DEPARTMENT OF THE INTERIOR

DRAFT

ENVIRONMENTAL STATEMENT

PROPOSED MASTER PLAN

GRAND CANYON COMPLEX

ARIZONA

Prepared by
Grand Canyon National Park
Department of the Interior
National Park Service

Approved: Lyle F. Mitchell
Regional Director, Western Region

Presented by the Flagstaff
Chamber of Commerce
1976

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SUMMARY

(X) Draft ( ) Final Environmental Statement

Department of the Interior, National Park Service,
Grand Canyon National Park, Arizona

1. Type of Action: (X) Administrative ( ) Legislative

2. Brief Description of Action: To provide a Master Plan for the use, development, interpretation, and preservation of Grand Canyon National Park, Arizona. The park will be enlarged to encompass the entity of "Grand Canyon". Grand Canyon Village will be redeveloped for concentrated, heavy day use activities. The majority of park lands will be managed as natural or wilderness areas.

3. Summary of Environmental Impact and Adverse Environmental Effects: Redevelopment and relocation of developments and support facilities will be done in their present areas with heavy alteration of the present environment. Public transportation will reduce air pollution and fuel consumption. The complex natural and cultural resources of the Grand Canyon will retain their integrity in the future and yet be used for the edification and inspiration of park visitors.

4. Alternatives Considered:

a. No action
b. Removal of South Rim accommodations and support facilities
c. Removal of accommodations and support facilities from the North Rim
d. Intensify use of park
e. Lesser land acquisition and deletions
f. By-pass road

5. Comments Have Been Requested from the Following:
(See page ii for listing)

6. Date Made Available to CEQ and to the Public:

Draft Statement: MAY - 6 1974
MAY 28 1974

Advisory Council on Historic Preservation
Department of Agriculture
  Forest Service
  Soil Conservation
Department of the Interior
  Bureau of Indian Affairs
  Bureau of Mines
  Bureau of Outdoor Recreation
  Bureau of Sport Fisheries and Wildlife
  Bureau of Land Management
  Bureau of Reclamation
  U.S. Geological Survey
Department of Transportation
  Federal Aviation Administration
Federal Power Commission
Arizona State Clearinghouse
  State Liaison Officer for Historic Preservation
Havasupai Tribal Council
Hualapai Tribal Council
Navajo Tribal Council

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1. DESCRIPTION OF THE PROPOSAL

The National Park Service proposes a Master Plan to guide the use, development, interpretation, and preservation of Grand Canyon National Park, Grand Canyon National Monument, and Marble Canyon National Monument. For the purposes of this impact statement the national park and two national monuments will hereinafter be referred to as the Grand Canyon Complex. See the map on page 2 for an overview of the region involved in this proposal.

The Master Plan for the Grand Canyon Complex is the framework of concepts upon which, and within which, the logic and details of contingent development and management plans will be developed. As these detailed and specific and contingent plans evolve, they will be accompanied by detailed and specific Environmental Assessments and Environmental Impact Statements. These plans have yet to be developed and, therefore, the specific details of many actions and impacts generated by the Master Plan for the Grand Canyon Complex cannot be ascertained for this document. However, where specific actions are proposed their impacts will be quantified.

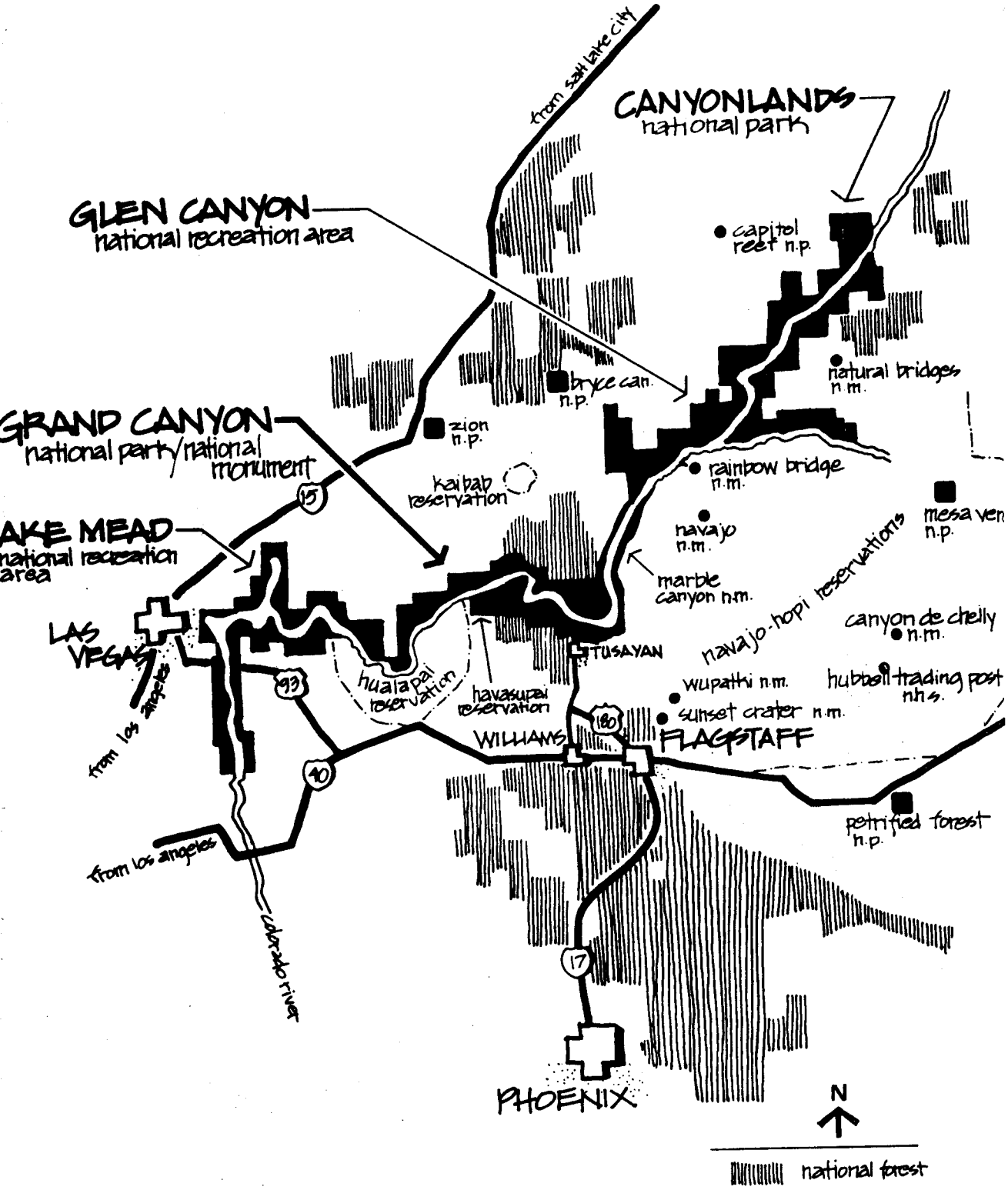
The goal of this Master Plan is to provide the concepts through which the integrity of Grand Canyon's exceptional natural spectacle can be preserved and still sensitively and realistically provide for the millions of park visitors who are drawn to it each year. The concepts of the Master Plan can be divided into three major areas of concern, which are as follows.

A. Seeking national park status for all of the Grand Canyon by combining the Grand Canyon National Park, and Grand Canyon and Marble Canyon National Monuments, and extending the park westward to river Mile 277, including lands now part of the Lake Mead National Recreation Area.

B. Managing the park to retain the primitive qualities of the canyon, and utilizing the South Rim as the optimum canyon-viewing area for the majority of park visitors.

C. Initiating environmental controls and regulations on visitor flow, access and use which are based on scientific research and are aimed at protecting the park environment and improving the human experiences within the park.

To meet its concern in these areas and to fulfill its obligation to provide for the preservation and enjoyment of Grand Canyon for this and for future generations, the National Park Service has enunciated the following objectives in its Master Plan for the Grand Canyon Complex.



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Cooperative efforts will be expanded in the following areas to provide a more effective service to the public. Regional planning will be conducted on resource management and visitor use with other Federal, State, and local agencies that have jurisdictions and responsibilties in and vicinity of the Grand Canyon Complex. Local Indian tribes will be offered planning and technical assistance for recreational use of reservation lands.

A jointly operated public information service will be provided at major access intersections. The orderly development of campgrounds and visitor-use facilities outside of the complex's boundaries will be encouraged. Visitor-use facilities and services providing for a predominantly day-use pattern will be developed within the complex, with the recognition that the National Park Service has a limited responsibility to meet a portion of the Regional demands for lodge, cabin, trailer, and campground facilities directly resulting from the attraction of the Grand Canyon and in recognition of regional ecological factors. Reclaimed water will be used to supplement and conserve the limited supply of fresh water resources within the Complex.

The boundaries of Grand Canyon National Park will be expanded to incorporate Grand Canyon National Monument and Marble Canyon National Monument, and a portion of Lake Mead National Recreation Area. The enlarged park would extend from Navajo Bridge at Glen Canyon National Recreation Area to the Grand Wash Cliffs at Lake Mead. This complex would be managed and classified under the Administrative Policies for natural areas of the National Park System. Lands not needed for the management and protection of the canyon resource and not meeting the criteria for national park status will be excluded from the complex. Legislation to effect this is currently before Congress.

The Master Plan recommends that legislation which enacts the boundary proposal also repeal the reclamation provision in the Act of February 29, 1919, which established Grand Canyon National Park. This provision now allows the Secretary of the Interior to permit utilization of areas within the park for the development and maintenance of government reclamation projects.

Services and facilities will be available for the visitor to the South Rim all year and from April to November on the North Rim. The North Rim will be open to limited winter use from November through April. The Grand Canyon Village on the South Rim will be retained as the major visitor service and park support area. The village will be planned for high density utilization. Visitor facilities will be buffered from the park employee community and support base. Police, fire, and visitor services will be provided on a 24-hour basis throughout the year in the village area. A mass transportation system will be developed in phased stages on the South Rim to alleviate the ever-increasing automobile congestion in Grand Canyon Village and to provide a more leisurely, quiet viewing experience along the West Rim Drive. After considering ecological

factors, the quality of the visitor experience, and safety of the visitor, optimum visitor-use capacities will be established for each area in the new complex. This will set the maximum limits for development and visitation.

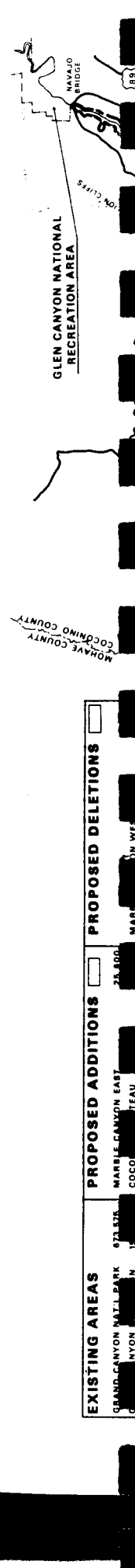
The main interpretive effort will be toward giving the visitor the opportunity, and directing him toward, an understanding and an experience of the Grand Canyon as it exists in its natural state. The canyon's dynamic story of time and change is as important to the canyon experience as is it's awesomeness and beauty. Park interpretation will be directed toward helping the visitor sense man's and his own relevant position in time, space, and his environment.

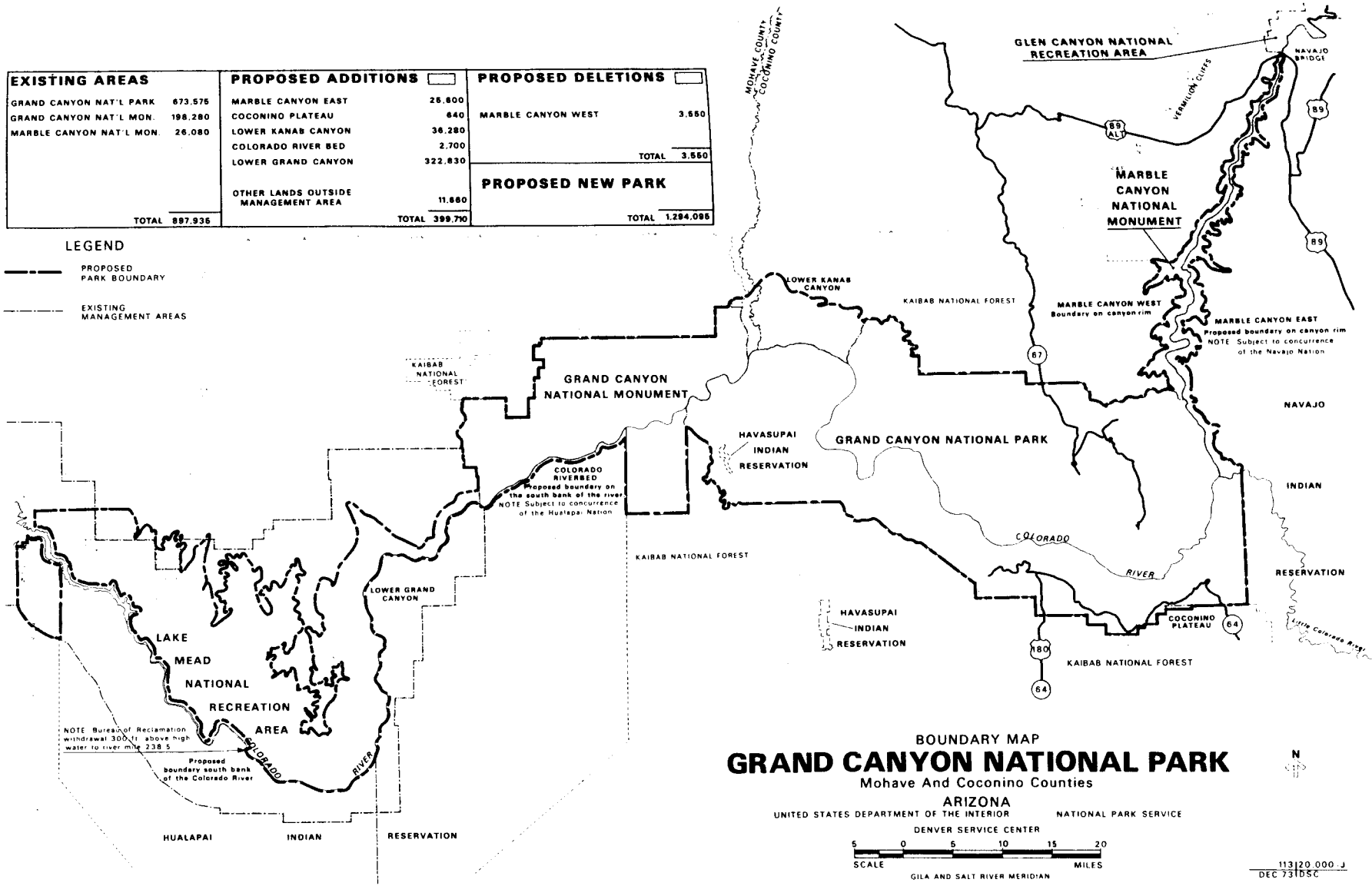
A multi-phased, park-oriented research program will furnish a broad spectrum of environmental information to support resource management, general management and development programs. Independent research and basic inquiry into the resources of Grand Canyon will be supported and encouraged by the establishment of research stations. Historic buildings now within the complex will have their significance assessed according to the historic buildings policy of the National Park Service.

The majority of the Grand Canyon Complex has the essential qualities of wilderness, and qualifies for placement under the National Wilderness Preservation System. All roadless areas have been studied within Grand Canyon National Park, as provided in the Wilderness Act of 1964. Legislative recommendations have been made and an Environmental Impact Statement prepared for those areas having wilderness value.

Development within or along the rim of the canyon which would detract from the natural character of the area and the visitor's viewing experience, will not be allowed. Primitive access roads and overlooks at Toroweap and other selected points will be retained where they now exist. Trails between the North and South Rims within the Bright Angel and Kaibab Trail corridor will be managed for intense visitor use while all other trails in the canyon will be managed to provide back-country hiking experiences for the more hardy visitors.

Hiking, horseback, bicycle, and motor trails will be provided on both rims of the canyon, but the North Rim visitor development outside the concentrated visitor use area of Bright Angel Point, will encourage a slower pace, a longer visit, and a constant involvement with the forest environment. Development on the North Rim will thus be limited to maintain the quality of this involvement and preservation of the more subtle qualities of the North Rim forest and overlooks.




EXISTING AREAS
GRAND CANYON NAT'L PARK 673,575
GRAND CANYON NAT'L MON. 198,280
MARBLE CANYON NAT'L MON. 26,080
TOTAL 897,935
PROPOSED ADDITIONS
MARBLE CANYON EAST 25,600
COCONINO PLATEAU 640
LOWER KANAB CANYON 36,280
COLORADO RIVER BED 2,700
LOWER GRAND CANYON 322,830
OTHER LANDS OUTSIDE MANAGEMENT AREA 11,660
TOTAL 399,710
PROPOSED DELETIONS
MARBLE CANYON WEST 3,550
TOTAL 3,550
PROPOSED NEW PARK
TOTAL 1,294,095
LEGEND
PROPOSED PARK BOUNDARY
EXISTING MANAGEMENT AREAS
MOHAVE COUNTY
COCONINO COUNTY
GLEN CANYON NATIONAL RECREATION AREA
NAVAJO BRIDGE
VERMILION CLIFFS
89
89 ALT
MARBLE CANYON NATIONAL MONUMENT
LOWER KANAB CANYON
KAIBAB NATIONAL FOREST
MARBLE CANYON WEST
Boundary on canyon rim
MARBLE CANYON EAST
Proposed boundary on canyon rim
NOTE Subject to concurrence of the Navajo Nation
67
KAIBAB NATIONAL FOREST
GRAND CANYON NATIONAL MONUMENT
NAVAJO
HAVASUPAI INDIAN RESERVATION
GRAND CANYON NATIONAL PARK
COLORADO RIVERBED
Proposed boundary on the south bank of the river
NOTE Subject to concurrence of the Hualapai Nation
INDIAN
KAIBAB NATIONAL FOREST
COLORADO
RIVER
RESERVATION
LOWER GRAND CANYON
HAVASUPAI INDIAN RESERVATION
COCONINO PLATEAU
64
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KAIBAB NATIONAL FOREST
LAKE MEAD NATIONAL RECREATION AREA
NOTE Bureau of Reclamation withdrawal 300 ft above high water to river mile 238.5
Proposed boundary south bank of the Colorado River
COLORADO RIVER
HUALAPAI INDIAN RESERVATION
BOUNDARY MAP
GRAND CANYON NATIONAL PARK
Mohave And Coconino Counties
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UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL PARK SERVICE
DENVER SERVICE CENTER
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The environment along the Colorado River within the Inner Canyon will be managed, insofar as it is possible, to minimize the ecological changes caused by the control of water flow from Glen Canyon Dam. Intensive management of recreational use is needed to assure protection of its wilderness values from human overuse and to provide for a quality experience for the river user. A River Management Plan and an Environmental Impact Analysis for that plan have been prepared. This plan will hold a limitation on recreational use until environmental studies can ascertain ecologically acceptable load limits.

Mechanical access into the canyon is limited to emergency and management helicopter use. Negotiations with the 16 scenic flight firms that operate in the area of the Grand Canyon Complex have reduced the visual and audible impact of these overflights upon the visitors at the most popular overlooks. Efforts will be continued to reduce the effects of these flights upon the canyon viewing experience of the backcountry hiker.

The actions and environmental impacts of the proposals contained within the Master Plan, for each area of the Grand Canyon Complex can be analyzed only superficially owing to its conceptual nature. More detailed and exhaustive analyses will be made in the environmental impact statements for the various Development Concept Plans. Detailed environmental impact statements will also be written for all projects or actions which become controversial or promise to have a significant impact upon the human environment of the complex or of the region surrounding it.

A CONSOLIDATED NATIONAL PARK

Bringing national park status to all of Grand Canyon has long been the goal of those people whose primary concern is in assuring that the canyon will always retain its integrity and remain free of adverse commercial or private development. Over the years, various sections of the canyon have been preserved by their placement within various units of the National Park System. The Master Plan proposes that the following boundary changes be made to achieve consolidation of the Grand Canyon under a single designation. (See Map, page 5)

The boundary at Marble Canyon would extend downstream along both rims from the boundary of Glen Canyon National Recreation Area near Lees Ferry. Extension of the park boundary to the East Rim of Marble Canyon will be with the concurrence of the Navajo Nation. Land back from the rims will remain under existing jurisdictions. State lands included within the proposed boundary would be acquired as soon as possible. Provisions would be made for buffer or easement zones back from the rims of Marble Canyon so that no intrusive developments would be visible from the Colorado River. The National Park Service will provide for the continued use by Indians of traditional religious sites included within the new boundary and

protection will be extended to all of these sites to protect them from park visitor desecration, or visitation. The minor deletion of 3,550 acres of land back from the west rim of Marble Canyon is too small to be delineated on the boundary map on page 5.

The Coconino Plateau Addition will provide an additional buffer to maintain a park atmosphere along the East Rim Drive. The present boundary is within one-quarter mile of the highway at this point and non-park use such as timber cutting would be unavoidably visible from the roadway. This addition of 640 acres is currently under Forest Service jurisdiction.

The Lower Kanab Creek Addition is proposed to add a significant section of the North Rim and a portion of one of the major tributary canyons to the park. This will allow for a more complete interpretation and protection of the canyon resource as all of the north bank of the Colorado River would be under a single jurisdiction and thus there would be no conflict in land use policy. This addition consists of 36,280 acres of land which are currently under Forest Service jurisdiction.

The Colorado River Bed Addition of 2,700 acres will provide National Park System status to this part of the Colorado River and will make improved management possible for river-running parties because of the continuity of regulations from Lees Ferry to Lake Mead within the Grand Canyon. Portions of the Colorado River which lie in the Hualapai Reservation will be added with the concurrence of the Hualapai Tribe.

The Lower Grand Canyon Addition involves 322,830 acres of land within Lake Mead National Recreation Area which contain outstanding scenic and geologic features including the Lower Granite Gorge of the Grand Canyon. This addition would complete Grand Canyon National Park by establishing the western boundary near river Mile 277 at Grand Wash Cliffs. National park status for lands in the recreation area lying north of the Colorado River at this point would help insure preservation of the canyon's and river's character and facilitate control of river-running boat parties under one jurisdiction. The National Park Service will offer recreational planning assistance to the Hualapai Tribe for lands on the south side of the river. National Park Service lands not deemed necessary for the protection of the canyon resource and not meeting the criteria for national park status will be deleted from the Complex and transferred to appropriate Federal land management agencies. Certain park lands in the Manakacha-Topocoba area and on Tenderfoot Plateau are under study for exclusion from the park to enlarge the reservation of the Havasupai Tribe, and in exchange for certain tribal agricultural privileges within the park.

THE CANYON

The canyon of the Colorado River is the heart of the national park and the spectacle which attracts millions of visitors to the Grand Canyon Complex each year. To protect its integrity it is proposed to manage it as wilderness and limit its access to visitors on foot, horse or muleback, and boat. The primitive quality of the canyon will be maintained to strict ecological and esthetic standards. To this end, legislative recommendations have been made to include the majority of these lands below the canyon rim within the Nation's National Wilderness Preservation System.

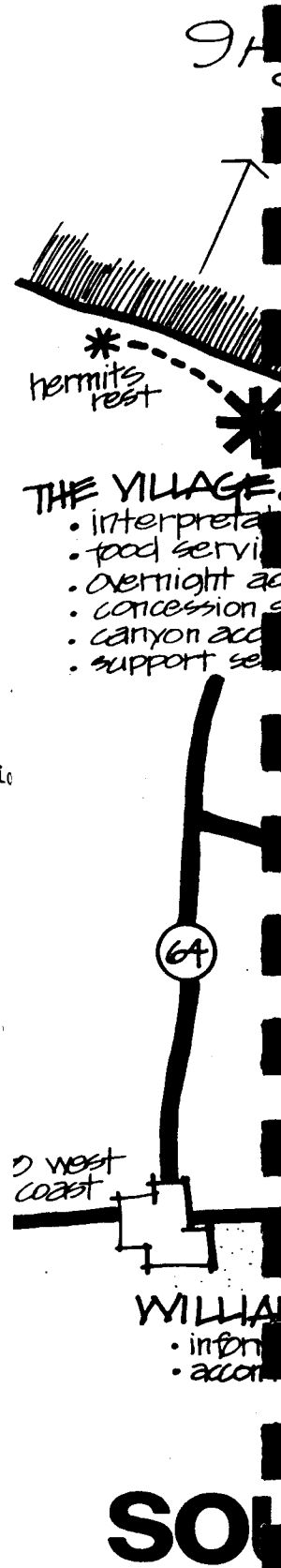
The exception to the management of the canyon as wilderness is a cross-canyon corridor between Grand Canyon Village and Bright Angel Point. This corridor is heavily used by park visitors hiking to the river from the rims or from rim to rim. It is the main access to the canyon for hikers, and has such developments in it as the transcanyon waterline, campgrounds, overnight accommodations, stables, rest houses, two bridges across the Colorado River and the main loading and unloading point for boating parties between Lees Ferry and Lake Mead. The concession muleback trips into the canyon are limited to the cross-canyon corridor. The developments and facilities within this corridor preclude its recommendation for wilderness status. It will be managed as a natural area, and Phantom Ranch and Indian Gardens will be retained as overnight campsites and accommodations for the canyon hiker. Use limitations have been placed on all campgrounds and trails within the canyon to prevent degradation from overuse. These limitations are listed under the Descripti of the Environment section of this statement, page 26.

