unstable walls and loose stones. In addition, labor and funding needs cannot be programmed in advance.

c. Cyclic Maintenance. Site inspection would be performed on a regular basis as recommended by a preservation specialist. This would lead to estimates of person-days, supplies and scheduling needed to maintain the ruins according to NPS standards. Also, supervision and training of park maintenance personnel would be the responsibility of this specialist. Maintenance would include resetting loose wall sections and capstones, repointing joints, recoloring old mortar and modifying site drainage as necessary.

Impacts. Impacts to the natural and cultural environments would be minimal. For sites in open areas, excess vegetation which would weaken walls or obscure inspection will be removed. Beyond the initial stabilization, most of this work would produce no further impact to the ruin, but visitor use patterns and interpretation may be temporarily interrupted. Such a program would allow for advance planning and budgeting and help fulfill agency responsibilities to comply with cultural resource legislation and NPS guidelines and policies.

4. Recommended Course of Action:

Park managers recommend that the ruins be stabilized and put on cyclic maintenance programs. Regularly scheduled inspections and repair work will prevent the further deterioration of sites previously stabilized as well as those slated for stabilization in project GRCA-C-5. In FY 82, inspection and work will begin on Tusayan Pueblo, Bright Angel Pueblo, Walhalla Glades ruin, Horseshoe Mesa Cabin, Greenland Lake Salt Cabin and Vasey's Paradise (See Package #523). Since Nankoweap granaries were not stabilized until late 1981, it will be added to the work load in FY 83.

This follows the edicts of legislation and policies for the preservation of the park's archeological resources. Long-range management planning and budgeting will be possible. Finally, the long-term preservation of the individual sites as well as the educational and aesthetic qualities of the resources will be insured allowing for continued enjoyment by the public.

PROJECT TITLE: GRCA-C -4 - Cyclic Maintenance of Arcehological and Historic Structure - Resources Management Actions

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Preserve/stabilize six ruin sties. Examine each site for maintenance needs; contact WACC for professional assistance; perform any necessary archeological investigations in connection with maintenance.	17.0
Total	17.0
2. Fiscal Year 83	
Examine each site for maintenance needs; contact WACC for professional assistance; perform any necessary archeological investigations in connection with maintenance.	19.8
Total	19.8
3. Fiscal Year 84	
Examine each site for maintenance needs; contact WACC for professional assistance; perform any necessary archeological investigations in connection with maintenance.	20.0
Total	20.0
4. Fiscal Year 85	
Examine each site for maintenance needs; contact WACC for professional assistance; perform any necessary archeological investigations in connection with maintenance.	20.0
Total	20.0
5. Fiscal Year 86	
Examine each site for maintenance needs; contact WACC for professional assistance; perform any necessary archeological investigations in connection with maintenance.	20.0
Total	20.0

CULTURAL RESOURCES PROJECT STATEMENT

1. GRCA-C-5 Stabilization of Selected Archeological Structures.

2. Statement of Issue or Problem:

Statement of Condition. The eight sites in immediate need of stabilization include:

1. Cardenas Ruin (Ariz. C:13:2)
2. Crystal Ruin (Ariz. B:16:3)
3. Deer Creek Ruin, Structure 2 (Ariz. B:10:4)
4. Ruin below Deer Creek Falls (Ariz. B:10:1)
5. Shinumo Ruin (Ariz. B:15:1)
6. Ruin below Indian Gardens (Ariz. B:16:31)
7. Site opposite Cardenas (Ariz. C:13:10)
8. Basalt Creek Ruins (Ariz. C:13:9).

Each of the ruins is accessible, via hiking trails or the Colorado River, to as many as 100,000 visitors annually. Such extensive and uncontrolled use has accelerated natural deterioration caused by weathering. Ruin walls, chimneys, roofs and flooring have been prematurely weakened and pose safety hazards. Emergency stabilization was required at Nankoweap Ruins after a weak wall was pushed over by a visitor in August 1981. Trenching caused by water erosion on trails, especially at Ariz. B:10:1, C:13:10 and C:13:9, is undermining these structures. This is hazardous and alters the interpretive and aesthetic values of the resources.

Further, each of the sites constitutes an irreplaceable cultural resource. At the current rate of deterioration, the valuable scientific information embodied in the structures and their contexts will be lost prematurely. All eight sites have been placed on the National Park Service List of Classified Structures (LCS) or are included in the National Register nomination for the park. As part of the collective Grand Canyon cultural resources, they are considered to be of national significance.

Current Management Action. Except at Nankoweap Ruins, no direct actions have been taken to protect the selected ruins. However, representatives of the various commercial river running companies are advised on the history and fragility of the structures, associated artifacts and the physical context in which these are found. Hikers receive little or no briefing on cultural resources. Backcountry hiking and river running permit systems do involve quotas, but do not prevent visitation and further damage to the sites. Recent efforts at public education include a brochure on the enjoyment and preservation of archeological sites for distribution to river trip leaders during Spring 1982 and an article published in the Grand Canyon Guide (Vol V. No. 23) for distribution to the general public. If effective, both may be reprinted for larger audiences.

Comparison photographs and descriptions taken in the early 1960's and in 1978 (Euler 1978) document changes in site conditions.

Precedent for this project was set by the stabilization of Tusayan Ruin at Desert View, Walhalla Glades Ruin on Cape Royal, Bright Angel Pueblo at Phantom Ranch and the Nankoweap granaries. Periodic inspections by historic preservation specialists indicate that only minimal routine and cyclic maintenance are necessary after the initial stabilization. Also, safety and appearance are enhanced, thus augmenting interpretive efforts.

Results of Current Action. Quotas within the permitting systems are not sufficiently stringent to prevent visitation by up to 100,000 people annually. Education of hikers and boaters at the current level of effort is not adequate as evidenced by the continued degradation of these resources. Irreplaceable ruin walls are collapsing. A continuation of current management practices will result in continued deterioration and the eventual loss of the resource and the information contained therein.

This management action has resulted in non-compliance with the cultural resources legislation. Preservation of these resources is mandated in the National Park Service Organic Act, the National Historic Preservation Act as amended in 1980, the National Environmental Policy Act and National Park Service Management Policies. In addition, enabling legislation for the park and the Grand Canyon National Park Enlargement Act (P.L. 93-620) calls for preservation and protection of cultural resources.

3. Alternative Actions and Their Probable Impacts:

a. No Action. This alternative involves allowing the natural and man-caused erosional processes to continue with no attempts at monitoring or mitigating impacts. Natural rates of deterioration are magnified by the trampling and scavenging by large numbers of visitors who, at best, have received minimal briefing on the importance and fragility of the sites.

Impacts. This "no action" alternative fails to comply with public legislation or to address the irreplaceable nature of the resource. It will result in the eventual destruction of the resource and of data necessary for research, management and interpretive programs. Visitor safety will also be endangered.

b. Use of "Stop-Gap" or Emergency Preservation Techniques. Such methods could include bracing, stabilizing only weakened areas, restoring collapsed and eroded areas, or covering the sites with soil or plastic to retard weathering.

Impacts. As opposed to complete stabilization, this action will result in the gradual loss of the resource and the information contained therein. Such measures may cure the visible symptoms but not the underlying problem of instability caused by continued erosion. Visitor safety may not be insured and aesthetic and

interpretive values will be impaired. In addition, this alternative may be more costly in terms of labor and money which cannot be programmed in advance due to the nature of the action.

c. Closure. All sites can be closed to visitation by the Park Superintendent under the Code of Federal Regulations (35 CFR 2.6). These sites are in heavily visited backcountry areas, accessible only by foot, mule, helicopter or from the Colorado River. The sites would need to be signed to establish the closure, but under current budget and manpower limitations, patrols to help enforce the closure are unfeasible.

Impacts. Closure by fencing is unsightly and has proven ineffective and expensive at Stanton's Cave where fencing of only the cave entrance was necessary. The decrease of access to the sites would also lower the interpretive potential.

d. Continue Present Management. This alternative involves the continuation of the present monitoring and interpretive program. The deterioration of the selected sites has been monitored for nearly 20 years by the Park Anthropologist. Photographs taken of the river sites in the early 1960's were duplicated in 1978. Comparisons of the photographs and descriptions document an increasing rate of destruction at each site.

Impacts. Further monitoring will help document the progress of the destruction but does nothing to preserve the ruins or to bring the park into compliance with historic preservation legislation and mandates. Visitor safety will be endangered and with the loss of the resource, on-site interpretive and research potential will disappear.

e. Increase Public Awareness. The public is poorly informed about the important scientific and cultural heritage represented by cultural sources and yet these sites comprise some of the greatest attractions along trails and the river.

Impacts. Increased briefing and public education may make the public more aware of the fragility of the ruins and therefore help to preserve them. At the same time, it is not likely to decrease the visitation which is the main source of the problem. This may even increase instances of digging and collection.

f. Full Stabilization. This alternative consists of full stabilization with materials compatible with the original fabric. Pre-stabilization research will include careful mapping, photography, surface collection and detailed notetaking to help mitigate impact and resource loss. Inspection and occasional sampling of the mortar and plaster of individual ruins will be performed to 1) determine the best materials and techniques of preservation for that ruin; 2) evaluate the extent of loss of the original fabric; and 3) determine if important data will be lost during stabilization and thus, if emergency data recovery will be necessary. Where wall sections need to be rebuilt or repointed, a sample of the original mortar will be taken for mineralogical and pollen analysis. Artifacts in the wall

matrix and samples of wooden structural members will also be collected as necessary.

The removal of depositional fill will be kept to a minimum. Where trenches need to be excavated in order to rebuild walls and the fill must be removed, excavation will be performed according to a research design for controlled stratigraphic excavation. This will proceed according to professional standards and will involve copious note-taking, screening of removed fill by provenience, and the recovery of artifacts and floral and faunal specimens.

Impacts. The natural vegetation, as well as visitation patterns, aesthetic appearance and interpretation may be temporarily altered. Also, some information contained in the ruin will be lost and the character altered because of wall footing excavation and wall rebuilding, mortaring and capping.

Following stabilization, visitor safety will be insured and the interpretive potential of each site may be realized. Brochures or signs may be used to disseminate information on the structures which was gained through minimal research done prior to stabilization. Because safety hazards have been reduced or eliminated, the need for the park to provide an on-site interpreter or patrol will also be reduced.

4. Recommended Course of Action:

The park recommends the full stabilization of selected archeological sites and the implementation of a broader public education program. This recommendation follows the edicts of legislation and policies established to preserve the park's cultural resources. This alternative also provides for the long-term preservation of the individual sites and the continued educational and scientific value of the resources.

The implementation of a broader education program, through the dissemination of printed information and interpretive talks, will also allow continued enjoyment of these sites.

PROJECT TITLE: GRCA-C-5-Stabilization of Selected Archaeological Structures - Resources Management Actions

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Stabilize ruins at Cardenas and Crystal.	6.0
Total	6.0
2. Fiscal Year 83	
Stabilize ruins across from and below Deer Creek.	6.0
Total	
3. Fiscal Year 84	
Stabilize ruins at Shinumo and below Indian Gardens.	6.0
Total	6.0
4. Fiscal Year 85	
Stabilize ruins at Basalt Creek and opposite Cardenas.	6.0
Total	6.0
5. Fiscal Year 86	
Total	

1. GRCA-C-6 Assessment of Effects of Management Fires on Archeological Resources.

2. Statement of Issue or Problem:

Statement of Condition. Fire is an integral part of Grand Canyon ecosystems. Accordingly, after many years of complete suppression, a fire management plan is being implemented to reintegrate fire into the ecosystem.

Research in *Pinus ponderosa* communities has documented a fire cycle of 5 to 10 years (Kallender 1969). This research and field reconnaissance indicates that many if not all archeological sites in forested areas have been burned in the past. At Grand Canyon, surficial evidence from sites subjected to the 1976 Dutton Point fire on Powell Plateau indicates alteration to surface features. Stone masonry became friable and cracked. Diagnostic features of ceramics such as decorations were either burned off or obscured by smoke smudging which was not removable with vigorous washing. Sites that have burned in the not so recent past do not indicate similar surface impacts. Research on fire impact in other areas has relied on test plots and artificial sites or on the evaluation of data collected after sites were burned unintentionally. The research is inconclusive, especially with respect to damage of subsurface remains such as pollen, floral and faunal material, perishable artifacts, and clay hearths used for archaeomagnetic dating. This is partially due to the lack of a good control sample, i.e. data collected before and during the fire.

NPS management policies call for the suppression of all fires if they threaten cultural resources (1978:IV-14). Fire management guidelines (NPS-18:16-3) specify that research be undertaken to evaluate the effects of fire on historic and archeological resources. Additional legislation such as the National Historic Preservation Act and its amendments and the National Environmental Policy Act mandate that the impact of Federal projects on sites be assessed prior to the project.

Current Management Action. Under the present fire management plan, the park is divided into natural fire zones based on vegetation, fuel loads, and degree of cultural development. Management burn areas for fire breaks, prescribed natural burns ("let-burn") and suppression zones are receiving archeological surveys in that order of priority. Depending on vegetation and the expected site density, park and regional personnel have agreed that 5% to 20% sample survey is adequate to allow the assessment. In each area, three to five representative sites are chosen to have fire lines constructed and maintained around them. All fires will be suppressed at these sites.

Results of Current Action. The actions described above are contributing to fulfilling compliance survey requirements of the National

Historic Preservation Act as amended. Yet NPS policy and guidelines to suppress all fires endangering cultural resources and to conduct research to assess the fire impact are not being followed. Only a few sites are being totally protected. The rationale behind the park's actions is that most sites have burned previously. However, greater fuel loads due to decades of suppression may have increased danger of damage due to high temperatures. In addition, fire suppression activities, especially mechanical or hand line construction, may result in damage to unidentified or unmarked sites.

3. Alternative Actions and Their Probable Impacts:

a. No Action. This alternative would involve implementing the fire management plan without previous archeological research and survey.

Impacts. Taking no action on this problem would result in an unknown amount of damage or even loss of irreplaceable cultural resources. Without assessing the effects of fires, Federal cultural resource compliance legislation and NPS policy and guidelines would be violated. Also, management decisions on the disposition of cultural resources within burn areas would be based on inadequate or nonexistent data.

b. Fire Suppression. According to NPS guidelines (NPS-18), all fires which threaten cultural resources will be suppressed. A variation of this would be to place fire lines around all known sites. These lines would need to be maintained periodically to keep them free of vegetation and duff and must be monitored during a fire to prevent spot fires. In addition, in areas where sites have not been so delineated or where compliance surveys are not completed, an archeologist should be present during a fire to direct fire crews and define site boundaries.

Impacts. Since sites are found in virtually every location within the park, this alternative would require the suppression of nearly all fires. Thus, the current plan to reintegrate fire into the natural system could not be implemented. The placement of fire lines around all known sites would be inordinately expensive and time-consuming, especially because periodic maintenance would still be required. Also, placing an archeologist on every fire to mark and protect all sites would deter effective containment and control of the fire itself. This is an inefficient use of both the fire crew and the archeologist's time and knowledge. Future management of archeological and historical resources would be hampered by lack of data about the impact of fire.

c. Research Using Test Plots and Laboratory Tests. Various test plots and artificial sites would be set up in different vegetation and fuel load zones and allowed to burn under different prescriptions. Thermocouples or heat-sensitive crayons, paint chips, or cones could be used to monitor surface and subsurface temperatures. Laboratory tests could be used to assess the effects of a range of temperatures on artifacts and clay hearth samples.

Impacts. This type of research upholds NPS guidelines and policies. However, similar testing in Yosemite National Park has yielded inconclusive data on fire impact. Only surficial artifacts were examined. No data on non-artifactual materials such as soils and pollen, and no subsurface data are available. No quantification of fuel loads, temperature levels, and fire duration was made. Where these data exist, such as for the La Mesa fire in Bandelier National Monument in 1976, little is known about pre-fire artifact/site conditions. The effects of fire on subsurface elements cannot be determined through these artificial means. In addition, complex fire and site conditions cannot be replicated in the lab. Thus, management decisions based on this type of research may be inadequate.

d. Sample Data Recovery. For this alternative to be implemented, a portion of a small site would be stratigraphically excavated using current professional methods. Artifacts, faunal and floral material, pollen and soil samples and archaeomagnetic samples would be collected by provenience. Concurrently, thermocouples or other temperature monitoring devices would be placed, and the remainder of the site burned under prescription conditions. Post-fire excavation would provide samples comparable to those already collected. The results from the two phases could be compared and analyzed with respect to data on the fire conditions.

Impacts. This alternative would conform to NPS guidelines by providing detailed and accurate data on fire impacts. This information would serve as an adequate base for future decisions on how to manage fire when archeological resources are present. Part of the physical remains of a site would be lost; however, the site and fire data would be preserved in the records and photographs and would still be available for management, research, and interpretive uses.

4. Recommended Course of Action:

No single alternative fulfills compliance and management needs. Thus a combination of several actions is recommended. First, a 5% to 20% sample survey will be performed and a representative sample protected from all fire by the placement of a hand line around them. When a natural fire is allowed to burn in an unsurveyed area, an archeologist will locate and mark all sites on fire lines. All man-caused or wild fires occurring outside of prescription conditions will continue to be suppressed.

This will begin compliance with statutes requiring surveys and with National Park Service policy supporting fire suppression (NPS-18). Since fire is a natural part of the ecosystem and most sites have probably been burned, little damage is expected from fires allowed to burn over sites under controlled conditions. This action should be a more efficient use of both manpower and funding than complete suppression and will allow the immediate implementation of the fire management plan. To fulfill research requirements, excavation is recommended for several small sites in different environmental situations. Data gathered prior to and after the burns will be

integrated with that gathered in the Western Region from lab tests. In this way, subsurface as well as surface, artifactual and non-artifactual data will also be obtained under natural conditions which cannot be approximated artificially. In addition, areas which are burned each year will be inspected to determine the effects on surficial remains.

This program begins compliance with NPS and Federal requirements for inventory and the assessment of the impact of fire on sites. The multi-use data base will be augmented, and the long-term preservation of the sites insured.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA- C - 6 - Assessment of Effects of Management Fires on Archeological Resources - Resources Management Actions

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Check areas that have been burned for surficial effects on sites	1.0
Total	1.0
2. Fiscal Year 83	
Test excavate ½ of 1 room of prehistoric site before management fire; test excavate other half after fire	3.0
Total	3.0
3. Fiscal Year 84	
Check areas that have been burned for surficial effects on sites	1.0
Total	1.0
4. Fiscal Year 85	
Check areas that have been burned for surficial effects on sites	1.0
Total	1.0
5. Fiscal Year 86	
Check areas that have been burned for surficial effects on sites	1.0
Total	1.0

CULTURAL RESOURCES PROJECTS STATEMENT

1. GRCA-C-7-Monitoring of Cultural Resources

2. Statement of Issue or Problem:

Statement of Condition. Over 2000 prehistoric and historic sites have been recorded within the boundaries of the park. Most of these are accessible only by foot, mule, helicopter or boat, and yet annual visitation may reach between 14,000 and 20,000 people. Monitoring of a few sites along the river for nearly 20 years (Euler 1978) indicates that heavy visitor use and natural erosional processes are irreparably damaging these resources.

The most visible problem is the pitting and undermining of structural features and fragile midden areas caused by illegal digging and collecting of archeological remains and floral specimens which can be seen on the surface. Impacts by people walking and climbing on the sites include trail entrenchment and gullying and the weakening of walls, floors, and chimneys. Similar effects are caused by the grazing of horses and cattle in those areas of the park where this is permitted.

Sixty-one prehistoric sites are on the NPS List of Classified Structures (LCS) and are also included in the nomination of the park's cultural resources to the National Register. The sites constitute a non-renewable resource and are protected by cultural resources compliance legislation. However, the cultural heritage and the scientific and interpretive data embodied in the structures and their physical contexts are being lost prematurely.

An additional element of this issue involves the LCS. As mentioned above, many of the prehistoric structures with standing walls greater than one meter high are included. For these, the Western Archeological and Conservation Center (Sudderth et al. 1976) prepared recommendations and estimates for treatment. Western Regional personnel prepared the documentation for historic sites and buildings including 10 structures on the South Rim, 137 on the North Rim, two at Tuweep and 17 in the Inner Canyon. The total for the park is 220.

Monitoring of the LCS would involve periodic updates as well as the addition of prehistoric and historic sites not presently on the list but which do meet the criteria.

The park Archeologist also needs to monitor the effects of all park projects on cultural resources. This can easily be done through inspection of planning documents such as 10-238s and 10-237s. Periodic monitoring would allow the timely completion of fieldwork and compliance documentation and help avoid delays in the project.

Current Management Actions. In 1978, an NPS river trip was conducted to monitor the natural (including burro) and visitor impacts on the

sites along the Colorado River. Views in photographs taken in the early 1960's were duplicated and notes taken which verify a rapid rate of deterioration including wall collapse, pothunting and collecting, gullying and removal or rearrangement of structural features by campers. A similar trip occurred in 1981. Because other management activities were also scheduled, only 35 sites were inspected. Time did allow for permanent datums to be placed in five of the six stratified sites planned for sample data recovery. Site records were updated and the maps redrawn using a tape and compass. Records from other sites throughout the park are periodically updated when time and staffing permit on-site inspection.

Permit systems for backcountry hiking and river running dictate ceilings on the number of overnight campers in the Inner Canyon but do not prevent visitation and further damage to sites. Hikers are given almost no instruction on the fragility of the sites and the illegality of digging or collecting; however, representatives of the commercial river companies are instructed in this on an annual training river trip. It is doubtful that much of this information gets disseminated to other boatmen and tourists, though, because no formal scheduling of training or interpretive talks is done. The effects of a recent article printed in the Grand Canyon Guide and a brochure, both aimed at educating hikers and river runners about the enjoyment and preservation of archeological resources, cannot be assessed.

The List of Classified Structures (LCS) is currently monitored by Maintenance Division personnel who have little knowledge about the historical elements and condition of historic structures or even the location of prehistoric structures. Consequently, unnecessary recommendations have been made for the active preservation of structures in remote areas which are in good condition. Further, many nearly identical cabins on the North Rim are slated for continued preservation when a small, yet representative, sample might best fulfill management and visitor needs. Additional structures which fulfill LCS criteria must also be added by qualified personnel.

Results of Current Actions. With the exception of a few sites along the river, no monitoring is done.

Prior to effective planning and fulfillment of legislative mandates, monitoring of other sites to delineate and quantify the types and extent of the impacts, must be done. Depending on this, sites may need to be excavated, stabilized or closed, but the current data base is inadequate and out-of-date. Visitor safety may be endangered and the aesthetic appearance of the site marred.

Methods of keeping the LCS up-to-date are inadequate because of current budgeting and manpower limitations. Unnecessary recommendations to stabilize and preserve remote archeological sites in good condition have been tendered.

Finally, the current management action has resulted in non-compliance with Federal legislation. Preservation and active stewardship of cultural resources is mandated in the NPS Organic Act, the National

Historic Preservation Act as amended in 1980, the National Environmental Policy Act and NPS Management Policies. In addition, enabling legislation for the park and the Grand Canyon National Park Enlargement Act (P.L.93-620) calls for the protection of these resources.

3. Alternative Actions and Their Probable Impacts:

a. No Action. Taking no action would involve allowing natural erosional processes to continue without monitoring or active mitigation of the results. Quotas put on the number of hikers and boaters will remain the same and heavy visitation to the sites will intensify the natural processes of deterioration. The LCS would still be monitored by maintenance personnel.

Impacts. This alternative insures the premature destruction of non-renewable resources. Not only does it fail to comply with Federal cultural resources compliance legislation but the usefulness of the List of Classified Structures is not realized. Data necessary for informed management and planning, and valuable in research and interpretation of the history of the park will be lacking. In addition, visitor safety may be endangered. Further, the extent and rates of impact cannot reliably be estimated without further monitoring.

b. Monitoring the Resource. Monitoring of cultural resources throughout the park would involve periodically visiting sites, especially in heavily used areas. Photographs and notes would be made to document the types and rate of deterioration caused by visitation, grazing and natural forces. Information from the mapping and collection of newly exposed sections of a site will prevent the complete loss of irreplaceable scientific and interpretive data. Also, it will become the basis for future management decisions on the necessity of stabilization, test or salvage excavation, continued neglect, and List of Classified Structure status.

Impacts. Cultural resource monitoring would have no adverse impacts on the natural environment; artifacts and other specimens exposed in disturbed areas would be collected by the archeologist or anthropologist. The program would lead to the expansion of the data base for planning, research and interpretive activities. It would insure that site records be kept current, but may lead to recommendations for future actions such as fencing or sample data recovery which would affect the natural environment.

The monitoring information would also be used to evaluate the present structures on the LCS. This could lead to recommendations for adaptive use of similar structures. Archeological structures which do not require preservation at present could be allowed to deteriorate naturally. In both cases, funding and labor can be reduced and diverted to more needed projects. Also, structures fitting LCS criteria not presently on the list could be added using data gained from monitoring, thus conforming more closely with NPS policy.

4. Recommended Course of Action:

The park recommends that an ongoing program of monitoring be instituted. Such monitoring will augment a multi-purpose data base and pave the way for better planning and interpretation of the park's cultural resources. Decisions will no longer be based on inaccurate and outdated information. Possible hazards to visitor safety will be known. This alternative will help fulfill management responsibilities to preserve the resources and keep the LCS up-to-date, thus insuring the long-term educational and scientific value of the sites.

PROJECT TITLE: GRCA- C - 7 - Monitoring of Cultural Resources
Resources Monitoring Actions

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Monitor ca. 75 sites on trails and along Colorado River (1 river trip).	
Monitor and update LCS (prehistoric and historic).	4.0
Total	4.0
2. Fiscal Year 83	
Monitor ca. 75 sites on trails and along Colorado River (1 river trip).	
Monitor and update LCS.	4.0
Total	4.0
3. Fiscal Year 84	
Monitor ca. 75 sites on trails and along Colorado River (1 river trip).	
Monitor and update LCS.	4.0
Total	4.0
4. Fiscal Year 85	
Monitor ca. 75 sites on trails and along Colorado River (1 river trip).	
Monitor and update LCS.	4.0
Total	4.0
5. Fiscal Year 86	
Monitor ca. 75 sites on trails and along Colorado River (1 river trip).	
Monitor and update LCS (prehistoric and historic).	4.0
Total	4.0

1. GRCA-C-8-Curatorial Cyclic Maintenance.

2. Statement of Issue or Problem:

Statement of Condition. The park study collection consists of 35,000 objects representing the fields of geology, zoology, botany, history and anthropology/archeology. These are used for reference by interpreters, resource management specialists, and researchers and for interpretation and display for the public. The collections are housed in a specially built room. Current workspace was created by partitioning off nearly half of the 1830 $ft.^2$ room. Environmental factors such as light, humidity and air quality should be independently adjustable to allow for proper storage of collections in one room and comfortable working conditions in the other. Monitoring showed temperature to be within acceptable standards (Lewis 1980). Proper security depends on key restrictions and functional burglar and smoke alarms.

Problems with the collection proper are the result of backlogs and improper storage. Many items, accessioned during periods of understaffing, have not been catalogued into the National Catalog. However, insect and plant specimens and most anthropological/archeological collections are catalogued and organized into other systems so that they are accessible. Improper storage results from space limitations. Proper cabinets and shelving are used, but time has not allowed all objects to be placed into acid-free cardboard trays.

Current staffing consists of two people, including a permanent curator (Museum Technician (GS-7)). The museum technician spends all her time working with the collections and its users. Her supervisor (Park Ranger (Interpretation)) spends approximately 15% of her time working with the photographic collections with additional hours used for budgeting, personnel management, and interpretation. Lewis (1980) estimated that the annual total of 2500 hours should be adequate for maintenance and to allow for the alleviation of backlogs and improper storage problems. Necessary maintenance includes: 1) inspection of exhibited specimens and environmental conditions; 2) housekeeping chores; 3) inspection of specimen condition, fumigant, and preservation fluid renewal and inventory; 4) museum records including work on the cataloguing backlog; 5) specimen filing to upgrade storage conditions and 6) service to staff and visitors using collections.

Two special projects are necessary to upgrade the safety and use of the collections. First, approximately 3,000 nitrate photographic negatives, which are extremely flammable and subject to rapid deterioration, need to be copied so the originals can be removed from the collection area. Second, all documents, newspaper articles, photographs and documentary negatives should be copied to reduce the handling, and therefore the maintenance and conservation of the originals.

Current Management Action. Some measures have been taken to control the fluctuations in lighting, humidity and air quality. Lighting is controlled by blocking off storage area windows with opaque black plastic sheeting and using standard warm white lamps and ultraviolet (UV) filter sleeves. A few banks of lights extend from the work area into the storage area increasing the possibility of damage to objects from heat and unnecessary light. Humidity is not under any control and varies from 7% to 61% although the average is under 35%. Variations in the range and rate are caused by intermittent functioning of heaters and the opening of windows and doors for ventilation. The most important air quality problems are dust and the fumes of paradichlorobenzene (PDB). Dust has been reduced by partitioning off the collections and keeping the doors, windows and vents closed and by regular dusting and vaccuming. PDB is now used in carefully controlled doses only in the closed cases in which it is absolutely necessary. The separation of work from storage areas and the use of a fan and grill for ventilation has reduced this health hazard.

Security is maintained by strict key control of the workshop and storage areas. A "Press-o-matic" lock for the storage area was recently installed. Storage cabinets can also be locked. Smoke and burglar alarms are scheduled for installation before May 1, 1982. These are monitored by the curatorial staff.

Backlogs in cataloguing and filing of specimens are slowly being cleared. This will include the elimination through loan or gift of items not within the present scope of collections. Also, the park archeologist must curate the large number of archeological specimens collected annually. Cleaning, conservation, numbering, photographing and cataloguing is due. Then the collections are turned over to the curator for accessioning along with copies of the catalog cards. Obsolete catalog cards are being microfilmed. Their removal from the Study Collection will create more space. Other maintenance responsibilities, as described above, are being performed on a regular basis by the curator, allowing for a continual upgrading of the facility. Recommendations for the scheduling of these activities, found in the Collection Preservation Guide (Lewis 1980), are being followed.

Special problems include the management of flammable nitrate film and negatives and fragile documentary material. All nitrate negatives have been segregated from the remainder of the collection and are kept in a well ventilated area to prevent the concentration of combustible gases. Microfiching of historic documentary materials, funded by Grand Canyon Natural History Association, has begun. This project could take up to one year on a full-time basis.

Results of Current Action. The hiring of a full-time curator allows the necessary person-hours to be spent on routine maintenance and cataloguing of the collections. The installation of a partition to separate the work area from the storage area has improved work and storage conditions. Environmental conditions and security from fire and theft are still below the standards required in the NPS Manual

for Museums (Lewis 1976). Irreparable damage may be done to the objects and specimens if these conditions persist. The presence of nitrate negatives in the work area consititutes a further hazard.

3. Alternative Actions and Their Probable Impacts:

a. No Action. This alternative would involve keeping the present staff, space, and environmental conditions. Security will be achieved by 1982 with the installation of recently purchased burglar and smoke alarms.

Impacts. Routine maintenance and cataloguing could be accomplished, but no further space would be available for new specimens unless those not within the scope of collections were removed. Poor control of light, humidity, and air quality would result in gradual but inevitable damage to collections. However, security against fire and theft will be more than adequate following alarm installation.

b. Implement Plans to Modify Present Facility and Complete Special Projects. The recent division of the facility into work and storage areas has decreased environmental fluctuations and increased the security of the collections. This would be augmented by rewiring the rooms separately, and installing humidifiers and dehumidifiers, smoke alarms, and an effective burglar alarm. Present staffing would be retained with approximately 2,500 hours spent annually in caring for the collections. Approximately 3,000 nitrate negatives would be copied. The estimated cost of this project would be $6,000 ($2 per negative). In addition, all historic documents, photographs and negatives as well as obsolete catalog cards would be copied onto microfiche. Given adequate funding, these projects could be completed within two years.

Impacts. Deterioration of the collections due to environmental fluctuations would be reduced considerably. Danger from fire or theft would also be alleviated. Current staffing is adequate to perform the routine housekeeping, maintenance and paperwork. Copying the nitrate negatives and their subsequent removal from the collection would eliminate a significant safety hazard as well as preserve that information before it deteriorates. Microfiching would reduce the handling, and therefore maintenance and conservation of fragile historic specimens.

c. Construct a New Facility. A new facility or addition to the present building would be constructed according to museum and NPS standards, incorporating proper environmental controls and security measures.

Impacts. A building designed according to present standards would insure the best possible preservation and spacing. However, the Scope of Collections Statement is being used to remove unnecessary objects from the collection. The construction of the partition has also created more space for storage. Thus, the present facility is probably adequate providing no further material is added to the collection. Manpower and budget constraints as well as the desire to

control further development within Grand Canyon Village preclude the construction of a new facility. Also, a larger facility would require a larger curatorial staff to maintain it.

4. Recommended Course of Action:

Park management recommends the second alternative by implementing current plans to modify the present study collection. The facility will be upgraded to conform to standards for environmental control, security, and storage space. This should include completion of the photocopying of nitrate negatives and the microfiching of other documentary materials.

This action will be in keeping with NPS guidelines outlined in the Manual for Museums (Lewis 1976). Safety for curatorial personnel and security of the specimens will be augmented. Funding and manpower will be saved by not building a new facility and can be used to fund the copy work. These measures should help insure the long-term preservation and usefulness of the specimens, thereby enhancing the scientific, educational, and management potential of the collection.

Implementation of most of this program can be achieved within three years as funding becomes available. Even after eliminating objects not within the scope of collections, curatorial personnel estimate that, at the present rate of accession, the space will become inadequate within five years. Thus, the recommended action insures the preservation of the present collection but does not allow for growth beyond the life span of this plan.

FIVE-YEAR MANAGEMENT PROGRAM

PROJECT TITLE: GRCA-C -8 - Curatorial Cyclic Maintenance-Resources Management Actions

ACCOMPLISHMENTS (In Priority Order)	AMOUNT (In Thousands)
1. Fiscal Year 82	
Maintain natural and cultural collections through modern cataloging, photographic, and preservation techniques	20.0
Total	20.0
2. Fiscal Year 83	
Maintain natural and cultural collections through modern cataloging, photographic, and preservation techniques, plus microfiching records and copying 1,500 nitrate negatives on safety film	32.0
Total	32.0
3. Fiscal Year 84	
Maintain natural and cultural collections through modern cataloging, photographic, and preservation techniques, plus copying 1,500 nitrate negatives on on safety film	23.0
Total	23.0
4. Fiscal Year 85	
Maintain natural and cultural collection through modern cataloging, photographic, and preservation techniques	20.0
Total	20.0
5. Fiscal Year 86	
Maintain natural and cultural collection through modern cataloging, photographic, and preservation techniques	20.0
(5)	20.0

III. PROJECT PRIORITY LIST AND SUMMARY OF 5-YEAR MANAGEMENT PROGRAM

The following tables indicate ranking priorities for all natural and cultural management projects identified within the Natural-Cultural Resources anagement Plan (NCRMP), as they compare with one another, and as they compare with other types of projects on parkwide priority lists.

Natural and Cultural Resources Management Plan project reference numbers (second column from left) serve the duel purpose of identifying individual projects and of ranking their relative importance in the current plan. Thus, the park feels "Colorado River Use and Impact Monitoring (N-1)" is a higher priority project than "Backcountry Water Quality Monitoring (N-4)" or the "Biocide Use Program (N-20)." Reference numbers will not change or be duplicated once they are assigned and will be eliminated once the project is completed.

More important to funding considerations is the "Area Priority" number in the extreme left hand column of the table. These numbers indicate the ranking of individual resource management projects with all other programs within the park, including building and construction programs. These numbers are actually the rankings reflected on the most recent priority lists for 10-237's (Detail of Annual Operating Requirements) and 10-238's (Development/Study Package Proposal). Most likely these priorities will change annually, as the park reconsiders its environmental, budget, and political considerations.