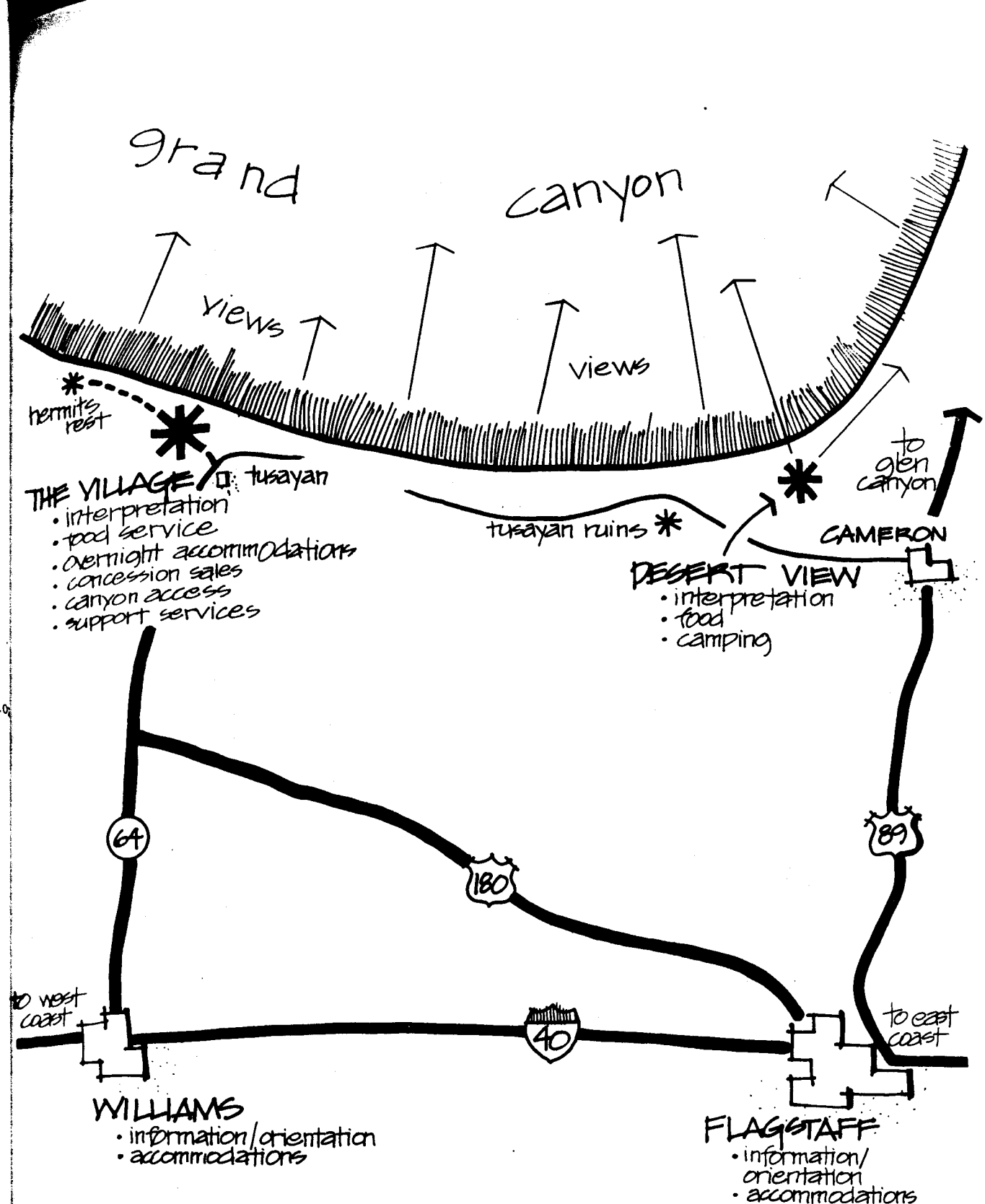
THE SOUTH RIM - DEVELOPED

It is from the rims of the canyon that most visitors have their "Grand Canyon Experience." The rim areas absorb the heavy impact of most of the park's visitors and all of the accommodations and developments designed to cater to their needs and give them access to the canyon. Approximately 90 percent of the visitors to Grand Canyon National Park view the spectacle of the canyon from the South Rim, and the focus of nearly every one of these visits has been the resort settlement known as Grand Canyon Village. (See Map, page 9)

The Village is the focal point of travel to the South Rim, but it alone cannot satisfy the needs of the visitors in viewing the canyon. Because it serves as a broad viewing platform, the National Park Service believes that the entire South Rim - Developed area should be more intensely utilized to spread the use from the heavily impacted area of Grand Canyon Village.

The majority of park visitors enter and leave the park through the South Entrance on Arizona route 64, which joins the East and West Rim Drives





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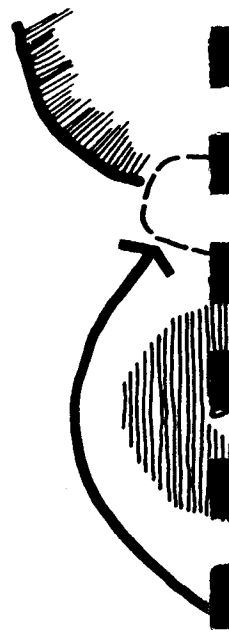
at Grand Canyon Village. The West Rim Drive dead-ends at Hermits Rest 8 miles to the west of this junction. Arizona 64 continues east for 22 miles along the East Rim Drive to Desert View before it leaves the park for its junction with U.S. 89 at Cameron.

The Master Plan proposes that this two way circulation loop of Arizona 64 through the park along the East Rim Drive be maintained as tangential to Grand Canyon Village to reduce congestion there and to provide the essential framework from which to view the canyon.

Grand Canyon Village. Grand Canyon Village is recognized as a problem of urban planning in the Master Plan. The Village is visualized as taking the maximum brunt of overnight accommodations, public use facilities, employee community, support facilities, and other developments to meet the needs of nearly the entire visitor load to Grand Canyon. The maximum allowable amount of natural habitat to be displaced by development in the Village will be determined on broad ecological evaluations and is currently estimated as approximately 100 acres.

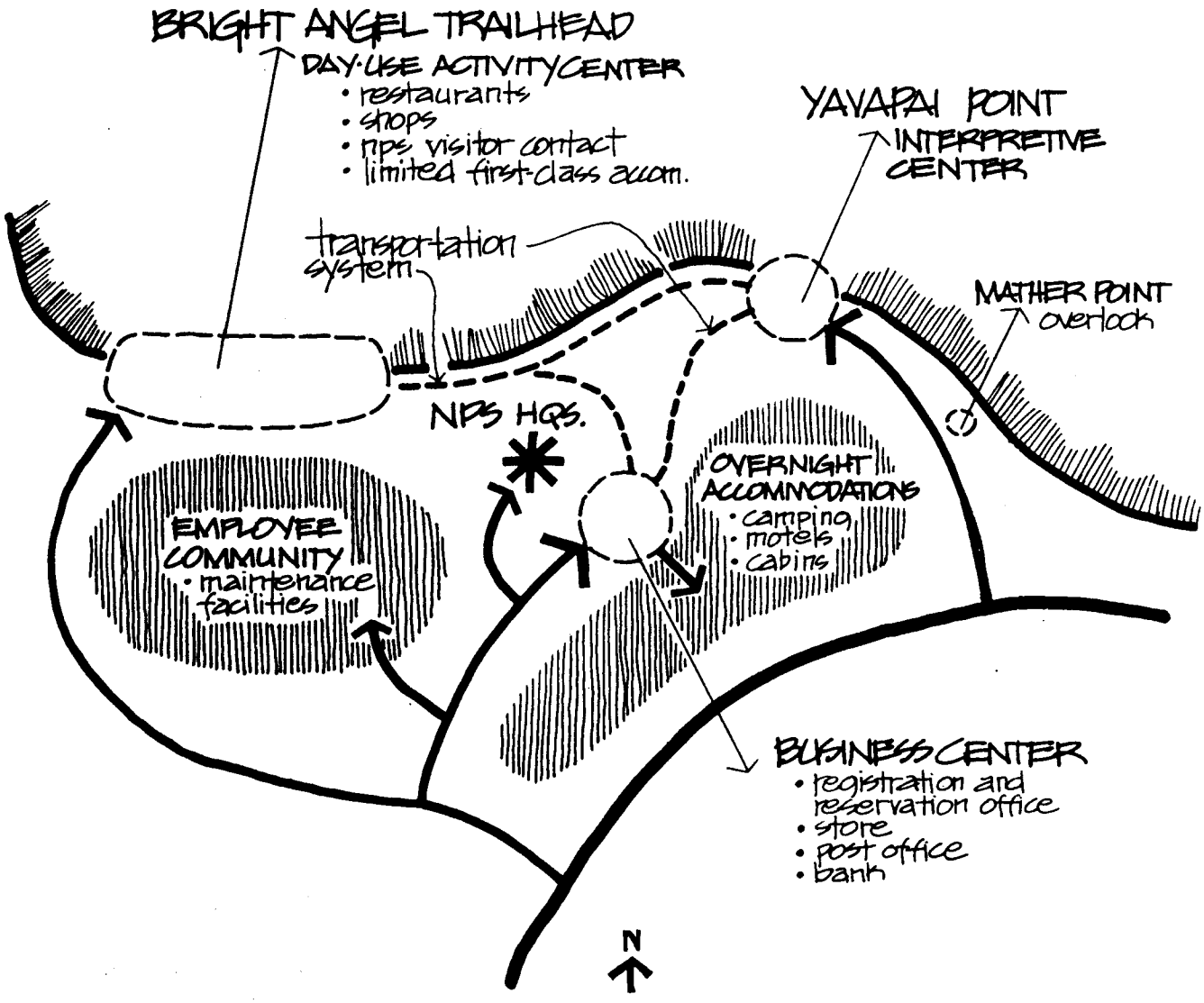


The Village will continue to serve primarily as the park's major facility. The concept of the Master Plan is that a visitor seeking an explanation for the Grand Canyon's existence should not become entangled with those visitors who are in search of a meal; nor should those simply wishing to briefly view the canyon, and then move on, be thrust into an interpretive facility. Ideally, related facilities should be organized into clearly defined, tightly knit zones which are accessible over routes serving those facilities alone, and connected by common feeders.

Essential to the interpretation of the area is an adequate interpretive center where the story of the canyon can be told and which is capable of handling a large number of visitors each day. This interpretive center will be located on the rim near the present Yavapai Museum in the eastern village area (see map, page 10a).

The details of the reorganization and redevelopment of Grand Canyon Village proposed for the next 25 years may be found in the Development Concept Plan - South Rim Village, National Park Service 1973. The impact and environmental consequences of this plan are detailed in the draft environmental impact statement accompanying it. Public meetings will be held in 1974 before the plan becomes final and before the final environmental impact statement is prepared.

Hermits Rest - West Rim Drive. Hermits Rest is a rest-stop with limited concession facilities. It is reached over the 8-mile-long West Rim Drive from Grand Canyon Village. The closeness of the West Rim Drive to the Canyon rim offers the visitor a more intimate viewing experience. A public transportation system of free, propane fueled buses is proposed for this roadway to the exclusion of automobile traffic. Hiking and bicycling along the drive would be encouraged. The modest concession facilities at Hermits Rest would continue to serve the park visitor in conjunction with the public transportation system.



grand canyon village

an approach to its restructuring

Desert View - East Rim Drive. The Desert View development is located near the eastern entrance to the South Rim. It is a small complex which consists of a campground, store, trading post, gas station. The Watchtower, entrance station, and support facilities provide services to the visitor entering and leaving the park through the Desert View Entrance. Desert View is the eastern terminus of the present concessioner bus tour. Desert View will continue as a small visitor complex and may eventually serve as the eastern terminus of the public transportation system on the South Rim. Support facilities will be increased slightly and the small campground increased by no more than 50 sites.

Three miles west of Desert View is the Tusayan Ruin and Museum. This is one example of man's prehistoric settlement along the canyon rim. The ruin has been excavated and the story is interpreted at the museum to give a human dimension to the canyon area. The present use of the area fulfills a vital aspect of canyon history and will be continued.

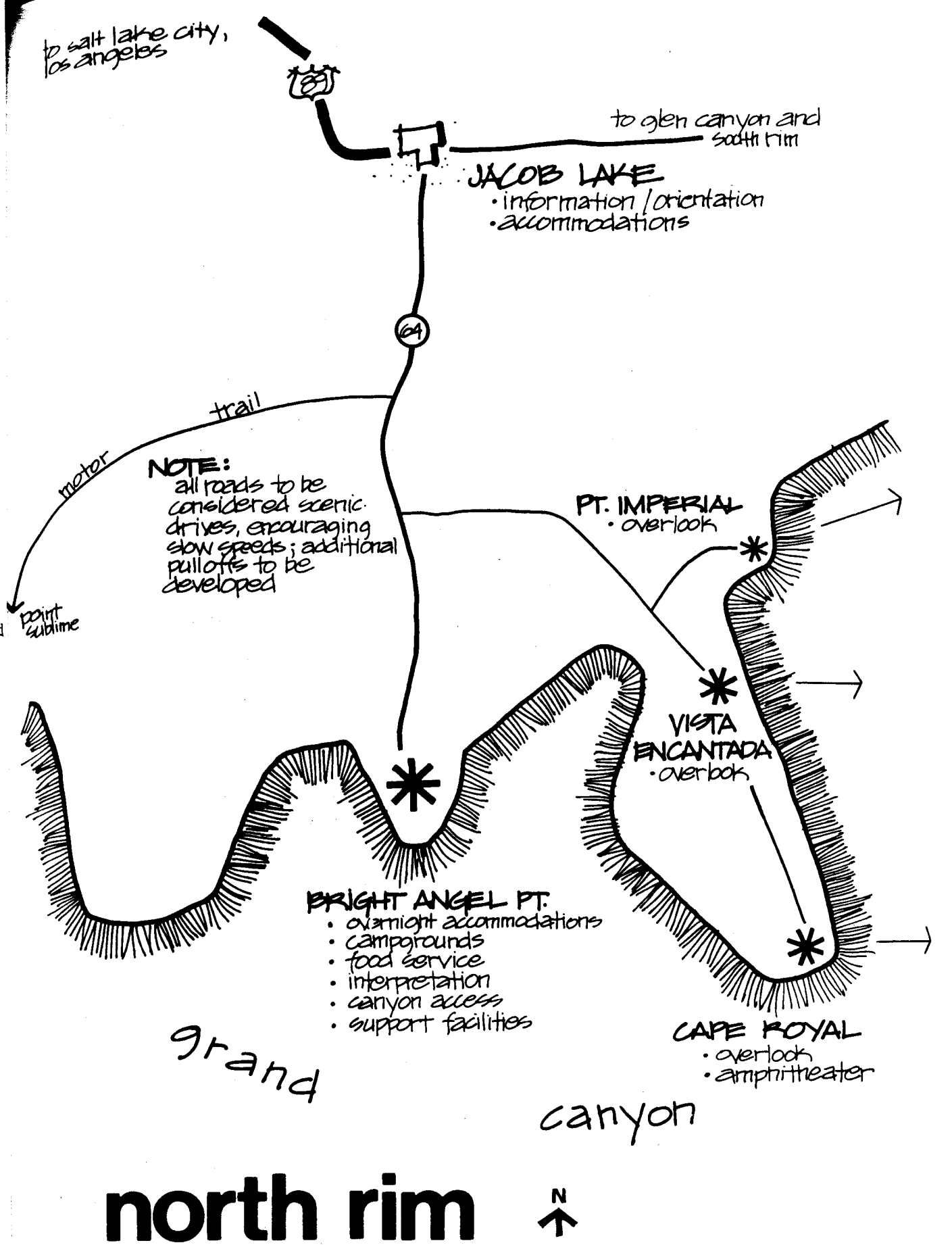
THE SOUTH RIM - UNDEVELOPED

The primitive South Rim backcountry west of Hermits Rest, extends for some 45 miles to National Canyon. The pinyon-juniper forest and desert plateau lands above the canyon rim will be managed to maintain their primitive environment. The existing road routes will be retained to provide for jeep touring trips to the many excellent backcountry viewpoints. Primitive overnight camping areas and capacities will be designated at various backcountry sites. Developments will be minimal and minor and in accordance with the Backcountry Operations Plan.

THE NORTH RIM

On the North Rim of the canyon the variety of vegetation and its distribution combine with climatic conditions to create an environment of outstanding scenic appeal. Tree-covered salients thrust from the main plateau and intermingle the feeling of the forest ecosystem with that of the canyon below. On the North Rim the developments will be traditional and subservient to the natural surroundings and will serve to constantly involve the visitor with his environment. The pattern and intensity of visitor use and the developments of the North Rim currently allow the visitor to slow down and appreciate the beauty around him and invite him to a quiet, leisurely experience of a natural environment. The Master Plan visualizes a continuance of this opportunity.

In contrast to the South Rim objective of accommodating an extremely high level of visitation, the North Rim objective will be to base use limitations primarily on esthetic judgment. The quiet, leisurely drives through the forest of the North Rim are considered a vital part of the visitors experience. Travel along these roads will, therefore, have to be limited to maintain the quiet atmosphere. See map page 13 for North Rim locations.



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Bright Angel Point. Development on the North Rim is almost entirely confined to Bright Angel Point and almost all visitors to the North Rim visit its facilities. The visitor facilities include the Grand Canyon Lodge of wood and stone, rustic wooden cabins, a cafeteria, a gas station, a small store, and a campground of 83 sites. The point also contains concessioner dormitories, Park Service housing, headquarters, and support facilities.

Future development will provide only for the improvement of the quality and functioning of these existing facilities. If any replacement of lodging units is made it will be done without any significant loss of esthetic, traditional, or environmental values. Expansion of the campground by 100 sites will bring Bright Angel Point to its optimum camping capacity.

Orientation. The existing road alignment leads all visitors directly to Bright Angel Point where the present developments infringe upon the initial view of the canyon. A proposed public information center at Jacob Lake plus improved signing at the junction of the roads leading to Bright Angel Point, Point Imperial, and Cape Royal, should permit the visitor to reach the primary goal of his choice, either viewing the canyon first or finding accommodations and visitor services. Wayside interpretive facilities will be provided at a number of the overlooks.

Backcountry. The bulk of the North Rim area is to be managed for wilderness and backcountry use. The network of fire roads on the North Rim will be phased out. The fire road to Point Sublime will remain open to visitor use as a motor trail to encourage leisurely enjoyment of the scenery and natural environment of the forest.

Toroweap. Toroweap is a unique, remote viewpoint located in Grand Canyon National Monument in the western portion of Grand Canyon. Its development and access will be handled in such a way as to maintain the remote quality of the road trip through Toroweap Valley and the awesome view of the canyon from Toroweap Point. As grazing rights expire in the national monument most of the ranch roads will be phased out but a few will be selected to be used as low-speed, 4-wheel drive touring routes to provide for visitors seeking low-key motor experiences on their way to canyon viewing points. Refer to Resources Map, page 17 for location.

THE COLORADO RIVER

The rapid growth in river-running through Grand Canyon during the last few years has brought to the Inner Canyon the first indications that uncontrolled use will lead to an end of the desired experience on the river. Sanitation problems are appearing. The controlled flow of the Colorado River through the canyon by Glen Canyon Dam has severely altered the natural river ecosystems.

The effect of controlled river flow and human impact on the river environment is not completely known. A continuing ecological research program is underway to determine what these impacts are and the severity of their impact. A River Management Plan has been implemented to control the number and scheduling of river trips as well as the total number of recreation users. An environmental analysis of this plan has been made. A negative declaration of significant impact was prepared on January 12, 1973. Public notice of these actions was made through press releases. As conclusions of the environmental research are made the present controls will be modified to reflect their findings, to help maintain or restore the river environment to as natural conditions as possible.

CARRYING CAPACITY

A park's carrying capacity is produced by the combined effect of many determinents and is limited by the most restrictive of the factors permitting its use. Geological make-up, geographical location and climatic history determine the basic parameters for Grand Canyon National Park. Local environmental conditions determine plant and animal types, successional stages and, in large part, the susceptibility of those ecosystems to damage. The resistance to impact does not remain constant but normally varies with weather, season and human maintenance. Social, economic and aesthetic factors can determine the carrying capacity for an area by influencing visitors' opportunities, desires, satisfactions and behavior.

The carrying capacity for an area in any national park is that number of persons for which the area can provide quality recreation without deteriorating. Carrying capacities can be set for developed areas as well as for natural areas. Visitation is in excess of carrying capacity when it results in damage and degradation to the elements of the natural environment; when it results in degradation of a facility, as reflected in inefficiency, unreasonable maintenance or visitor stress owing to overcrowding, service delays or unsafe conditions; and when it results in a degradation of the desired visitor experience.

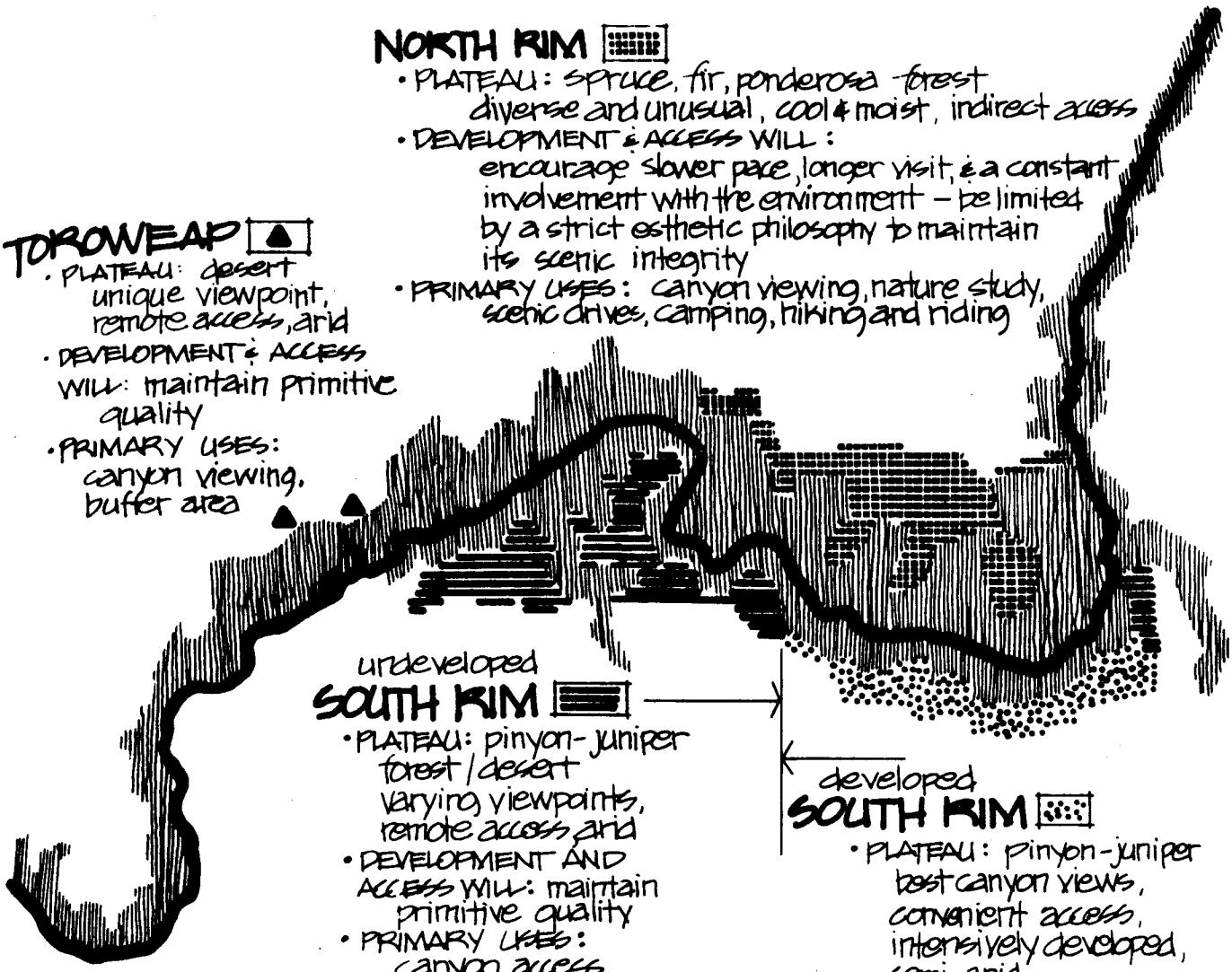
In Congressional mandates, administrative policies, management principles and the enabling legislation for the National Park Service and for Grand Canyon National Park, the responsibilities of management and the standards for meeting its objectives are clearly defined and dictate what uses of the park are appropriate. The maximum allowable level of use is thus a function of the difficulty it presents to the maintenance of those defined standards. The Master Plan for the Grand Canyon Complex prescribes the appropriate development for the park, and in this sense, pre-determines the capacity and the efficiency of the appropriate developments within the park.

It is a popular concept that a carrying capacity formula can be developed for each specific area and that limits can be quantified in terms of numbers of visitors per hour or per day. It has been a common practice in the past to determine the carrying capacity for an area by observation of that intensity of use at which deterioration of the resource becomes evident. This, or a slightly lower intensity of use, is then set as the carrying capacity. The number is thus an entirely subjective, "seat of the pants" decision by an experienced park manager.

There are obviously a great many variables which influence impact and determine capacity for an area. As varied and complicated as these determinents may be, they conceivably are all measurable, even the aesthetic judgements of visitors via surveys and questionaires. New standards are rapidly accumulating for water and air quality and for optimum conditions for plants and animals. Noise standards are being set for various kinds of activities. Obtaining data through research and monitoring of the environment within the Grand Canyon Complex is an objective of the park's Master Plan. As this information is collected and analyzed it will be used to establish objective guidelines which will indicate to a park manager when the capacity of his area has been reached and when further visitation will result in unacceptable deterioration. Such information is currently being utilized to develop a mathmatical modeling program for river running on the Colorado River within the complex.

ECOSYSTEM MANAGEMENT

The preservation of the Grand Canyon natural environment is a fundamental requirement for its continued existence as a relatively unimpaired natural area. The Master Plan, therefore, looks first to the care and management of the natural resources of the park. The Master Plan concept is for the preservation of a total environment, as compared with the protection of only a single feature or species. See page 17 for an overview of the resource, and page 18 for land classification in the Grand Canyon Complex.