RESOURCES PROGRAMMING SHEET

Grand Canyon (Park) | Western (Region) | Arizona (State) | X Natural ___ Cultural | September 1981 (Date) | Page 1 of 4 Page (s)

Area Priority(*)	N & C RMP Ref. No.(*)	Incr. or Pkg. No.(*)	PROJECT TITLE	Action Type (**)	YEAR 1 NPS Cost/ M.Y.	YEAR 1 $1,000	YEAR 2 NPS Cost/ M.Y.	YEAR 2 $1,000	YEAR 3 NPS Cost/ M.Y.	YEAR 3 $1,000	YEAR 4 NPS Cost/ M.Y.	YEAR 4 $1,000	YEAR 5 NPS Cost/ M.Y.	YEAR 5 $1,000
7.9	N-1	386	Colorado River Use/GLCA Dam and Impact Monitoring and Research	M	1	76.0	1	76.0	2	108.2	2	108.2	2	108.2
3.8	N-2	394	Air Quality Monitoring	M	1	11.5	1	11.5	1	22.4	1	25.9	1	25.9
10.7	N-3	387	Analysis of Roaring Springs Water Withdrawal Impacts	M	.1	20	.1	20	.1	20	.1	20	.1	20
14.5	N-4	395	Backcountry Water Quality Monitoring	M	1	55	.2	20	.2	20	.2	20	.2	20
	N-5		Feral Burro Management and Ecosystem Restoration Program	M	.1	26.9	.1	20	.1	15	.1	10	.1	10
3	N-6	247	Backcountry Management Plan	RM	.12	5	-	-	-	-	-	-	-	-
18	N-7	126	Fire Management Plan	RM	.2	22.5	.2	26.5	.2	22.5	.2	21.5	.2	21.5
	N-8	124	Desert Bighorn Population & Ecology Study-Havasupai Use Lands and Burro Impact Areas	R	.1	70	.1	70	.1	70	-	-	-	-
19	N-9	408	Aircraft Noise Management Plan Task Directive	RM	.3	21	.3	4	.1	.5	.1	.5	.1	.5
	N-10		Fish Management Plan	RM	.1	.5	.1	.5	.1	.5	.1	.5	.1	.5
	N-11	388	Backcountry Water Management Plan	RM	.5	5	-	-	-	-	-	-	-	-
	N-12	160	Desert View Boundary Fence	RM	.3	35	-	-	-	-	-	-	-	-
	N-13	130	Backcountry Carrying Capacity Impact Study	R	.2	50	.2	50	.2	50	-	-	-	-
	N-14	410	Air Quality Monitoring AQRV's and Smoke Management	RM	-	-	.5	12.0	-	12.0	-	-	-	-
11.5	N-15	397	Backcountry Use Impact Monitoring	M	.1	5	.1	5	.1	5	.1	5	.1	5
	N-16		Resources Base Inventory	R	.2	55	.2	55	.2	55	.2	55	.2	55
3.2	N-17	423	Havasupai Use Lands Grazing Carrying Capacity Study	R	.1	20	.1	20	.1	20	-	-	-	-

*) An asterisk (*) next to a priority number indicates a listing on a 10-238 list. All others are 10-237 projects.

(**) RM = Resources Management
M = Monitoring R = Research

RESOURCES PROGRAMMING SHEET

Grand Canyon Park | Western Region | Arizona State | X Natural ___ Cultural | September 1981 Date | Page 2 of 4 Page (s)

Area Priority(*)	N & C RMP Ref. No.(*)	Incr. or Pkg. No.(*)	PROJECT TITLE	Action Type (**)	YEAR 1 NPS Cost/ M.Y.	YEAR 1 $1,000	YEAR 2 NPS Cost/ M.Y.	YEAR 2 $1,000	YEAR 3 NPS Cost/ M.Y.	YEAR 3 $1,000	YEAR 4 NPS Cost/ M.Y.	YEAR 4 $1,000	YEAR 5 NPS Cost/ M.Y.	YEAR 5 $1,000
	N-18		Grazing Monitoring Program	M	.1	2	.1	2	.1	2	.1	2	.1	2
11.5*	N-19	332	Kanab Plateau Boundary Fence	RM	.2	21	-	-	-	-	-	-	-	-
	N-20		Biocide Use Program	RM	.1	.3	.1	.3	.1	.3	.1	.3	.1	.3
	N-21	410	Air Quality Monitoring - AQRV Sensitivity and Smoke Dispersal	R	-	-	-	60.0	-	75.0	-	-	-	-
19.5	N-22	427	Aircraft Noise Sociological Study	R	-	6	-	-	-	-	-	-	-	-
	N-23		Identification of Threatened/ Endangered Plant Habitats	R	-	-	.2	2	.2	2	-	-	-	-
	N-24		Foreign Visitor Study	R	.2	10	.2	10	-	-	-	-	-	-
	N-25		Stock Tank Abandonment/ Rehabilitation Study	R	.1	15	.1	15	.1	15	-	-	-	-
277 / 44.5*	N-26	118 / 421	Pasture Wash Fence Repair	RM	-	-	.1	45	-	-	-	-	-	-
	N-27		Fish Ecology Study	R	-	-	-	-	.1	50	.1	50	.1	50
	N-28		Status & Ecology of Peregrine Falcon and Golden Eagle Populaions	R	-	-	-	-	.1	10	.1	10	.1	10
	N-29		Rehabilitation of Impacted Areas	RM	.2	25	.2	15	.1	9	.1	15	.1	5
	N-30	227	North Rim Fence Repair	RM	-	-	.1	25	-	-	-	-	-	-
	N-31	196	Predatory Mammal Study	R	-	-	.1	50	.1	50	.1	50	.1	50
	N-32		Control of Nuisance Rock Squirrels and Skunks	RM	.1	.5	.1	.5	.1	.5	.1	.5	.1	.5
	N-33		Control of Exotic Plants	RM	.2	.5	.2	.5	.1	.5	.1	.5	.1	.5
	N-34		Control of Feral Dogs and Cats	RM	.1	.2	.1	.2	.1	.2	.1	.2	.1	.2
	N-35		Monitor South Rim Small Mammals Populations	M	.1	.5	.1	.5	.1	.5	.1	.5	.1	.5

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RESOURCES PROGRAMMING SHEET

Grand Canyon (Park) | Western (Region) | Arizona (State) | X Natural ___ Cultural | September 1981 (Date) |

Area Priority(*)	N & C RMP Ref. No.(*)	Incr. or Pkg. No.(*)	PROJECT TITLE	Action Type (**)	YEAR 1 NPS Cost/ M.Y.	YEAR 1 $1,000	YEAR 2 NPS Cost/ M.Y.	YEAR 2 $1,000	YEAR 3 NPS Cost/ M.Y.	YEAR 3 $1,000	YEAR 4 NPS Cost/ M.Y.	YEAR 4 $1,000	YEAR 5 NPS Cost/ M.Y.	YEAR 5 $1,000
	N-36		Cave Use Impact Monitoring	M	.1	.5	.1	.5	.1	.5	.1	.5	.1	.5
	N-37	399	Monitor/Deer Population Trends	M	.1	.5	.1	.5	.1	.5	.1	.5	.1	.5
	N-38		Impact of Stock Use in the Inner Canyon	R	-	-	.2	4	.2	4	.2	4	-	-
	N-39		Forest Insect and Disease Monitoring	M	.1	.5	.1	.5	.1	.5	.1	.5	.1	.5
	N-40	127	Monitor Kaibab Squirrel Population Trends	M	.1	.3	.1	.3	.1	.3	.1	.3	.1	.3
	N-41	134	Meadow Restoration and Ecology Study	R	.1	1	.1	1	.1	7	.1	7	.1	7
	N-42		Monitor Elk, Antelope, & Turkey Populations	M	.1	1	.1	1	.1	1	.1	1	.1	1
	N-43	135	Study of Visitor Impact on Mather Campground	R	-	-	-	-	.1	7	.1	7	.1	7
	N-44		Feasibility Study For Reintroduction of River Otter	R	-	-	.1	3	-	-	-	-	-	-
4*/32	N-45	333/190	Sanup Plateau Boundary Survey	RM	-	-	-	-	-	-	-	-	-	50
4*	N-46	333	Sanup Plateau Boundary Fence	RM	-	-	-	-	-	-	-	-	-	385
	N-47		Mining and Mineral Files System	RM	.1	2.5	.1	2.5	.1	.5	.1	.5	.1	.5
	N-48		Control of Exotic Birds	RM	.1	.1	.1	.1	.1	.1	.1	.1	.1	.1
	N-49		Hazard Tree Program	RM	.3	8	.3	6	.3	6	.3	6	.3	6
			OTHER SUPPORT PROGRAMS											
7		164	Restore Traditional Use Lands Resource Management		.1	29	.1	29	.1	29	.1	29	.1	29
25		137	Resource Management Technician		1	19	1	19	1	19	1	19	1	19
42		195	Resource Management Specialist Position		1	20.7	1	20.7	1	20.7	1	20.7	1	20.7
43		097	Increased Resource Management Program			39		39		39		39		39

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RESOURCES PROGRAMMING SHEET

Grand Canyon (Park) — Western (Region) — Arizona (State) — X Natural ___ Cultural — September 11, 1981 (Date) — Page 4 of 4 Page (s)

Area Priority(*)	N & C RMP Ref. No.(*)	Incr. or Pkg. No.(*)	PROJECT TITLE	Action Type (**)	YEAR 1 NPS Cost/ M.Y.	YEAR 1 NPS Cost/ $1,000	YEAR 2 NPS Cost/ M.Y.	YEAR 2 NPS Cost/ $1,000	YEAR 3 NPS Cost/ M.Y.	YEAR 3 NPS Cost/ $1,000	YEAR 4 NPS Cost/ M.Y.	YEAR 4 NPS Cost/ $1,000	YEAR 5 NPS Cost/ M.Y.	YEAR 5 NPS Cost/ $1,000
11*	C-1	373	Excavation of Heavily Impacted Prehistoric Sites	RM	.5	60	-	20	-	20	-	-	-	-
	C-2		Liaison with Indian Tribes	RM	.08	1	.08	1	.08	1	.08	1	.08	1
17 / 15*	C-3	160 / 813	Conduct Cultural Resource Compliance Surveys	RM	.6	30	.6	30	.6	30	.6	30	.6	30
10.5	C-4	390	Cyclic Maintenance of Archeological and Historic Structures	RM	.5	17.0	.5	19.8	.5	20.0	.5	20.0	.5	20
9*	C-5	406	Stabilization of Selected Archeological Structures	RM	.1	6	.1	6	.1	6	.1	6		
15.5*	C-6	419	Assessment of Effects of Management Fires on Archological Resources	RM	.06	1	.1	3	.06	1	.06	1	.06	1
	C-7	843	Monitoring of Cultural Resources	M	.5	4	.5	4	.5	4	.5	4	.5	4
10.2	C-8	416	Curatorial Cyclic Maintenance	RM	1	20	1.2	32	1	23	1	20	1	20

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IV. ENVIRONMENTAL ASSESSMENT

A. Project Environmental Impact Matrix.

The impact matrix sheets outline the environmental impacts resulting from resources management actions recommended in the Natural and Cultural Resources Management Plan. Details of these impacts can also be found in the project narrative and Project Statements sections of this documents. Projects whose titles are followed by an asterisk (*) are those which were included in the 1977 Natural Resources Management Plan and Environmental Assessment. These projects have undergone previous public review and the Project Statements have been updated to reflect current budget needs and other administrative changes. The matrix sheets for new projects present environmental impacts for both the proposed actions and alternatives to these actions.

Matrix sheets for individual follows:

PROJECT STATEMENT TITLE: GRCA-N-16-Resources Base Inventory (*)

NEED FOR THE PROPOSAL: This research project is needed to provide baseline information for other park management and decision documents.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Continue the Resource Base Inventory Project.
Resource Elements (vegetation, soils water, wildlife, etc.)	Representative samples of major resource elements (vegetation, small mammals, soils, etc.) will be collected by researchers during the course of this study. The sum total of these collections will not adversely effect any park resource. Endangered or threatened species will not be collected.
Aesthetic Values	Knowledge gained from this research effort will permit park managers to make management decisions based upon a better understanding of environmental factors and individual resource elements.

PROJECT STATEMENT TITLE: GRCA-N-2- Air Quality Monitoring.

NEED FOR THE PROPOSAL: This project is needed to gather information on current pollution levels and visibility in establishing air quality standards for this Class I area and to monitor long range effects of air pollution.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Continue Operation of Present Air Monitoring Program.	NO ACTION
Visibility and Air Quality	Action will provide data to establish standards and monitor Class I air quality at Grand Canyon. Monitoring program will provide data used as an indicator of long and short-term trends in visibility and air pollution.	Without the monitoring program the park will not have sufficient informaiton to establish air quality standards for this E.P.A. designated Class I area. Ozone levels will not be monitored. The park will not be able to offer a defensible position against increased levels of this pollutant from point sources. Pollution particulates will not be monitored. The park will be unable to offer baseline data to measure increases or decreases of this pollutant. Acidity levels of precipitation will not be monitored. No standards for evaluating increased or decreased levels will be available.
Vegetation	No Impact.	Data loss will deprive managers of the information needed to monitor pollution effects on vegetation. The effect of ozone on the park's ponderosa pine forest will be unknown.
Wildlife	No Impact.	No. Impact.
Cultural Resources	No. Impact.	Pollution effects on artifacts and sites will be difficult to monitor. No baseline data will be available.

PROJECT STATEMENT TITLE: GRCA-N-2- Air Quality Monitoring (Continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Continue Operation of Present Air Monitoring Program.	NO ACTION
Water Resources	Program will act as an early warning system on adverse effects to water resources caused by acid rains.	Loss of monitoring information on precipitation deposited pollutants in park waters will make it difficult to monitor effects of pollutants on water resources.
Soils	Program will provide a means of monitoring indirectly deposit of airborne pollutants and acid rain on park soils.	Information on pollutants being deposited on park soils will be lost.
Social-Aesthetic	Monitoring program will act as a warning system against further degradation of park visibility and its effect on the park visitor enjoyment of the Grand Canyon.	Failure to establish air quality standards and execute the monitoring program will deny managers information needed to respond to sources of pollution from new developments. Deterioration of visibility will adversely affect the tourist industry at the canyon and throughout the state by lessening the aesthetic beauty of the Grand Canyon.

PROJECT STATEMENT TITLE: GRCA-N-4- Backcountry Water Quality Monitoring
GRCA-N-11- Water Resources Management Plan

NEED FOR THE PROPOSAL: The project complies with Section 208 of the Federal Water Pollution Control Act and establishes baseline data concerning backcountry water quality.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE
	Monitor Bacteriological and Chemical Composition of Backcountry Water Sources four times per year.	Discontinue the Water Monitoring Project.	Reduce Monitoring of Backcountry Water Sources to once a year.
Public Health	Park will comply with Federal Water Pollution Control Act. Contaminated water sources will be identified each season, thus reducing hiker exposure to pathogenic bacteria.	Park will not be in compliance with Federal Water Pollution Control Act. Backcountry users will be exposed to unknown levels of water contaminants.	Action will increase hiker exposure to health hazards, because polluted waters will go undetected for longer periods.
Water	Information gained from monitoring project will be used to insure that the natural quality of park water is maintained.	Failure to implement the monitoring project will prevent the park from being able to present baseline information in defense against threats to water resources.	A reduced monitoring program will significantly slow the accumulation of data. Information needed to defend water resources will be unavailable.
Noise	Remote areas of the park will be subject to approximately 10 hours of helicopter noise four times a year.	No Impact.	Remote areas will be impacted by aircraft noise only once a year.
Vegetation, Soils & Wildlife	The development and implementation of the Water Resources Management Plan will have no direct impact on these park resources. Information learned from monitoring efforts will be used to protect water resources and, therefore, insure its natural quality within the park.	Threats to these resources caused by man-introduced pollution will continue unabated. No data-base will be available for use by park managers in defense of park's water resources.	Data needed to mitigate water pollution induced impacts to these resources will be unavailable.

PROJECT STATEMENT TITLE: GRCA-N-10 Fish Management Plan
GRCA-N-27 Fish Ecology Study

2. THREATENED AND ENDANGERED SPECIES PROJECT

NEED FOR THE PROPOSAL: This proposal is needed to protect native fish populations, including endangered species, from sport fishing pressures and to develop a data base for future management decisions.

ALTERNATIVE ACTIONS / IMPACT CATAGORIES	ALTERNATIVE
	Implement the Fish Management Plan.
Wildlife	Special regulation proposals dealing with closure of the Little Colorado River confluence and implementation of an artificial lure policy will lessen impacts on native fish species. The humpback chub, and bottom feeding native species, will benefit by reducing the possibility these fish will accidentally be caught by trout fishermen. The small number of fishermen unable, or unwilling, to change to an artificial lure fishing technique will not significantly impact trout populations.
Aesthetic Values	Persons preferring to fish for trout with food items as bait will be adversely affected by the proposal package. Persons willing to fish with either bait or lures will be unaffected by the special regulations. Except for an estimated 10 to 20 fishermen unwilling to adopt the artificial lures-only proposal, the social pleasures derived from trout fishing in the Grand Canyon will be largely un-impacted.

PROJECT STATEMENT TITLE: GRCA-N-10 Fish Management Plan (continued)
GRCA-N-27 Fish Ecology Study

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATAGORIES	ALTERNATIVE
	Implement the Fish Management Plan.
Socio-economic	The sale of fishing equipment and bait items by merchants in the vicinity of the South Rim Village will be reduced slightly as food and bait items are restricted in the park. (Annual sales for all fishing items total approximately $200).
Water	Fish waste products will be permitted to be disposed of directly into the Colorado River. The total amount of organic nutrients added to the river by fishermen will not significantly impact the quality of water in the Colorado. Bright Angel Creek will benefit from the special regulation as waste-products previously disposed of illegally in this system will be placed in the Colorado River. Biologists estimate that whereas Bright Angel Creek might have trouble assimilating this material without a reduction in water quality, the Colorado River can easily dilute this material and still maintain high water quality standards.

PROJECT STATEMENT TITLE: Other Threatened/Endangered Species Projects (*)

NEED FOR THE PROPOSAL: These projects are needed to provide baseline information concerning the ecology of each species. Data will be used to develop management plans intended to protect these wildlife species.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION		
	Implement Endangered/Threatened Plant Habitat Study, GRCA-N-23.	Implement Peregrine Falcon and Golden Eagle Status and Ecology Study, GRCA-N-28.	Implement Kaibab Squirrel Monitoring Project, GRCA-N-40.
Vegetation	Work involving the evaluation of habitat requirements will not directly impact these species. The knowledge gained from this work will have long-term benefits to these plants by allowing the park to make management decisions which insure their protection and well-being.	No Impact.	No Impact.
Wildlife	No Impact.	The animals may experience temporary trauma if qualified banders decide to affix radio-telemetry or leg-bands on individual birds. No permanent harm will result. Long-term benefits of the study will include a better understanding of population trends and an increased ability of the park to protect these species through better management decisions. Information will be especially useful to management projects involving backcountry use and the aircraft noise problem.	Except for possible temporary trauma experienced by individual squirrels during capture and marking operation (an optical management tool), the squirrels will not be adversely affected by this project. Other field work associated with this project will likewise not impact this "restricted" species.

PROJECT STATEMENT TITLE: Other Threatened/Endangered Species Projects (*) (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATAGORIES	ALTERNATIVE		
	Implement Endangered/Threatened Plan Habitat Study, GRCA-N-23.	Implement Peregrine Falcon and Golden Eagle Status and Ecology Study, GSCA-N-28.	Implement Kaibab Squirrel Monitoring Project, GRCA-N-40.
Aesthetic Values	Persons concerned about the well-being of these plant species will be pleased by the parks efforts to protect them. Park visitors will benefit by having an increased opportunity to view these plants in the national park.	Persons interested in viewing these birds will be pleased by an increased opportunity to view them in the Grand Canyon.	Persons concerned about being of this "restricted" species will be pleased about the park's efforts to manage Kaibab squirrels. All visitors will benefit by having an increased opportunity to see these native animals.
Socio-Economic	No impact.	The preservation of golden eagles on NPS lands will not be expected to impact livestock grazing activities on adjoining lands.	No impact.

PROJECT STATEMENT TITLE: GRCA-N-5- Feral Burro Management and Ecosystem Restoration Plan (*)

3. EXOTIC AND NUISANCE SPECIES AND DISEASE CONTROL PROJECTS

NEED FOR THE PROPOSAL: This proposal is needed to complete the Feral Burro Management and Ecosystem Restoration Plan identified in the 1981 Final Environmental Impact Statement

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Implement the final phases of the Feral Burro Management and Ecosystem Restoration Plan.
Vegetation	Recovery of impacted vegetation, as identified in the environmental impact statement, will continue. Species diversity, frequency, and density will eventually restore itself to a natural state. Threats to endangered plant species in burro impacted areas will cease.
Soils	Trampled, compacted soils will stabilize and ultimately return to a natural state. *Tortula sp.* cover will eventually re-establish itself in a natural state.
Wildlife	Small mammals will return to natural levels of abundance and composition. Larger herbivores will utilize food items and will range as before.
Burros	An estimated five to seven animals will need to be located and destroyed by NPS personnel. Carcasses will be allowed to recycle back into the park ecosystem. The burros will be dispatched instantly by trained marksmen.
Aesthetic Values	Persons opposed to the removal of burros might be opposed to implementation of the final phases of the management program. Persons supporting the perpetuation of natural ecosystems in the park will approve of the removal of the burro herd vestiges.

PROJECT STATEMENT TITLE: GRCA-N-39- Forest Insect and Disease Monitoring Program

NEED FOR THE PROPOSAL: Of approximately 121,000 acres of forested park lands, as many as 100,000 acres are currently infested by one or more nuisance insects or diseases such as Spruce Budworm, Mountain Pine Beetle, Pandora's Moth and Dwarf Mistletoe. To participate knowledgeably with the U.S. Forest Service on decisions regarding control efforts on forest and park lands, the park needs current information on the extent and rate of spread of forest nuisance insects and diseases.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE
	Continue to Participate in the U.S.F.S. Monitoring Effort.	Discontinue all Efforts to Monitor Forest Insect and Disease Pests.	Initiate an Independent Monitoring Program.
Coordination with Other Agencies and Projects	Periodic meetings between NPS and USFS to discuss monitoring and possible control efforts will allow all activities to be tailored to meet the management needs of both agencies. With lines of communication open, the park will make its concerns known formally when and if control programs are proposed.	Communication on this problem may deteriorate. Plans for control efforts will be made without input from Grand Canyon National Park. Without adequate background information, the aprk will not be able to provide knowledgeable management information as input for multiagency decisions.	Communication on this problem may deteriorate. Though the park will be knowlegeable, lack of communication will prevent park concerns from being heard in a timely manner.
Vegetation	Loss of some trees will be expected until natural controls stem the infestations.	Loss of some trees will continue until natural controls stem the infestations.	Loss of some trees wil be expected to continue until natural controls stem the infestations.
Insect Pest and Disease Populations	Endemic infestations will be allowed to increase or subside naturally. Exotic insect and disease infestations will be evaluated and controlled in a timely manner.	Endemic infestations will be allowed to increase or subside naturally. Exotic insect and disease infestations will not be evaluated and controlled in a timely manner.	Endemic infestations will be allowed to increase or subside naturally. Needed management actions on endemic or exotic infestations will be delayed due to the slowness of data analysis.
Visitor Disturbances from Aircraft Noise	Minimal disturbances will be expected as survey flights will occur on only four to five days a year and will usually be away from areas of concentrated visitor use.	Same as for Proposed Action Without NPS participation, the USFS will continue to monitor infestations on park lands.	Possibly will increase beyone other alternatives. A NPS monitoring program will duplicate flights made by the USFS.

PROJECT STATEMENT TITLE: GRCA-N-39 Forest Insect and Disease Monitoring Program (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE
	Continue to Participate in the USFS Monitoring Effort.	Discontinue All Efforts to Monitor Forest Insect and Disease Pests.	Initiate an Independent Monitoring Program.
Wildlife	Native wildlife species will be afforded maximum protection from unwarranted spraying programs. Alterations in the forest canopy from insect populations will benefit some wildlife species through the creation of multi-habitats. Other wildlife species will be adversely impacted by the loss of vegetative cover provided by mature trees.	Park wildlife may be impacted by control programs carried out on adjacent lands. Alterations in the forest canopy from insect populations will benefit some wildlife species and and adversely affect others.	Wildlife and habitat protection will be delayed due to the slowness of data collection and analysis. Alterations in the forest canopy insect populations will beneficially or adversely affect wildlife species.

PROJECT STATEMENT TITLE: GRCA-N-20- Biocide Use Program

NEED FOR THE PROPOSAL: This proposal is needed to control various plant an animal species currently threatening public health and native ecosystems. The proposal ensures that minimal impacts will result from the use of approved biocides.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE
	Augment present action with a Comprehensive Pest Management Program.	No control of biocide use in the park.	Continue present management.
Target Pest Species	Effective control with minimal adverse impacts will be achieved.	Effective control of target pests by persons unqualified to use pesticides will be reduced.	Control will have average effectiveness.
Non-Target Species	Application will be avoided to tailored to the target species minimizing effects on non-target species.	Serious impacts on non-target species will result.	Serious impacts on non-target species will be minimized though not entirely avoided.
Biocide Contaminations of the Environment	The possibility of chemical contamination of terrestrial and aquatic ecosystems will be minimized though not eliminated.	Contamination of terrestrial and aquatic ecosystems through misuse of biocides will occur.	Contamination of the terrestrial and aquatic ecosystems will be slight though not minimized.
Public Health	Control of pests hazardous to public health will ensure minimal exposure to disease carrying organisms.	Reduced effectiveness of target pest control will increase exposure to disease organisms.	Control of pests hazardous to public health will be adequate.
Vegetation	Vegetation damage from misapplication of biocides will be minimized.	Vegetation damage from misuse of biocides will be likely.	Vegetation damage from misapplication or excessive use of biocides will be slight though not minimized.
Property Damage by Plant and Animal Pests	Control of property damage from plant and animal pests will ensure maximum protection for historic structures and park visitor facilities.	Reduced effectiveness of target pest species will increase damage to historic structures and visitor use facilities.	Control of property damage from plant and animal pests will be adequate.

PROJECT STATEMENT TITLE: Control of Exotic and Nuisance Species (*)

NEED FOR THE PROPOSAL: This project is needed to reduce or eliminate the disruption of native ecosystems caused by exotic and feral species.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Control exotic plant species by cutting and/or application of an approved herbicide, GRCA-N-33. Control feral dogs, cats, and exotic birds by trapping and/or shooting, GRCA-N-34 and N-48.
Target Species	An estimated 10 tons of tamarisk, camelthorn and Russian olive will be cut annually. Ten to 20 dogs and 50 to 75 cats will be destroyed annually. An estimated 200 English sparrows, pigeons, and starlings will be destroyed annually.
Native Plants	Native vegetation will spread into areas where exotics have been removed. An estimated two to three acres will revert to natural vegetation succession as a result of tamarisk removal. Native wildlife species dependent on exotic vegetation for feeding areas and nesting cover will temporarily be forced to move. The relatively low numbers of exotic plants to be removed will make this impact negligible. Small mammals, reptiles, and birds will return to wooded areas in and around park residential areas. Natural balances of native species will be restored. Competition for food and available nesting sites will be reduced. Observations of native birds will increase slightly, as social conflicts with exotic species are eliminated.
Water	Isolated springs and seeps choked by tamarisk growth will assume natural flow rates. Since approved herbicide will be manually painted on stumps, no water sources will be affected by chemical contamination.
Social	Beaches rendered unusable by camelthorn will be available for camping and recreation. Tamarisk removal at isolated springs and seeps will result in the removal of some shade and the aesthetic loss of greenery in an otherwise stark environment. People opposed to killing of any kind will be adversely impacted by the destruction of feral dogs, cats, and exotic birds. Persons interested in viewing native wildlife will benefit from the proposal and appreciate the more natural atmosphere of the park.

PROJECT STATEMENT TITLE: GRCA-N-32- Control of Nuisance Rock Squirrels and Skunks

NEED FOR THE PROPOSAL: This project is needed to regulate high concentrations of rock squirrels and skunks caused by man-induced food sources at concessions facilities, mule corrals, and backcountry campsites.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 2
	Implement Direct Reduction Program.	Let Natural Control Process Reduce Populations.	Relocate Squirrels to Other Areas of the Park.	Remove food sources
Social-Aesthetic	Persons opposed to killing of any kind will be adversely affected by the reduction project	Squirrel and skunk populations will grow to extremely high levels. Reductions will occur only through disease infesta-	No squirrels or skunks need be killed. An estimated 2 to 3 man/hours would be required to trap and relocate each squirrel and skunk.	Alternative 2 will involve stricter enforcement of illegal feeding regulations and the restriction of the use of campgrounds and mule facilities.
Vegetation	Vegetation will gradually return to natural levels.	Impacts to vegetation will increase. Grasses and low growing vegetation will be consumed.	Vegetation will gradually return to natural levels in areas where populations are reduced. In relocation areas, the vegetation will be slightly reduced	Vegetation will slowly recover as food sources are eliminated. However, it is doubtful if food sources can be eliminated based upon past experiences.
Soils	Erosion and burrowing activities will assume natural levels as populations drop.	Erosion and burrowing activities will increase as population grows.	Soils in areas presently impacted by squirrels and skunks will recover. "Relocation" areas will experience slightly increased levels of impact.	As squirrel and skunk population levels decline, impact to soils will decrease.

PROJECT STATEMENT TITLE: GRCA-N-32- Control of Nuisance Rock Squirrels (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 2
	Implement Direct Reduction Program.	Let Natural Control Processes Reduce Populations.	Relocate Squirrels to Other Areas of the Park.	Remove food sources.
Public Health	Removal of excessive numbers of squirrels and skunks will reduce human/rodent interaction and chances of disease transmittal.	Population increases will increase human contact and chances of disease transmittal.	Populations will gradually be reduced. Chances of disease transmittal will be reduced.	Gradual removal of food will eventually reduce the number of squirrels and skunks in the park and will reduce rodent/human contact.
Wildlife	Squirrels and skunks will be kept at "natural" population levels.	Squirrels and skunks will reach high populations. Stress starvation, and diseases will eventually reduce excessive populations.	Natural selection as to sub-species and populations will be upset. Gene pools will become mixed.	Populations will eventually decline to normal levels.

PROJECT STATEMENT TITLE: GRCA-N-1- Colorado River Use and Impact Monitoring 4. Human Use and Carrying Capacity Projects.

NEED FOR THE PROPOSAL: The Colorado River Management Plan states that the goals for management of the Colorado River in the Grand Canyon will be to: (1) perpetuate the wilderness river running experience; and (2) protect the resources found in the river corridor from the impacts of recreational use and other human impacts. The Monitoring Project is designed to analyze and quantify impacts caused by visitor use and to predict impacts caused by changes in management policy, recreational use levels, and boat launch schedules; and to assess, through monitoring and research, the impacts of proposed future resource developments. This project was identified in the Colorado River Management Plan and Final EIS.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Implementation of the Colorado River Management Plan. Monitoring and Research Actions	PROPOSED ACTION Implementation of the Colorado River Management Plan. Resource Management Actions
Vegetation	Field work will result in a limited amount of trampling and vegetation damage.	Resources Management actions will distribute recreational use to reduce negative impacts to vegetation in sensitive areas; will reduce multiple trailing to allow revegetation; and will allow for revegetation and recovery from human disturbance of impacted beaches through a program of rest rotation.
Wildlife	Field activities will cause some temporary disturbance of wildlife. No significant impacts are anticipated.	Resources Management actions will reduce human disruption of wildlife food chains through control of food wastes and human feces. Human impacts to wildlife food sources and vegetation cover will be reduced through resource management actions affecting vegetative impacts (as discussed above).
Water Quality	No Impact.	Identification of water quality trends for the Colorado River and selected tributaries will determine appropriate management actions to maintain water quality standards for bodily contact and consumption, and stop infiltration of radio-active and other types of wastes associated with development and sewage disposal.
Recreational Use	NPS monitoring and research river trips will, by their use of canyon beach campsites, preclude use by other recreational parties. This will be an insignificant impact.	Management actions may affect launch schedules, waste disposal activities, and camp availability through closure of sensitive areas. However, overall effects to recreationists will be positive including: reduction in visitor congestion at attraction sites, reduced competition for camp-sites, reduced frequency of red ants, improved

PROJECT STATEMENT TITLE: GRCA-N-1 Colorado River Use and Impact Monitoring (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Implementation of the Colorado River Management Plan. Monitoring and Research Actions	PROPOSED ACTION Implementation of the Colorado River Management Plan. Resource Management Actions
Recreational Use (continued)		quality of the natural environment, and stabilization of cultural resources for viewing.
Cultural Resources	No Impact.	Monitoring of cultural resources along the Colorado River will allow identification of resource management actions, including stabilization needs, and the necessity for site closure for rehabilitation or protection.

PROJECT TITLE: GRCA-N-1 Colorado River Use and Impact Monitoring (*) (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	ALTERNATIVE
	NO ACTION Field work will not be performed; current management policies will continue.
Vegetation	Impacts to vegetation will continue including loss of, and damage to, sensitive plants; possible reduction in species diversity and abundance, increase in frequency of exotics, and reduction in total ground cover at camp and attraction sites. The magnitude of these impacts will be unknown, and management actions appropriate to mitigate or eliminate these impacts will not be supported by scientific data.
Wildlife	Impacts to wildlife resulting from the presence of river recreationists will continue; magnitude of impacts will be unknown. Possible impacts include disruption of invertebrate food chains and changes to small mammal species composition and abundance at beach campsites.
Water Quality	Trends in water quality will be unknown. The effects of mineral developments and sewage disposal on the water resources will be unknown. Impacts will continue. Appropriate management actions to protect the health of visitors from waterborne disease will be unknown.
Recreational Use	Crowding and congestion at river attraction sites will continue and may worsen; competition for campsites will continue. "Stacking up" of boat parties at the head of difficult rapids will continue.
Cultural Resources	Further loss and degradation of cultural resources will occur. This will go undocumented.

PROJECT . TEMPLAT TITLE: GRCA-N-3 - Analysis of Roaring Springs Water Withdrawal Impacts

NEED FOR THE PROPOSAL: This project is needed to evaluate the impacts of water withdrawal needed for use by the park and for sale to the town of Tusayan, AZ. The project is intended to monitor the net effect of continuous withdrawal as measured by biological indicators established during the 1980 and 1981 research project.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE
	Implement Roaring Springs Water Withdrawal Monitoring Project.	Do Not Implement A Monitoring Project.	
Vegetation	The monitoring project itself will have no direct impact on park vegetation. Information gained during the monitoring effort will be used by the park to preserve natural flows of water and thus assure the normal balances of riparian vegetation.	Without this project the park will be unable to respond to increased demands for water, by surrounding communities, with defensible resource data. This may lead to increased water withdrawal and a permanent loss of parts of the Roaring Springs and Bright Angel Creek ecosystem.	
Wildlife	Some invertebrates will be collected during routine monitoring efforts. These collections will not significantly impact any animal species. Knowledge gained from the monitoring effort will be used by the park to insure the long-term stability of this ecosystem, including native wildlife species and the trout fishery.	Same as Above	

PROJECT STATEMENT TITLE: GRCA-N-3/ Analysis of Roaring Springs Water Withdrawal Impacts (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE
	Implement Roaring Springs Water Withdrawal Monitoring Project.	Do Not Implement A Monitoring Project.	
Socio-economic	The monitoring project itself will have no direct influence on the socio-economic environment of the park or surrounding communities. The data gained by this project will, however, directly influence the park's interpretation of what water is "excess" to the park needs and when the sale of water to the town of Tusayan is "detrimental." The monitoring project will, therefore, influence the availability of park water to Tusayan which, in turn, may influence the amount and cost of water available to town residents and tourists.	Failure to implement the monitoring project will result in the use and sale of park water being based totally on economic or political edicts. The park will fail in its responsibilities to protect this natural resource and associated ecosystems.	

PROJECT STATEMENT TITLE: GRCA-N-13-Backcountry Carrying Capacity Study

NEED FOR THE PROPOSAL: This proposal is needed to establish levels of human use compatible with the long-term preservation of the natural and social environment of the Grand Canyon's backcountry areas.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Implement a Backcountry Carrying Capacity Study.
Vegetation, Wildlife and Soils.	The monitoring and aerial photography aspects of the Backcountry Carrying Capacity Study will have no, or insignificant, impacts on the park's natural resources.
Sociological.	Impacts resulting from carrying capacity limitations and new patterns of use recommended in the Backcountry Management Plan will be examined in a separate environmental assessment made available to the public.

PROJECT STATEMENT TITLE: GRCA-N-9-Aircraft Noise Management (*)

NEED FOR THE PROPOSAL: This proposal is needed to assist the park in gathering data needed to forumalte an effective aircraft noise management program, including the management of the park's own aircraft.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Implement an Aircraft Noise Management Program.
	The monitoring and sociological aspects of the program will have no direct impacts on park resources. The management proposals outlined in the final Aircraft Management Plan will be accompanied by a separate environmental assessment made available to the public. The Aircraft Use Mitigation Plan for Grand Canyon National Park will have the following environmental impacts:
Natural Sounds.	The number of flights by NPS aircraft will be reduced. Subsequently, intrusions into the natural quiet of the park by NPS management aircraft will be reduced. Visitors will be less affected by the sound and sight of aircraft in the park.
Sociological.	The reduction in overall use of park management aircraft will not adversely affect the park's ability to protect park visitors. Emergency and medical flights will be made on a priority basis.
Vegetation.	Fire reconnaissance aircraft will be flown fewer hours in coming years. Forest fires will be spotted from manned fire observation towers and USFS reconnaissance aircraft. A reduction in NPS fire reconnaissance flights is not expected to impede the park's ability to respond to wildfires.
Wildfire.	No aspect of the park's Aircraft Use Mitigation Plan will significantly impact park wildlife.