NORTH RIM

- PLATEAU: spruce, fir, ponderosa forest diverse and unusual, cool & moist, indirect access
- DEVELOPMENT & ACCESS WILL: encourage slower pace, longer visit, & a constant involvement with the environment – be limited by a strict esthetic philosophy to maintain its scenic integrity
- PRIMARY USES: canyon viewing, nature study, scenic drives, camping, hiking and riding

TOROWEAP

- PLATEAU: desert unique viewpoint, remote access, arid
- DEVELOPMENT & ACCESS WILL: maintain primitive quality
- PRIMARY USES: canyon viewing, buffer area

undeveloped

SOUTH RIM

- PLATEAU: pinyon-juniper forest/desert varying viewpoints, remote access, arid
- DEVELOPMENT AND ACCESS WILL: maintain primitive quality
- PRIMARY USES: canyon access, canyon viewing, buffer area

developed

SOUTH RIM

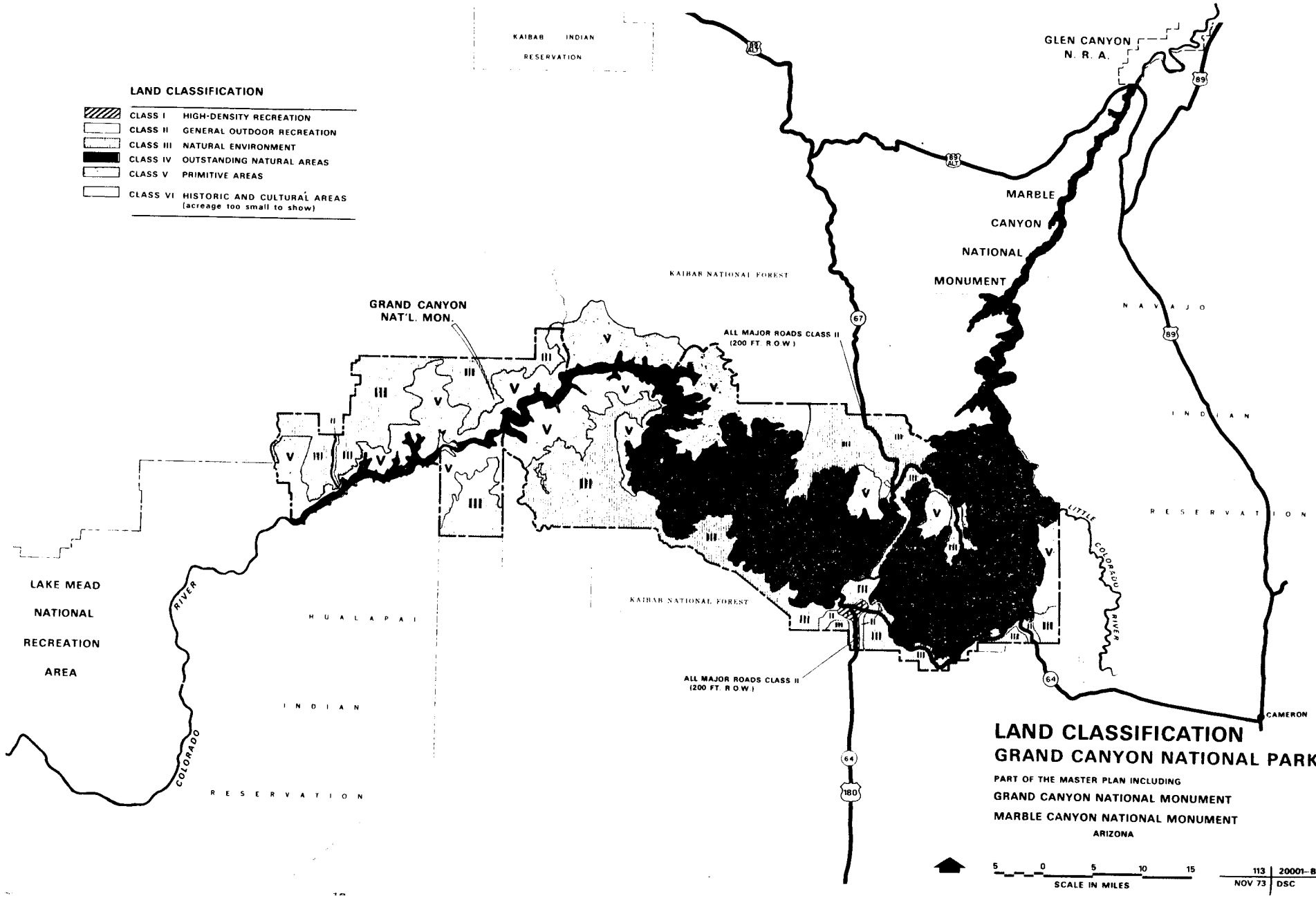
- PLATEAU: pinyon-juniper best canyon views, convenient access, intensively developed, semi-arid, uniform vegetation
- DEVELOPMENT AND ACCESS WILL: accommodate a high volume of visitation, be highly efficient, be limited by ecological and operational standards
- PRIMARY USES: canyon viewing, canyon access, visitor service

GRAND CANYON

- CANYON: desert unique, diverse, difficult access
- DEVELOPMENT & ACCESS WILL: be limited by strict ecological and esthetic standards to maintain a wilderness quality
- PRIMARY USES: hiking and riding, scientific study, boating

N

the resource and its use


LAND CLASSIFICATION
CLASS I HIGH-DENSITY RECREATION
CLASS II GENERAL OUTDOOR RECREATION
CLASS III NATURAL ENVIRONMENT
CLASS IV OUTSTANDING NATURAL AREAS
CLASS V PRIMITIVE AREAS
CLASS VI HISTORIC AND CULTURAL AREAS (acreage too small to show)
KAIBAB INDIAN RESERVATION
GLEN CANYON N. R. A.
MARBLE CANYON NATIONAL MONUMENT
KAIBAB NATIONAL FOREST
GRAND CANYON NAT'L. MON.
ALL MAJOR ROADS CLASS II (200 FT. R.O.W.)
NAVAJO INDIAN RESERVATION
LITTLE COLORADO RIVER
LAKE MEAD NATIONAL RECREATION AREA
COLORADO RIVER
HUALAPAI INDIAN RESERVATION
CAMERON
LAND CLASSIFICATION
GRAND CANYON NATIONAL PARK
PART OF THE MASTER PLAN INCLUDING
GRAND CANYON NATIONAL MONUMENT
MARBLE CANYON NATIONAL MONUMENT
ARIZONA
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A Natural Resource Management Plan is being prepared for the Grand Canyon Complex. It will delineate the broad objectives for the management of the park's natural resources. A draft environmental impact statement is being concurrently developed for this plan. Any future action which will have significant impact upon the natural resources of the park will have either an environmental impact statement prepared for it or an environmental analysis made. Environmental analysis is certainly a must for all potentially controversial control programs such as feral burro reduction or prescribed burning.

All areas within the park cannot, however, be managed as natural ecosystems. Some must be managed for intensive visitor use. Management will make the decisions as to how intensively a particular tract will be developed in providing for visitor services. Carrying capacities based on research will be set for each area. The allowable degree of departure from natural conditions will be decided upon each area's individual merits. The following discussion covers only the broader aspects of ecosystem management in the Master Plan for the Grand Canyon Complex.

Forest. The forests of Grand Canyon National Park are important and fragile features which are easily damaged but difficult to restore. Developments within the forests will be limited to those necessary for visitor use and support facilities and will utilize previously or presently used sites insofar as possible. The pinyon-juniper forest offers better sites for construction and development because it offers the best balance between the ease of alteration and ease of natural restoration of any forest type in the park. However, it should be pointed out that this is a relative consideration. No forest or other vegetative type will be easy to restore to its natural condition.

Resource management programs will be derived from a continuing research program based on total ecosystems concepts and the goal of preserving rare, endangered and unique species. Intensive management practices such as fire suppression, animal control and other forms of control will continue in high visitor use areas. These areas will be considered special management use areas and not natural ecosystems.

Existing management roads, dumps, and borrow pits not necessary for future use will be obliterated and restored as near as possible to the natural conditions of the immediate vicinity.

Brushlands. In brushland areas, the scarcity of water causes slow and sparse growth. Development will be carefully planned in brushlands since abandoned developments leave enduring scars.

Control of the feral burro population in the brushlands is necessary. Since traditional methods of control are uncertain and costly, research into biological and chemical controls will be undertaken to supplement existing methods.

Small brushland animal species are the principal food source for the now-rare peregrine falcon and golden eagle. In accordance with Park Service Policy, stringent controls will be exercised in the use of pesticides, because of their possible harmful effects upon non-target species and their biological magnification in animals.

As soon as fire behavior in Grand Canyon brushlands has been determined and suitable management practices initiated, wildfire will be allowed to run its course, insofar as the safety of visitors and preventing fires from running outside the park will permit.

Aquatic and Streamside Resources. The few permanent water sources in the Grand Canyon Complex serve as focal points for the plant and animal life and the greatest variety of plant and animal life occurs there. Due to their isolation and relative immobility, the aquatic species have developed unique characteristics particular to each individual site.

Insofar as possible, water sources will be allowed to remain in their natural condition and every effort will be made to keep these free of pollution. Where rare and endangered species are known to exist, special effort will be made to eliminate conflicting human use and pollution of the resource. Three known species of fish that are in the rare and endangered category in the Colorado and Little Colorado Rivers, and Clear Creek are the Colorado River Squawfish, Humpback Chub, and Clear Creek Gambusia. It is estimated there are less than 1,000 individuals of each species in existence.

Grasslands. Grasslands within the park are irregular and sparse, and are locally important in the ecological overview. Unfortunately, some grassland areas have been damaged by primitive roads. Special management care should be exercised for esthetic as well as ecological reasons in an effort to restore these areas to as near their natural condition as possible.

Wet grasslands--that is, meadows--on the North Rim are more fragile than dry sites, since their soils are more easily eroded and trampled. Development in wet, grassy areas usually results in a rapid reduction of soil moisture. Many of the meadows on the North Rim have been invaded by management roads for fire-control purposes; these roads will be phased out and the meadows allowed to revert to a natural state.

RESEARCH

Natural resources research is a prerequisite to all phases of planning and resource management. Four kinds of knowledge are needed: (1) the current condition of the park's natural resources; (2) the primeval condition of these resources; (3) the most feasible methods of restoring the resources and associated environmental influences to the natural ecological state required for their continuing natural evolution, and (4) what ecological successional processes are operative. Trends in resource deterioration must be identified in order to stop or minimize detrimental influences.

The major thrust of National Park Service research at Grand Canyon will be management-oriented; the greater portion of research funds allotted to the park will be directed to such studies. The scientific community, which is primarily interested in basic research, will be assisted in its basic research efforts.

Research already underway in the park covers a variety of investigations into the geology and ecology of the area. These studies include river ecology, visitor-use impact on the park plant and animal life, meadow ecology, limnological study of the Colorado River, feral burro control, various pollution studies, and many geological projects in an effort to piece together the story of the canyon.

To aid management-oriented and basic research, present research facilities in Grand Canyon Village, at Pasture Wash and on the North Rim will be expanded. A cooperative approach to research will be undertaken through arrangements with various universities and other recognized research oriented institutions.

SPECIAL ENVIRONMENTAL AREAS

Two types of environmental study areas exist within Grand Canyon, which are preserved for the primary purposes of research and education, and where natural processes are allowed to predominate: the Research Natural Area and the Environmental Study Area.

Research Natural Areas. These areas include typical or unusual biotic phenomena and characteristic or outstanding geologic, pedologic, or acquatic features and processes that preserve examples of significant natural ecosystems for comparison with those influenced by man. They provide research areas where scientists can study the ecology of the natural environment, and they serve as gene pools and preserves for rare, endangered plant and animal species. They are surrounded or buffered by park lands. Research conducted in connection with them is non-destructive and is within the scope and purpose for which the park was established.

The Federal Committee on Research Natural Areas has designated six areas in the Grand Canyon Complex as examples of significant natural ecosystems to provide educational and research areas for study and to preserve rare and endangered species.

Additional areas within the park meet the criteria for research natural areas such as portions of the Inner Canyon river environment and brushlands. Their designation as Research Natural Areas will be sought.

Environmental Study Areas. As part of the National Park Service's environmental awareness program two environmental study areas have been defined within the park on the South Rim. The Hermit Basin ESA below the rim near Hermits Rest is centered around a geological theme to show man's relationship to biological evolution, time, and space. The Grandview ESA on the rim in the Grandview area illustrates the theme of man's relationship to the biological world. The areas require special management and are not to be altered by development or management.

The resources of these study areas have been carefully catalogued and are available to school groups. The teachers are furnished the necessary data that enable their pupils to relate to man's place in his modern environment.

Additional environmental study area potential exists on the North Rim and Colorado River, which will be designated and utilized in the future as the environmental awareness program expands.

HISTORIC AND ARCHEOLOGICAL RESEARCH

Historic structures at Grand Canyon National Park are to be preserved. They will be used to increase the visitor's understanding of the resource and promote his comprehension of the development of the park. The structures, which are being evaluated include, but are not limited to, the Santa Fe Railroad Station, the Buckey O'Neill Cabin, the old Cameron Hotel (or Red Lake Stage Station), the Salt Cabin at Greenland Lake, El Tovar Hotel, Kolb Studio, and the mine structures on Horseshoe Mesa.

There are many archeological sites within the park. Due to their potential for destruction through vandalism, protective measures will be taken to insure their preservation. Some sites near public access will be excavated, stabilized and interpreted. Excavation of these sites will be done as funding is made available. Archeological site surveys will be conducted to determine the extent of this resource. Sites threatened by destruction will be excavated, in accordance with the best established archeological practices. Interpretive thrust for this resource will be on the multi-phased interaction of the site and its occupants with their surroundings and with other cultural groups.

Measures taken to comply with historical and archeological laws, regulations and policies will be covered in sections 2 and 4 of this impact statement.

REGIONAL COOPERATION

Regional cooperation among Federal and State land management agencies, Indian groups, and northern Arizona communities in the Grand Canyon region is essential to provide for the visitor during his travels within the region. This cooperation should take several directions.

Regional Information Centers. Information centers are proposed for four key points in the region--Flagstaff, Williams, Cameron, and Jacob Lake--to assist tourists and for dispensing information regarding the park, recreation areas, and Indian activities. The centers will be set up and operated jointly with other Federal agencies, Indian tribal councils, and community chambers of commerce.

The concept of public information centers in the park designed to serve the visitor prior to his reaching the South and North Rim will be developed. Their location should be centrally located in the visitor service area, since they may ultimately become part of the transportation system.

National Park Service Assistance to Indian Tribes. The National Park Service will offer planning and technical assistance to the Indian Tribes on the recreational use of Indian lands, and in joint planning efforts involving national park and Indian lands.

The Service will seek cooperative agreements and authorization to use funds for this type of regional planning and development.

Federal Agencies. The National Park Service will participate in and encourage planning efforts with all groups and agencies concerned with outdoor recreation activities in the Grand Canyon Region.

There is continuing concern for providing sufficient services for tourists in this region. Federal agencies provide the greater portion of camping space. Private campgrounds are meeting some of the demand and will be able to expand and install new facilities in the future. Indian reservations offer a great potential for this and other recreational activities. Regional cooperation will go beyond the inventorying of each agency's present capabilities and programs. Joint planning sessions will initially be conducted on common specific problems between the U.S. Forest Service, Bureau of Land Management, Bureau of Indian Affairs, and National Park Service, and then progress into joint master planning.

Aircraft control. To control a growing noise pollution problem over Grand Canyon negotiations have been instituted for restricting areas, heights, and routes that different types of aircraft can use in the vicinity of Grand Canyon. U.S. Air Force and some aircraft operators have agreed to restrict flights over heavy visitor use areas. Negotiations are being conducted with the Federal Aviation Administration for better control of air space over the canyon.

If this approach does not control the noise level in and over the canyon Congressional legislation will be sought for control of air space and aircraft activities over Grand Canyon.

RELATED PROPOSALS

The boundary revisions as suggested in the Master Plan for the Grand Canyon Complex are reflected in S1296 introduced into the Senate of the United States by Senator Goldwater of Arizona. This bill has now passed the Senate and has gone to the House of Representatives as HR5900, introduced by Representative Udall of Arizona.

Legislative action is now underway to place eligible portions of Grand Canyon into the National Wilderness System as outlined in the Wilderness Proposal for the Grand Canyon Complex and its accompanying Final Environmental Impact Statement (FES 73-68). This action is one of the major goals of the Master Plan for the Grand Canyon Complex. Unfortunately, this action is preceding the boundary legislation and wilderness areas not presently within the boundaries of the national park and two national monuments will have to be dealt with in later legislation.

A portion of the Havasupai Reservation lies within Havasu Canyon and is surrounded by park lands. Tourism is the most promising economic asset of the Havasupai Indians who reside in a picturesque setting at the bottom of the canyon. The Havasupai Tribe is currently studying land base and natural resources which may be exploited. The National Park Service will join with the Havasupai Indians in studying surrounding National Park Service lands for possible transfer to the Havasupai Tribe. No lands will be deleted from the park which are required as a resource base to protect, or interpret the park or which are of national park caliber in their environmental content. The grazing potential without extensive range rehabilitation in these lands is poor at its best.

A large-scale overnight facility of motel units and campsites has been proposed for the Apex Siding on the Santa Fe Railroad line just south of the park boundary on the South Rim of the canyon. Road access has been granted by the Forest Service to the private business proposing the development. A 55-year lease has been granted the business for the railroad lands at the siding and water rights have been obtained to the Santa Fe wells at Williams, Arizona. If this proposed development goes to completion, it will undoubtedly cause changes in subsidiary plans to the Master Plan within the next 3 to 5 years. The rail access to Grand Canyon Village from the development and a possibility of the demand for entrance to the park along Rowe Well Road to the west of the village, must certainly be taken into consideration in the Development Concept Plan for Grand Canyon Village. This development lends even greater emphasis to the proposal of the Master Plan to retain the village in its present location and to relocate and revitalize the functional relationships between related facilities and the public transportation system.

The implications of a paved road linking the little-visited Grand Canyon National Monument with a major, and heavily traveled Interstate, are far ranging. The Master Plan for the Grand Canyon Complex does not take this possible development into consideration. Should plans go forward to construct this highway the park's Master Plan would have to be altered considerably. The impacts of other proposed paved highways encircling the park and near to its boundaries have not been taken into consideration for the planning of the Grand Canyon Complex. If the legal pathways are cleared for the construction of the Hualapai Dam, these proposed roads would provide ready access to Grand Canyon National Park from the recreation area surrounding the reservoir. These roadways would cross large expanses of now uninhabitated land owned by a few large cattle companies. With power and water readily available from the Hualapai Dam, it is easy to envision the rapid development of retirement cities and recreational homesites. While not, "on the boards" yet, this scenario shows that no Master Plan for any park can be set in concrete when it rests on the unknowable vicissitudes of the future.

2. DESCRIPTION OF THE ENVIRONMENT

GENERAL

The 897,935 acres of the Grand Canyon Complex lie adjacent to the Colorado River in northern Arizona. The complex extends for 180 miles along the Colorado River, from Navajo Bridge near Lees Ferry, Arizona, to a point just beyond Lava Falls Rapids in Grand Canyon National Monument. The complex, thus, extends east-west across the southern portion of the Colorado Plateau which is a vast, semi-arid land of raised plains and basins. Dividing the complex into north and south portions is the 217-mile-long Grand Canyon which ranges from 4 to 18 miles in width and is up to 1 mile in depth. The 60-mile-long Marble Canyon forms the eastern boundary of the complex and extends the entity known as "Grand Canyon" to a total length of 277 miles. Elevation within the complex ranges from 1,700 feet at the western portion where the Colorado River enters Lake Mead, to 9,165 feet on the North Rim. Lake Mead National Recreation Area adjoins the complex along its western boundary. One portion of the Havasupai Indian Reservation lies 35 miles west of Grand Canyon Village and consists of 518 acres within the boundaries of the complex.

ARCHEOLOGY

Archeological resources in Grand Canyon constitute a primary scientific and historic value of the park. The more than 1,200 known Indian ruins within the complex indicate and represent the adaptation of man to his environment over the past 4,000 years in the Grand Canyon region. The initial occupation of the canyon began about 4,000 years ago, and is represented by Desert Culture/Pinto occupation of dry caves. These deposits contain split-twig figurines which are found only in a few other locations in the southwest. An apparent lull in human occupation followed, with primary occupation in the canyon occurring between A.D. 700 and 1200. During this time, Anasazi to the north and east, and Cohonina to the south and west, used first the plateaus and then the depths of the canyon for their agriculturally based way of life. In the historic period, Hualapai and Paiute evidenced the only use of the canyon by the surrounding Indian tribes. These various cultures all left evidence of their life styles upon the land, but only the Havasupai still remain within the boundaries of the Grand Canyon Complex.

The archeological resources within the Grand Canyon Complex can be expected to contribute significantly to our knowledge and understanding of:

1. The sequence of human occupation in the canyon area.

2. The environment faced by prehistoric man.

3. The effects of the canyon as a barrier to movement in prehistoric times, and the results of contact between the Cohonina and the Anasazi.

4. Past climates from the evidence found in cave floor deposits.

5. The changes in population and settlement patterns by Puebloan peoples in the special environment of the canyon. This can provide significant perspective and comparative data for understanding population shifts and adaptation for the Anasazi and Cohonina cultures that bordered the canyon.

6. Historic perspective for surviving southwestern Indians, particularly Hopi, Havasupai, and Paiute.

7. The adaptation of a horticultural economy to an extreme environment.

8. The effects of migration of Puebloan cultures.

9. The causes of abandonment of the canyon at the end of the 12th century.

HISTORY

All areas have a past, and thus a history. The historic resources of the Grand Canyon Complex relate primarily to the establishment and development of the Grand Canyon as a National Park. The relationship of the historic structures within the complex to historic events of significance to the State of Arizona or to the Nation appears to be insignificant. However, in compliance with Executive Order 11593, May 13, 1971, Section 2, Responsibilities of Federal Agencies, an archeological and historic survey to locate, inventory and nominate to the National Register of Historic Places has been made. Sites of archeological and historical value, within the two national monuments and the national park which appear to qualify for listing have been nominated to the Register. These include but are not limited to, the Santa Fe Railroad Station, the Buckey O'Neill Cabin, the Red Lake Stage Station, the Salt Cabin at Greenland Lake, El Tovar Hotel, the Kolb Studio, the mine structures on Horseshoe Mesa, and the Tusayan archeological site.

In compliance with Section 106 of the National Historic Preservation Act of 1966, Procedures for Compliance with Section 106, item B (2), the National Register of Historic Places as published in the Federal Register of February 28, 1973, along with supplements through November 30, 1973, have been consulted. No National Register properties are located within the Grand Canyon Complex or within any of the lands proposed for addition to the complex at the present time.

GEOLOGY

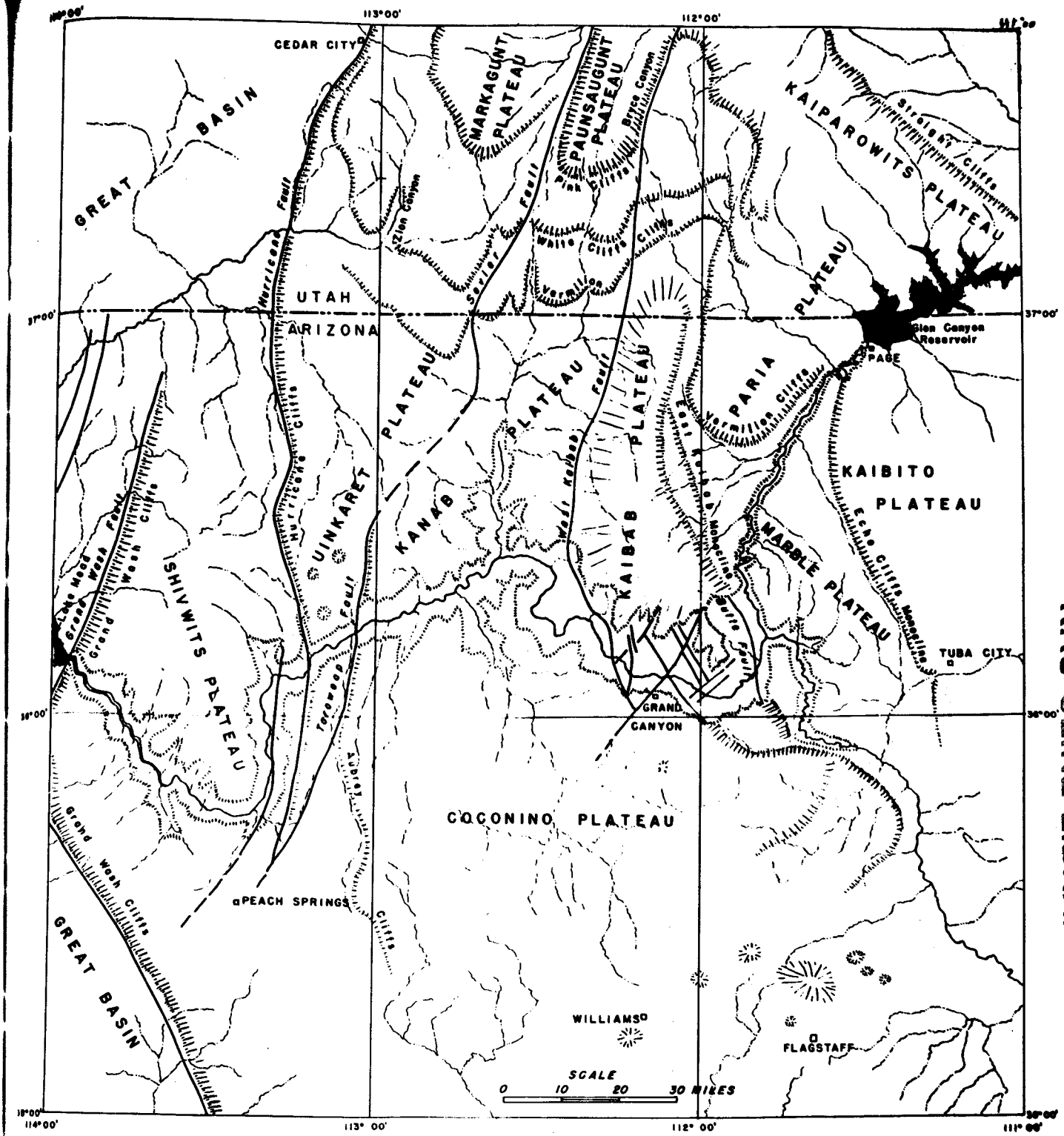
The Grand Canyon lies in the physiographic region known as the Colorado Plateau, or the Plateau Province. The Colorado Plateau includes southwestern Colorado, southeastern Utah, Northwestern New Mexico and north central and northeastern Arizona. It is characterized by a thick sequence of flat to gently dipping sedimentary rocks that erode into majestic plateaus and mesas separated by deep canyons. The Colorado Plateau is a stable region with few earthquakes and its surface rocks have undergone very little deformation in comparison to other portions of southwestern United States. See page 29 for physiographic map of the Grand Canyon Region.

The mile-deep Grand Canyon is the deepest and most extensive canyon found in the plateau country. It is a geologic timepiece studied by scientists and laymen, and it is a world renowned scenic spectacle. The exposed rock layers represent all of the eras of geologic time and contain evidence of the evolution of life through more than 600 million years of earth history. The oldest dated rocks in the Inner Canyon approach 2,000 million years in age and, thus, the observer comes metaphorically face to face with the beginnings of time. See page 30 for geologic cross section.