NEED FOR THE PROPOSAL: This proposal is needed to: (1) minimize environmental impacts caused by grazing use permitted under P.L. 93-620; and (2) insure that native vegetation, wildlife, and soil communities are offered maximum protection in areas of the park impacted by trespass grazing. This proposal is intended to manage all grazing use in the park including life-tenure and term permits and continuous grazing on Havasupai Use Lands.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Continue Implementation of Grazing Management and Boundary Fence Projects, GRCA-N-12, N-18, N-19, N-26, N-30, N-38, N-45, N-46.
Vegetation	The careful administration of legal grazing permitees will minimize impacts to native vegetation by regulating livestock grazing pressures. Most grazing will be phased out of the park on January 2, 1985. Meanwhile, native grasses and other preferred cattle forage will be reduced on lands. Species diversity and frequency will continue to shift to less palatable species (snakeweed, sagebrush) as long as grazing continues. As areas of the park are fenced, the above trends will be reversed. Trespass grazing will cease and vegetation will gradually (estimate of 15 to 25 years) shift to natural balances of species and diversity. Vegetation on the Havasupai Traditional Use Lands will shift to less preferred forage species as livestock occupy pristine lands. Impacts will be mitigated by the close monitoring of this use to insure compliance with carrying capacity limits.
Soils	Soils on permit grazing lands will return to natural levels of moisture and compaction as grazing is phased out. Soils on lands presently impacted by trespass grazing will slowly recover as fences are constructed. The fence itself and construction activities will temporarily disturb an estimated 10 acres of soils. Soils on the Havasupai Traditional Use Lands will become compacted and reduce their soil moisture. Some soil will be lost by deflation as vegetative cover is removed by livestock use. This accelerated erosion rate may continue indefinitely.
Wildlife	Native wildlife will be benefitted by lands protected from livestock grazing and allowed to return to a natural state. Wildlife on lands currently under permit grazing will not be impacted by grazing monitoring efforts. Fence construction will be such that it does not interfere with natural patterns of movement of deer and bighorn sheep. Fence construction activities will cause only a temporary disturbance to wildlife.

PROJECT STATEMENT TITLE Livestock Use and Boundary Management (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Continue Implementation of Grazing Management and Boundary Fence Projects, GRCA-N-12, N-18, N-19, N-26, N-38, N-45, N-46.
Wildlife (continued)	The diversity and frequency of wildlife will shift on Havasupai Use Lands as grazing use expands. Small mammals preferring less vegetation will increase; those preferring more vegetation will decrease.

PROJECT STATEMENT TITLE: GRCA-N-29- Rehabilitation of Impacted Areas (*)

NEED FOR THE PROPOSAL: This proposal is needed to: (1) stop environmental impacts caused by past administrative actions (grazing-range "improvements", fire roads, old utility buildings, etc.); and (2) to allow these areas to revert to natural conditions.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Rehabilitate Impacted Areas of the Park.
Soils	Soils lost to compaction and erosion will become stabilized. Approximately 200 acres of park lands will be returned to natural conditions through road closures, stock tank removal, barrow pit closures, and removal of unneeded buildings.
Vegetation	Scarred areas will slowly be covered by vegetation, first by exotic grasses and then by native plants. Eventually, each of the impacted areas will reach a distinct climax vegetative type in keeping with topographic and climatic conditions.
Visitor Use	Visitor access to all areas of the park will not be affected by road closures. Visitors may be temporarily inconvenienced by work crews rehabilitating backcountry trails and closing unneeded trails. The visitor ability to select multiple pathways to attraction sites will be reduced. Access to attraction sites will not be reduced by trail network closures.
Wildlife	As stock tanks on old grazing permit lands are breached, or allowed to fill in naturally, wildlife will be forced to seek other water sources, i.e., natural seeps, springs, or stock tanks on lands adjoining the park. Since the phase-out period will be gradual, wildlife will be able to adjust to these closures. Deer populations using tanks on the Shivwits and Kanab Plateau will shift watering habits to sites outside the park boundary or move to natural waterholes. The closure of stocktanks on NPS lands is not expected to significantly change the deer population from present numbers. Since desert bighorn are extremely scarce on the Kanab and Shivwits Plateau, stock tank closures will not significantly impact this wildlife species. Wildlife will generally benefit as livestock grazing is phased out of the park and the country reverts back to natural conditions.

PROJECT STATEMENT TITLE: GRCA-N-47 Mining and Mineral File System

NEED FOR THE PROPOSAL: This proposal is needed to monitor threats to the park stemming from potential mining operations on the South Rim and oil and gas exploration in the western sections of the park.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Develop a Mining and Minerals File System.	PROPOSED ACTION Do nothing.	PROPOSED ACTION
Vegetation, Soils Wildlife, etc.	No natural or cultural resources will be directly impacted by the implementation of the field monitoring program or the mining filing system. However, possible impacts to vegetation and soils communities will be prevented by halting potential encroachment activities.	Failure to implement the monitoring program could lead to encroachment of mining operations on park lands, i.e. roads, pits and other development. Failure to develop a mining filing system will leave the park without an adequate database regarding mining laws and will increase the need to depend on Regional and Service Center staff to administer mining problems.	

PROJECT STATEMENT TITLE: GRCA-N-43- Study of Visitor Impact on Mather Campground (*)

NEED FOR THE PROPOSAL: This proposal is needed to repair and restore one of the most heavily used campgrounds in the National Park System. This area is a major attraction site in the park and represents the scope and quality of park management to those using this campground.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Implement a 3-Year Research Project Assessing Impacts of Mather Campground.
Vegetation	Native vegetation will not be directly affected by the research action. Benefits to this resource will be gained through the accumulation of research data needed to better manage the campgrounds. Through the development of the management program, native vegetation will stabilize and revegetate areas presently impacted.
Soils	The data obtained through the research proposal will be used to implement a management program preserving the soil community. Impacted soils will gradually recover and will assume normal levels of moisture and bulk.
Socio-Aesthetic	Campers will be benefitted by the research action as Mather Campground gradually returns to a more natural state. The trees will recover from heavy scarring, understory vegetation will flourish and present a balanced, aesthetically pleasing environment. The research study itself will not directly impact the visitor's ability to use and enjoy this area of the park.

PROJECT STATEMENT TITLE: GRCA-N-24- Foreign Visitor Study

NEED FOR THE PROPOSAL: Information obtained from this study will enable park managers to better serve the increasing numbers of foreign visitors to the park.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE
	Conduct a Two Year Study on Foreign Visitation at Grand Canyon.	Do Not Initiate Any Demographic Studies of Foreign Visitors.	
Social	Foreign visitors who do not like to be questioned or asked to fill out forms will be adversely affected. Foreign visitors will ultimately benefit from the study through improved National Park Service and concessioner services. It is anticipated that the study will not affect the total numbers of foreign visitors to the park.	Information needed by park managers to address the needs of the foreign visitor will not be available.	
Economic	The improvement of foreign visitor services is not expected to significantly increase visitation to the park. It may affect the local economy by encouraging the visitor to spend more time in the area.	Visitors may choose to spend their time in other areas with better services thereby reducing the local economy.	
Park Resources	A better interpretative program will provide foreign visitors with a better understanding of park values, rules and regulations. The study will reduce the number of "negative" public relations contacts (inadvertent law violations and medical emergencies in the backcountry).	Foreign visitors who do not understand park rules and regulations will continue to have adverse impacts on park resources through carelessness and ignorance.	
Vegetation & Wildlife	The study will not directly impact any natural resource at the park.		

NEED FOR THE PROPOSAL: This proposal will protect fragile cave resources and allow for their recreational use through a program of monitoring and establishing carrying capacities for individual caves.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Continue Implementation of the Cave Management Plan.
Cave Resources	Some irreplaceable formations will be damaged by any use of the park's cave resources. This will include the occasional breakage of flowstone and gypsum speleothems. This impact will be expected to be minimized by the enforcement of carrying capacity limits and by insuring that all visitors are well versed in cave etiquette.
Visitor Use	Some visitors will be denied access to specific caves due to closures or carrying capacity limits. However, the low frequency of backcountry cavers will make the prospects of overcrowding almost nonexistent.
Wildlife	Wildlife endemic to cave environments will be temporarily disturbed by humans visiting these resources. No long-term damage to any wildlife species will result from the implementation of the Cave Management Plan.
Cultural and Scientific Resources	Some minor disturbance of archeological or paleontological resources may result when new caves are discovered. This impact will be minimized by the closure of all such caves until the resource can be thoroughly investigated by trained researchers.

PROJECT STATEMENT TITLE: GRCA-N-41- Meadow Restoration and Ecology (*)

NEED FOR THE PROPOSAL: This project is needed to restore meadow areas presently impacted by roads to a natural condition and to develop a data base needed for future management of the meadow ecosystems.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Implement the road closure program and initiate a Meadow Ecology Study.
Vegetation	Meadow vegetation previously trampled and destroyed by roads will regenerate and will return to natural patterns of diversity and frequency. Approximately three acres of meadow will be restored.
Wildlife	Small mammals inhabiting meadows will benefit from increased habitat and a reduction in disturbances caused by passing vehicles. Closures will not be expected to significantly alter the diversity or numbers of present wildlife populations or the predatory species preying on them.
Social-Aesthetics	Road closures will not impede the ability of the park to patrol and protect meadow resources. Routine fire patrols will continue on other roads. Visitor access by vehicles to certain areas of the North Rim meadows will be terminated. Closures will not interfere with any significant visitor attraction sites. Access will still be available to persons on foot.

PROJECT STATEMENT TITLE: GRCA-N-8- Desert Bighorn Population and Ecology Study - Havasupi Use Lands & Burro Impact Areas (*)

NEED FOR THE PROPOSAL: This project is needed to ensure that present management efforts (backcountry use, grazing, Havasupai Traditional Use) are not adversely affecting bighorn populations. It is also needed to provide park management with data needed to maintain the natural ecology of this animal.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Implement the Desert Bighorn Population and Ecology Study on Traditional Use Lands and Burro Impact Areas.
Bighorn Sheep population.	Bighorn populations will generally be benefited by the park's increased knowledge of their ecology. Future management decisions will be made with a better understanding of herd needs. One or two sheep mortalities may occur as a result of immobilization procedures needed for attachment of population marking and tracking devices.
Aesthetic	Some visitors may be inconvenienced by the temporary closure of park areas during various phases of the study. However, these closures are expected to be of short duration (one or two days). Some visitors may find it objectionable to view sheep with marking collars around their necks. Other people will find enjoyment in having witnessed a part of a comprehensive wildlife research program intended to benefit this species.

PROJECT STATEMENT TITLE: Other Wildlife Management Projects.

NEED FOR THE PROPOSAL: This proposal is needed to provide park managers with basic population information on the indicated species. This information is needed to enable park administrators to make management decisions in keeping with the protection and well-being of these native wildlife species.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Continue to Monitor Deer Population Trends, GRCA-N-37.	PROPOSED ACTION Implement the South Rim Small Mammal Study, GRCA-N-35.	PROPOSED ACTION Implement the Elk, Turkey and Antelope Monitoring Program, GRCA-N-42.	PROPOSED ACTION Implement the Otter Reintroduction Feasibility Study, GRCA-N-44.	PROPOSED ACTION Implement the Predatory Mammal Study, GRCA-N-31.
Wildlife	Deer populations will not be impacted by transect analysis. Deer will experience temporary stress during capture operations needed to attach radio collars.	All animals will be live-trapped and released. Otherwise, the monitoring effort will not affect wildlife populations.	The establishment and reading of transects will not affect these animals. Elk and antelope will experience temporary stress if, and when, marking collars are placed around their necks.	Reintroduction will allow individual otters to propagate and insure the stability of the species. The Feasibility Study itself will not impact the otter population.	Lion, bobcat, and coyote will be temporarily stressed by the capture process needed to place marking collars around their necks. No permanent damage will result.
Socio-economic	Data gained from monitoring efforts will be used to recommend alternative hunting patterns on lands adjoining the park to the USFS and the Arizona Game and Fish Department. These recommendations will involve decreased or increased hunting quotas on adjoining USFS lands. If the Arizona Game and Fish Department concurs with park policy.	Data gained from the monitoring effort will be used to reemphasize the pet leash law and, possibly, for a recommendation to eliminate pets from the park. This would adversely affect the pet owners among park residents.	Monitoring data will lead to the stabilization of target species and the increased enjoyment gained from viewing these animals.	If the study results in an otter transplant, the public will have an increased opportunity to view these animals and will enjoy the aesthetics of knowing a native animal has been reestablished in its natural habitat. The reintroduction of otters will not significantly impact the trout fishery in the park.	Study data May result in park recommendations to adjoining management agencies to alter predator depradation hunts and trapping programs. If these management agencies adhere to NPS recommendations to reduce hunts, ranchers may suffer some increased losses of livestock.

PROJECT STATEMENT TITLE: Other Wildlife Management Projects (continued).

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	PROPOSED ACTION	PROPOSED ACTION	PROPOSED ACTION	
Socio-economic	Aesthetics of hunting these animals will be reduced or increased, accordingly.				

PROJECT STATEMENT TITLE: GRCA-N-7- Fire Management Plan 7. Fire Management

NEED FOR THE PROPOSAL: This proposal is needed to restore and maintain the natural ecological processes of the park's ecosystem.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Continue Implementation of the Fire Management Program.
Soils	Chemical concentrations of phosphorus, magnesium, calcium, potassium, and nitrogen will increase in the soil, as they are released from forest debris in the combustion process. Soil alkalinity will increase following a fire. Water absorption capacities will be reduced in burned area. Soil bacterial populations will increase in the burn area. Nitrogen fixing plants will be more active immediately following a fire. Surface erosion rates will increase up to eight times the normal rate following a fire. Soil aeration will be reduced. Each year the soils on 5,000 to 10,000 acres of land will be affected by natural or prescribed fire.
Water Resources	The removal of ground cover and increased water repellancy in soil layers will cause a temporary increase in surface runoff, possibly exceeding eight times the normal rates. The removal of ground cover, increased runoff, and reduced protection from winds will cause temporary significant increases in soil erosion. Erosion rates for prescribed burned areas on the relatively flat park lands forested with ponderosa pine are not known. Snow melting rates will increase as much as 50 percent on burned over land due to removal of shade sources and heat absorbing characteristics of blackened tree trunks. Soil moisture storage will be increased as plants which would normally use the moisture are removed by fire.

PROJECT STATEMENT TITLE: GRCA-N-7- Fire Management (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Continue Implementation of the Fire Management Program.
Water Resources (continued)	Concentrations of nitrates, phosphorus, bicarbonates, magnesium and calicum will increase, temporarily following fires in surface streams. Nitrate concentrations will not exceed 10 ppm. Sedimentation and turbidity will increase temporarily due to increased erosion rates.
Air Quality	Carbon dioxide emissions of 2000 to 3500 pounds per ton of fuel burned have been measured and will be expected. Carbon monoxide emissions will range from 200 ppm close to the flame to less than 10 ppm 100 feet from the fire. Forest fuels contain less that 0.2% sulfur. Sulfur oxides will be produced in negligible amounts. Information on nitrogen oxides from forest fires is scanty and inconclusive. Formation of nitrogen oxides normally occurs in the combustion zone at temperatures above 1540° c. This is above the temperatures normally achieved in prescribed burns. Hydrocarbons will be generated at the rate of five lbs. per ton. Smoke impacts on plants will vary ranging from reduced photosynthesis to toxicity. Smoke will reduce growth and germination of some fungal pathogens. Canyon visibility may be reduced an estimated 14 days per year. Emission standards for Class I areas may exceed Class I standards 21 days per year.

PROJECT STATEMENT TITLE: GRCA-N-7- Fire Management (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION
	Continue Implementation of the Fire Management Program.
Wildlife	Fire will stimulate plant growth and increases food production. Fire will create a varied forest habitat consisting of diverse plant and age classes. The open ponderosa pine habitat favored by Kaibab Squirrels will be restored. Desert bighorn populations will benefit from inner canyon fires which favor the germination and growth of grasses over shrubs. Fire will reduce the dense forest understory and remove tangles of dead trees. Egress for mule deer and predator species will improve. Warmer, drier burned areas will provide favorable habitat for blue grouse on the North Rim due to increases in nutritious spring vegetation and increased numbers of litter dwelling insects.
Vegetation	Plant growth and productivity will be stimulated by increased nutrient levels and by removal of competing vegetation. Diversity of habitat and plant species will be created by varying fire intensities and conditions. Fire dependent plants will be restored and maintained. The probability of holocaust wildfires will be reduced as prescribed burns lower high fuel concentrations. Fire in sagebrush-grasslands will revert these areas to their original grassland vegetation type. Fire in desert-scrub will favor establishment of desert grass over shrubs. Fire will restore and maintain open ponderosa pine habitat. Each year 5,000 to 10,000 acres of vegetation will be affected by natural fires or prescribed burning.

PROJECT STATEMENT TITLE: GRCA-N-7- Fire Management (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Continue Implementation of the Fire Management Program.
Vegetation (cont.)	Fire in pinyon-juniper communities will create openings of grass and sagebrush.
Endangered and Threatened Plant and Animal Species	Fire effects on many of these plants and animals is presently unknown. The diversification of habitat and general stimulus to the ecosystem caused by fire will work for the benefit of all plants and animals.
Social Impacts	Some views of the canyon may be obscured by smoke approximately 14 days per year. Visitors may experience delays of five to ten minutes along paved roads during prescribed burns. Two to three miles of roadside views will be impacted by the presence of fire killed trees, scorched tree trunks, and blackened ground cover which will remain to some degree for two to five years. Long range effects will be the enhancement of the visitor's park experience by improving roadside forest vistas and the opportunity to observe more wildlife.
Cultural Resources	The Park Archeologist estimates that most sites on the canyon rims have been burnt over by historical fires at least once. Possibility of high intensity fires will be reduced by low intensity prescribed fires which will reduce heavy fuel concentrations. Fire will destroy perishable materials on the surface and discolors surface artifacts. Fire suppression activities will destroy artifact context and area stratigraphy. Archeomagnetic dates may be altered by high intensity fires. Exact effects of fire on archeomagnetic dating is not known. Rock walls will be weakened by high intensity fires. To evaluate impacts on cultural resources, archeological clearances will be obtained on all prescribed burns.

PROJECT STATEMENT TITLE: GRCA-C-1- Excavation of Heavily Impacted Prehistoric Sites

NEED FOR THE PROPOSAL: Sites with middens are deteriorating at increasing rates due to natural erosion and heavy visitor use. Some walls and floors are being undermined. Non-renewable resources, interpretive potential and valuable and rare research data are currently being lost.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 2
	Excavation of 6 Prehistoric Sites.	No Monitoring or Mitigation of Impacts.	Stabilization.	Increase Public Awareness.
Resource Preservation	Partial loss of physical remains; preserved in notes; photographs and collections.	Gradual loss of resource.	Gradual loss of resource due to lack of technique for midden preservation.	Increased visitation will result in some loss of the resource due to wear and tear.
Legislative Compliance	Full compliance.	Non-compliance.	Partial compliance.	Partial compliance.
Management/Planning	Data important for resource evaluation and preservation planning recovered.	No planning necessary. Data for planning inaccurate or inadequate.	Data for planning inadequate.	Increased visitation will require an increase in interpretive material onsite.
Visitor Use	1. Use patterns temporarily interrupted or altered. 2. Interp. potential during and after project enhanced. 3. Visitor safety insured.	1. Use patterns unaltered. 2. Interp. potential unknown. 3. Visitor safety possibly endangered.	1. Use patterns interrupted. 2. Interp. potential not realized. 3. Visitor safety insured. 4. Appearance marred.	Increased visitation will require closer monitoring of use patterns and probably require stricter enforcement of existing laws.
Research Value	Problem solving possible. Collections available for all researchers.	Research value lost.	Research potential not realized or impaired. Inadequate data for problem solving.	Most research data will be preserved.

PROJECT STATEMENT TITLE: GRCA-C-1- Excavation of Heavily Impacted Prehistoric Sites (continued)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	ALTERNATIVE 3	ALTERNATIVE 4	ALTERNATIVE 5
	Use Emergency Preservation Techniques only.	Closure of Sites.	Continue Present Management.
Resource Preservation	Loss of site integrity with possible loss of resource will result.	Loss of physical remains will be slowed but will still continue.	Loss of physical remains will be slowed but will still continue.
Legislative Compliance	Park will fail to comply with existing laws.	Park will partially comply with existing laws.	Park will partially comply with existing laws.
Management/ Planning	Park will be unable to plan for needed preservation of sites.	Enforcement of closure will require more manpower. More signs will be required.	
Visitor Use	Use patterns and on-site interpretation will be temporarily interrupted. Safety hazards at these sites will continue.	Visitors will be denied all access to site. Visitor safety will be assured.	Use patterns will be temporarily impaired by monitoring activities. Visitor safety hazards will continue.
Research Value	Research data will continue to be lost.	Research data loss will be slowed but will still continue.	Research data will continue to be lost.

PROJECT STATEMENT TITLE: GRCA-C-2- Liaison with Indian Tribes

NEED FOR THE PROPOSAL: American Indian Religious Freedom Act mandates consultation between properly sensitized and trained Federal agents and tribal officials. Cooperation is needed to solve mutual concerns.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION Liaison by Park Anthropologist and Rangers.	ALTERNATIVE 1 Cut All Liaison Actions.	ALTERNATIVE 2 Liaison by Ranger Personnel Only.	ALTERNATIVE 3 Liaison by Park Anthropologist Only.
Legislative Compliance	Full compliance with legislative edicts.	Non-compliance.	Non-compliance.	Full compliance.
Management/ Planning	All concerns and phases of management not represented.	Potential for complaints and suits increased.	Potential for complaints and suits increased. Problems solved more slowly.	All factions not represented.
Social Aesthetics	Traditional lifestyles supported.	Deterioration with respect to park lands.	Deterioration with respect to park lands.	Traditional lifestyles supported.

PROJECT STATEMENT TITLE: GRCA-C-3- Conduct Cultural Resource Compliance Surveys

NEED FOR THE PROPOSAL: Surveys are needed to locate, evaluate, and nominate to the National Register all cultural resources on Federal lands as required by the National Historic Preservation Act as amended in 1980 and by E.O. 11593. Data is needed for planning, interpretive, and research purposes.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE
	Conduct Compliance Surveys.	No Surveys.	Continue Present Management.
Resource Preservation	Sights in project areas may be preserved if significant. Artifacts collected from surface.	Loss and damage unknown.	Sites in project areas may be preserved if significant.
Legislative Compliance	Full compliance begun.	Non-compliance.	Partial compliance.
Management Planning	Better data base for planning.	Decisions based on inadequate or outdated data.	Decisions based on incomplete or inaccurate data.
Visitor Use	Possible safety hazards will be established. Use patterns unimpaired. Interp. potential will be realized.	Safety hazards unknown. Use patterns unimpaired. Interp. potential unknown or lost.	Few hazards known. Use patterns unimpaired. Interp. potential unrealized.
Research Value	Regional and site research problems will be solved.	Research potential unrealized or lost.	Data for broad research problems unavailable. Project areas too limited for synthesis.

PROJECT STATEMENT TITLE: GRCA-C-4- Cyclic Maintenance of Archeological and Historic Structures.

NEED FOR THE PROPOSAL: Previously stabilized structures, and those to be stabilized, need regularly scheduled maintenance to prevent deterioration and loss of the irreplaceable resource. Cyclic maintenance will also prevent wasting of labor and funds already expended, and to reduce possible safety hazards.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE
	Cyclic Maintenance.	No Monitoring or Mitigation of Natural and Man-caused Impacts.	Continue Present Management of Irregular Inspection and Maintenance or Emergency Preservation.
Resource Preservation	Long-term preservation and integrity insured.	Eventual loss of physical remains.	Eventual loss of remains and/or loss of structure integrity.
Legislative Compliance	Compliance insured.	Non-compliance.	Non-compliance or partial compliance.
Management/ Planning	Long-term labor assignment and budgeting possible.	No planning necessary.	Planning not possible due to short term or emergency type action.
Visitor Use	1. Use patterns and interpretation temporarily interrupted.	1. Use patterns uninterrupted but visitor safety impaired.	1. Use patterns and interpretation temporily impaired.
	2. Aesthetic and interpretive value enhanced.	2. Loss of appearance and on-site interp. potential.	2. Aesthetic and interp. potential may or may not be realized.
	3. Visitor safety insured.	3. Safety hazards probable.	3. Safety hazards probable.

PROJECT STATEMENT TITLE: GRCA-C-5- Stabilization of Select Archeological Structures

NEED FOR THE PROPOSAL: Ruins with standing walls are deteriorating at increasing rates due to natural erosion and heavy visitor use. Walls, floors and chinmeys are unstable and unsafe. Nonrenewable resources are being lost.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
	Stabilization.	No Monitoring or Mitigation of Impacts.	Closure.	Continue Present Management.	Use of Emergency Preservation.	Increase Public Awareness.
Resource Preservation	1. Long-term preservation and integrity of sites will be insured. 2. Minor loss of physical remains will result.	Eventual loss of physical remains.	Gradual loss of remains.	Gradual loss of remains.	Loss of site integrity with possible loss of physical remains.	Probably result in gradual loss due to increased visitation.
Legislative Compliance	Compliance insured.	Non-compliance.	Partial compliance.	Partial compliance.	Non-compliance.	Partial compliance.
Management/ Planning		No planning necessary.	1. Enforcement needs will be increased. 2. Increased sign placement/ maintenance costs.		The park will be unable to plan for labor and budget needs in advance.	1. Increased interp. and publication costs. 2. Need monitoring to determine results and effectiveness.

PROJECT STATEMENT TITLE: GRCA-C-5- Stabilization and Selected Archeological and Historic Structures (continue)

NEED FOR THE PROPOSAL:

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
	Stabilization.	No Monitoring or Mitigation of Impacts.	Closure.	Continue Present Management.	Use of Emergency Preservation.	Increase Public Awareness.
Visitor Use	1. Use patterns and interp. will be temporarily interrupted.	1. Use patterns uninterrupted but safety impaired.	1. Use patterns permanently impaired.	1. Use patterns temporarily impaired by monitoring.	1. Use patterns and interp. will be temporarily interrupted.	1. Increased visitor appreciation.
	2. Aesthetic and interp. value will be enhanced.	2. Loss of appearance and on-site interp. potential.	2. No on-site interp.	2. On-site interp. and minimal training. continues.	2. Aesthetic and interp. values may or may not be realized.	
	3. Visitor safety insured.		3. Visitor safety insured.	3. Safety hazards probable.	3. Safety hazards probable.	
Research Value	Recovery of limited amount of data. Research potential not radically impaired.	Total loss of research potential, provenences, etc.	Gradual loss of provenience and other data needed for problem solving.	Research problems not solved. Gradual loss of resource potential.	Loss of research potential.	

PROJECT STATEMENT TITLE: GRCA-C-6- Assessment of Effect of Management Fires on Cultural Resources

NEED FOR THE PROPOSAL: Effects of various fire conditions on archeological sites is unknown. Prior research is inconclusive. To fulfill compliance requirements and allow implementation of fire management plans, a survey and research effort is needed.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE 1	ALTERNATIVE 2
	Partial Survey, Selection Suppression and Field Research.	Implementation of Fire Management Plan Without Archeological Work.	Complete Suppression.	Research with Test Plots and Lab Tests.
Resource Preservation	1. Total preservation of representative sample. 2. Possible surface to some sites burned under controlled conditions. 3. Loss of physical remains of several sites due to excavation; information preserved in records, photographs.	1. Possible surface and subsurface damage to many sites.	1. Total preservation except that fuel build-up results in wildfires. 2. Possible damage during line construction.	Total preservation.
Legislative Compliance	Compliance begun.	Non-compliance.	Full compliance.	Full compliance.
Management/ Planning	1. Better data base for planning. 2. Immediate implementation of Fire Plan possible.	1. Incomplete data base. 2. Immediate implementation of Fire Plan possible.	1. Costly in manpower and suppression funds. 2. Fire Plan cannot be implemented.	1. Incomplete data base using artificial conditions. 2. Difficulty in determining proper fire prescriptions.
Research Value	Archeological method and theory augmented by data on effects of previous natural burns.	Extent of loss unknown.	Value unchanged.	1. Research value of resource unchanged. 2. Correlation between test and real data uncertain.

PROJECT STATEMENT TITLE: GRCA-C-7- Monitoring of Cultural Resources

NEED FOR THE PROPOSAL: Sites are deteriorating at increasing rates due to natural erosion and heavy visitor use. The types and rates of impact must be established before corrective measures required by legislation can be planned. Without preservation and monitoring, structures on more sites will become unstable, unsafe and nonrenewable resources will be lost.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION
	Monitoring of Cultural Resources.	No Monitoring or Mitigation of Impacts.
Resource Preservation	1. Can be preserved if necessary. 2. Removal of surface artifacts and non-artifactual samples.	Loss and damage to resources unknown.
Legislative Compliance	Compliance begun.	Non-compliance.
Management/ Planning	1. Data base for planning augmented. 2. May result in future recommendations of more costly actions such as stabilization or excavation, or changes in the LCS.	1. Inadequate data base. 2. List of Classified Structures outdated and unrealistic.
Visitor Use	1. Use patterns temporarily interrupted. 2. Safety hazards known. 3. Data base for interp. added to.	1. Use patterns uninterrupted. 2. Safety hazards unknown. 3. Loss of appearance and on-site interp. potential.
Research Value	Research potential may be augmented.	Research potential unrealized or lost.

PROJECT STATEMENT TITLE: GRCA-C-8- Curatorial Cyclic Maintenance

NEED FOR THE PROPOSAL: The parks museum collection of 35,000 objects and specimens requires constant maintenance. Lack of environmental controls is causing rapid deterioration and higher curatorial costs. Special funding is needed for certain phases of upgrading the collections to present curatorial standards.

ALTERNATIVE ACTIONS / IMPACT CATEGORIES	PROPOSED ACTION	NO ACTION	ALTERNATIVE
	Modify Present Facility and Complete Two Special Projects.	Retain Present Staff, Space and Environmental Conditions.	Construct a New Facility.
Resource Preservation	Collection condition and long-term preservation of specimens will be improved.	Collection conditions of degradation; will continue resulting in the loss of resource.	Collection condition and long-term preservation will be improved.
Legislative Compliance	Full compliance.	Non-compliance.	Full compliance.
Interpretive Value	Collection access and reference use will be enhanced.	Access and use for reference and display will be restricted.	Access for reference and display will be increased.
Research Value	Collection access and reference use will be improved.	Access and use for reference and display will be restricted.	Access of usefulness will be improved.
Management/ Planning	Plans for growth of collection not made beyond five year period.	Does not allow for growth of collection.	Construction would mean increased development in park. However, construction could insure that there would be space available for growth of collections beyond the present five year period.

B. List of Agencies and Persons Consulted in EA Preparation

Many of the projects outlined in the present Natural and Cultural Resources Management Plan were approved under the 1977 Natural Resources Management Plan and Environmental Assessment. This document was made available for a 45-day public review period, and informational copies were sent to organizations and to State and Federal agencies listed below. In addition, over 800 copies were sent to individuals during the initial public release period.

Beyond local fishermen responding to the fish management proposals identified in the 1977 plan (see Fish Management Plan Project Statement), this document received little public comment. It is anticipated that the resources management actions, monitoring efforts, and proposed ecological studies identified in the 1981 Natural and Cultural Resources Management Plan will not generate significant public controversy.

Informational copies of the Natural and Cultural Resources Management Plan and Environmental Assessment will be sent to the various agencies, organizations, and individuals listed below. Notices concerning the availability of this document will be published in local newspapers.

Letters of comment received will be reviewed by the Superintendent and acted upon as deemed necessary. Copies of public comments will be made available at Grand Canyon National Park. If it is determined by the National Park Service that this document does not entail a significant impact to the natural environment of the park, a Finding of No Significant Impact document will be prepared and the Natural and Cultural Resources Management Plan will be granted final approval by the Park Superintendent and the Regional Director, Western Region.

Informational copies will be sent to the following:

State and Federal Agencies

Advisory Council on Historic Preservation
Department of Agriculture
- Forest Service
- Soil Conservation Service

Department of the Interior
- Bureau of Indian Affairs
- Bureau of Land Management
- Bureau of Reclamation
- Fish and Wildlife Service
- Geological Survey

Environmental Protection Agency
Arizona State Clearinghouse
Arizona State Historic Preservation Officer

Organizations:

- Coconino County Board of Supervisors
- Coconino County Planner and Director

Mohave County Planning and Zoning Commission
City Manager, Kingman, Arizona
City Manager, Williams, Arizona
Mayor, Flagstaff, Arizona
Tusayan Chamber of Commerce
Havasupai Tribal Council
Hopi Tribal Council
Hualapai Tribal Council
Kaibab-Paiute Tribal Council
Navajo Tribal Council
Archeological Consulting Services
Archeological Research Services
Arizona Archeological Council
Arizona Academy of Science
Advisory Commission of Arizona Environment
Arizona Conservation Council
Arizona Desert Bighorn Sheep Society, Inc.
Arizona Friends of the Earth
Arizona Historical Society
Arizona Mountaineering Club
Arizona Parks and Recreation Association
Arizona Wilderness Study Commission
Arizona Wildlife Federation
Arizona Wildlife Society
Arizona-New Mexico Wildlife Society
Arizonans for Quality Environment
Colorado River Wildlife Council
Conservation Foundation
Conservation Law Society of America
Defenders of Wildlife
Desert Bighorn Council
Desert Protection Council
Environmental Conscience Corporation
Federation of Western Outdoor Clubs
Huachuca Conservation Council
Izaak Walton League of America
Janus Associates
Maricopa Audubon Society
Mearns Wildlife Society
Museum of Northern Arizona
National Audubon Society
National Parks and Conservation Association
National Recreation and Park Association
National Speleological Society - Escabrosa Chapter
National Speleological Society - Arizona Regional Association
National Wildlife Federation
Nature Conservancy
Northern Arizona Audubon Society
School of American Research
Sierra Club - Wildlife Committee
Sierra Club - Grand Canyon Chapter
Southern Arizona Hiking Club
Scottsdale's Sportmens' Club
Tucson Audubon Society

Wilderness Society
Wildlife Management Institute
Wildlife Society - Arizona Chapter
Wildlife Society, A.S.U. Chapter
American River Touring Association
Arizona Cattle Growers Association
Arizona River Runners, Inc.
Canyoneers, Inc.
Colorado River and Trail Expeditions, Inc.
Cross Tours and Explorations, Inc.
Georgie's Royal River Rats
Grand Canyon Dories
Grand Canyon Expeditions
Grand Canyon Youth Expeditions, Inc.
Harris Boat Trips
Hatch River Expeditions
Moki Mac River Expeditions
O.A.R.S., Inc.
Outdoors Unlimited
Sanderson River Expeditions
Tour West, Inc.
Western River Expeditions, Inc.
White Water River Expeditions
Wilderness World
Wonderland Expeditions

C. Coordination and Planning

Coordination and cooperation in the implementation of the Natural and Cultural Resources Management Plan will be maintained on a continuing basis between the National Park Service and adjacent land managing agencies, neighboring Indian tribes, appropriate State and Federal agencies, and regional planning organizations to insure that all projects cause minimum adverse impacts on surrounding lands.

Individual projects requiring special cooperative efforts with specific agencies include:

1) Air and Water Quality Projects - Environmental Protection Agency, Arizona State Bureau of Air Quality, Arizona State Public Health Services.

2) Endangered Species Projects - U.S. Fish and Wildlife Service, Bureau of Reclamation, Arizona and Nevada Departments of Game and Fish.

3) Aircraft Noise Management Project - Federal Aviation Administration, Grand Canyon National Park Airport, Environmental Protection Agency, Commercial Tour Operators, and the private sector of the aircraft community.

4) Colorado River Monitoring Program - NPS river concessioners and the private river running sector.

5) Rehabilitation, Grazing, and Boundary Management Projects - Arizona Game and Fish Department, U.S. Forest Service, Bureau of Land Management, Indian tribes including Havasupai, Hualapai, and Navajos, and individual grazing permittees.

6) Exotic and Nuisance Species and Disease Management - Environmental Protection Agency, U.S. Forest Service, Arizona State Department of Health Services, and U.S. Public Health Service.

7) Wildlife Management Projects - U.S. Fish and Wildlife Service, Bureau of Reclamation, Arizona Game & Fish Department, and Navajo, Havasupai and Hualapai Indian Tribes.

8) Mining and Mineral File System - Lake Mead National Recreation Area, Bureau of Land Management, and U.S. Forest Service.

9) Cave Management Plan - National Speleological Society, Arizona Grotto Chapters, and the Cave Research Foundation.

10) Fire Management Plan - U.S. Forest Service, Lake Mead National Recreation Area, Bureau of Land Management, Arizona Game and Fish Department, Arizona Bureau of Air Quality Control, adjacent Indian Tribes and National Park Service Western Archeological Center.

REFERENCES.

A. Natural Resources Management Projects.

See individual Project Statements for references and contacts pertinent to each management proposal. Literature references within the text of the document include the following:

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Hoffmeister, Donald F. 1971. Mammals of Grand Canyon. University of Illinois Press, Urbana. 183 pp.

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Huntoon, Peter W. 1977. Relationship of Tectonic Structure to Aquifer Mechanics in the Western Grand Canyon District, Arizona University of Wyoming Water Research Series 66.

Malm, William C. 1974. Air Movement in the Grand Canyon. Plateau. 46 (4):125-132.

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Mouat, David, Karen Reichhardt and Peter Warren. 1981. Grand Canyon National Park Vegetation Inventory Final Report. University of Arizona, Office of Arid Lands Studies. In press.

Suttkus, Royal D. and Glenn H. Clemmer. 1977. The Humpback Chub, (Gila cypha), in the Grand Canyon Area of the Colorado River. Tulane University Museum of Natural History, Occasional Paper 1.

USDI, Bureau of Indian Affairs. 1976. Secretarial Land Use Plan for the Havasupai Indian Reservation and Draft Environmental Impact Statement.