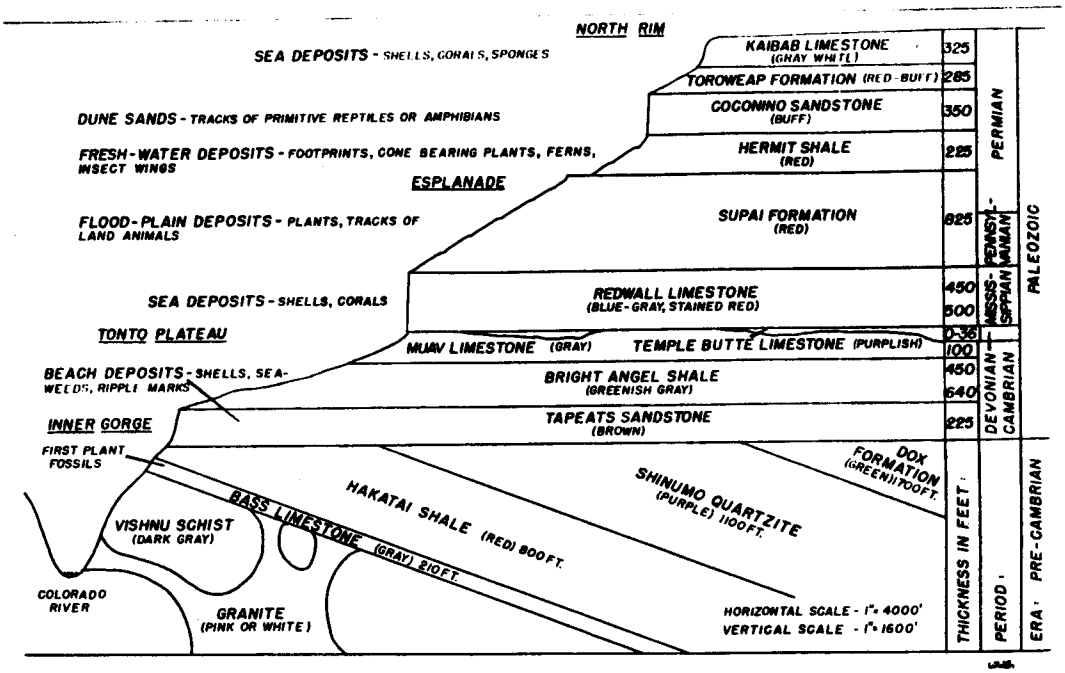
In a planimetric sense, all of the individual plateaus within the Plateau Province are elongated in a north-south direction and bounded on the east and west by sharp structural breaks and folds. These major zones occur at intervals ranging from 15 to 40 miles apart across northern Arizona. In carving the Grand Canyon, the Colorado River cut a clean east-west cross section through several of these plateaus providing a window through which the geologic history of the region may be viewed.

The Early Precambrian, Vishnu Schist is the oldest rock formation exposed within Grand Canyon. It consists of 25,000 feet of fine-grained sedimentary rock and 12,000 to 15,000 feet of lava flows; both of which have been metamorphosed into gneiss and schist. In general, the fine-grained clastic rocks of the Vishnu are believed to have accumulated in the relatively shallow waters of an epicontinental sea. The floor of this sea slowly subsided and an enormous thickness of rather monotonous sands and shales was deposited. The apparent thickness of the fine clayey sands exceeds 25,000 feet, but it is not known how much this has been increased by repetition through folding and by injection of granitic material or decreased by compression, recrystalization, and flowage. Considerable quantities of calcite found in some places are interpreted as having been calcareous concretions.

Volcanic activity increased during the later stages of Vishnu time, and basaltic lava flows poured into the ancient sea floor. The basalts were later metamorphosed into schists and layers of sand and silt between the flows were changed into quartzite and quartz mica schist.



PHYSIOGRAPHY--GRAND CANYON REGION



GENERALIZED

GEOLOGIC SECTION

AT GRAND CANYON VILLAGE

The Vishnu Schist is suspended, as it were, in the roof of a much younger batholith of granite, which invaded it in a molten condition. This granite has a radiometric age determination of 1,720 million years, so the older Vishnu may prove to be over 2,000 million years old or older. No traces of life have been found in these ancient metamorphosed rocks.

The long, long episode of sedimentation and volcanism was ended by uplift, compression, and mountain-building on a grand scale; the Mazatzal Revolution. Folding and recrystallization under pressure (metamorphism) profoundly changed the attitude and constitution of the rocks previously accumulated. The Vishnu strata and flows in the Bright Angel Canyon area were folded tightly into a huge geosyncline. Under heat and pressure, recrystallization of the less stable minerals occurred and their directions of easiest growth were oriented in a general northeast-southwest direction more or less parallel to the original bedding planes of the sediments and flow lines of the lavas.

The invasion of the Zoroaster Granite began sometime after deformation and perhaps during later phases of the regional metamorphism and mountain-building. It is a coarse-grained granite of reddish color. Not only was granitic material injected as a melt, but granitic minerals were introduced by permeating gases and schists were granitized. New minerals resulting from contact metamorphism were added to the original mineral assemblages and to their recrystallized regional metamorphic derivatives. The mountains were probably as high as the modern Himalayas or Andes.

The last episode of the Early Precambrian was a long interval of erosion which developed the Arizonan Plain or Ep-Archean erosion surface. The high mountains which had dominated the landscape were worn away by streams and other forces of erosion until a nearly level plain remained. In the Grand Canyon, this surface has a relief not exceeding 20 feet in most areas, and an observed maximum of 50 feet.

A long time elapsed after the conclusion of the Mazatzal Revolution, and before the first Late Precambrian sedimentation began. Inasmuch as there are no rocks representative of this time, it represents a gap in our knowledge of the geologic history of this area. Faulting and fracturing initiated during the Mazatzal Orogeny continued after the cooling of the Zoroaster Granite.

The Unkar Group includes all of the lower, Late Precambrian rocks found in the Grand Canyon region. The Unkar Group has a cumulative thickness of over 5,000 feet. Here and there on the Arizonan Plain up to 50 of the basal Hotauta Conglomerate was deposited. It incorporates angular and sub-angular fragments of quartzite, quartz, granite, pegmatite and schist derived from the underlying and inundated rocks of the Arizona Plain.

A sea encroached upon the desert plain from the west, removing soil and interstream ridges by wave action and marine abrasion as it advanced. The surface upon which this sea began to lay down its deposits was amazingly flat. It possessed a maximum local relief of 20 to 50 feet. In remnants found over an area that perhaps exceeds 1,000 square miles, the relief is scarcely discernable. No other surface of erosion of such an extent has been reported in the world. The Bass Limestone was the first sea deposit to be laid down upon this nearly level surface. It is dominantly composed of gray dolomites which are dark brown on weathered surfaces. Interbedded shales and sandstone in the upper part, some with ripple marks, indicate fluctuating shallow water as their condition of deposition. The formation is about 200 feet thick in the canyon below Grand Canyon Village where it forms a cliff on exposure. Probable algal deposits found in this formation indicate the existance of primitive forms of life.

The Hakatai Shale overlies the Bass Limestone and consists of some 800 feet of reddish and vermillion mudstones and shales with some sandstones. It is the most vividly colored formation of Grand Canyon. An outcrop north of Pipe Creek may easily be seen from the South Rim. Ripple marks, mud cracks, and raindrop imprints are fairly common. Cubical impressions on upper surfaces of beds may be molds of salt crystals. All these features indicate that the Hakatai was deposited under shallow water conditions with occasional emergence. The formation generally erodes to a smooth slope.

The Rama Intrusives are plugs, dikes, and sills of basalt and diabase which have been intruded into the Bass Limestone and the Hakatai Shale. A 240-foot thick sill occurs in the Hakatai Shale of Bright Angel Canyon, and is also exposed in Hindu Amphitheater. There is no known connection between the Rama Intrusives and the later volcanics of the Cardenas Formation.

The Shinumo Sandstone consists of thick-bedded to massive white, purple, red, and brown sandstone strata which grade into cemented quartzites. The formation is about 1,100 feet thick. Many outcrops are cross-bedded and some show ripple marks. They were deposited under rather uniform shallow water conditions. Where exposed, the Shinumo stands in imposing cliffs.

The Dox Formation (1,700 to 3,000 feet thick) consists largely of reddish-brown sandstones and calcareous sandstones with some green, white, and buff beds. There are some interbedded shales. Ripple marks and cross-bedding indicate shallow water deposition. Where exposed, it stands in steep cliffs and slopes.

The Cardenas Formation consists of at least 13 lava flows interbedded with eight very fine grained sandstone beds. Characteristics of the lavas and sandstone beds suggest deposition in standing water that became shallower with time and intermittently disappeared altogether. The shallow water environment was maintained by basin

subsidence or rising water level, or both, during accumulation of the lava flows and sandstones. Radiometric dates of 845 ± 15 and 1,150 ± 30 million years have been obtained from lavas in this formation and paleomagnetic pole positions indicate an age range of from 1,000 to 1,200 million years. The formation is nearly 1,000 feet thick in the eastern Grand Canyon. A 70-foot thick sill of probable Cardenas age is found in the upper part of the Shinumo Quartzite in Bright Angel Canyon.

The Nankoweap Group overlies the Unkar Group and is more properly considered a formation which consists dominantly of sandstone. It is separated from both overlying and underlying formations by unconformaties. It is found only in the eastern Grand Canyon where it reaches a maximum thickness of 330 feet.

The youngest Precambrian rocks of the Grand Canyon region are found overlying strata of the Nankoweap and Unkar Groups in the eastern part of the park, and are referred to as the Chuar Group. These formations were elevated as fault block mountains and then eroded from most of the area while the Ep-Algonkian or Grand Canyon Peneplain was being formed.

At the base of the Chuar Group is the Galeros Formation. It consists of some 40-80 feet of massive, coarsely crystalline dolomite at the base, with 580 feet of predominantly shale strata above.

The Kwagunt Formation is the middle member of the Chuar Group. It is 1,200 feet thick and consists primarily of shales and mudstones with interbedded, thin limestones and dolomites. The basal 80 feet of this formation is a red sandstone unit which is very prominant on Carbon Butte in the eastern Grand Canyon.

The Sixty Mile Formation is the upper member of the Chuar Group and is mainly composed of breccias and coarse, pebbley sandstones, with subordinate cherty siltstones. It is only 120 feet thick, but its breccias suggest tectonic uplift with erosion of the surrounding outcrops of younger formations in the Chuar Group due to slight warping.

Following the deposition of the Late Precambrian Chuar strata, the Grand Canyon area was subjected to stresses reviving earlier faults and leading to the elevation of block faulted mountains similar to those now seen in the Basin and Range section of western America. This period of mountain building is called the Grand Canyon Revolution.

The uplifted block-faulted mountains were then subjected to a long period of subaerial erosion. This erosion produced the Ep-Algonkian erosion surface which, although often referred to as the Grand Canyon Peneplain, actually consists of a series of block-faulted, quartzite ridges, some of which rise 800 to 900 feet above the general base of erosion.

Rocks of the Paleozoic Era began being deposited in Middle Cambrian time in Grand Canyon. The Grand Canyon Peneplain was slowly submerged beneath a sea encroaching from the west. Here and there, thin basal conglomerates, arkoses, and quartzite breccias were deposited as surface debris were reworked by the waves. Then thick, cross-bedded, brown sandstones were deposited. The monadnocks of the Grand Canyon Peneplain projected above the water as islands until successively covered by Tapeats and later sediments. The Tapeats Sandstone averages about 200 feet thick below Grand Canyon Village.

The Bright Angel Shale was deposited on top of the Tapeats Sandstone and grades into thin-bedded sandstones and greenish to buff micaceous shales. Most of the dolomite beds, which weather to a brownish color, occur in the upper part of the formation. During the last part of Bright Angel time the last of the Cambrian islands were buried. The Bright Angel Formation is generally 350-400 feet thick below Grand Canyon Village. Trilobites, small extinct marine crustaceans, are the characteristic fossils. Some primitive brachiopods are also found. The Bright Angel represents an intermediate stage in the west to east transgression of the Cambrian sea.

The Mauv Limestone consists largely of gray and buff limestones. The base has layers of impure, mottled limestone interbedded with greenish shale and buff sandstone lithologically similar to the Bright Angel Formation from which it is transitional. The top of the formation consists of brown shales and sandstones. It varies in thickness from 300 to 400 feet below Grand Canyon Village. Trilobites and brachiopods are the characteristic fossils. The Muav Limestone was deposited well offshore as the Cambrian sea advanced from west to east across the Grand Canyon Region.

No beds of certain Ordovician or Silurian age have been found in Grand Canyon National Park. They either were never deposited or were removed by erosion since deposition. An undulating dolomite overlies the Muav Limestone in the western Grand Canyon near the Hurricane Fault. Fossil evidence is yet lacking but this formation may prove to be Ordovician or Silurian in age.

Hollows and channels eroded in the top of the Muav Limestone are filled with a calcareous sandstone and a lavender to purplish colored dolomitic limestone. These outcrops of the Devonian Temple Butte Limestone are usually found in cliff faces. Scales from an extinct armored fish have been found in this formation as well as corals, brachiopods, and gastropods. Nearly all of the remnant outcrops of this formation are less than 100 feet thick in the eastern Grand Canyon. In the middle portion of the Grand Canyon, the Temple Butte Limestone is several hundred feet thick and everywhere separates the Mauv Limestone from the Redwall Limestone. The formation becomes progressively thicker to the west and, toward the lower end of Grand Canyon it attains a maximum thickness of more than 1,000 feet. This difference in thickness is primarily due to erosion in Late Devonian and Early Mississippian time.

The Mississippian Redwall Limestone consists of thick to massively bedded, bluish-gray limestone beds. Various horizons contain irregular white chert nodules. The formation averages 500 feet in thickness below Grand Canyon Village and forms the major part of a cliff generally 600 feet high. It is the most conspicuous cliff above the Tonto Rim. The prevailing red color is a surface feature only, an iron oxide painted over it by rainwash from the overlying Supai redbeds. Various marine invertebrates, including brachiopods, corals, and crinoids, are the characteristic fossils found in this formation.

During a period of erosion following Redwall deposition, caves, solution hollows, cavities, and fissures (karst topography) were eroded in the Redwall Limestone. Erosion probably began in Mississippian time and extended into the Pennsylvanian Period.

The Supai Formation was deposited in Late Pennsylvanian and Early Permian time. It is a thick (1,000 foot) series of alternating red cross-bedded sandstones and shales. The lower fourth of the formation, which includes calcareous sandstones and limestones, may be marine in origin and is Pennsylvanian in age. The upper part, the bulk of the formation, is probably Permian as is the overlying Hermit Shale. It is nonmarine and on bedding plane surfaces, trails of quadrupeds are found. Some of the footprints indicate that the animals making them were the size of small lizards. Some larger tracks, 2-3 inches across, were made by heavier and probably more sluggish creatures. The animals are believed to have been either amphibians or primitive reptiles.

The Permian Hermit Shale is 100-300 feet in thickness, and is a deep red color. The strata are mostly shales and siltstones with a few lenticular sandstones near the base. The red color resulting from iron oxide, mud cracks, and ripple marks, indicate shallow water conditions and intermittent exposure to air. Thirty-five species of fossil plants, mostly ferns, have been described from the Hermit. There are also quadrupedal footprints on some of the bedding planes.

The Coconino Sandstone is a massive, white to buff, cross-bedded sandstone and is 400 feet thick below Grand Canyon Village. It is a rather pure, uniformly fine-grained quartz sandstone. The grains are rounded and commonly pitted and frosted. Eolian cross-bedding on a large scale is characteristic. The formation was accumulated in a huge desert sand dune area. Trails of quadrupedal animals, small primitive reptiles or amphibians, have been found on cross-bedded surfaces.

The Toroweap Formation, deposited by the Toroweap sea, includes red and yellowish sandstones at top and bottom with intermediate gray limestones. The Toroweap sea spread over the Coconino dune area from the northwest while the sand was still fairly loose. The formation is about 290 feet thick below Grand Canyon Village.

The Toroweap sea retreated westward from the Grand Canyon Region, and then returned as the Kaibab sea, advancing across the Grand Canyon Region from west to east.

The Kaibab Limestone is composed of massive, marine limestones. They form the uppermost cliff along the rim. Some of the beds contain admixtures of sand and nodules of white chert. Bedded cherts also occur. Where erosion has not removed the uppermost beds near the rim, it measures 320 feet in thickness. The Kaibab has a rather abundant marine fauna of brachiopods, corals, cephalopods, crinoids, and sponges.

After withdrawal of the Kaibab sea, there followed a period of arid erosion. No mountain-building or even slight deformation affected the thick succession of Paleozoic strata. Broad shallow valleys were cut, but nowhere did the downcutting continue long enough to remove much of the upper part of the Kaibab Formation. Some karst erosion took place at the end of the Permian or near the beginning of the Triassic.

The presence of an erosion surface at the top of the Kaibab rimrock of the Grand Canyon indicates that the land surface was above sea level at the beginning of the Mesozoic Era. Erosion has removed most of the Triassic Moenkopi Formation and almost all of the more recent Mesozoic and Cenozoic rocks from the Grand Canyon region. Their prior existence over the canyon's strata can only be established through inference and extrapolation from outcrops in nearby areas.

The Moenkopi Formation is found both immediately east and south of the park. It consists of 500-600 feet of continental, red to chocolate brown shales, siltstones, mudstones, and sandstones. It also contains thin beds of yellowish to greenish limestones and some gypsum. The fossil fauna includes plants, reptiles, amphibians, and fish. Cedar Mountain, just east of Desert View, is an erosional remnant of Moenkopi capped by Shinarump Conglomerate. Red Butte, 15 miles south of Grand Canyon Village, is composed of Moenkopi and Chinle strata and is capped by a 150-foot thick flow of Pliocene basalt.

The basal member of the Chinle Formation is the Shinarump Conglomerate. Regional upwarping had ended the deposition of the Moenkopi Formation and caused a general withdrawal of the Triassic seas. Recurrent uplift along the Mogollon Highlands formed a generally northwestward-flowing drainage system. At first, streams cut valleys and large channels, and then later began to aggrade and deposit the conglomeritic and sandy sediments of the basal members of the Chinle Formation followed by the upper layers of siltstone, claystone, and thin sandstones. These fluviatile deposits contain large quantities of petrified wood and form the Painted Desert between Cameron and Tuba City, Arizona.

The reddish-orange, parallel-bedded siltstones of the Wingate Sandstone were apparently not deposited in the Grand Canyon area. This formation is very prominant in Navajo Country, but is absent in the Echo Cliffs east of Marble Canyon.

The Jurassic Period was ushered in by the fluvial and small lake deposits of the Moenave Formation. The basal Dinosaur Canyon member is a moderate reddish-orange sandstone which conformably overlies the Chinle Formation. The upper Springdale Sandstone member is a pale-reddish-brown, fine to medium grained, cross-bedded sandstone. Primitive crocodile fossil remains indicate a tropical to sub-tropical climate in this area at that time. The original thickness in the Grand Canyon area would be probably less than 100 feet.

The Kayenta Formation east of Grand Canyon consists of approximately 500 feet of variegated sandstones and mudstones formed in marshes and in dune areas. The overlying Navajo Sandstone is a massive, cross-bedded, pale-reddish-brown to pale orange, medium-grained sandstone. It is primarily a sand dune deposit.

The Carmel Formation and the Entrada Sandstone are undifferentiated just to the east of the Grand Canyon. The strata consist of friable white cross-bedded and flat-bedded sandstone banded by a few thin beds of rust-colored siltstone. Total thickness is between 200 and 300 feet. The deposits indicate fluviatile and shallow water deposition. The strata lie unconformably on the beveled tops of the Navajo Sandstone dunes.

The Cow Springs Formation is a massive, greenish-gray to yellowish-gray, fine-grained, cross-bedded sandstone. Its thickness to the east of Grand Canyon is approximately 350 feet. It is an eolian deposit and may be mistaken for the Navajo Sandstone which it closely resembles.

Epirogenic uplift to the south and southwest of the canyon area marked the end of the Jurassic Period and the beginning of the Cretaceous. Widespread erosion leveled the Triassic and Jurassic rocks in northern Arizona and produced a gently rolling and channeled landscape. The Dakota sandstone represents the initial transgression of the Late Cretaceous sea into the Grand Canyon area from the east. It consists of a lower, fluvial sandstone, a middle carbonaceous member of lagoonal origin, and an upper shallow marine sandstone. The formation is approximately 100 feet thick east of Grand Canyon.

The Mancos Shale is mostly banded, light to medium gray shales with some yellowish-grays in the sandier parts. Its thickness to the east of Grand Canyon is 400-500 feet. The overlying Toreva Formation consists of a basal, cliff-forming sandstone member, a middle slope-forming carbonaceous member, and an upper cliff-forming sandstone member. Above this, the Wepo Formation comprises a series of intercalated siltstones, mudstones, sandstones, and coal. The siltstone and mudstone units are dark olive-gray to olive-brown. The Straight Cliffs Sandstone of the Kaiparowits Basin is correlative with the Toreva and Wepo Formations. It is a massive, fine-to-medium-grained sandstone with some coal and carbonaceous shale in the middle part.

The marine, near-shore Wahweap Sandstone outcrops in the Lake Powell - Kaiparowits Region and consists of alternating sandstone and shale in the lower part, and massive resistant sandstone and shale in the lower part, and massive resistant sandstone in the upper part. Westward, it grades into fluvial siltstones and shales.

Unconformably overlying the Wahweap is the Kaiparowits Formation, composed of thin-bedded sandstone with subordinate amounts of calcareous siltstone, limestone, and conglomerate. This formation was deposited in streams and fresh-water lakes and ponds in a tropical climate.

The Canaan Peak Formation is mostly a pebble-cobble conglomerate and conglomeratic sandstone containing a few interbedded mudstone. It lies uncomformably on the Kaiparowits Formation and ranges from 0 to 1,000 feet in thickness. The initial movement of the Kaibab Uplift probably began during the deposition of this formation. The conglomerates were derived from western sources.

Regional uplift, tilting and structural development related to the Laramide Orogeny began perhaps as early as just before the deposition of the Kaiparowits Formation and was certainly underway by the end of Kaiparowits time.

At the close of the Cretaceous, the dominant regional drainage direction was east and northeast across the large flood plain that was northeastern Arizona. A blanket of Mesozoic rocks as thick as 4,000 to 8,000 feet had been deposited over the top of the Kaibab Limestone as the land surface gradually sank. The subsidence was interrupted by short periods of erosion indicating that the land surface remained very close to sea level. This Mesozoic subsidence took place on a very large scale that involved most of the Colorado Plateau. Gentle regional warping of the Paleozoic rocks may have occurred during this period, but faulting and intense folding did not occur in the Grand Canyon region. At the beginning of the Cenozoic Era, the Kaibab Limestone which forms the present rim of Grand Canyon, was more than 4,000 feet <u>below</u> sea level--more than 2 miles below its present elevation.

The quiescence of 500 million years of Paleozoic and Mesozoic rule abruptly came to an end with the advent of the Cenozoic Era and the Laramide Revolution. The Laramide Revolution was a series of orogenies that caused world-wide structural deformation. The Colorado Plateau was not exempt from this deformation and was affected throughout most of Paleocene and early Eocene time (between 50 and 60 million years ago).

Strong, eastward-directed, compressive forces created north trending folds and monoclines such as the East Kaibab Monocline which bounds the Kaibab Plateau on the eastern side of the park. The Colorado Plateau was generally uplifted in Laramide time, perhaps as much as three-quarters of a mile above sea level. This drained the seas from the region and initiated a major erosion cycle that is continuing to this day. The uplift of the Plateau was not uniform; instead, the surface

rose in gentle swales and arches which were terminated at their margins by north-south structural zones. The anticlinal Kaibab Uplift and many other broad-scale features began during this period of uplift.

Following the Laramide Revolution the Colorado Plateau stabilized in an elevated position and its surface underwent vigorous erosion. The land surface in the Grand Canyon area was beveled and most of the Cretaceous, Jurassic and Triassic formations were stripped away. Early Cenozoic sediments accumulated in adjacent areas but, little definite record remains of Early Cenozoic sedimentation on the Grand Canyon section of the Colorado Plateau.

North of the Grand Canyon the Pine Hollow Formation is of Paleocene (?) age and is predominately red to purplish-gray mudstone, calcareous mudstone, or very fine-grained clastic limestone. It is generably conformable on, and locally intertongues with, the Canaan Peak Formation in southern Utah. However, in places, it appears to lie on an irregular, low-relief surface formed on the Canaan Peak Formation.

The Wasatch (Claron) Formation consists of a lower, pink, fine-grained limestone member about 800 feet thick, a middle white limestone member about 550 feet thick, and an upper, variegated sandstone member which is 300 to 600 feet thick. The lower part of the Wasatch Formation is probably Paleocene and early to middle Eocene fresh-water mollusks have been found in the middle member. The Wasatch unconformably overlies older formations involved in the folding of the East Kaibab Monocline to form the Kaibab Uplift. The Wasatch was not deformed by this uplift and, thus, indicates that the movement occurred prior to its deposition.

Igneous intrusive activity began in southern Utah during the Oligocene. In the Aquarius Plateau the Wasatch Formation is overlain by several hundred feet of white tuffaceous sandstone, volcanic breccia, and latite welded tuff, which is believed to be of Oligocene age as it is in turn overlain by the Tuff of Osiris, which has been radiometrically dated as early Miocene. Uplift began during the Oligocene in the Central Arizona Mountain area. The Kaibab Plateau would not have stood as a barrier to east or west-flowing streams. The eolian Chuska Sandstone in the eastern Navajo Reservation may be partially or wholly Oligocene in age.

The Ancestral Little Colorado River had excavated a large valley to the east of Grand Canyon by Miocene time. Paleozoic and Precambrian gravels were being washed north across the present trace of the Grand Canyon from the uplifted Central Arizona Mountains. The volcanic Peach Spring Tuff was emplaced in Peach Springs Canyon some 18 million years ago and effectively blocked any large river from exiting through this canyon from the Grand Canyon area. By 14 million years ago, the broad valley drained by the present Cataract Creek had been excavated and stream and shallow lake deposits were covered by basaltic lavas from the Mt. Floyd area to the south.

The second major orogeny to affect the Colorado Plateau since Precambrian time occurred in Late Miocene and Early Pliocene time. Throughout the region west of the Rocky Mountains the earth's crust was under tensional stress and normal faulting became prevalent over the Colorado Plateau. This was the Basin and Range Orogeny and it was largely responsible for the intense block faulting in the Basin and Range Province to the west and south of the Colorado Plateau. Normal faulting commenced in Late Miocene time but appears to have reached its peak of intensity in Pliocene time in the Grand Canyon region. The great Hurricane Fault of western Grand Canyon, and the faulting along the West and Central Kaibab Fault zones was initiated at this time, displacing the plateaus west of the Kaibab Plateau downward and leaving the Kaibab elevated above its surroundings.

Tensional stress downdropped central Arizona away from the Mogollon Rim and basaltic vulcanism closely followed the normal faulting. The renewed uplift of the Colorado Plateau left its surface at an average elevation of about one and one-half miles. The Pliocene Muddy Creek Formation was deposited in basins between the block faulted mountains in the Lake Mead area. These deposits lie athwart the path of the present Colorado River near Hoover Dam. A date of 10.6 million years on the overlying Fortification Basalt member and a lack of earlier Colorado River gravels indicate that the Colorado River could not have exited from the Grand Canyon area at that point before that date.