USDI, Fish & Wildlife Service. 1981. Life History, Habitat Relationships, and Population Status of the Humpback Chub (Gila cypha) in the Little Colorado and Colorado Rivers, Arizona, Interim Report.

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USDI, National Park Service, 1978. National Park Service Management Policies.

USDI, National Park Service, 1979. Glen Canyon National Recreation Area General Management Plan.

USDI, National Park Service. 1979. Grand Canyon National Park Colorado River Management Plan and Environmental Statement.

USDI, National Park Service. 1980, Grand Canyon National Park Feral Burro Management and Ecosystem Restoration Plan and Final Environmental Statement.

Walters, James E. and Richard M. Hansen. 1978. Evidence of Feral Burro Competition with Desert Bighorn Sheep in Grand Canyon National Park. Desert Bighorn Council. 1978 Transactions.

Walters, James E. 1979. Bighorn Sheep Population Estimate for the South Tonto Plateau - Grand Canyon, Desert Bighorn Council, 1979 Transactions.

B. Cultural Resources Management Projects.

Brook, Richard A. 1974. Final Report for the Cultural Resources of the Grand Canyon Cross Corridor Survey. Ms. on file at Grand Canyon National Park.

Dellenbaugh, F.S. 1935. Resume of Grand Canyon History. Grand Canyon Natural History Association Bulletin 2:1-6.

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Euler, Robert C. 1958. Walapai Culture History. University of New Mexico, Ph. D. dissertation. University Micro-films, Ann Arbor.

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Euler, Robert C. and Susan M. Chandler. 1978. Aspects of Prehistoric Settlement Patterns in Grand Canyon. In Investigations of the Southwestern Anthropological Research Group, The Proceedings of the 1976 Conference, edited by Robert C. Euler and George J. Gummerman. Museum of Northern Arizona, Flagstaff.

Euler, Robert C., George J. Gummerman, Thor N.V. Karlstrom, Jeffrey S. Dean, Richard H. Hevly. 1979. The Colorado Plateaus: Cultural Dynamics and Paleoenvironment. Science 205(4411): 1089-1101.

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Sudderth, W. E., Steve Adams, Robert L. Hall, Mary T. Morehead, Sonja Sandberg, George A. Teague and Marianne Trussell. 1976. List of Classified Structures Survey: Grand Canyon National Park. Manuscript on file at Grand Canyon National Park.

Thompson, Richard A. and Georgia Beth Thompson. 1974. A Preliminary Report of Excavation in the Grand Canyon National Monument. Sites GC-670, GC-671 and GC-663, Manuscript on file at Grand Canyon National Park.

APPENDICES

Appendix A	Grand Canyon Bibliographies
Appendix B	Information Baseline List
Appendix C	Grand Canyon Vegetation Communities
Appendix D	Grand Canyon Mammals and Birds
Appendix E	List of Amphibians and Reptiles
Appendix F	List of Classified Structures (LCS)

APPENDIX A

GRAND CANYON BIBLIOGRAPHIES

There are literally thousands of references and publications on the various aspects of the Grand Canyon. The most significant references to the natural and cultural resources of the park are included in the following bibliographies:

Carothers et al. 1973. A Preliminary Report on the History and Bibliography of Biological Research in the Grand Canyon Region With Emphasis on the Riparian Habitat. Park files, Grand Canyon National Park.

Farquhar, Francis P. 1953. The Books of the Colorado River: The Grand Canyon. Published by Dawson Books. Los Angeles, California.

Nelson, Rebecca. 1979. An Annotated Bibliography of Research Related to Roaring Springs, Bright Angel, Garden and Pipe Creeks in Grand Canyon National Park. Park files, Grand Canyon National Park. 26 pages.

Ruder, Ruth L. 1970. Selected List of References on the Grand Canyon Area. Park files, Grand Canyon National Park. 42 pages.

Spamer, Earle E. 1981. Bibliography of the Grand Canyon and Lower Colorado River 1540-1980. Grand Canyon Natural History Association, Grand Canyon National Park. 119 pages.

Voth, Hazel Hunt and Harold Gill. 1939. Grand Canyon National Park. A Bibliography. Western Archaeological Center, National Park Service.

APPENDIX B

INFORMATION BASELINE LIST: MAPS, PHOTOS, AND REFERENCES

1. Topography. U.S. Geological Survey maps of the entire park are on file in the Division of Resources Management offices and are available as commercial sales items throughout the region. These maps include: Twenty 15 minute quadrant maps (scale 1:62,500) covering the eastern end of the park; thirty-three 7.5-minute maps (scale 1:24,000) covering the western end of the park; a one degree Grand Canyon National Park and Vicinity map (scale 1:62,500) covering the eastern section; and a series of two degree maps (scale 1:250,000) covering the Grand Canyon region.

   To complement the topographic map files, the park maintains sets of aerial photographs. These include:

Project	Scale	Date
Park general (B&W)	1:36,000	1968
Vegetation Mapping (color)	1:24,000	1978
Colorado River Visitor Use/Beach Impact Monitoring (B&W)	elevation 500 ft and 2,000 ft	1981

2. Geology. A one degree map entitled Geology Map of the Grand Canyon National Park, Arizona (scale 1:62,500) is available as a sales item at various Grand Canyon Natural History Association (G.C.N.H.A.) outlets within the park. This map was completed under an N.H.A. sponsored research contract in 1976. It covers the eastern end of the national park and includes an area from Marble Canyon to approximately Havasupai Canyon. Preliminary geology maps of the remaining western end of the National Park, at the same scale, are on file at the Division of Resources Management offices.

   The park also maintains a file of cave locations and maps of individual caves. These maps are in a variety of formats and scales and are on file at the Division of Resources Management. Because of the delicate nature of cave resources, and in cooperation with the caving community, cave maps are not generally available to the public.

   A thorough review of references pertaining to the geology of the Grand Canyon is available in the bibliographies indentified in Appendix A.

3. Other. Individual maps needed for various resources management projects have been developed by the park staff using standard

USGS topographic maps. These are on file under individual subject titles in the Division of Resources Mangement offices. Subjects include: grazing exclosures, fire management zones, aircraft management zones, trails, fence projects, Colorado River campsite inventories, and water resources.

4. Wildlife. The Grand Canyon has no overall map showing wildlife distribution in the park. Information on the range and distribution of major wildlife species is contained in separate research reports and publications available in park files. These documents represent a variety of wildlife forms including: desert bighorn, mountain lion, humpback chub, Kaibab squirrels, peregrine falcons, and various reptiles, fish and small mammals.

   The park also has maps concerning deer pellet transect locations, boundaries of the old (1906) Grand Canyon Game Reserve, and feral burro distribution and home-range maps. These maps are on file at the Division of Resources Management offices. Other information concerning the distribution and range of individual wildlife species within the park can be found in references listed in bibliographies identified in Appendix A.

5. Soils. A soils map of Grand Canyon National Park is not available. The need for a comprehensive soil survey is addressed in the Natural Resources Project Statement N-17. U.S. Forest Service soils maps entitled Tusayan District Soils Survey and North Kaibab District Soils Survey identify soils in lands adjoining the park along the Kaibab and Coconino plateaus, north and south of the park boundary.

6. Hydrology. Most of the hydrological features of the park can be found on appropriate USGS topographic maps. A water resource inventory is currently in progress within the park and a partially completed map system delineating streams, springs, and seeps is available at the Division of Resources Management offices. In his 1981 research report entitled, "Analysis of Erosion Trends on Grand Canyon Beach Terraces," Dr. Robert Dolan included maps of 38 beach campsites on the Colorado River in the Grand Canyon. An overview of water resources in Arizona is presented in a map entitled, "Drainages of Arizona Showing Perennial Streams and Some Important Wetlands," developed by the Arizona Game & Fish Department in 1978. The scale on this map is 1:1,000,000.

   Climatological data, compiled for five weather stations within the park, is available at Division of Resources Management offices. Data date from 1903.

7. Vegetation. A four-year study of the vegetation of Grand Canyon National Park was completed in 1981 by the Office of Arid Land Studies, University of Arizona at Tucson. This project resulted in four detailed vegetation maps encompassing the entire park. These maps were developed in a scale of 1:62,500. The 1:24,000 color aerial photographs identified above were developed as part of this project.

Earlier vegetation maps of portions of the Grand Canyon include: a 1973 vegetation map of Point Sublime (scale 1:22,200) and two 1935 vegetation maps developed on topographic maps entitled "Grand Canyon National Park East Half" and "Grand Canyon National Park West Half" (scale 1:48,000). These 1935 maps include locations for approximately 300 photographs taken during the mapping projects.

In 1977 the Museum of Northern Arizona completed a contract research project involving a map of the riparian vegetation communities along the Colorado River. These maps were completed at a scale of 1:9600 and are available at Division of Resources Management offices. The Division also has maps entitled, "The Natural Vegetative Communities of Arizona," (scale 1:500,000) developed by the Arizona Game & Fish Department, 1973, and, "Biotic Communities of the Southwest," (scale 1:1,000,000) developed by David E. Brown and Charles H. Lowe of the U.S. Forest Service. These maps depict plant communities throughout the southwestern United States and northwestern Mexico.

8. Cultural. A complete collection of USGS 7.5 and 15 minute topographic quadrangle maps showing site locations and permanent site numbers are kept on file by the Division of Resources Management. Because of the sensitive nature of the data, these maps are not generally available to the public as specified in the Archaeological Resources Protection Act (P.L. 96-95). Areas which have been surveyed, and the locations of specific projects, are recorded on USGS maps at a scale of 1:250,000. Various other maps may be found with reports and publications listed in the reference and bibliography section of this plan.

9. Recreation, Development and Support Facilities. Maps relating to each of these elements are contained in a variety of management documents developed for the park. The most significant of these documents include:

1976 Final Master Plan and E.I.S.
1976 Park Suitability Study
1976 Proposed Wilderness Classification and Draft E.I.S.
1977 Development Concept Plan and E.I.S.
1977 Natural Resources Management Plan and Environmental Assessment
1978 Capacity Analysis/Water Management Alternatives
1979 Proposed Colorado River Management Plan and Final E.I.S.
1981 Draft Adjacent Lands Study

Other documents offering the reader insight into the management of Grand Canyon's recreation and development management programs include:

1972 Coconino and Yavapai (Cocopai) Resource Conservation and Development Project
1979 Northern Arizona Council of Governments Water Quality Management Plan
1979 Arizona Department of Health Services Rules and Regulations for Air Pollution Control

1980 Decision Report on B.L.M. Wilderness Review, Arizona
1981 The Secretarial Land Use Plan for the addition to the Havasupai Indian Reservation and Final E.I.S.

APPENDIX C

GRAND CANYON VEGETATION COMMUNITIES

In 1981 the park completed a four year research contract entitled: Grand Canyon National Park Vegetation Inventory. This project was the first phase of the park's Resources Base Inventory and was intended to provide the park with an accurate and detailed information baseline for its vegetative resources. The physical products resulting from this study included: a set of four detailed mylar vegetation maps (1:62,500) covering the entire National Park, descriptions of 104 vegetation mapping units (vegetation types), and a final report.

The classification system used for the vegetation mapping project was adopted from Brown, Lowe and Pase (1979). It is a digitized, computer compatible system for natural vegetation in North America following a six-level hierarchical format. For accuracy and detail in the Grand Canyon project, two additional levels of identification were added to account for the variability of species found within plant associations and the spatial distribution of species within a vegetative type.

Vegetation types within the park were described in terms of vegetation associations, physiognomy, floristics, variation within types, and distribution. A Legend and Vegetation Description List for the Grand Canyon, along with an example of a Vegetation Type Classification Sheet, is attached. A complete copy of the final report is available in the files of the Division of Resources Management, Grand Canyon National Park.

Attachment 1

3.0 Legend and Vegetation Descriptions for Grand Canyon

3.1 The Hierarchical Legend

120 Forest and Woodland Formation
- 121 Boreal Forests and Woodlands
  - 121.3 Rocky Mountain Subalpine Conifer Forest and Woodland
  - 121.31 Englemann Spruce - Alpine Fir Series
  - 121.311 Picea engelmannii - Abies lasiocarpa Association
  - 121.3111 Picea engelmannii - Abies lasiocarpa
  - 121.317 Picea engelmannii - Mixed Conifer Association
  - 121.3171 Picea engelmannii - Mixed Conifer Aspen Subclimax
- 122 Cold Temperature Forests and Woodlands
  - 122.3 Rocky Mountain Montane Conifer Forest
  - 122.32 Pine Series
  - 122.321 Pinus ponderosa Association
  - 122.3211 Pinus ponderosa with Mixed Shrub Understory
  - 122.3212 Pinus ponderosa with Forbs and Grasses
  - 122.3213 Pinus ponderosa - Populus tremuloides Subclimax
  - 122.322 Pinus ponderosa - Mixed Conifer - Populus tremuloides - Subclimax
  - 122.3221 Pinus ponderosa - Mixed Conifer - Populus tremuloides - Subclimax
  - 122.323 Pinus ponderosa - Quercus gambelii Association
  - 122.3231 Pinus ponderosa - Quercus gambelii and Robinia neomexicana
  - 122. 3232 Pinus ponderosa - Quercus gambelii and Scleroscrub-Rim Type
  - 122.326 Pinus ponderosa - Picea engelmannii Association
  - 122.3261 Pinus ponderosa - Picea engelmannii Association
  - 122.327 Pinus ponderosa - Abies concolor Association
  - 122.3271 Pinus ponderosa - Abies concolor - Populus tremuloides Subclimax
  - 122.3272 Pinus ponderosa - Abies concolor - Deciduous Understory
  - 122.4 Great Basin Conifer Woodland
  - 122.41 Pinyon-Juniper Series
  - 122.414 Pinus edulis - Juniperus spp. Association
  - 122.4141 Pinus edulis - Juniperus spp. with Mixed Scleroscrub - Esplanade
  - 122.4142 Pinus edulis - Juniperus spp. with Mixed Shrub
  - 122.4143 Pinus edulis - Juniperus spp. with Artemisia tridentata and Chapparal
  - 122.4144 Pinus edulis - Juniperus spp. with Artemisia tridentata
  - 122.4145 Pinus edulis - Juniperus spp. with Artemisia tridentata and Cowania mexicana
  - 122.4146 Pinus edulis - Juniperus spp. with Chapparal
  - 122.7 Rocky Mountain Deciduous Forest
  - 122.71 Aspen Series
  - 122.711 Populus tremuloides association

130 Scrubland Formation
- 132 Cold Temperature Scrublands
  - 132.1 Great Basin Montaine Scrub
  - 132.11 Oak-Scrub Series
  - 132.111 Quercus gambelii association
  - 132.1111 Quercus gambelii - Mesic Scrub
  - 132.1112 Quercus gambelii - Sclerophyllous Scrub

133 Warm Temperature Scrublands
- 133.3 Interior Chaparral
- 133.32 Manzanita Series
- 133.322 Arctostaphylos pungens Association
- 133.3221 Arctostaphylos pungens - Mixed Shrub

140 Grassland Formation
- 142 Cold Temperature Grasslands
  - 142.2 Great Basin Shrub - Grassland
  - 142.25 Great Basin Shrub - Grassland Disclimax Series
  - 142.251 Toroweap Valley Shrub - Grassland
  - 142.252 Shrub - Grassland Gutierrezia Disclimax
  - 142.4 Rocky Mountain Montain Grassland
  - 142.41 Mixed Meadow Series

150 Desertland Formation
- 152 Cold Temperature Desertlands
  - 152.1 Great Basin Desertscrub
  - 152.11 Sagebrush Series
  - 152.111 Artemisia tridentata Association
  - 152.1111 Artemisia tridentata-Flats, Valleys and Low Hills
  - 152.1112 Artemisia tridentata with Cowania mexicana and Pinus edulis, Juniperus sp.
  - 152.112 Artemisia tridentata - Mixed Scrub-Grass Association
  - 152.1121 Artemisia tridentata - Gutierrezia sarothrae, Ephedra, Mixed Shrubs
  - 152.1122 Artemisia tridentata - Mixed Desertscrub with Pinus/ Juniperus
  - 152.13 Blackbrush Series
  - 152.131 Coleogyne ramosissima Association
  - 152.1311 Coleogyne ramosissima-Desertscrub, Talus Slopes
  - 152.1312 Coleogyne ramosissima - Desertscrub, Esplanade
  - 152.16 Mixed Scrub Series
  - 152.1621 Mixed Scrub Association
  - 152.1622 Mixed Scrub with Grasses and Succulents - Soil Pockets, Esplanade
  - 152.1623 Mixed Scrub with Scleroscrub, Succulents and Pinus/ Juniperus
  - 152.163 Mixed Desertscrub with Succulents - Toroweap Valley
  - 152.17 Saltbush Series
  - 152.172 Atriplex canescens Association
  - 152.1721 Atriplex canescens with Mixed Desertscrub
  - 152.2 Desertscrub Annual Disclimaz - Great Basin
- 153 Warm Temperature Desertlands
  - 153.1 Mohave Desertscrub
  - 153.11 Creosotebush Series
  - 153.114 Larrea divaricata Mixed Desertscrub and Succulents Association
  - 153.12 Blackbush Series
  - 153.121 Coleogyne ramosissima
  - 153.1211 Coleogyne ramosissima - Acacia greggii - Tonto Association
  - 153.18 White Bursage - Brittlebush Series - Interior
  - 153.19 Desertscrub Series
  - 153.191 Desertscrub Associations
  - 153.1911 Desertscrub - Mixed Shrub - Vulcan's Throne

223 Warm Temperate Swamp and Riparian Forests

233.2 Interior Southwestern Riparian Deciduous Forest and Woodland

233.21 Cottonwood - Willow series

233.211 Populus fremontii - Salix spp. Association

Attachment 2
Example of Vegetation Type Classification Sheet
for Grand Canyon National Park

121.3111

Name: Picea engelmanni - Abies lasiocarpa (Engelmann Spruce - Alpine Fir) Association

Physiognomy:

Evergreen needle-leaved forest. Evenly distributed stands of mixed narrow-crown coniferous trees, 5 to 20 meters high with deciduous broadleaf trees, 5 to 20 meters high, spaced irregularly throughout. Variable ground cover composed of summer seasonal herbs and grasses or sedges. Small coniferous shrubs may be present. Total cover of this type is estimated to be 50-75 percent or sometimes greater with conifers sharing greatest prominence.

Floristics:*	Prominence	Frequency - %
Characteristics Species	Range	(22 samples)
Picea engelmanni	2-5	75-100
Abies lasiocarpa	2-4	75-100
Populus tremuloides	2-4	75-100
Associated Species		
Juniperus communis	1-3	50-75
Pinus ponderosa	1-3	50-75
Pseudotsuga menziesii	1-4	25-50
Abies concolor	1-4	25-50
Robinia neomexicana	3	0-75
Carex spp.	1-3	50-75
Herbs and grasses	1-3	0-25

Variation Within Type:

Picea engelmanni is generally more frequent within the type than is Abies lasiocarpa. Other conifer trees are present only when habitat conditions are favorable.

Distribution:

Kaibab Plateau, North Rim on loam to silty loam soils derived from Kaibab limestone. Elevation 7,900-8,600 feet. North or northwest facing slopes (15-20%). This type is distributed among the Pinus ponderosa vegetation types (122.324 and 122.327) which occupy rides and south facing slopes of the same elevation. Representation of this type is on north or northwest facing slopes of Kanabownits Canyon on the North Rim.

*Nomenclature follows Arizona Flora, by T.H. Kearney and R.H. Peebles, 1951, University of California Press.

APPENDIX D

GRAND CANYON MAMMALS AND BIRDS

I. Mammals

SHREWS

Merriam's Shrew (*Sorex merriami*)
Dwarf Shrew (*Sorex nanus*)
Desert or Gray Shrew (*Notiosorex crawfordi*)

AMERICAN LEAF-NOSED BATS

California Leaf-nosed Bat (*Macrotus californicus*)

PLAINNOSE BATS

Yuma Myotis (*Myotis yumanensis*)
Arizona Myotis (*Myotis lucifugus*)
Long-eared Myotis (*Myotis evotis*)
Fringe-tailed Myotis (*Myotis thysanodes*)
Long-legged Myotis (*Myotis volans*)
California Myotis (*Myotis californicus*)
Small-footed Myotis (*Myotis leibii*)
Silver-haired Bat (*Lasionycteris noctivagans*)
Western Pipistrell (*Pipistrellus hesperus*)
Big Brown Bat (*Eptesicus fuscus*)
Red Bat (*Lasiurus borealis*)
Hoary Bat (*Lasiurus cinereus*)
Spotted Bat (*Euderma maculatum*)
Lump-nosed or Townsend's Big-eared Bat (*Plecotus townsendii*)
Allen's or Mexican Big-eared Bat (*Idionycteris phyllotis*)
Pallid Bat (*Antrozous pallidus*)

FREE-TAILED BATS

Mexican Free-tailed Bat (*Tadarida brasiliensis*)
Big Free-tailed Bat (*Tadarida macrotis*)

HARES AND RABBITS

Black-tailed Jack Rabbit (*Lepus californicus*)
Mountain or Nuttall's Cottontail (*Sylvilagus nuttallii*)
Desert Cottontail (*Sylvilagus audubonii*)

SQUIRRELS, CHIPMUNKS AND PRAIRIE DOGS

Whitetail or Gunnison's Prairie Dog (*Cynomys gunnisoni*)
Spotted Ground Squirrel (*Spermophilus spilosoma*)
Rock Squirrel (*Spermophilus variegatus*)
Harris' Antelope Squirrel (*Ammospermophilus harrisii*)
White-tailed Antelope Squirrel (*Ammospermophilus leucurus*)
Golden-mantled Ground Squirrel (*Spermophilus lateralis*)
Least Chipmunk (*Eutamias minimus*)
Colorado Chipmunk (*Eutamias quadrivittatus*)
Uinta Chipmunk (*Eutamias umbrinus*)

Cliff Chipmunk (Eutamias dorsalis)
Abert Squirrel (Sciurus aberti)
Kaibab Squirrel (Sciurus kaibabensis)
Red or Spruce Squirrel (Tamiasciurus hudsonicus)

POCKET GOPHERS
Common or Valley Pocket Gopher (Thomomys bottae)
Northern Pocket Gopher (Thomomys talpoides)

POCKET MICE AND KANGAROO RATS
Silky Pocket Mouse (Perognathus flavus)
Apache Pocket Mouse (Perognathus apache)
Little Pocket Mouse (Perognathus longimembris)
Arizona Pocket Mouse (Perognathus amplus)
Great Basin Pocket Mouse (Perognathus parvus)
Long-tailed Pocket Mouse (Perognathus formosus)
Rock Pocket Mouse (Perognathus intermedius)
Merriam's Kangaroo Rat (Dipodomys merriami)
Ord's Kangaroo Rat (Dipodomys ordii)
Chisel-toothed Kangaroo Rat (Dipodomys microps)

BEAVERS
Beaver (Castor canadensis)

NEW WORLD RATS AND MICE

Western Harvest Mouse (Reithrodontomys megalotis)
Canyon Mouse (Peromyscus crinitus)
Cactus Mouse (Peromyscus eremicus)
Deer Mouse (Peromyscus maniculatus)
Brush Mouse (Peromyscus boylii)
Pinyon Mouse (Peromyscus truei)
Northern Grasshopper Mouse (Onychomys leucogaster)
Southern Grasshopper Mouse (Onychomys torridus)
White-throated Wood Rat (Neotoma albigula)
Desert Wood Rat (Neotoma lepida)
Stephen's Wood Rat (Neotoma stephensi)
Mexican Wood Rat (Neotoma mexicana)
Bushy-tailed Wood Rat (Neotoma cinerea)
Long-tailed Vole (Microtus longicaudus)
Mexican Vole (Microtus mexicanus)
Muskrat (Ondatra zibethicus)

OLD WORLD MICE AND RATS
House Mouse (Mus musculus)

AMERICAN PORCUPINES
Porcupine (Erethizon dorsatum)

DOGS AND ALLIES
Coyote (Canis latrans)
Kit Fox (Vulpes macrotis)
Gray Fox (Urocyon cinereoargenteus)

BEARS

Black Bear (*Ursus americanus*)

RACCOONS AND ALLIES

Ringtail (*Bassariscus astutus*)
Raccoon (*Procyon lotor*)

WEASELS AND ALLIES

Long-tailed Weasel (*Mustela frenata*)
American Badger (*Taxidea taxus*)
Western Spotted Skunk (*Spilogale gracilis*)
Striped Skunk (*Mephitis mephitis*)
River Otter (*Lutra canadensis*)

CATS

Mountain Lion (*Felis concolor*)
Bobcat (*Lynx rufus*)

DEER

Elk or Wapiti (*Cervus canadensis*)
Mule Deer (*Odocoileus hemionus*)
Pronghorn Antelope (*Antilocapra americana*)
Desert Bighorn or Mountain Sheep (*Ovis canadensis*)

II. Birds

Refer to: *Birds of the Grand Canyon Region: An Annotated Checklist*. This document is a Grand Canyon Natural History Association sales item available at the park.

APPENDIX E

GRAND CANYON AMPHIBIANS AND REPTILES

	Abundance
SALAMANDERS	
Utah Tiger Salamander (*Ambystoma tigrinum utahensis*)	Common
Arizona Tiger Salamander (*Ambystoma tigrinum nebulosum*)	Rare
SPADEFOOT TOADS	
Great Basin Spadefoot (*Scaphiopus intermontanus*)	Common
TRUE TOADS	
Great Plains Toad (*Bufo cognatus*)	Hypothetical*
Red-spotted Toad (*Bufo punctatus*)	Common
Rocky Mountain Toad (*Bufo woodhousei woodhousei*)	Common
TREE FROGS	
Canyon Tree Frog (*Hyla arenicolor*)	Common
TRUE FROGS	
Bullfrog (*Rana catesbeiana*)	Hypothetical*
Leopard Frog (*Rana pipiens pipiens*)	Rare
TURTLES	
Desert Tortoise (*Gopherus agassizi*)	Rare
Western Box Turtle (*Terrapene ornata*)	Rare
GECKOS	
Banded Gecko (*Coleonyx variegatus*)	Uncommon
IGUANIDS	
Zebra-Tailed Lizard (*Callisaurus draconoides*)	Rare
Collarded Lizard (*Crotaphytus collaris*)	Common
Black Collard Lizard (*Crotaphytus bicinctores*)	Common
Leopard Lizard (*Crotaphytus wislizeni*)	Rare
Desert Iguana (*Dipsosaurus dorsalis*)	Hypothetical*
Mountain Short Horned Lizard (*Phrynosoma douglassi*)	Common
Southern Desert Horned Lizard (*Phrynossoma platyrhinos*)	Rare
Chuckwalla (*Sauromalus obesus*)	Common
Sagebrush Lizard (*Sceloporus graciosus*)	Common
Desert Spiny Lizard (*Sceloporus magister*)	Abundant
Fence Lizard (*Sceloporus magister*)	Abundant
Western Brush Lizard (*Urosaurus graciosus*)	Hypothetical*
Tree Lizard (*Urosaurus ornatus*)	Common
Side-blotched Uta (*Uta stansburiana*)	Abundant
VENOMOUS LIZARDS	
Gila Monster (*Heloderma suspectum*)	Rare
NIGHT LIZARDS	
Yucca Night Lizard (*Xantusia vigilis*)	Rare

WHIPTAILS AND THEIR ALLIES	
Northern Whiptail (Cnemidophorus tigris)	Abundant
Plateau Whiptail (Cnemidophorus velox)	Uncommon
SKINKS	
Many Lined Skink (Eumeces multivirgatus)	Common
Great Basin Skink (Eumeces skiltonianus)	Uncommon
SLENDER BLIND SNAKES	
Western Blind Snake (Leptotyphlops humilis)	Rare
COLUBRIDS	
Glossy Snake (Arizona elegans)	Hypothetical*
Night Snake (Hypsiglena torquata)	Uncommon
King Snake (Lampropeltis getulus)	Common
Utah Mountain King Snake (Lampropeltis pyromelana)	Uncommon
Red Racer Snake (Masticophis flagellum)	Uncommon
Striped Whipsnake (Masticophis taeniatus)	Common
Gopher Snake (Pituophis melanoleucus)	Common
Long Nosed Snake (Rhinoceilus lecontei)	Common
Mojave Patch-Nosed Snake (Salvadora hexalepis)	Uncommon
Utah Black Headed Snake (Tantilla utahensis)	Rare
Wandering Garter Snake (Thamnophis elegans)	Common
Sonoran Lyre Snake (Trimorphodon biscutatus)	Rare
PIT VIPERS	
Speckled Rattlesnake (Crotalus mitchelli)	Rare
Black-Tailed Rattlesnake (Crotalus molossus)	Rare
Mojave Rattlesnake (Crotalus scutulatus)	Hypothetical*
Hopi Rattlesnake (Crotalus viridis nuntius)	Uncommon
Grand Canyon Rattlesnake (Crotalus viridis abyssus)	Uncommon
Great Basin Rattlesnake (Crotalus viridis lutosus)	Uncommon

*Hypothetical: no record of species from park, but may occur by virtue of known range and habitat.

APPENDIX F
LIST OF CLASSIFIED STRUCTURES

1. Prehistoric Structures

Number	Title
GC-1	Tusayan Ruin
GC-2	
GC-60	
GC-63	
GC-212	Walhalla Glades Ruin
Ariz. B:10:2	
Ariz. B:10:16	
Ariz. B:10:19	
Ariz. B:11:2	
Ariz. B:11:9	
Ariz. B:11:10	
Ariz. B:11:14	
Ariz. B:11:16	
Ariz. B:11:19	
Ariz. B:11:20	
Ariz. B:11:22	
Ariz. B:11:36	
Ariz. B:11:38	
Ariz. B:11:61	
Ariz. B:11:62	
Ariz. B:11:78	
Ariz. B:11:79	LCS-1
Ariz. B:15:1A	
Ariz. B:15:19	
Ariz. B:15:20	
Ariz. B:15:30	
Ariz. B:15:38	
Ariz. B:15:53	
Ariz. B:15:63	
Ariz. B:16:1	Bright Angel Pueblo
Ariz. B:16:2	
Ariz. B:16:3	
Ariz. B:16:4	
Ariz. B:16:5	
Ariz. B:16:14	
Ariz. B:16:15	
Ariz. B:16:18	
Ariz. B:16:24	
Ariz. B:16:30	
Ariz. B:16:31	
Ariz. B:16:32	
Ariz. B:16:34	
Ariz. B:16:59	Point Sublime Ruin
Ariz. B:16:65	
Ariz. B:16:66	

Number	Title
Ariz. B:16:71	Transcept Trail Run
Ariz. B:16:75	
Ariz. C:5:1	
Ariz. C:13:1	Unkar Ruins
Ariz. C:13:2	
Ariz. C:13:11	
Ariz. C:13:18	
Ariz. C:13:22	
Ariz. C:13:34	
Ariz. C:13:40	
Ariz. C:13:41	
Ariz. C:13:42	
Ariz. C:13:43	
Ariz. C:13:45	
Ariz. C:13:54	
Ariz. C:13:60	

2. Historic Structures

HS-1	Superintendent's Residence
HS-2	Water Disposal Plant
HS-166	Old Post Office
HS-76	Ranger's Dorm
HS-10	Powell Memorial
HS-110	Yavapai Point Museum Observation Station
HS-103	Operations Building (Old Administrative Building)
HS-114	Tusayan Museum
HS-320	Toroweap Station
HS-321	Toroweap Garage/Barn
HS-617	Kolb Garage
HS-533	Kolb Bros. Studio
HS-11-A	Grand Lodge
HS-11-B	North Budget Wash Room
HS-11-C	South Budget Wash Room
HS-11-D	(Budget) Clean Linen Rooms
HS-11-E	(Budget) Dirty Linen Rooms
HS-11-F	Garage, Budget Cabins
HS-11-G	Deluxe Cabins Linen Room
HS-11-H	Warehouse
HS-11-I	NPS Cabin--Wash Room
HB-1-FA	Budget Cabin #1 and First Aid
HB-2-6	Budget Cabin
HB-3-7	Budget Cabin
HB-4-9	Budget Cabin
HB-8-11	Budget Cabin
HB-10-12	Budget Cabin
HB-14-19	Budget Cabin
HB-15-20	Budget Cabin
HB-16-20	Budget Cabin
HB-17-22	Budget Cabin
HB-18-23	Budget Cabin
HB-24-29	Budget Cabin
HB-25-30	Budget Cabin

Number	Title
HB-26-31	Budget Cabin
HB-27-32	Budget Cabin
HB-28-33	Budget Cabin
HB-30-31	NPS Cabin
HB-32-33	NPS Cabin
HB-34-35	NPS Cabin
HB-34-40	Budget Cabin
HB-35-41	Budget Cabin
HB-36-37	NPS Cabin
HB-36-42	Budget Cabin
HB-37-43	Budget Cabin
HB-38-39	NPS Cabin
HB-38-44	Budget Cabin
HB-39-45	Budget Cabin
HB-40-41	NPS Cabin
HB-42-43	NPS Cabin
HB-44-45	NPS Cabin
HB-46-47	NPS Cabin
HB-46-51	Budget Cabin
HB-47-52	Budget Cabin
HB-48-53	Budget Cabin
HB-49-54	Budget Cabin
HB-50-55	Budget Cabin
HB-56-61	Budget Cabin
HB-57-62	Budget Cabin
HB-58-63	Budget Cabin
HB-59-64	Budget Cabin
HB-60-65	Budget Cabin
HB-66-69	Budget Cabin
HB-67-70	Budget Cabin
HB-68-71	Budget Cabin
HB-72-76	Budget Cabin
HB-73-77	Budget Cabin
HB-74-75	Budget Cabin
HB-74A-75A	Budget Cabin
HB-78-83	Budget Cabin
HB-79-84	Budget Cabin
HB-80-85	Budget Cabin
HB-81-86	Budget Cabin
HB-82-87	Budget Cabin
HB-88-93	Budget Cabin
HB-89-94	Budget Cabin
HB-90-96	Budget Cabin
HB-91-99	Budget Cabin
HB-92-100	Budget Cabin
HB-95-101	Budget Cabin
HB-97-102	Budget Cabin
HB-98-103	Budget Cabin
HB-104-108	Budget Cabin
HB-105-109	Budget Cabin
HB-106-110	Budget Cabin
HB-107-111	Budget Cabin
HB-112-118	Budget Cabin

Number	Title
HB-113-119	Budget Cabin
HB-114-120	Budget Cabin
HB-115-121	Budget Cabin
HB-116-122	Budget Cabin
HB-117-123	Budget Cabin
HB-124-128	Budget Cabin
HB-125-129	Budget Cabin
HB-126-130	Budget Cabin
HB-127-131	Budget Cabin
HB-132-136	Budget Cabin
HB-133-137	Budget Cabin
HB-134-138	Budget Cabin
HB-135-139	Budget Cabin
HB-140-143	Budget Cabin
HB-141-144	Budget Cabin
HB-142-145	Budget Cabin
HB-146-148	Budget Cabin
HB-147-149	Budget Cabin
HB-150-151	Budget Cabin
HB-150-154	Budget Cabin
HB-153-155	Budget Cabin
HB-200-201	Budget Cabin
HB-202-203	Budget Cabin
HB-204-205	Budget Cabin
HB-206-207	Budget Cabin
HB-208-209	Budget Cabin
HB-210-211	Budget Cabin
HB-212-213	Budget Cabin
HB-214-215	Budget Cabin
HB-216-217	Budget Cabin
HB-218-219	Budget Cabin
HB-220-221	Budget Cabin
HB-222-223	Budget Cabin
HB-301-305	Deluxe Cabin
HB-304-307	Deluxe Cabin
HB-306-309	Deluxe Cabin
HB-308-310	Deluxe Cabin
HB-312-314	Deluxe Cabin
HB-315-317	Deluxe Cabin
HB-316-318	Deluxe Cabin
HB-319-320	Deluxe Cabin
HB-321-322	Deluxe Cabin
HB-323-324	Deluxe Cabin
HB-325-326	Deluxe Cabin
HB-327-328	Deluxe Cabin
HB-329-330	Deluxe Cabin
HB-331-332	Deluxe Cabin
HB-333-334	Deluxe Cabin
HB-335-336	Deluxe Cabin
HB-337-338	Deluxe Cabin

Number	Title
HB-339-340	Deluxe Cabin
HB-341-346	Deluxe Cabin
HB-343-348	Deluxe Cabin
HB-349-354	Deluxe Cabin
HB-351-356	Deluxe Cabin
HB-357-360	Deluxe Cabin
HS-18	Residence
HS-92	Ranger Residence
HS-93	Ranger Residence
HS-121	Entrance Station
HS-122	Gate Residence
HS-122-A	Garage
HS-141	Trailside Shelter
HS-142	Trailside Shelter
HS-143	Trailside Shelter
HS-179	Trailside Shelter
HS-220	Fossil Fern Exhibit Case, Exhibit Structure
HS-222	Mule Shelter and Corral
HS-12	Suspension Bridge
HS-12A	South Kaibab Trail
HS-12B	North Kaibab Trail
HS-12C	Bright Angel Trail
HS-12D	Connecting River Trail
HS-1-A	Stone Building, Grandview Mining District
HS-1-B	Grandview Trail
HS-8-A	Roaring Springs Pump House
HS-8-B	Water Tank
HS-13	Greenland Lake Salt Cabin
HS-14	Cave House
HS-215	Exhibit Building/Trail Shelter

GPO 590-636/410