About 9.4 million years ago, a small olivene basalt flow poured out across what is now Red Butte, just south of the park. It caps approximately 1,000 feet of Triassic strata and indicates the thickness of Moenkopi and Chinle formations which still existed in this area at that time. A similar flow occurred at Cedar Ranch on the north side of the San Francisco Peaks and covered Triassic strata now lie 400 feet above the general surface of erosion. This flow has been dated at 7.35 million years which is very close to the 7.6 million year date for the Switzer Mesa flow in nearby Flagstaff, Arizona.

The Cretaceous Mancos Formation outcrops only east of the Kaibab Plateau drainage divide. Microfossils from this formation are found in Colorado River sediments below Lake Mead that are no older than 5.5 million years. This indicates that the Kaibab Uplift had not been breached before this date by the Colorado River and the Grand Canyon was thus not in existence as we know it today. However, by 3.3 million years ago the Colorado River was well established in the western Grand Canyon and had cut to within 350 feet of its present elevation.

Lake Bidahochi formed in Late Miocene to Early Pliocene time in the valley of the Little Colorado River, indicating that no great river such as the Colorado could have passed through there since that time. The middle member of the Bidahochi Formation (the Hopi Buttes volcanics) has a radiometric age of 4.1 million years. Stage 1 volcanics of the

San Francisco field began eruption about 2.5 million years ago and eruptions have continued intermittently in that area until 1064 A.D. with the eruption of Sunset Crater. Lava flows have intermittently blocked the Colorado River near Toroweap in Grand Canyon National Monument. There is evidence to indicate that one of the lakes backed up behind the highest of these flows probably extended upstream as far as Lees Ferry and maintained itself until the lava dam was breached. The oldest of these canyon blocking flows has an age of 1.2 million years and shows that at that time the Colorado River had excavated the Grand Canyon to within 50 feet of its present depth.

The Pleistocene Epoch was marked by three periods of mountain glaciation in the San Francisco Peaks south of the park. Meltwaters from these glaciers and those upstream on the Colorado River drainage in the Rocky Mountains greatly increased the volume of water passing through the canyon and undoubtedly accelerated canyon cutting. The primary volcanos in the San Francisco Peaks area were erupted during the Pleistocene. The Tappan Wash flow, just east of the park, flowed into the Little Colorado in the last 500,000 years and blocked its flow for several miles. Very little erosion has occurred on the Coconino Plateau south of the park during the Pleistocene and appears today much as it did then.

The mineral potential of the Grand Canyon Complex is not known in any detail. The first American prospectors entered Grand Canyon in 1874 and hundreds of claims were located between then and the establishment of the national park in 1919. Small deposits have been found of silver, gold, lead, uranium, vanadium, copper, guano, tungsten, molybdenum, antimony, salt, kayanite, selenium, tellurium, and asbestos. In most instances, the low tenor of the ore bodies and their small extent, coupled with the lack of water and excessive difficulty of transportation, has prevented any significant amount of mineral production from Grand Canyon. The copper mines on Horseshoe Mesa produced for a number of years before the owners discovered the greater wealth to be had in transporting tourists instead of copper ore on their pack mules.

The only mine which has produced a significant amount of ore is the Little Orphan Lode Mine on the South Rim of the Grand Canyon and 2 miles west of Grand Canyon Village. The primary ore body consists of uranium and some copper mineralization in a pipe with a very limited extent. The mine covers approximately 3.5 acres on the surface. The mine was operated by Western Gold and Uranium, Inc., (subsequently Western Equities and then Westec, Inc.) until May 1966. At that time they had completed an Atomic Energy Commission production allocation of 2.2 million pounds of uranium ore (U_3O_8). Shortly after meeting their production allocation, Westec, Inc., went through voluntary bankruptcy proceedings. The mine was sold to the Cotter Corporation in September 1967. They operated the mine from October 1967 through December 1969. The depressed state of uranium market forced closure of the mine and it has not produced since December 31, 1969. Market prices would have to at least double before any profitable value could be associated with ore reserves in the mine.

The deed to the Little Orphan Lode Mine was transferred to the National Park Service in the autumn of 1962 by Western Equities, Inc. The following reservations and conditions were made in conveying the Orphan Lode Mining Claim No. 43506 to the United States of America. All mineral rights on the claim are reserved to the grantor for a period of 25 years but shall be limited to underground mining, and surface rights are maintained for the approximately 3 acres of land required for the operation of the mine until the expiration of mineral rights. Thus by November 19, 1987 all rights and properties of the claim will become National Park Service property.

All park visitors using the West Rim Drive must pass by the mine site which is an intrusion into the canyon perspective. The mining area is unsightly and obtrusive, security fences are in poor repair, and the entire mine site is a safety hazard to curiosity seekers. Theft and acts of vandalism are not uncommon as the mine has been idle since December 1969. The value of Cotter's developments has been estimated at $140,000 and an offer has been made to them to give up their rights to the operation prior to 1987.

No oilshale or coal-bearing strata are known to exist within the Grand Canyon Complex or in areas proposed for expansion. Petroleum or natural gas has not been drilled for within the park. As the Colorado River has cut through to the basement of metamorphic rocks, it is assumed that any fluid resources that may have existed have long since followed the path of the groundwater resource and drained from the strata adjacent to the canyon. Two wells have been drilled well 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 known geothermal resources present in the Grand Canyon Complex.

SOILS

Erosion and weathering of the highly jointed Kaibab Limestone and the few remnant patches of Moenkopi siltstone along the rims of the canyon have produced thin, stony, poorly developed mountain soils. Rim soils are developed in place and are so immature that in only a few small areas can the beginnings of soil profiles be seen. Soils within the canyon resemble those on the rims in that soil profiles have not developed and most of the soil material is derived from the immediate bedrock. Alluvial deposits along the Colorado River and major tributaries combine with colluvial deposit to form the major transported soils of the Inner Canyon. Comprehensive or detailed soil mapping of the park has not been done and only excessively generalized soils classification has been done. Perhaps the best way to vie the soils within the park is just to consider them as a shallow skin of dirt covering the bedrock.

The shallow soils insure that any excavations will require extensive blastin into the underlying bedrock. The shallow soils and scattered vegetation provide for rapid infiltration of rain and snowmelt. Productivity of the so is low and wherever revegetation attempts are contemplated special soil studies will have to be done to insure success of the planting.

CLIMATE

The Grand Canyon has many climates, depending mainly on the elevation. Average annual precipitation varies from more than 25 inches along the forested North Rim (8,200 feet) to less than 9 inches on the desert of the Inner Canyon (2,400 feet). Intermediate amounts of about 16 inches per year fall on the South Rim (7,000 feet). The North Rim receives more precipitation in winter than in summer; the South Rim and the Inner Canyon receive about equal amounts during the two seasons. The spring and fall are relatively dry in all three areas. Summer precipitation usually falls from thunderstorms that form over the heated canyon walls almost every afternoon from early July until the end of August. Although these storms are capable of producing locally heavy downpours, they rarely last more than 30 minutes and usually cease completely shortly after sundown.

Winter precipitation is not as consistent as that of summer, varying greatly from year to year in both amount and frequency of occurrence. It is associated with middle latitude storms moving eastward from the Pacific Ocean and normally falls in gentle to moderate showers which may persist for several days. When these storms intensify over the California Coast, move directly into Northern Arizona from the west, and meet a cold wave sweeping down from the northwest, severe storms with heavy snow and strong winds can strike the areas. Practically all of the winter precipitation on the North and South Rims occurs as snow. An annual average accumulation of more than 150 inches on the Kaibab Plateau makes snowplowing expensive and has kept the road to the North Rim closed from November until mid-May in the past. Snowfall is a rarity in the Inner Canyon and averages less than 1 inch per year.

As can be seen from the temperature data which follows, the temperature will increase as one descends into the canyon. However, during the winter months there are short periods of temperature inversion when clouds fill the canyon and cold air drains into and is trapped within the canyon while the rims are being warmed by direct sunshine. Based on an elevation gradient of 4,800 feet and a dry adiabatic lapse rate of 5.4°F/1,000 feet, the average adiabatic temperature change between the rim and the river is approximately 26°F. The air in the canyon is considered to be conditionally stable in August and September; statically unstable in June and July; and statically stable for the rest of the year. The hourly temperatures at the rim and the river approach each other to within a few degrees in the hour just preceding sunrise.

MONTHS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
MEAN MAXIMUM TEMPERATURES (°F)												
INNER CAN.	56	62	71	82	92	101	106	103	97	84	68	57
DESERT V.	40	43	48	57	69	78	84	80	73	61	49	39
SO. RIM	41	45	51	60	70	81	84	82	76	65	52	43
NO. RIM	37	39	44	53	62	73	77	75	69	59	46	40
MEAN MONTHLY TEMPERATURES (°F)												
INNER CAN.	46	52	59	69	77	86	92	89	83	72	57	47
DESERT V.	31	34	37	44	56	64	72	68	61	50	39	30
SO. RIM	30	33	38	46	54	64	69	67	61	50	39	31
NO. RIM	26	29	33	41	48	56	62	60	54	45	35	30
MEAN MINIMUM TEMPERATURES (°F)												
INNER CAN.	36	42	48	56	63	72	78	75	69	58	46	37
DESERT V.	21	24	26	32	42	50	59	56	49	39	30	21
SO. RIM	18	21	25	32	39	47	54	53	47	36	27	20
NO. RIM	16	18	21	29	34	40	46	45	39	31	24	20
MEAN PRECIPITATION (Inches)												
INNER CAN	.68	.75	.79	.47	.33	.29	.80	1.36	.88	.70	.51	.87
DESERT V.	.85	.92	1.45	.74	.56	.36	1.25	1.45	1.01	1.70	.81	1.80
SO. RIM	1.32	1.53	1.37	.92	.65	.46	1.87	2.28	1.50	1.21	.95	1.61
NO. RIM	3.17	3.22	2.63	1.73	1.17	.86	1.93	2.85	1.99	1.38	1.48	2.83

AIR QUALITY

Natural dust particles, water vapor, chemicals given off by growing plants, and the refraction of light all combine to form a haze which is a natural part of the Grand Canyon environment. The predominant wind direction in the Grand Canyon area above the rims is from the southwest. Below the rims of the canyon there is little large-scale horizontal air movement. The deep, narrow configuration of the canyon forms a relatively closed air system of over 5,000 vertical feet. In 1880, Clarence Dutton described the natural haze within the confines of the canyon thusly, "The very air is then visible. We see it, palpably, as a tenuous fluid, and the rocks beyond it do not appear blue, as they do in other regions but reveal themselves clothed in colors of their own. The Grand Canyon is ever full of this haze. It fills it to the brim. We are really looking through miles of atmosphere under the impression that they are only so many furlongs. This apparent concentration of haze, however, greatly intensifies all the beautiful or mysterious optical defects which are dependent upon the intervention of the atmosphere."

The visibility within the canyon is constantly being monitored by a laser beam which is directed from the Yavapai Museum on the South Rim to a mirror at Phantom Ranch at river level. By measuring the amount of light scatter of the returning beam of light, a measure of air contaminants can be obtained. This experiment is being performed by Dr. R. Layton of the Physics Department at Northern Arizona University.

Surveys have been made to measure the aerosol-sized particles in the air. These are much smaller particles than wind borne dust and the measurements are independent of the amount of dust in the air. In 1970, measurements made on backcountry trails indicated that aerosol particles measured from 300 to 700 parts per million. This compares quite favorably with some of the cleanest air on Earth (over the Pacific Ocean) where aerosol counts commonly range from 100 to 200 parts per million. Measurements made on those trails which start near Grand Canyon Village (the area of highest automobile and human use) the count rose to 1,500 to 1,700 parts per million. When there are strong up-canyon winds along the Colorado River, the small particle count rises to about 2,400 parts per million. These winds would be coming from the Henderson-Las Vegas area where there are both automobiles and coal-fueled powerplants. An analysis of particulate matter in the air at Phantom Ranch made by the University of Utah indicated only a tiny amount of fly ash which would be an indicator of air pollution from powerplants. Thus, at this time the major air pollution problem at the Grand Canyon is the automobile. The aerosol analyses were performed by Dr. Eric Walther of the Colorado Plateau Environment Advisory Council.

The National Park Service operates an air quality sampling station just north of the Visitor Center in Grand Canyon Village. The 24-hour air samples, which have been taken periodically since 1970, are analyzed by the Environmental Protection Agency for particulate matter, sulphur dioxide, nitrogen oxides and heavy metals. Sulfation plates have been exposed within the park in a cooperative program with the Forest Service. Available information indicates that dustfall and sulfation rates, as well as the levels of sulphur dioxide, nitrogen oxides, lead, benzene organics, and total oxidants are all low to very low. When compared with national standards of air quality set by the EPA, the data indicate that the air of the village and of the canyon is excellent, see page 46.

Because of its almost pristine purity, the air in Grand Canyon can be degraded by introducing pollutant levels which would be considered negligible in metropolitan areas. The development and operation of the park must contribute to the perpetuation of this outstanding resource.

NOISE LEVELS

One of the many environmental stresses that man seeks to escape by visiting Grand Canyon is the clamor of our technological society. To a great degree, he can do this if he travels into the outback of the canyon's wilderness. But all of the park is not wilderness and the vast majority of park visitors do not pass beyond the developed areas or the corridor trails where the problem of noise pollution is at its highest.

Noise pollution is insidious, in that we suffer less from noises that we accept, and thus, noise levels creep upward unnoticed. If Grand Canyon Village, for instance is as noisy as the metropolis that the visitor has just left, then it is doubtful if the visitor will notice any noise pollution. Grand Canyon Village is not a quiet place, and there are periods when one cannot escape from the noise of man even by being deep within the canyon.

Summary of available air quality data for Grand Canyon Village and immediate vicinity, 1970-1972.

Pollutant	Grand Canyon EPA Mean	Annual Phoenix mean	Grand Canyon Walther's data	EPA Standard-1[1]	EPA Standard-2[2]	Arizona 24-hour standard
Total particulates (aerosol) ug/m^3	34 (n=56)	108-265	18	260[3]	150[3]	100
Dustfall ug/cm^3/day	-	11.5	10	-	-	-
Sulphur Dioxide ppb	4 (n=50)	ca.4	ca.4	30[3]	20[3]	-
Sulfation rate ug/cm^2/day	-	1.75	0.38	-	-	-
Nitrogen Dioxide ug/m^3	21 (n=58)	168	22	100[4]	100[4]	
Total oxidants ug/m^3	-	17.5	10.4	160[5]	160[5]	-
*Lead ug/m^3	0.15	3.12	-	-	-	-
Benzene organics ug/m^3	1.0	-	-	-	-	-
Benzopyrene ug/m^3	0.11	-	-	-	-	-

*1969 data. n = number of data points

1. Level of pollutant which, if exceeded, endangers "public health"
2. Level of pollutant which, if exceeded, endangers "public welfare"
3. Maximum 24-hour concentration
4. Annual arithmetic mean
5. Maximum 1-hour concentration

A preliminary sound survey was made on Labor Day in 1971 by Dr. Black of Northern Arizona University. He reported that the drone of aircraft engines could be heard almost continuously on that day of survey. The aircraft are a mixture of fixed-wing and helicopter tour planes, private planes, military aircraft, and high altitude commercial craft. Automobile noises were the most pervasive at overlooks and within Grand Canyon Village.

Black found that in general the ambient noise levels ranged from about 45-50 decibels in remote backcountry areas to around 70 decibels in late afternoon on the front steps of the El Tovar Hotel. At most sampling stations it was found that noise from automobiles, aircraft, buses, and motorcycles elevated the ambiant levels as much as 25-30 decibels while nearby human conversations would raise the levels by 5-15 decibels. While measuring sound levels in front of the superintendent's residence, Black found eight occasions during a single 15-minute period when the motor vehicle noise raised sound levels above 85 decibels. Prolonged exposure to noise levels of 80 decibels will result in hearing loss.

The sound of motor vehicles and aircraft are the most disruptive noise source in Grand Canyon Village and on Bright Angel Point, while aircraft and outboard motor noise are the most disruptive in backcountry areas and near the river.

The viewing of the Grand Canyon and the Grand Canyon "experience" should be within the context of a certain modicum of quiet contemplation. The Master Plan calls for a reduction in noise levels within the park both through regulation and through a program of education. The widespread mistique which says that a mechanical device is not efficient unless it is noisy is being countered by environmentally oriented interpretive programs within the park.

BIOTA

More than a thousand species of plants are found within the complex. Large native animals such as mule deer, bighorn sheep, mountain lion, bobcat, and coyote seek their livelihood within the Grand Canyon and surrounding plateaus. Seventy-five to eighty species of mammals, 225 varieties of birds, and 35 species of amphibians and reptiles have been recorded from the Grand Canyon Complex. Bird and mammal species and abundance are given on pages 48-51 and 53-56.

Sixteen species of fish have been recorded from the Colorado River and its tributaries within the Grand Canyon Complex. However, the available data indicate that the main channel of Marble and Grand Canyons is unfavorable fish habitat. The volume and swiftness of the river, plus the shortened period of sunlight due to the high walls, in conjunction with the cold water being discharged from Glen Canyon Dam, keep the river cold throughout most of the canyon. No major tributaries effectively ameliorate the low temperature of the waters, and spawning temperatures for the native fishes are not met. Daily changes in river level preclude the availability of warm, rich backwaters for juvenile

Grand Canyon Birds

KEY

a—abundant
c—common
u—uncommon
r—rare
[?]—hypothetical
*—specimen

	South Rim	Inner Canyon	North Rim	Grand Canyon National Monument
GREBES				
Eared Grebe *	r			
Western Grebe				r
Pied-billed Grebe *	r	r		
PELICANS AND CORMORANTS				
Double-crested Cormorant		r		
HERONS AND IBISES				
Great Blue Heron	u	u	u	u
Common Egret				r
Snowy Egret	r	u		
Black-crowned Night Heron		r		
American Bittern	?			
Wood Ibis	r			
White-faced Ibis	r	r		r
SWANS, GEESE AND DUCKS				
Canada Goose		r	r	r
Snow Goose	r	r		
Mallard *	u	u	u	
Gadwall		?	?	?
Pintail		r		r
Green-winged Teal	u	u	u	
Blue-winged Teal	r		r	
Cinnamon Teal		r	r	
Shoveler	r		r	r
Canvasback				r
Lesser Scaup *	r			r
Bufflehead *		r		
White-winged Scoter		r		
Ruddy Duck			r	
Hooded Merganser *	r	r		
Common Merganser *		r		
Red-breasted Merganser *	r			
GROUSE, QUAIL AND TURKEYS				
Blue Grouse *			c	
Gambel Quail				c
Turkey	c	r	c	
RAILS AND COOTS				
Virginia Rail *	r	r		
American Coot *	u	r	r	

	South Rim	Inner Canyon	North Rim	Grand Canyon National Monument
SHORE BIRDS				
Killdeer *	u	u		u
Common Snipe *	u		r	
Long-billed Curlew	r	r		r
Spotted Sandpiper *	u	u	u	
Solitary Sandpiper *	u	u	u	
Greater Yellowlegs	r			
Least Sandpiper *	r			r
Dowitcher, sp.	r			
American Avocet		r		r
Black-necked Stilt			r	
Wilson's Phalarope *	u		u	r
Northern Phalarope *	r	r	r	
GULLS AND TERNS				
Ring-billed Gull		r	r	
Sabine's Gull	r			
Tern, sp.	?			
DOVES AND PIGEONS				
Band-tailed Pigeon *	u	u	u	u
Mourning Dove *	c	c	c	c
Ground Dove	r			
VULTURES, HAWKS AND EAGLES				
Turkey Vulture	c	c	c	c
Goshawk *	u		r	
Sharp-shinned Hawk *	c	c	c	
Cooper's Hawk *	u	u	u	u
Red-tailed Hawk *	c	c	c	c
Swainson's Hawk	u		u	
Ferruginous Hawk	r	r	r	r
Golden Eagle *	c	u	c	c
Bald Eagle	r	r	r	r
Marsh Hawk *	u		u	u
Osprey	r			
Prairie Falcon *	u		u	
Peregrine Falcon *	r	r	r	
Pigeon Hawk *	r	r	r	
Sparrow Hawk *	c	c	c	c
CUCKOOS AND ROADRUNNERS				
Yellow-billed Cuckoo		r		
Roadrunner	u	u		u

Grand Canyon Birds

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	South Rim	Inner Canyon	North Rim	Grand Canyon National Monument
OWLS				
Screech Owl*	u			
Flammulated Owl *	r	r	r	
Great Horned Owl *	c	c	c	c
Pygmy Owl *	r			
Burrowing Owl	r	r		r
Spotted Owl *	r	r		
Long-eared Owl *	r			u
Saw-whet Owl *	r			
POOR-WILLS AND NIGHTHAWKS				
Poor-will *	c	u	u	
Common Nighthawk *	c	u	u	u
SWIFTS AND HUMMINGBIRDS				
White-throated Swift *	a	a	a	a
Black-chinned Hummingbird *	c	c		c
Broad-tailed Hummingbird *	c	c	c	
Rufous Hummingbird *	u		u	u
Calliope Hummingbird	?		?	
KINGFISHERS				
Belted Kingfisher *	u	c	u	
WOODPECKERS				
Yellow-shafted Flicker *	r			
Red-shafted Flicker *	a	r	a	
Pileated Woodpecker			r	
Acorn Woodpecker *	u			
Lewis' Woodpecker *	c			u
Yellow-bellied Sapsucker *	u	u		
Williamson's Sapsucker *	u		a	
Hairy Woodpecker *	c	r	c	
Downy Woodpecker*	u	u	u	
Ladder-backed Woodpecker*		u		
Northern Three-toed Woodpecker	*		u	
SILKY FLYCATCHERS				
Phainopepla	r	u		u
SHRIKES AND STARLINGS				
Loggerhead Shrike*	u		u	c
Starling		r		u
VIREOS				
Bell's Vireo		r		r
Gray Vireo	u			
Solitary Vireo *	u	u		
Red-eyed Vireo*		r		
Warbling Vireo*	u		c	

	South Rim	Inner Canyon	North Rim	Grand Canyon National Monument
THRUSHES, BLUEBIRDS AND SOLITAIRES				
Robin *	a	u	a	a
Hermit Thrush*	u	r	a	
Western Bluebird*	a	u	u	a
Mountain Bluebird*	c	r	c	c
Townsend's Solitaire*	c	u	c	
GNATCATCHERS AND KINGLETS				
Blue-gray Gnatcatcher*	c	a	u	c
Golden-crowned Kinglet*	r	r	u	r
Ruby-crowned Kinglet*	c	c	c	
PIPITS AND WAXWINGS				
Water Pipit*	r			
Bohemian Waxwing	r			
Cedar Waxwing*	u	r		
FLYCATCHERS				
Eastern Kingbird		r		
Western Kingbird *	c	u	u	c
Cassin's Kingbird *	u	u	u	
Ash-throated Flycatcher*	c	c	u	c
Black Phoebe*		c	r	r
Say's Phoebe*	c	a	r	c
Traill's Flycatcher*	r	r		
Hammond's Flycatcher*	r		r	
Dusky Flycatcher*		r		
Gray Flycatcher*	c	r		
Western Wood Pewee*	c		a	
Olive-sided Flycatcher*	u	u	c	
Vermilion Flycatcher		r		
LARKS				
Horned Lark*	u	u	u	c
SWALLOWS				
Violet-green Swallow*	a	a	a	
Tree Swallow		r	r	
Bank Swallow		?		
Rough-winged Swallow	u	r	r	
Barn Swallow	r	r		
(Cliff Swallow	?			
Purple Martin*	u			r
JAYS, MAGPIES AND RAVENS				
Steller's Jay*	a	u	a	
Scrub Jay*	c	c	u	
Black-billed Magpie			r	
Common Raven*	a	a	a	a
Common Crow*	r			
Pinon Jay*	c	c	c	c
Clark's Nutcracker*	u	r	c	

Grand Canyon Birds

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	South Rim	Inner Canyon	North Rim	Grand Canyon National Monument
WARBLERS				
Orange-crowned Warbler*	u		r	
Nashville Warbler*	u	r	r	
Virginia's Warbler*	u	r	u	
Lucy's Warbler		c		
Yellow Warbler*	c	c	r	u
Audubon's Warbler*	a	u	a	c
Black-throated Gray Warbler*	c	r	u	
Townsend's Warbler	r		r	
Black-throated Green Warbler*				r
Hermit Warbler*	r		r	
Grace's Warbler	u	?	u	
Northern Waterthrush*	r	r		
MacGillivray's Warbler	u	u	u	
Yellowthroat*		u	r	r
Yellow-breasted Chat*		c		
Wilson's Warbler*	u	u	u	
Painted Redstart		r		
WEAVER FINCHES				
House Sparrow	c	r		u
MEADOWLARKS, BLACKBIRDS AND ORIOLES				
Eastern Meadowlark	?			
Meadowlark, sp.	u	r	r	c
Yellow-headed Blackbird	u	r	u	u
Red-winged Blackbird*	r	c	r	c
Scott's Oriole				c
Bullock's Oriole*	u	r		r
Brewer's Blackbird*	u	u	u	c
Brown-headed Cowbird*	c		u	c
CHICKADEES AND TITMICE				
Black-capped Chickadee	?		?	
Mountain Chickadee*	a	r	a	
Plain Titmouse*	c	r	r	
Verdin		?		
Common Bushtit*	c	r	c	
NUTHATCHES AND CREEPERS				
White-breasted Nuthatch*	a	u	a	u
Red-breasted Nuthatch*	c	r	c	
Pygmy Nuthatch*	a	r	a	
Brown Creeper*	c		c	
THRASHERS				
Mockingbird	u	u	u	c
Sage Thrasher*	r	r		r

	South Rim	Inner Canyon	North Rim	Grand Canyon National Monument
GROSBEAKS, FINCHES AND SPARROWS				
Rose-breasted Grosbeak*	r	r		
Black-headed Grosbeak*	c	u	c	
Blue Grosbeak*		r		
Indigo Bunting		r		
Lazuli Bunting*	u	c	u	u
Dickcissel*		r		
Evening Grosbeak*	c		c	
Purple Finch*	u			
Cassin's Finch*	a	u	c	
House Finch*	u	u	u	c
Pine Grosbeak*	u		u	u
Black Rosy Finch*	r			
Pine Siskin*	c	r	c	
American Goldfinch		r		
Lesser Goldfinch*	u	r	u	u
Red Crossbill*	c		u	
Green-tailed Towhee*	c	c	c	
Rufous-sided Towhee*	c	c	c	
Brown Towhee	r		r	
Lark Bunting	r			
Savannah Sparrow*	r	r		
Grasshopper Sparrow*	?			
Vesper Sparrow*	u	u	u	u
Lark Sparrow*	c	c	c	c
Rufous-crowned Sparrow*		u		
Black-throated Sparrow*	u	a	r	a
Sage Sparrow*	r	r		
Slated-colored Junco*	u	r		
Oregon Junco*	c	c	u	c
Gray-headed Junco*	a	c	a	
Tree Sparrow		r		
Chipping Sparrow*	a	r	a	
Brewer's Sparrow*	u	r	u	r
White-crowned Sparrow*	c	c	r	c
Fox Sparrow	r	r		
Lincoln's Sparrow*	u	u	u	
Song Sparrow*	c	c	c	
WRENS				
House Wren*	u	r	u	
Winter Wren	r			
Bewick's Wren*	r	r		r
Long-billed Marsh Wren*		r		
Cañon Wren*		a		a
Rock Wren*	c	c	c	c
TANAGERS				
Western Tanager*	c	u	c	u
Hepatic Tanager	r			
DIPPERS				
Dipper*		c		

fish and reduces the number of aquatic life forms that would normally make up a food base for the fish. To an aquatic biologist, the river through the Grand Canyon Complex is a very sterile environment. The rare humpback chub and the Colorado River squawfish are not reproducing successfully and will dissappear from the river within the complex as the present adult population dies. It is very likely that only those native species, such as speckled dace, bluehead, and flannelmouth sucker, which are adapted to tributary streams will survive.

The variety of physical habitats within the Grand Canyon Complex, interacting with the plants and animals that have come to live in them, have produced definite and characteristic assemblages of plants and animals called biotic communities. Each of these communities, with its distinctive floral and faunal makeup, gives diversity and life to the landscape and illustrates variations in lifeforms in response to differing physical environments. These communities are best defined and delimited by their plant species as many of the animals can occupy more than one plant association. The biotic communities are thus not exclusive and many of the plants and animals that characterize a community merely reach their greatest abundance there.

Many physical factors are involved in delimiting such biotic communities: temperature, precipitation, slope exposure, rock and soil types, elevation, and humidity are just a few. Although all of the plant communities except for the spruce-fir and mountain grassland are duplicated north and south of the Colorado River, there is much isolation caused by the river and the Inner Canyon.

The Riparian Community along the Colorado River and its major tributaries is characterized by such plants as cottonwood, willow, desert willow and the exotic tamarix. Some of the mammals which can be expected within the Riparian community and in the desert scrub community of the Inner Canyon are the spotted skunk, ringtail, rock pocket mouse, long-tailed pocket mouse, raccoon, beaver, Yuma myotis and perhaps even the rare river otter. Rising from the Riparian community along the river is the desert scrub community of the Inner Gorge. Its plants are characteristically catclaw, mesquite, saltbrush, krameria and a few tenacious clumps of various cacti and grasses.

Above the Inner Gorge in the eastern and central portions of Grand Canyon National Park there is a bench or platform called the Tonto Plateau. This area contains the flatest continuum within this section of the canyon, extends along both sides of the river above the Inner Gorge and is a mile wide in some places. The Tonto Plateau is predominantly below an elevation of 4,500 feet and is cut by numerous canyons leading to the Inner Gorge. The predominant plant of this community is blackbrush. Other common plants are desert thorn, burrobrush, wolfberry bursage, agave, and narrowleaf yucca. Some mammals commonly found within the desert scrub community of the Tonto Plateau

GRAND CANYON MAMMALS

SHREWS

Merriam's Shrew *(Sorex merriami)*
Arid areas of sagebrush or bunchgrass above 7,000 ft.; both rims;

Dwarf Shrew *(Sorex nanus)*
Meadow, Coniferous Forest; North Rim above 8,000 ft.; rare.

Desert or Gray Shrew *(Notiosorex crawfordi)*
Shrub Desert, Evergreen Woodland; South Rim, in Canyon;

BATS

California Myotis *(Myotis californicus)*
Chiefly a crevice dweller; common in Park and Monument; nocturnal.

Long-eared Myotis *(Myotis evotis)*
Thin forests, buildings, occasionally caves; South Rim; nocturnal; uncommon.

Small-footed Myotis *(Myotis subulatus)*
Caves, crevices near forested areas; South Rim; nocturnal; uncommon.

Long-legged Myotis *(Myotis volans)*
Buildings, crevices; South Rim; nocturnal; uncommon.

Silver-haired Bat *(Lasionycteris noctivagans)*
Solitary, tree-dwelling bat; South Rim; nocturnal; uncommon.

Western Pipistrelle *(Pipistrellus hesperus)*
Caves, crevices, buildings near watercourses; common in Canyon; nocturnal.

Big Brown Bat *(Eptesicus fuscus)*
Caves, crevices, buildings near wooded areas; common on both rims; nocturnal.

Red Bat *(Lasiurus borealis)*
Solitary tree-bat; uncommon in Canyon; nocturnal.

Hoary Bat *(Lasiurus cinereus)*
Solitary tree bat; uncommon in Canyon; nocturnal.

Lump-nosed Bat *(Plecotus townsendii)*
Caves, buildings; common on South Rim and in Canyon; nocturnal.

Pallid Bat *(Antrozous pallidus)*
Caves, crevices, buildings, trees; common in Park and Monument; nocturnal.

BEARS

Black Bear *(Euarctos americanus)*
Coniferous Forest, Evergreen Woodland; uncommon on South Rim, rare on North Rim.

RACCOON and RINGTAIL

Raccoon *(Procyon lotor)*
Riparian; in Park and Monument except North Rim; nocturnal.

Ringtail *(Bassariscus astutus)*
Shrub Desert, near water, rocky areas; uncommon in Park and Monument; nocturnal.

GRAND CANYON MAMMALS

COYOTES and FOXES

Coyote *(Canis latrans)*
Abundant in Park and Monument; nocturnal-diurnal.

Gray Fox *(Urocyon cinereoargenteus)*
Shrub Desert, open forest; common on both rims and in Monument; . in Canyon; nocturnal-diurnal.

CATS

Mountain Lion *(Felis concolor)*
Rugged mountains and forests; uncommon in Park and Monument, nocturnal-diurnal.

Bobcat *(Lynx rufus)*
Shrub Desert, rimrock; common in Park and Monument; nocturnal.

SQUIRRELS, GROUND SQUIRRELS, CHIPMUNKS, PRAIRIE DOGS

Whitetail or Gunnison's Prairie Dog *(Cynomys gunnisoni)*
Shrub Desert, Grassland, Evergreen Woodland; rare on South Rim; diurnal.

Golden-mantled Ground Squirrel *(Citellus lateralis)*
Coniferous Forest; common on North Rim; diurnal.

White-tailed Antelope Squirrel *(Citellus leucurus)*
Shrub Desert; uncommon in Canyon, common in Monument; diurnal.

Rock Squirrel *(Citellus variegatus)*
Rocky areas; common in Park and Monument; diurnal.

Cliff Chipmunk *(Eutamias dorsalis)*
Evergreen Woodland· common on both rims and in Canyon; Monument diurnal.

Least Chipmunk *(Eutamias minimus)*
Evergreen Woodland, Coniferous Forest; common on North Rim; diurnal.

Uinta Chipmunk *(Eutamias umbrinus)*
Coniferous Forest, rocky areas; common on North Rim; diurnal.

Abert Squirrel *(Sciurus aberti)*
Coniferous Forest (Ponderosa Pine); common on South Rim; diurnal.

Kaibab Squirrel *(Sciurus kaibabensis)*
Coniferous Forest (Ponderosa Pine); common on North Rim; diurnal. Considered a separate species from Abert Squirrel by Hall and Kelson.

Red or Spruce Squirrel *(Tamiasciurus hudsonicus)*
Coniferous Forest; common on North Rim; diurnal.

PORCUPINES

Porcupine *(Erethizon dorsatum)*
Evergreen Woodland, Coniferous Forest; common on both rims; diurnal.

GRAND CANYON MAMMALS

WEASEL, BADGER, OTTER, SKUNKS

Long-tailed Weasel *(Mustela frenata)*
All land habitats near water; uncommon on South Rim, common on North Rim; nocturnal-diurnal.

River Otter *(Lutra canadensis)*
Riparian; uncommon in Canyon; diurnal.

Badger *(Taxidea taxus)*
Open grassland, desert; uncommon in Park, common in Monument; nocturnal-diurnal.

Spotted Skunk *(Spilogale putorius)*
Brushy or wooded habitat; common on South Rim, Monument and in Canyon; North Rim nocturnal.

Striped Skunk *(Mephitis mephitis)*
Semi-open country near water; common on South Rim, in Canyon nocturnal.

POCKET GOPHERS

Valley Pocket Gopher *(Thomomys bottae)*
Meadows, valleys, rocky areas; common on both rims; nocturnal-diurnal.

Northern Pocket Gopher *(Thomomys talpoides)*
Meadow, Coniferous Forest; common on North Rim; nocturnal-diurnal.

HARES and RABBITS

Blacktailed Jack Rabbit *(Lepus californicus)*
Shrub Desert, Evergreen Woodland, Grassland; uncommon on both rims.

Desert Cottontail *(Sylvilagus audubonii)*
Shrub Desert, Evergreen Woodland; common on South Rim.

Mountain or Nuttall's Cottontail *(Sylvilagus nuttallii)*
Coniferous Forest, Evergreen Woodland, Shrub Desert; common on both rims and Monument.

DEER, ANTELOPE, ELK BIGHORN SHEEP and BURRO

Elk or Wapiti *(Cervus canadensis)*
Meadow, Coniferous Forest; rare on South Rim; nocturnal-diurnal.

Mule Deer *(Odocoileus hemionus)*
Shrub Desert, Coniferous Forest, Evergreen Woodland; abundant in Park and Monument; nocturnal-diurnal.

Prong-horned Antelope *(Antilocapra americana)*
Open prairies, sagebrush; uncommon South Rim and Monument.

Desert Bighorn Sheep *(Ovis canadensis)*
Rugged, rocky terrain; uncommon in Canyon; diurnal.

Burro *(Equus asinus)*
Shrub Desert, Evergreen Woodland; common in Canyon; not a native.

BEAVER

Beaver *(Castor canadensis)*
Riparian: uncommon in Canyon; nocturnal.

GRAND CANYON MAMMALS

POCKET MICE and KANGAROO RATS

Rock Pocket Mouse *(Perognathus intermedius)*
Rocky areas, sparse vegetation; common in Canyon; nocturnal.

Great Basin Pocket Mouse *(Perognathus parvus)*
Shrub Desert. Evergreen Woodland, Coniferous Forest; Monument nocturnal.

Merriam's Kangaroo Rat *(Dipodomys merriami)*
Shrub Desert, rocky areas; Monument , nocturnal.

Ord's Kangaroo Rat *(Dipodomys ordii)*
Sandy soil; uncommon on South Rim, Monument nocturnal.

MICE, RATS and VOLES

Western Harvest Mouse *(Reithrodontomys megalotis)*
South Rim and in Canyon nocturnal.

Brush Mouse *(Peromyscus boylii)*
Rocky and arid areas; common in Park; nocturnal.

Canyon Mouse *(Peromyscus crinitus)*
Rocky areas; in Canyon and on North Rim ; nocturnal.

Cactus Mouse *(Peromyscus eremicus)*
Shrub Desert, rocky areas; abundant in Canyon; nocturnal.

Deer Mouse *(Peromyscus maniculatus)*
Arid areas; abundant on both rims; nocturnal.

Pinyon Mouse *(Peromyscus truei)*
Rocky areas, Evergreen Woodland; uncommon on both rims; nocturnal.

Northern Grasshopper Mouse
(Onychomys leucogaster)
South Rim nocturnal.

White-throated Wood Rat *(Neotoma albigula)*
Rocky areas, brushland; common on South Rim and in Canyon; nocturnal.

Bushy-tailed Wood Rat *(Neotoma cinerea)*
Mountains, rocky areas, Coniferous Forest; common on North Rim and in Canyon; nocturnal.

Desert Wood Rat *(Neotoma lepida)*
Shrub Desert; common in Canyon and Monument; nocturnal.

Mexican Wood Rat *(Neotoma mexicana)*
Rocky areas; common on South Rim and in Canyon; nocturnal.

Stephen's Wood Rat *(Neotoma stephensi)*
Common on South Rim; nocturnal.

Longtailed Vole *(Microtus longicaudus)*
Riparian, meadows; common on North Rim; nocturnal-diurnal.

Mexican Vole *(Microtus mexicanus)*
Meadows, Coniferous Forest; common on South Rim and in Canyon; nocturnal-diurnal.

House Mouse *(Mus musculus)*
Not a native; around buildings; uncommon on South Rim.

are: white-tailed antelope squirrel, cliff chipmunk, canyon mouse, cactus mouse, desert wood rat, white-throated wood rat, Ord's kangaroo rat, desert shrew, silky pocket mouse, ringtail, spotted skunk, rock squirrel, spotted ground squirrel, Gunnison's prairie dog, black-tailed jackrabbit, grasshopper mouse, bighorn, and the exotic burro.

A woodland that consists primarily of pinyon and juniper trees occurs along each rim above the canyon walls and on some of the buttes and ridges within the canyon. This pinyon-juniper association forms a belt between desert scrub of the Inner Canyon and the yellow pine woodland on the rims. The pinyon-juniper community receives less water and warmer weather than the yellow pine woodland. Some plants of this community are pinyon, Utah juniper, cliff rose, broadleaf yucca, serviceberry, rabbit brush, ephedra, and blue gramma. Typical mammals to be found in the pinyon juniper association are pinyon mouse, Stephen's wood rat, desert cottontail, mountain lion, bobcat, rock squirrel, cliff chipmunk, gray fox and mule deer.

The yellow or ponderosa pine association is more extensive on the North Rim than it is on the South Rim. On the North Rim of the canyon this community is usually found between an elevation of 7200 to 8200 feet, and on the South Rim between 7000 and 7400 feet. The yellow pine forest is usually open and grasses are present. Rainfall is more than 20 inches annually and the mean temperature during the growing season is about 60°F. Yellow pines occur as an isolated stand on Shiva Temple within the canyon and in a nearly isolated state on Powell Plateau. The yellow pine forest is small within the boundaries of the park on the South Rim but extensive stands exist within the national forest contiguous with the Park boundary. Some typical plants in this community are: yellow (ponderosa) pine, Gambel oak, locust, mountain mahogany, blue elderberry, creeping mahonia, and fescue. Mammals common to the yellow pine forest are the Abert squirrel on the South Rim and the Kaibab squirrel on the North Rim, Merriam's shrew, striped skunk, Uinta chipmunk, golden-mantled ground squirrel, Mexican wood rat, bushy-tailed wood rat, Mexican vole, porcupine, Nuttall's cottontail, mountain lion, bobcat, deer mouse, and mule deer.

The spruce-fir forest with an intermixing of aspens occurs on the North Rim and continues northward onto the Kaibab Plateau. It occurs mostly above an elevation of 8200 feet and is an area of heavy snowfall, cold winters and a growing season of about three months. This area is isolated from other spruce-fir forests. The canopy of the spruce-fir forest is closed and there is little growth of herbs and grasses with an increased growth of mosses and lichens. Typical plants in this community are Englemann spruce, blue spruce, Douglas fir, white fir, aspen and mountain ash. Some mammals found in the spruce-fir community of the North Rim are: red squirrel, northern pocket gopher, dwarf shrew, long-eared myotis, long-tailed vole, porcupine, and Uinta chipmunk.

Grasses slow the surface runoff of precipitation, retard soil erosion, help maintain soil porosity and provide food for domestic animals and wildlife. Their surface growth is readily consumed by natural or man-caused ground fires but, their root systems usually remain viable and produce surface growth the following season. Elimination of fire from an area may actually cause a reduction in both the kind and amount of grasses capable of reproducing there. Grasses are the chief plants utilized for range rehabilitation and revegetation projects.

Grasses are widely distributed within the Grand Canyon Complex and are especially noticable in the meadows of the North Rim. Both native and domestic grasses are found within the complex as can be seen in the following list of genera.

Agropyron	Wheatgrass	Hordeum	Barley
Agrostis	Bentgrass	Imperata	Satintail
Alopecurus	Foxtail	Koeleria	Junegrass
Andropogon	Bluestem	Lolium	Ryegrass
Aristida	Threeawn	Lycurus	Wolftail
Avena	Wild Oats	Muhlenbergia	Muhly
Beckmannia	Sloughgrass	Munroa	Buffalograss
Blepharoneuron	Pine Dropseed	Oryzopsis	Ricegrass
Bouteloua	Grama	Panicum	Witchgrass
Bromus	Brome	Phleum	Timothy
Calamagrostis	Reedgrass	Poa	Bluegrass
Cenchrus	Sandbur	Polypogon	Polypogon
Cynodon	Bermudagrass	Phragmites	Reed
Danthonia	Oatgrass	Secale	Rye
Dactylis	Orchardgrass	Schleropogon	Burrograss
Deschampsia	Hairgrass	Setaria	Bristlegrass
Echinochola	Barnyardgrass	Sitanion	Squirreltail
Elymus	Wildrye	Sporobolus	Dropseed
Eragrostis	Lovegrass	Stipa	Needlegrass
Ftuca	Fescue	Trichachne	Cottontop
Glyceria	Mannagrass	Tridens	Tridens
Heteropogon	Tanglehead		

Meadows or mountain grasslands are present in limited numbers on the North Rim. They appear as open, shallow valleys, free of trees, with a large variety of grasses and forbs that are surrounded by spruce, fir and aspen. Soil moisture is high in the meadows from the melting of heavy snow cover. Some of the plants in the mountain grassland community are mountain muhly, blue gramma, black dropseed, squirreltail and pine dropseed. Some of the resident mammals are the long-tailed vole, northern pocket gopher, long-tailed weasel, least chipmunk and Uinta chipmunk. Members of one of the largest deer herds in the United States can often be observed browsing at the edges of these meadows. Several of these meadows have been damaged by being cut by primitive roads.

No accurate vegetational maps have been prepared for the Grand Canyon Complex and little work has been done on the areal extent of vegetation types within the two national monuments. The following vegetational data is only for Grand Canyon National Park.

VEGETATION TYPE	AREAL EXTENT IN ACRES	
	Sub-Types	Types
Sagebrush: Areas on which sage (Artemisia sp.) is dominant to the exclusion of tree species.		
Artemisia tridentata, Atriplex canescens, Cowinia stansburiana, Amelanchier utahensis, Ephedra viridis.	37,810.56	
Semi-barren	6,878.82	
		44,689.38
Sonoran Chaparral: Areas on which 80 percent of the vegetative cover consists of chaparral species characteristic of the Sonoran Life Zone and which are not capable of producing commercial stands of timber.		
Browsing species: Amelanchier utahensis, Quercus utahensis, Atriplex canescens, Cowinia stansburiana, Artemisia tridentata, Ptelea baldwinii crenulata, Leparagyrea rotundifolia, Ephedra viridis, Quercus turbinella, Arctostaphylos pungens, Garrya flavescens, Cercocarpus ledifolius.	15,504.52	
Semi-barren	11,397.12	
Non-browsing species: Grossularia inermis, Glossopetalon spinescens, Cercocarpus intricatus, Yucca sp., Robinia neomexicana luxurians, Gutierrezia sarothrae, Fallugia paradoxa, Rhus trilobata, Coleogyne ramosissima, Opuntia sp., Acacia greggii, Quercus undulata, Salidago sp.	35,075.96	
Semi-barren	13,582.57	
		75,560.27
Timberland Chaparral: Areas on which 80 percent of the vegetative cover consists of chaparral species characteristic of the Transition Life Zone or on which commercial stands of timber could be grown.		

Browsing species:
Quercus utahensis, Amelanchier utahensis, Artemisia tridentata, Ephedra viridis, Quercus turbinella, Lepargyrea rotundifolia, Symphoricarpus albus, Acer glabrum, Cowania stansburiana, Symphoricarpus oreophilus, Arctostaphylos pungens.

	13,006.26	
Semi-barren	737.67	

Non-browsing species:
Quercus undulata, Garrya flavescens, Acer grandidentatum, Robinia neomexicana luxurians, Holodiscus glabrescens, Rhus trilobata, Ptelea baldwinii crenulata, Cerococarpus intricatus.

	12,498.81	
Semi-barren	216.68	
		26,459.42

Semi-Desert Chaparral: Similar in species composition to the chaparral type but differing from it by being characteristically open. This type usually occupies slopes either bordering the desert, or within the range of desert climatic influence.

Browsing species:
Ephedra viridis - Grass — 3,374.87

Non-browsing species:
Coleogyne ramosissima, Opuntia sp., Yucca baccata, Yucca sp., Fallugia paradoxa, Rhus trilobata, Quercus turbinella, Acacia greggii, Guttierrezia Sarothrae.

	91,126.21	
Semi-barren	31,120.61	
		125,621.69

Woodland--Chaparral: Areas on which 80 percent or more of both broadleaf trees and chaparral species are present, each being present to at least 20 percent of the entire type. — 451.81

Woodland: Areas consisting of 80 percent or more of broadleaf tree species. — 4,218.55

Pinon - Juniper: Areas on which 20 percent or more of Pinon pines or Juniperus spp.are present, to the exclusion of commercial tree species.

Browsing species:
Pinus edulis, Juniperus californica utahensis, Artemisia tridentata, Cowania stansburiana, Arctostaphylos pungens, Quercus turbinella, Lepargyrea rotundifolia, Quercus utahensis, Amelanchier utahensis, Garrya Flavescens,

Atriplex canescens, Acer grandidentatum, Cercocarpus montanus, Ephedra viridis, Ptelea baldwinii crenulata, Grass	64,648.47	
Semi-barren	4,923.97	
Non-browsing species: Pinus edulis, Juniperus californica utahensis, Quercus turbinella, Caleogyne ramosissima, Fallugia paradoxa, Acacia greggii, Rhus trilobata, Quercus undulata, Cercocarpus ledifolius, Cercocarpus intricatus, Ceanothus greggii, Glossopetalon spinescens, Ribes cerum.	80,858.52	
Semi-barren	3,914.27	
		154,345.23
Douglas Fir: Areas on which there is a dominance of Douglas Fir to the exclusion of commercial pines.		
Pseudotsuga taxifolia		401.11
Fir-Douglas Fir: Areas on which Abies sp., and Pseudotsuga taxifolia each occupy at least 20 percent of the stand of coniferous trees to the exclusion of Pinus Ponderosa.	1,304.76	
Abies concolor, Pseudotsuga taxifolia		
Abies concolor, Pseudotsuga taxifolia, Pinus edulis, Juniperus californica utahensis	36.88	
Pseudotsuga taxifolia, Pinus edulis, Juniperus californica utahensis	36.88	
Abies concolor, Pseudotsuga taxifolia, Abies lasiocarpa, Picea pungens, Populus tremuloides	23.05	
Abies lasiocarpa, Pseudotsuga taxifolia, Picea pungens, Populus tremuloides	41.49	
Abies concolor, Pseudotsuga taxifolia, Populus tremuloides	198.25	
Abies concolor, Pseudotsuga taxifolia, Holodiscus glabrescens	18.44	
Abies concolor, Pseudotsuga taxifolia, Quercus utahensis	36.88	
Abies concolor, Pseudotsuga taxifolia, Amelanchier utahensis	13.83	

Abies concolor, Pseudotsuga taxifolia, Robinia neomexicana luxurians, Quercus utahensis, Acer grandidentatum	23.05	
Abies concolor, Pseudotsuga taxifolia, Pinus edulis, Juniperus californica utahensis, Amelanchier utahensis, Aretostaphylos pungens	18.44	
Abies concolor, Pseudotsuga taxifolia, Picea pungens	4.61	
Abies lasiocarpa, Pseudotsuga taxifolia, Picea pungens	4.61	1,761.17

Ponderosa Pine: Areas on which Pinus ponderosa occurs to the extent of 20 percent or more, to the exclusion of true firs and Douglas firs.

Pinus ponderosa	19,271.82	
Pinus ponderosa, Populus tremuloides	10,244,49	
Pinus ponderosa, Quercus utahensis (Shrub form)	11,111.26	
Pinus ponderosa, Pseudotsuga taxifolia, Populus tremuloides	92.21	
Pinus ponderosa, Picea pungens, Populus tremuloides	1,539.90	
Pinus ponderosa, Picea pungens	41.49	
Pinus ponderosa, Pseudotsuga taxifolia, Picea pungens, Populus tremuloides	110.65	
Pinus ponderosa, Populus tremuloides, Grass	267.41	
Pinus ponderosa, Pseudotsuga taxifolia, Quercus utahensis	64.54	
Pinus ponderosa, Quercus utahensis, Robinia neomexicana luxurians	668.52	
Pinus ponderosa, Quercus utahensis, Amelanchier utahensis	13.83	
Pinus ponderosa, Arctostaphylos pungens	368.84	
Pinus ponderosa, Grass	281.24	

Pinus ponderosa, Picea pungens, Populus tremuloides, Grass	32.27
Pinus ponderosa, Pteris aquillinn, Grass	4.61
Pinus ponderosa, Picea engelmanii, Pseudotsuga taxifolia, Picea pungens	23.05
Pinus ponderosa, Picea engelmanii, Populus tremuloides	23.05
Pinus ponderosa, Picea engelmanii, Picea pungens, Populus tremuloides	119.87
Pinus ponderosa, Quercus utahensis, Robinia neomexicana luxurians, Amelanchier utahensis	18.44
Pinus ponderosa, Populus tremuloides, Quercus utahensis, Robinia neomexicana luxurians	13.83
Pinus ponderosa, Robinia neomexicana luxurians	198.25
Pinus ponderosa, Populus tremuloides, Robinia neomexicana luxurians	55.32
Pinus ponderosa, Populus tremuloides, Quercus utahensis	23.05
Pinus ponderosa, Pinus edulis, Juniperus Californica utahensis	7,372.16
Pinus ponderosa, Cowania stansburiana	27.66
Pinus ponderosa, Cowania stansburiana, Grass	41.49
Pinus ponderosa, Quercus utahensis, Cowania stansburiana, Grass	23.05
Pinus ponderosa, Quercus utahensis, Cercocarpus ledifolius	46.10
Pinus ponderosa, Quercus utahensis, Cowania stansburiana	1,567.56
Pinus ponderosa, Quercus utahensis, Grass	64.54
Pinus ponderosa, Artemisia tridentata, Cowania stansburiana	27.66

Pinus ponderosa, Pinus edulis, Juniperus californica utahensis, Cowania stansburiana	285.85	
Pinus ponderosa, Quercus utahensis, Artemisia tridentata	1,705.87	
Pinus ponderosa, Artemisia tridentata	1,489.18	
Pinus ponderosa, Pinus edulis, Juniperus californica utahensis, Quercus utahensis, Artemisia tridentata	308.90	
Pinus ponderosa, Quercus utahensis, Artemisia tridentata, Cowania stansburiana	18.44	
Pinus ponderosa, Pinus edulis, Juniperus californica utahensis, Quercus utahensis	216.69	
Pinus ponderosa, Quercus utahensis (Tree form)	69.15	
		57,879.90

PINE-FIR-DOUGLAS FIR: Areas on which Pinus ponderosa, Douglas fir, and Abies sp., each occur to the extent of 20 percent or more of the stand of coniferous tree species.

Pinus ponderosa, Pseudotsuga taxifolia, Abies Concolor	4,213.98	
Pinus ponderosa, Pseudotsuga taxifolia, Abies Concolor, Quercus utahensis	437.99	
Pinus ponderosa, Pseudotsuga taxifolia, Abies Concolor, Pinus edulis, Juniperus californica utahensis	55.32	
Pinus ponderosa, Abies concolor, Populus tremuloides	7,814.76	
Pinus ponderosa, Pseudotsuga taxifolia, Abies concolor, Populus tremuloides	8,497.12	
Pinus ponderosa, Abies concolor	396.50	
Pinus ponderosa, Abies lasiocarpa, Picea pungens, Populus tremuloides	212.08	
Pinus ponderosa, Abies lasiocarpa, Populus tremuloides	9.22	

Pinus ponderosa, Picea pungens, Abies lasiocarpa	18.44	
Pinus ponderosa, Picea pungens, Abies concolor Abies lasiocarpa, Populus tremuloides	64.54	
Pinus ponderosa, Pseudotsuga taxifolia, Abies Concolor, Picea pungens, Populus tremuloides	119.87	
Pinus ponderosa, Picea engelmanii, Picea pungens Pseudotsuga taxifolia, Abies concolor	101.43	
Pinus ponderosa, Picea pungens, Abies Concolor, Pseudotsuga taxifolia	55.32	
Pinus ponderosa, Picea engelmanii, Pseudotsuga taxifolia, Abies concolor	216.69	
Pinus ponderosa, Pices engelmanii, Picea pungens Abies concolor, Populus tremuloides	23.05	
Pinus ponderosa, Abies Concolor, Pseudotsuga taxifolia, Amelanchier utahensis	36.88	
Pinus ponderosa, Picea pungens, Abies concolor, Populus tremuloides	165.97	
Pinus ponderosa, Abies Concolor, Pseudotsuga taxifolia, Quercus utahensis, Amelanchier utahensis	175.19	
Pinus ponderosa, Abies concolor, Populus tremuloides, Robinia neomexicana luxurians	9.22	
Pinus ponderosa, Abies concolor, Pseudotsuga taxifolia, Quercus utahensis, Robinia neomexicana luxurians	55.32	
Pinus ponderosa, Abies concolor, Pseudotsuga taxifolia, Arctostaphylos pungens	27.66	
		22,706.55

FIR: Areas on which there is a dominance of Abies sp., to the exclusion of commercial pines.

Abies concolor, Abies lasiocarpa, Populus tremuloides	27.66	
Abies lasiocarpa, Picea pungens	18.44	
Abies concolor, Picea pungens, Populus tremuloides	23.05	

Abies concolor, Populus tremuloides	119.87	
Abies lasiocarpa, Picea pungens, Abies concolor, Populus tremuloides	78.38	
Abies lasiocarpa, Picea pungens, Populus tremuloides	13.83	
Abies concolor, Quercus utahensis, Robinia neomexicana luxurians	23.05	
Abies concolor	4.61	
		308.89

SPRUCE: Areas on which spruce is the dominant tree species, to the exclusion of Ponderosa pine.

Picea pungens, Populus tremuloides	880.60	
Picea pungens, Populus tremuloides, Grass	147.53	
Picea pungens	9.22	
Picea pungens, Abies lasiocarpa, Populus tremuloides	442.61	
Picea pungens, Abies lasiocarpa, Pseudotsuga taxifolia, Populus tremuloides	59.93	
Picea pungens, Picea engelmanii, Abies lasiocarpa, Populus tremuloides	285.84	
Picea pungens, Picea engelmanii, Abies lasiocarpa	46.10	
Picea pungens, Picea engelmanii, Abies concolor, Populus tremuloides	9.22	
Picea engelmanii, Picea pungens, Populus tremuloides	36.88	
Picea engelmanii, Abies lasiocarpa, Populus tremuloides	73.76	
Picea pungens, Abies lasiocarpa	9.22	
Picea pungens, Abies concolor, Pseudotsuga taxifolia	9.22	
		2,010.13

GRASSLAND: Areas on which 80 percent or more of the vegetation is herbaceous.		47,500.00
BARREN: Areas which have less than 20 percent cover in vegetation.		10,000.00
Unclassified: Developed and residential areas, roads, stream channels, other works of man, etc., not classifiable, or not surveyed (considerable acreage below the rim of the canyon remains unsurveyed).		97,835.15
	TOTAL	673,575.00

Other plant communities occur in Grand Canyon National Monument and in the portions of Lake Mead Recreation Area which are proposed for addition to the Grand Canyon Complex. Creosote bush and salt bush along with such associated plants as burr sage are found westward from the national monument along the Colorado River. Above this is found a short grass community with various gramma grasses, June grass, burro grass, various cacti, banana yucca and ephedra growing on much of the elevated, nearly level terrain surrounding the Inner Canyon of the river. An extension of the Northern Desert Sagebrush community extends into Northern Arizona from the Great Basin and into the area of Grand Canyon National Monument. The dominant plant is big sagebrush in nearly pure stands with various grasses and a few scattered pinyon and juniper trees. A Palo verde-cacti-burr sage community occurs along the lower portions of Kanab Creek and along portions of the Colorado River near their junction. Other than a few rodent species the kit fox and the pronghorn are the two conspicuous mammals that occur in the western sections of the Grand Canyon Complex that do not also occur in the eastern portions.

RARE OR ENDANGERED SPECIES

No rare or endangered species of plants are known to exist within the park or the proposed enlarged park. The following animals have been observed within the park which are listed in the 1973 "Redbook" on "Threatened Wildlife of the United States".

Southern Bald Eagle	Haliaeetus, l. leucocephalus
American Peregrin Falcon	Falco peregrinus anatum
Ferruginous Hawk	Buteo regalis
American Osprey	Pandion haliaetus carolinensis
Prairie Pigeon Hawk	Falco columbarius
Kaibab Squirrel	Sciurus kaibabensis
Humpback Chub	Gila cypha
Colorado Squawfish	Ptychocheilus lucius
Humpback Sucker	Xyrauchen texanus

GRAZING

No land within Marble Canyon National Monument is grazed by domestic livestock. Three, life tenure, grazing permits exist for lands within the northern portion of Grand Canyon National Monument. At the present time approximately 250 head of cattle are being grazed on 26,560 acres of upland monument land. These grazing privileges were granted upon the establishment of the national monument. The members of the Havasupai Tribe hold grazing privileges on 73,600 acres within Grand Canyon National Park and the southern section of Grand Canyon National Monument. The tribe currently has 138 head of cattle and 322 horses on this land.

There is prime desert bighorn sheep habitat on the northern portions of the Great Thumb and Tenderfoot Plateaus. In these two areas the Havasupai livestock are in direct competition with the desert bighorn for food and water. These two areas are considered to be essential to the continued existence of bighorn in the park.

Grazing is a valid multiple use of Forest Service lands and is an acceptable use of recreational area lands under the jurisdiction of the National Park Service. At this time there are three permitees using 19,700 acres for grazing within the proposed Kanab Canyon addition. There are eleven permitees using 202,048 acres for grazing on the lands of Lake Mead National Recreation Area which are proposed for addition to Grand Canyon National Park. All eleven of these grazing permits are connected with patented water rights.

The land being used by domestic livestock within the current and proposed park does not provide a bountiful harvest. The lack of naturally occuring surface water combined with the low productivity and regrowth of vegetation make this land poor to very poor under most grazing classifications. A few stock roads and trails and scattered stock tanks are the main evidence that these areas are being used for grazing. As life-time permits expire the majority of these roads and trails will be abandonded and the stock tanks breached. No new permits will be granted. The only known competition north of the Colorado River between domestic livestock grazing and wildlife is with a small herd of pronghorn in Grand Canyon National Monument. This competition is very minor.

WATER RESOURCES

Water is a vitally necessary natural resource, especially in the arid Southwestern United States. Here, legal and institutional systems are organized to control the use of water. In the Grand Canyon region the use of water is subject to Federal law, the laws of individual States interstate compacts and agreements to apportion the waters of interstate streams. Water rights are generally based on beneficial use of the water and on the appropriation doctrine in which first-in-time is first-in-right. Most of the readily available surface water, and even most of that which can be developed only with difficulty, has been assigned to specific applicants or users. The remaining supply is usually desired and actively pursued by numerous State and interstate groups as well as private individuals.

The Federal Government has asserted, and the courts have affirmed, that it has the right to sufficient water to develop Federal "reserved" land such as that reserved for national parks, provided that the water is used for the purposes of the reservation. The right is effective as of the date of the reservation action. The Federal Government thus has the use right to waters originating in, or flowing through, Grand Canyon National Park for the development of the park.

Because of the complex nature of water development projects, cooperation among water users is usually essential to make the projects possible. In 1922, the Colorado River States drafted the Colorado River Compact to apportion the waters of the Colorado River. This compact was approved by Congress in the Boulder Canyon Project Act of December 21, 1928, and declared to be in effect by President Hoover on June 25, 1929. The compact divided the Colorado River into two drainage basins, Upper and Lower, with Lees Ferry, Arizona being used as the dividing line between them.

Most of the flow of the Colorado River through the Grand Canyon originates in the high mountain areas that rim the Upper Colorado Region. The estimated annual virgin runoff in the Colorado River at Lees Ferry, Arizona, at the head of Marble Canyon - has ranged from 5.6 to 24.0 million acre-feet. The 10-year means have ranged from 11.6 to 18.8 million acre-feet. Opinions thus differ concerning the period of record that best predicts future runoff. The significance is the fact that a period of about 25 years (1906-1930) of predominantly above-average runoff has been followed by a 40-year period (1931-1970) of predominantly below-average runoff.

In Article III, the Colorado River Compact requires that "the States of the Upper Division will not cause the flow of the river at Lees Ferry to be depleted below an aggregate of 75,000,000 acre-feet for any period of ten consecutive years." Projected depletion requirements for the Upper Basin to the year 2020 have been made by the Pacific Southwest Inter-Agency Committee for the U.S. Water Resources Council.

These indicate that by that year the streamflow at Lees Ferry will be reduced by 6.5 million acre-feet. Current usage accounts for much of the nearly complete utilization of the Colorado River, when the mean virgin flow at Lees Ferry is near the level at which it has been for the last 40 years, with the balance of usage caused by the initial filling of Upper Basin reservoirs. Although the flow of the Colorado River through Grand Canyon is thus assured, the daily, seasonal and yearly flow will fluctuate greatly as reservoir and energy commitments are met.

Downstream commitments in the Lower Basin below Lees Ferry are 2.8 million acre-feet for consumptive use in Arizona, 4.4 million for California, 0.3 million in Nevada, and 1.5 million for Mexico. Adding losses of 1.6 million (estimated for the 2020) from the river and its existing reservoirs makes a total requirement of 10.6 million acre-feet per year. Only about 0.8 million acre-feet of water is supplied to the Colorado River by tributaries between Lees Ferry and Mexico. If only the 7.5 million acre-feet required by the Colorado River Compact were released to flow by Lees Ferry, the apportionments in the Lower Basin would exceed the streamflow by 2.3 million acre-feet each year.

California is currently using 0.5 million acre-feet of water in excess of its apportionment as Arizona and Nevada do not have facilities for full utilization of their shares. Arizona has chosen to develop a portion of its unutilized share for the Central Arizona Project which will deliver Colorado River water to the Phoenix and Tucson areas of central Arizona, to other portions of Arizona, and to New Mexico by exchange. The overdraft in groundwater in the Phoenix and Tucson areas is 2.5 million acre-feet annually. It is obvious that even with no increase in water use that the Central Arizona Project can do little to stop this overdraft as it nearly equals Arizona's apportionment from the Colorado River at Lees Ferry. Under present conditions there is essentially no outflow from the Lower Colorado River Basin beyond that required to meet the 1944 Mexican Treaty obligation of 1.5 million acre-feet annually. As the Upper Basin states develop their portion of Colorado River water, and the flow at Lees Ferry is reduced toward its minimum legal flow it is evident that the water picture below Grand Canyon will not brighten.

As shown in the following tables, springs and tributaries between Lees Ferry and Lake Mead contribute approximately 0.5 million acre-feet of water to the Colorado River. Because of the remoteness of most of the minor tributaries many of these figures are based upon short-term observations and must be considered only approximate maximum values.

MAJOR TRIBUTARIES
LEES FERRY TO LAKE MEAD

Tributary	Flow in A.F./Yr.	TDS mg/l	Salt in Tons/Yr.
Paria River	18,000	1,173	30,000
Little Colorado River	134,000	712	130,000
Blue Springs	161,000	2,499	547,400
Bright Angel Creek	25,630	300	10,457
Tapeats Creek	58,000	147	12,000
Kanab Creek	3,000	1,103	4,500
Havasu Creek	50,000	500	34,000
Total	450,430	-----	768,357

MINOR TRIBUTARIES
LEES FERRY TO LAKE MEAD

Tributary	Maximum Flow Acre-Feet/ Year	Total Dissolved Solids (mg/l)	Salt in Tons/Year
3-Mile Wash	360	---	---
Vaseys Paradise	3,000	198	800
Nankoweap Creek	2,920	500	1,986
Lava Canyon Creek	1,095	750	1,117
Red Canyon Spring	2	44,835	122
Hance Canyon	2	---	---
Cottonwood Spring	8	387	4
Grapevine Spring	16	334	7
Clear Creek	1,460	309	613
Indian Gardens	480	305	197
Monument Creek	150	1,470	300
Hermit Creek	438	441	263
Boucher Creek	183	786	195
Crystal Creek	2,920	735	2,920
Shinumo Creek	5,000	200	1,360
Elves Chasm	200	588	160
Galloway Canyon	200	---	---
Stone Creek	250	367	125
Deer Creek	8,800	350	4,189
Matkatamiba Creek	44	1,139	68
Green Alcove	100	---	---
National Canyon	700	---	---
Fern Glen Canyon	360	---	---
Gateway Canyon	360	---	---
Lava Falls	4,380	845	5,037
Vulcan Springs	3,650	684	3,395
Spring Canyon	95	478	62
205 Mile Canyon	5	728	115
3-Spring Canyon	15	426	9
Diamond Creek	2,555	470	1,635
Travertine Canyon	365	742	369
Travertine Falls	37	937	47
Separation Canyon	10	441	6
Spencer Canyon	1,095	426	635
Lost Creek	50	---	---
Reference Point Creek	10	---	---
TOTAL	41,315	-----	25,626

Despite the tremendous quantity of water flowing through the mile deep canyon, the history of water supply at Grand Canyon has been one of insufficiency. As the river cut a canyon through the rock units of the canyon the ground water drained into the canyon. Collections of surface water are temporary and rare because of the ease with which precipitation penetrates into the substrata. The principal settlements at the canyon prior to 1900 were those at Grandview Point and Grand Canyon Village.

Some water was carried by mules to the rim from the springs at Indian Gardens and other amounts were collected in natural or dug tanks and cistern catchments. The railroad to Grand Canyon Village was completed on October 12, 1901 and water was then brought to the canyon in tank cars. A sewage disposal plant was completed on May 28, 1926 and reclaimed effluent became available for non-potable uses. On August 26, 1932, the Santa Fe Railroad completed a pipeline to Indian Gardens, about 3,200 feet below the rim at Grand Canyon Village. Pumps were installed with a capacity of 278,000 gallons per day.

The amount of water lifted from Indian Gardens proved to be sufficient until the large influx of park visitors following World War II. Additional reservoirs were constructed on the rim to provide storage for water pumped during the slack winter season. Water storage was approximately 4 million gallons by 1958 and had reached 13 million gallons by 1968. Water consumption in that year reached 96 million gallons; virtually the entire flow of the springs at Indian Gardens.

For many years the developed area on the North Rim at Bright Angel Point had obtained its water through a pipeline from Roaring Springs, a major source of Bright Angel Creek. In August, 1970, a 16-mile long transcanyon pipeline was completed which connects Roaring Springs with the pumping facilities at Indian Gardens. The pipeline operates continuously except for shutdowns due to breaks in the line. The waterline has a maximum carrying capacity of 208.8 million gallons water per year. Water in excess of pumping capacity or of needs on the South Rim is released into Garden Creek to return to the Colorado River. The springs at Indian Gardens are now allowed to flow freely into Garden Creek.

Bright Angel Creek is the fourth largest tributary to the Colorado River between Glen Canyon Dam and the Virgin River. The waters of this creek are low enough in total dissolved solids to dilute the salinity of the Colorado River by 1 to 2 parts per million. As Roaring Springs is one of the major sources of water for Bright Angel Creek, any reduction in their flow in effect increases the salinity of the Colorado River. All water transported to the South Rim is wasted through evaporation, use, or seepage into the subsurface where it leaves the Colorado River drainage and moves southward. Water removed from Roaring Springs for use on the South Rim reduces the amount available for downstream users and increases the need for such downstream storage facilities as dams.

The extracting capacity of the transcanyon waterline amounts to 641 acre-feet per year which is 2.5 percent of the normal flow of Bright Angel Creek. The flow of Bright Angel Creek consists of the flow from numerous other springs (contributing approximately 61 percent of the

total flow) and the runoff from 98 square miles of drainage basin which receives from 8 to 26 inches of precipitation a year. If the flow of Roaring Springs is as much as 10 cubic feet per second, then the waterline at capacity would consume 10 percent of its flow averaged out over the year. During the winter months the entire flow of Bright Angel Creek normally drops from 13 to 15 cubic feet per second.

Water commitments within the park will probably stabilize at approximately 162.3 million gallons per year by the late 1970's. The unincorporated village of Tusayan, just outside the south entrance to the park, on private property, does not have an adequate water supply and must haul its water by truck from Williams, Arizona. Businessmen within that community have proposed that the regulations prohibiting sale of water to consumers outside the park be reversed and that a pipeline be constructed to Tusayan for their use. As this proposal would have far ranging effects if implemented, it is covered in the alternatives section of this impact statement.

High levels of dissolved mineral salts in the Colorado River is a major water quality problem in Arizona. The Colorado River enters Grand Canyon with a total dissolved solids concentration averaging 586 miligrams per liter. This amounts to 8.7 million tons per year. The water is primarily of the calcium-sodium-sulfate type.

Grand Canyon contains several springs which are high in total dissolved solids and thus contributes to the total load of the Colorado River. Water quality is also affected by large amounts of sediment entering from flooding tributary streams. The watershed areas drained by streams tributary to the Colorado River through Grand Canyon contribute from 0.5 to 1.0 acre-feet of sediment per square mile per year. Long-term records show an average annual sediment discharge of about 10 million tons into the Colorado from the Little Colorado River. Heavy loads of sediment occasionally are carried into the Colorado River at Lees Ferry by the Paria River. Recorded sediment concentrations in Kanab Creek at Fredonia, Arizona, north of the park, have reached 700,000 parts per million and concentrations of up to 500,000 parts per million may often be found in this stream during periods of intense rainfall.

Substantial amounts of oil and gasoline can be spilled into the Colorado River at Lees Ferry from boat servicing facilities. Ruptured gasoline tanks can also leak during motorized trips through the canyon. On the average, an estimated 20 to 35 percent of the fuel used in outboard motors is wasted in the exhaust. Laboratory studies of pollutants from outboard motor exhuast indicate that approximately 0.23 pounds of oil, as measured by nonvolatile suspended solids, are wasted per gallon of fuel consumed. The turbulence caused by the propeller creates conditions ideal for dispersion of the waste material into the water. The rest enters the air as an air pollutant in the canyon. No estimate is available for the total amount of fuel used within the Grand Canyon by motorized trips each year. However, the scale of the problem may be visualized by using the National Park Service patrol boat as an example. This boat uses approximately 50 gallons of fuel for a run from Lees Ferry to Diamond Creek, and makes the trip about 10 times a season. In one year's time, the boat thus will leave approximately 115 pounds of unconsumed oil and gasoline in its wake.

Preliminary chemical and bacteriological surveys have been made in the Grand Canyon section of the Colorado River to assess possible health hazards to river travelers and hikers. The water quality of the main Colorado River channel is relatively stable with only slight increases in ionic concentration and bacterial load with respect to distance from Lees Ferry. The bacteriological contamination in the main river channel is normally at or below the standards set for drinking and recreational use set by the states of Arizona and Nevada and by the Federal Water Pollution Control Administration. This does not preclude the necessity of treating water taken from the main channel for drinking purposes but it does indicate that proper chlorination, boiling or other treatment will easily make the water safe for drinking.

Many of the side streams present quite another picture, at least with respect to recreational primary contact. The bacteriological contamination in most of the popular streams and swimming pools is in excess of the levels recommended for primary contact. The tributary streams show extreme temporal variability in chemical water quality and bacteriological contamination as a result of the summer rain and flood patterns. Bacteriological contamination of Havasu and Kanab Creeks may be the result of poor domestic waste treatment practices. Fredonia, Arizona and Kanab, Utah are the probable sources of fecal contamination load in Kanab Creek. The 2,500 inhabitants of Kanab use a single trickling filter unit for secondary treatment of fluid wastes. The 800 persons in Fredonia use septic tanks for the disposal of domestic wastes. Tremendous increases in bacteriological activity in the waters of Kanab Creek occur during flood periods.

Water samples from Havasu Creek show evidence of human fecal contamination. The source of this contamination is the village of Supai on the Havasupai Indian Reservation. There is a significant increase in bacteriological activity in Havasu Creek as it passes through the village of Supai. Supai lacks waste treatment facilities and has a considerable population of domestic animals. The waters of tributary streams must be considered to pose a potential health hazard to hikers and river travelers.

HYDROELECTRIC POTENTIAL

The Colorado River develops approximately 1940 feet of head between Glen Canyon Dam and the slackwater of Lake Mead. At least 25 sites have been surveyed within the 277 miles of Grand Canyon between Lees Ferry and the Grand Wash Cliffs for the possible construction of dams to utilize the fall of the river as a hydroelectric resource. These potential dam sites and their river mile distances below Lees Ferry are given below.

Marble Gorge	4.5	Specter Chasm	130.0
Redwall, Upper	29.0	Havasu	156.6
Redwall	30.0	Prospect Canyon	190.1
Vaseys Paradise	32.2	Diamond Creek, upper	225.5
Marble Canyon	39.5	Diamond Creek, lower	225.9
Mineral Canyon	77.8	Travertine Canyon	228.6
Clear Creek	84.4	Bridge Canyon	236.3
Granite Wall	85.1	Hualapai	237.5
Cremation	86.3	Spencer Canyon	246.2
Pipe Creek	89.0	Devils Slide	255.6
Ruby Canyon	103.9	Flour Sack Rapids	266.0
Hakatai	110.7	Pierces Ferry	277.3
Big Bend	113.3		

Three of these sites, Marble Canyon, Prospect Canyon and Hualapai, have received serious consideration and proposals for dam construction have been made by various entities. The most current of these proposals will be discussed here.

The Arizona Power Authority proposes that the Marble Canyon Dam consist of a constant-radius arch section, 700 feet in length along its crest, including a two-bay submerged spillway at each end of the arch dam. The dam would be approximately 400 feet high from the lowest point of the excavated foundation and 90-feet wide at that same point. A dam of this size would have a gross head of 293 feet with the maximum normal reservoir elevation of 3130 feet. The reservoir capacity would be 480,000 acre feet, have a surface area of 5300 acres and lose approximately 29,000 acre feet of water through evaporation each year. The reservoir would flood all of Marble Canyon to the mouth of the Paria River.

An indoor-type powerhouse would have a total installed capacity of 510,000 kilowatts in six units. The average annual energy production and peaking capability delivered to the load centers is estimated at 2,359,000,000 kilowatt hours and 549,000 kilowatts, respectively. This is the heating energy equivalent of 3.56 million barrels of oil per year. The average annual revenues, based on Colorado River Storage rates, which would accrue to the Arizona Power Authority from the sale of electrical power from this project would be approximately $15,500,000.

Under the U.S. Bureau of Reclamation plan the Marble Canyon Dam would consist of a double-curvature, concrete-arch structure, with a crest length of approximately 750 feet. It would have a structural height of 415 feet of which 105 feet would be below the stream bed. A dam of this size would have a gross head of 303 feet with the maximum normal reservoir elevation of 3140 feet. The reservoir capacity would be 363,000 acre feet, have a surface area of 4000 acres and lose approximately 10,000 acre feet of water through evaporation each year.

An underground powerhouse would have a total installed capacity of 600,000 kilowatts in four units. The average annual energy production and peaking capability delivered to the load centers is estimated at 2,255,000,000 kilowatt hours and 540,000 kilowatts, respectively. This is the heating energy equivalent of 3.40 million barrels of oil per year.

The Arizona Power Authority proposes that the Hualapai Dam consist of a double-curvature arch section 1100 feet in length, and a 243-foot spillway structure. The dam would be 480-feet high from the lowest point of the foundation. This dam would have a gross head of 390 feet with the maximum normal reservoir elevation of 1610 feet and provisions made for rising to 1866 feet. The reservoir capacity would be 820,000 acre feet at the lower reservoir elevation, have a surface area of 6400 acres and lose approximately 37,000 acre feet of water through evaporation each year.

An indoor-type power plant would have an installed capacity of 960,000 kilowatts. The yearly average energy production and peaking capability delivered to the load centers is estimated at 3,210,000,000 kilowatt hours and 903,000 kilowatts, respectively. The average annual revenues, based on Colorado River Storage rates, which would accrue to the Arizona Power Authority from the sale of electrical power from this project would be approximately $23,500,000. The electrical energy produced by this project would equal 4.85 million barrels of oil each year.

The Los Angeles Department of Water and Power proposes that the Hualapai Dam be a thin-arch concrete structure with a crest length of 1140 feet and a height above the foundation of 466 feet. The dam would have the same gross head, reservoir elevation, and surface area as the APA proposal. The reservoir capacity would be 20,000 acre feet greater but evaporation losses from the reservoir would be reduced to 24,000 acre feet per year.

The indoor-type power plant would have an installed capacity of 1,200,000 kilowatts. The yearly average energy production and peaking capability delivered to the load centers is estimated at 3,220,000,000 kilowatt hours and 1,279,000 kilowatts, respectively. This is the heating energy equivalent of 4.86 million barrels of oil per year.

The U.S. Bureau of Reclamation plan for this site would be for a conventional variable-radius, concrete-arch structure with a height of 736 feet above the foundation and having a crest length of approximately 1650 feet. The dam would have a gross head of 649 feet with the maximum normal reservoir elevation of 1866 feet. The reservoir capacity would be 3,710,000 acre feet, have a surface area of 16,700 acres and lose approximately 85,000 feet of water through evaporation each year.

An underground power plant would have an installed capacity of 1,500,000 kilowatts. The yearly average energy production and peaking capability delivered to the load centers is estimated at 5,250,000,000 kilowatt hours and 1,350,000 kilowatts, respectively. This is the heating energy equivalent of 7.93 million barrels of oil per year.

The Arizona Power Authority also proposes the Prospect Canyon Dam at river mile 190.1 to develop the head lost because of their low dam height proposed at the Hualapai site. The Prospect Canyon Dam would be of the constant-radius arch type with a crest length of 900 feet, and a height from the foundation of 315 feet. This dam would have a gross head of 256 feet with the maximum normal reservoir elevation of 1866 feet. The reservoir capacity would be 420,000 acre feet, have a surface area of 3,330 acres, and lose approximately 22,000 acre feet of water through evaporation each year.

An indoor-type power plant would have an installed capacity of 510,000 kilowatts. The yearly average energy production and peaking capability delivered to the load centers is estimated 2,110,000,000 kilowatt hours and 475,000 kilowatts, respectively. This is the heating energy equivalent of 3.19 million barrels of oil per year. The average yearly revenues, based on Colorado River Storage rates, which would accrue to the Arizona Power Authority from the sale of electrical power from this project would be approximately $13,600,000.

The economic costs of any or all of the above projects and their associated transmission lines and facilities are not available at this time. All of the proposed hydroelectric developments would also require from 1 to 4 dams to be built on streams tributary to the Colorado River as back-up sedimentation reservoirs.

A site on the Little Colorado River, halfway between Cameron, Arizona and the confluence of the Little Colorado River with the Colorado River, has been considered by all three of the above agenices variously as a pumped-storage site, for sediment retention, and for desalination purposes. Called the Coconino Project, it would differ from the conventional pumped-storage project in that the generating head would be about twice that of the pumping head. The net gain in head is possible because the water is pumped from the river upstream from the power plant and then transported to the plant by a canal. Under the designation of Lee Reservoir Project it would be a conventional pumped-storage project. As a desalination project the river would be dammed

below Blue Springs, water pumped to the rim by a nuclear or coal-fed power plant, the salt removed from the water and the fresh water sent via aquaduct 80 miles overland to the Verde Valley drainage system.

Although there are presently no hydroelectric generating projects or transmission facilities within the Grand Canyon Complex, or in any area proposed for addition to the complex the potential must be realized as being part of the environment just as would any other untapped natural resource. If any portion of this resource is eventually realized through development it will cause extensive changes in the resource management of some areas and eliminate the need for it in others.

The Little Colorado site would be highly visible from the eastern approach to Grand Canyon National Park. The Marble Canyon site is within Marble Canyon National Monument and the high dam proposed by the U.S. Bureau of Reclamation at the Hualapai site would back water approximately 30 miles into the present complex and inundate the mouth of Havasu Canyon. The low dam proposals for the Hualapai site would not back water into the present Grand Canyon Complex. However, the reservoir would lie almost wholly in that portion of Lake Mead National Recreation Area which is proposed for addition to the complex. The normal reservoir elevation of 1,610 feet for the low dams at the Hualapai site would back water to approximately river mile 192. The westernmost boundary of Grand Canyon National Monument is at river mile 184.4, eight miles upstream. The modification of river gradient by the reservoir would, however, cause heavy silting of the river for many miles upstream just as it has at Lake Mead.

Due to the energy crisis currently being experienced in this country, there have been recent political moves to change the laws prohibiting construction of these dams. Permission to construct the Hualapai low dam is particularly being sought. In 1968 the Hualapai project was dropped as a funding source for the Central Arizona Project with the agreement of the Arizona Congressional delegation. The Hualapai site lies outside of the Boulder Canyon Project Act area and all evaporative losses from the reservoir, would be taken from Arizona's allocation of water from the Colorado River, which is already too low for the State's water needs. The Master Plan for the Grand Canyon Complex does not address itself to the contingency that the legal restrictions prohibiting this and the other described dams will be lifted.

HAVASUPAI INDIAN RESERVATION

On June 8, 1880, President Rutherford B. Hayes established the first Havasupai Indian Reservation. A technical problem in the Executive Order resulted in a second order on November 23, 1880 but the reservation's boundaries remained unchanged. The reservation consisted of 34,240 acres in the Cataract Canyon - Havasu Creek area. The intent of reserving these lands for the use and occupancy of the Havasupai was to guarantee the Indians a land base for their livelihood and to guarantee white settlers peaceful entry into portions of the Coconino Plateau for homesteading.

With the homesteaders, however, came prospectors and in 1882 President Chester A. Arthur addressed the problem of mineral rights by reducing the Havasupai Indian Reservation to 518 acres. These 518 acres were the Havasupai's traditional farming lands in the bottom of Havasu Canyon, where they grew their crops during the spring and summer months of the year. The stock grazing lands and the hunting and gathering lands on the plateau above the village were excluded from the new reservation. The Havasupai, however, still retained the rights to traditional uses of non-reservation lands.

In 1944, the Tribe was awarded 4 sections of released railroad land which were exchanged for available state lands in the bottom of Cataract Canyon, 30 miles north of the present reservation. These 2,560 acres of land have poor access, no water and little agricultural or grazing potential. In 1969 the Indian Claims Commission awarded the Havasupai Tribe $1.24 million for lands "seized" without compensation. The award (Docket 91, 1969) included a quit claim to the Havasupai's land use rights on non-reservation lands.

The Havasupai Tribe's right to use non-reservation lands within Grand Canyon National Park were expressly recognized in the 1919 act establishing the Park. These recognized rights have been confined to 56,000 acres in the western part of the park adjoining the reservation. These lands have been used by a small number of cattle and horses for grazing. The grazing capacities on this range are low as stock water is minimal, forage of low quality, and the soils are of such poor quality that range "improvements" would result in little additional yield. The soil is porous and limey, occurs mainly as patches between outcrops of bedrock and is less than 20 inches deep. Precipitation is less than 10 inches per year and the low humidity restricts any forage growth above that naturally existing there. Based on the capability of the land to produce at least 50 pounds of air-dry forage per acre the land will support one cow for every 300 acres. The rim and plateau lands are not capable of maintaining a viable cattle industry, especially one of such magnitude as to be economically productive for the entire Tribe.

The green oasis of Supai with its famed waterfalls has been the goal of increasing numbers of tourists and hikers over the years. In 1972, more than 14,000 visitors made the 11-mile trip from the rim by

horseback or on foot. The primary economic industry of the Havasupai is tourism. Each visitor to the reservation pays an entry fee and many individuals of the Tribe work as mule skinners or packers.

The Havasupai desire a larger land base from which to develop their tourist industry, provide housing for an expanding population and to answer the emotional need for ancestral lands devoted to raising cattle and horses. The amount of land required to satisfy these needs varies with the intensity of the desires.

The National Park Service recognizes the desire and the need of the Havasupai Indians for a larger land base as well as its own Congressional mandate to protect from encroachment all national park lands of outstanding quality. The Master Plan for the Grand Canyon Complex thus supports the proposed study language in Section 10 of S1296. Full information must be the basis for land use designation so that these lands may be managed in such manner as to provide environmental protection and use compatible with the purposes of Grand Canyon National Park.

VISITOR USE

The whitewater, wilderness experience of running the Colorado River through Grand Canyon National Park has become increasingly popular in recent years. In 1972, there were 89,000 visitor/use/days used by commercial boat operators, and 7,600 visitor/use/days used by private parties. This amounts to approximately 16,400 visitors who "ran" the river in 1972. Beginning in the 1973 season and extending through the 1976 season, a new River Management Plan will keep river use at or below this level. This plan proposes to scale river use toward an environmentally determined carrying capacity and to phase out the use of motors on the river by 1977.

Beginning with the 1973 season, strict standards of safety, sanitation, licensing, and interpretation are being demanded of all commercial river operators. The maximum commercial/use/days allotted each month will be no greater than 25 percent of the operator's annual allotment. A maximum of 200 commercial passengers, and one party of up to 30 private users will be permitted to depart from Lees Ferry on any single day. Beginning in 1974, this number will be reduced to a total of 150. The maximum number of commercial passengers per boat will be 20 and the maximum number of passengers per commercial trip will be 40. Commercial trips will not travel more than 40 miles per day.

Commercial operators are being encouraged to begin conversion to oar operation, so they will be prepared when motors are phased out completely. It is anticipated that 20 percent of the trips in 1973 were oar-powered: A 25 percent reduction of motorized trips is encouraged for 1974, a 50 percent reduction in 1975, and a 75 percent reduction by 1976. By the beginning of the 1977 season, all trips, including National Park Service patrol trips, will be under oar or paddle power.

Ecological and sociological studies on the river will continue under the Master Plan, and be expanded both in scope and intensity. Research data gathered during each season will be analyzed and evaluated so that visitor/use quotas for the coming season can be established by mid-September each year. Indications of environmental degradation will be cause for immediate cut-backs on an annual, monthly, or daily basis so that environmental and wilderness qualities can be maintained to provide a quality wilderness experience for river users.

The canyon proper is the heart of the national park, and it is the view of this spectacle which draws millions of visitors to the park each year. Present visitor use patterns show that a majority of park visitors view the canyon from the developed areas on both rims. These areas of development will remain focal points of visitation, and no new areas of rim or Inner Canyon development are comtemplated in the Grand Canyon Complex Master Plan.

The protection and maintenance of natural conditions and a wilderness atmosphere have been paramount management objectives and practices on backcountry lands. Nothing in the way of human use has been permitted that would damage, impair, alter, or intrude upon the natural environment. Hiking trails are not maintained by motorized equipment. They are maintained only to those standards required for human safety. Wildfire is controlled as necessary to prevent unacceptable loss of wilderness values, loss of life, damage to property, and the spread of wildfire to lands outside the primitive areas. Motorized equipment is used in emergency situations involving the health and safety of persons, and to meet recognized management needs. To protect the resource from overuse, both hiking and camping registration and use limits have been established for these primitive areas. Current limitations on camping along the trail system within the canyon is as follows:

Indian Gardens	- 70 campers	Tonto East	- 15 campers
Phantom Ranch	- 65 campers	Horseshoe Mesa	- 15 campers
Cottonwood	- 40 campers	Hance Creek	- 15 campers
Roaring Springs	- 15 campers	Tanner Creek	- 15 campers
Clear Creek	- 20 campers	South Bass	- 15 campers
Hermit Creek	- 25 campers		
Tonto West	- 20 campers		

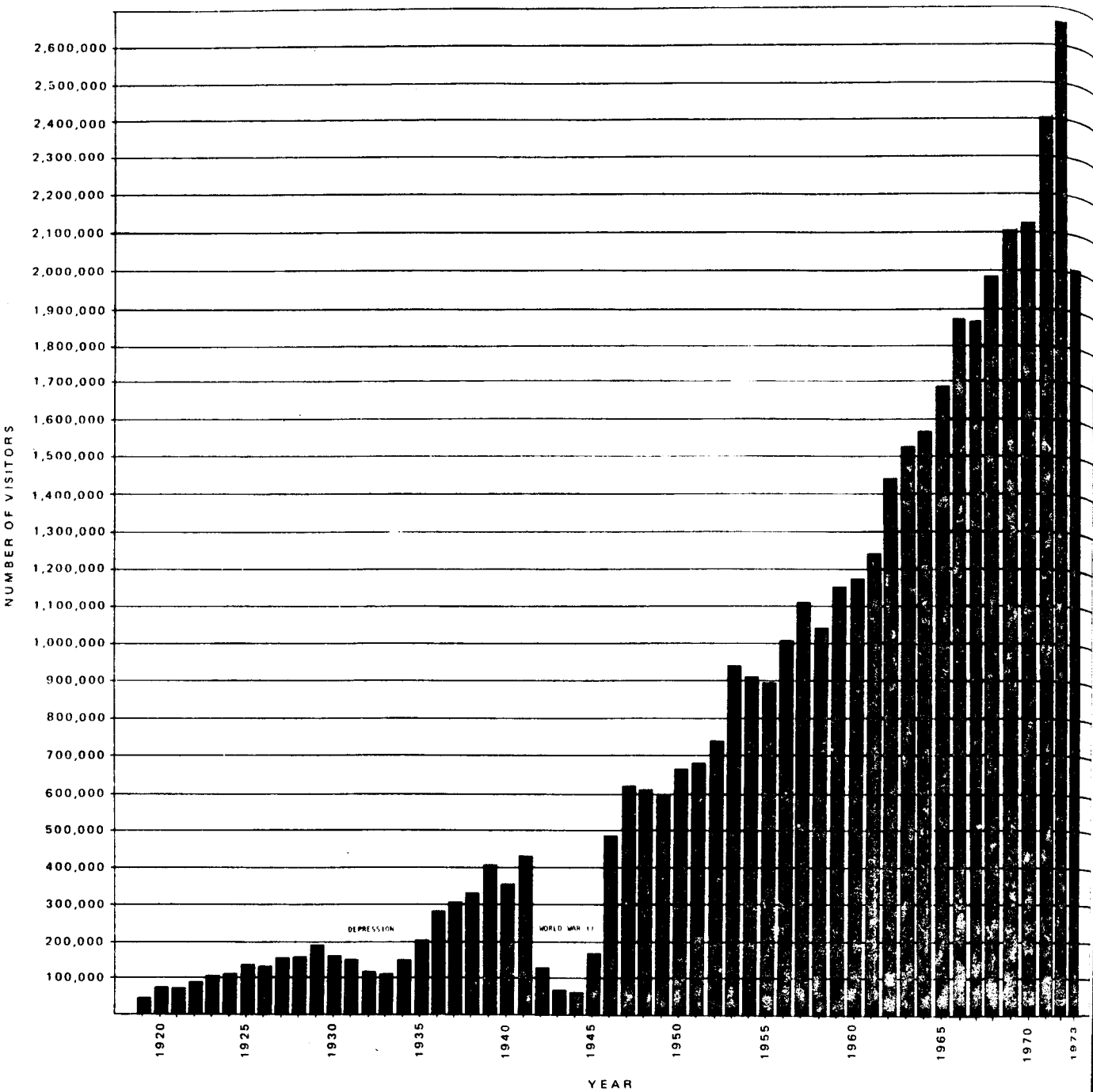
Visits to the National Park Service areas in the Grand Canyon region doubled in the decade of the 1960's to 4.8 million, and will probably double again during the 1970's. Travel to Grand Canyon National Park has also doubled in the last decade and approached 2-3/4 million visitors in 1972. By the end of the decade, it may easily reach the 4 million mark. The park is a major stop on the itineraries of summer travelers in the Southwest and West. A large number of foreign visitors make Grand Canyon National Park one of the principal stops on their tours of the United States. See page 82 for travel data.

Most visitors to the Grand Canyon stay only a few hours - just long enough to view the canyon from several viewpoints along the South Rim road system. During peak periods of travel, most visitors arrive and leave during daylight hours. Within the park are substantial overnight accommodations on the rims, capable of handling 3,500 people, and developed campgrounds with a total of 500 campsites. Approximately 500 rooms are available at Moqui Lodge and at the village of Tusayan, just outside the south entrance to the park in the Kaibab National Forest. Motel additions in the village of Tusayan will add 250 rooms by 1974. Camping sites are available 10 miles south of the park at the United States Forest Service's 10-X Campground. Several camper parking sites and campgrounds are being developed along Arizona 64, south of the park toward the city of Williams.

Private motels and campgrounds at and near Flagstaff and Williams, Arizona, can accommodate a sizeable number of visitors. Further expansion of campgrounds outside the park can be expected in proportion to the demand. This is exemplified by a 300-site campground currently being proposed for the Apex Siding area on the Santa Fe Railroad, just south of Grand Canyon Village and west of the Village of Tusayan. Cameron and Gray Mountain, 60 miles to the east of the park, have modest overnight accommodations. Although the tourist-oriented towns of Flagstaff and Williams are only 1-to-2 hours drive away from the park, hundreds of campers park along roads leading into the park during peak periods of visitation.

The undeveloped portions of the rim areas and the Inner Canyon have been managed as natural areas. A network of primitive fire and access roads are used by management and by the solitude-seeking visitor to reach remote, backcountry rim areas. Access to the Inner Canyon is by foot, horse, or muleback, and by boat from Lees Ferry. In 1971, more than 40,000 visitors reached the Inner Canyon by foot or muleback, and 11,000 users entered the canyon by boat. By contrast, an estimated 34,000 visitors saw the canyon from commercial, tourist air flights. The vast majority of the hikers use the trails in the Cross-Canyon Corridor between Bright Angel Point on the North Rim, and Grand Canyon Village on the South Rim. Backcountry wilderness trails require a greater degree of stamina and expertise on the part of hikers, than do the Cross-Canyon Corridor trails. The growing demand for an Inner Canyon hiking experience coupled with camping restrictions and limitations in the Cross-Canyon Corridor, is placing an ever-increasing load upon these historic trails.

Total Visitation 1919 - 1973
Grand Canyon National Park

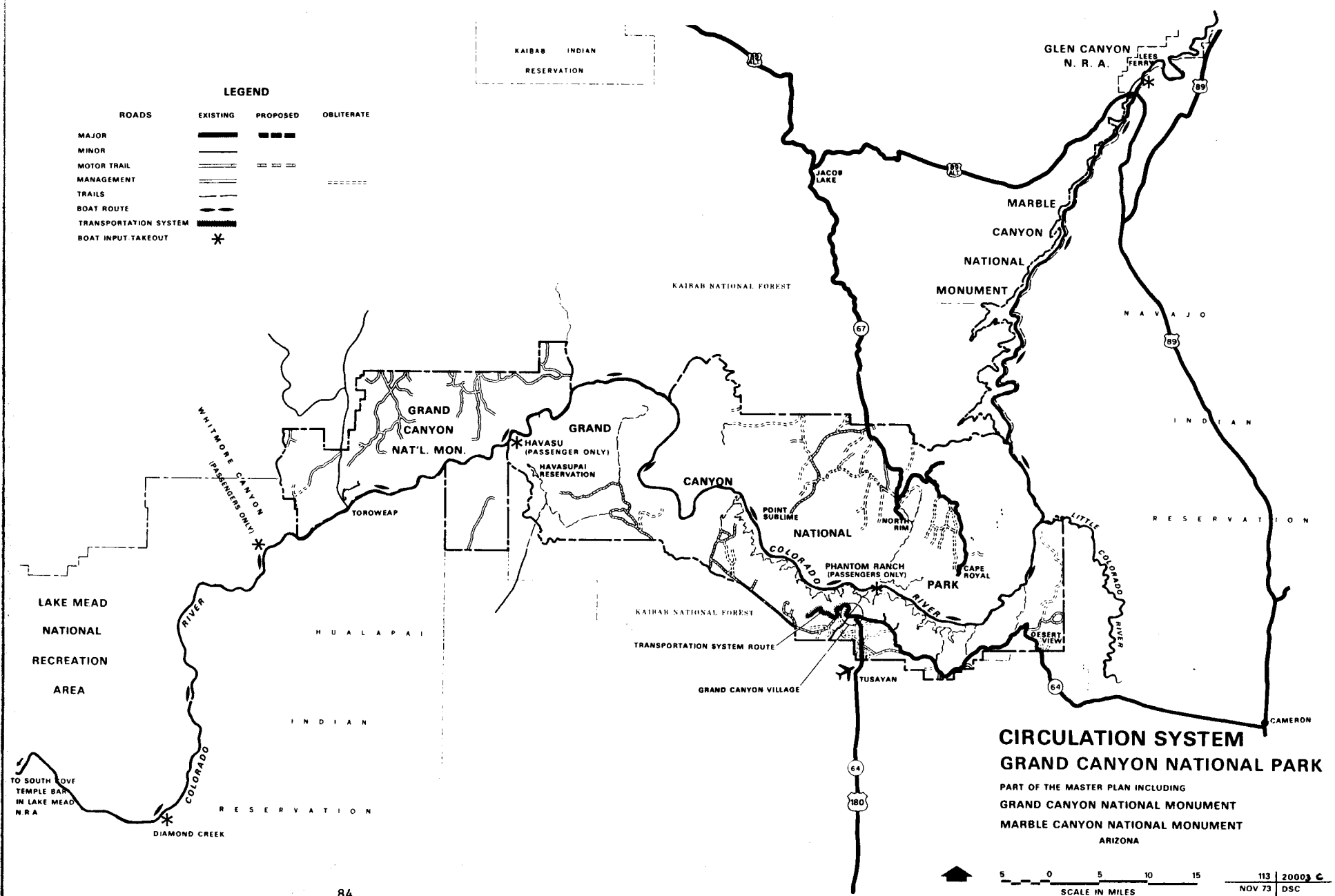


ACCESS AND CIRCULATION

Vehicular access to Grand Canyon is provided by two-lane paved roads from the south (Arizona 64 and U.S. 180), from the east (Arizona 64) and from the north (Arizona 67). The only vehicular access to Grand Canyon National Monument is over dirt roads. See map on page 84 for access and circulation routes.

Public transportation services to Grand Canyon are limited. Bus service is available to Grand Canyon Village from Flagstaff and Williams, but the runs are infrequent -- one or two runs per day. Air service is available from the Grand Canyon Airport just south of the park. Three main carriers provide service of 6 to 7 flights with connections to such points as Salt Lake City, Las Vegas, and Phoenix. Passenger rail service to Grand Canyon Village was discontinued by the Santa Fe Railroad in 1968. The resumption of such service, particularly in light of the current energy shortage, may once again become economically feasible. The Saratoga Transportation Company of Phoenix, Arizona is currently seeking a contract with the Santa Fe Railroad to provide passenger service from Phoenix to Grand Canyon Village. The reestablishment of such service would require considerable roadbed work on the section of track between Williams, Arizona and the canyon as the tracks are reportedly only safe for low speed travel.

Numerous road proposals are under consideration by the Arizona Department of Highways which may effect the planning for the Grand Canyon Complex. In essence these proposals would result in the park being encircled by paved highways only a few miles away from its boundaries. The road from Peach Springs, Arizona to Hualapai Hilltop is currently being paved. This highway will give the members of the Havasupai Tribe an all-weather route to the trailhead 11 miles south of the Village of Supai in Havasu Canyon. Future plans envision paving the Willaha Road, between Hualapai Hilltop and Arizona route 64 south of the park. A paved link between Interstate I-15 in the northwest corner of Arizona and Fredonia, Arizona has also been proposed. A short paved road would lead south from this highway to the northern boundary of Grand Canyon National Monument. Priorities and funding have not been wholly committed on these projects at this time, however the construction of such roads must be looked forward to as a possibility of the future.



THE FUTURE OF THE ENVIRONMENT WITHOUT THE PROPOSAL

Without implementation of the development and management actions proposed in the Master Plan, the environments to be most affected by these actions would continue to exist as at present, but with noticeable trends toward deterioration. The human environment of Grand Canyon Village would be subject to further degradation in that problems of inadequate employee housing, of congestion/pollution, and of a disfunctional relationship between the resident community and visitor services would not be resolved.

If Congress does not establish an enlarged Grand Canyon National Park, the natural environments encompassing the entity of the Grand Canyon will continue to be managed under conflicting land-use policies, which result in differing degrees of use and protection of the resources. Without visitor-use regulations, overuse of both the river and the backcountry would result in resource deterioration. Resource management programs such as prescribed burning and ferral burro control, would not be implemented, and the health of natural ecosystems could not be maintained.

3. ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

The Master Plan for the Grand Canyon Complex provides a general guide for the use, development, interpretation and preservation of Grand Canyon National Park, Grand Canyon National Monument, and Marble Canyon National Monument. It provides the metes and bounds within which specific plans for the area will be developed. Many of the environmental impacts implied by specific actions proposed in the Master Plan are readily apparent. The impacts generated by secondary effects or from conceptual direction given in the plan are seen much less acutely and may be far removed in time.

A development concept plan will be prepared for each area of concentrated development action within the park. A separate environmental analysis statement will be prepared to accompany each of these documents. Areas for which such plans will be developed include Grand Canyon Village, the North Rim, Indian Gardens, Phantom Ranch and Desert View. Public review and comment will be solicited as these plans are formulated, however, some of the impacts generated in these areas by the Master Plan can already be seen and will be outlined below.

The overall, anticipated impact of the Master Plan is that it will insure that the complex natural and cultural resources within the Grand Canyon will retain their integrity in the future and yet still be utilized for the edification and re-creation of visitors.

EFFECTS OF LAND CONSOLIDATION

Since Grand Canyon National Park, Grand Canyon National Monument and Marble Canyon National Monument are already under Federal ownership and administered by the National Park Service, the primary impact of consolidating these lands into a single national park will be to place all of the Grand Canyon in one management jurisdiction. This will provide for uniform regulations and standards of land use as well as simplify land use planning processes.

The areas added to the enlarged Grand Canyon National Park from Lake Mead National Recreation Area are also under National Park Service administration. The primary recreational loss here would be due to the prohibition of hunting. Hunting is not a current primary use in these areas. The Lower Kanab Canyon Addition and the Coconino Plateau Addition are from National Forest Lands. Timber harvesting, mining and hunting which are currently allowed on these lands would be prohibited once they became part of the National Park. Mineral resources have not been found on these lands, the timber resource is not extensive, and hunting pressures are minimal. The Lower Kanab Canyon Addition will bring all of the north bank of the Colorado River under the jurisdiction of the National Park Service. This single jurisdiction will eliminate any conflicts between single and multiple use land policies, improve management and provide for uniform regulation of the river resource.

The east rim of Marble Canyon will be added to the park only with the concurrence of the Navajo Nation. Land back from either rim of Marble Canyon will remain under its existing jurisdiction. All State lands within the Marble Canyon area will be acquired under appropriate exchange agreements. To insure that there is no impact upon the canyon resource from outside developments, a buffer, scenic easement, or similar safeguard will be obtained from those having jurisdiction along the rim. There will be no impact upon traditional Indian religious uses within the Marble Canyon area as the National Park Service honors such use and protection will be given to all shrines and sacred areas on park lands and on any lands that may be added to the park.

The joint study between the Havasupai Tribe and Federal agencies having jurisdiction over lands adjacent to the Havasupai Reservation may have an impact upon park lands. If it is determined that certain of these lands in the park are better utilized for grazing by domestic livestock than as part of the scenic and ecological base of the park environment, they may be deleted from the park and placed in reservation status. The extent of the lands involved if any in a possible deletion proposal cannot be determined without a thorough resource study. This study has not been completed at this time.

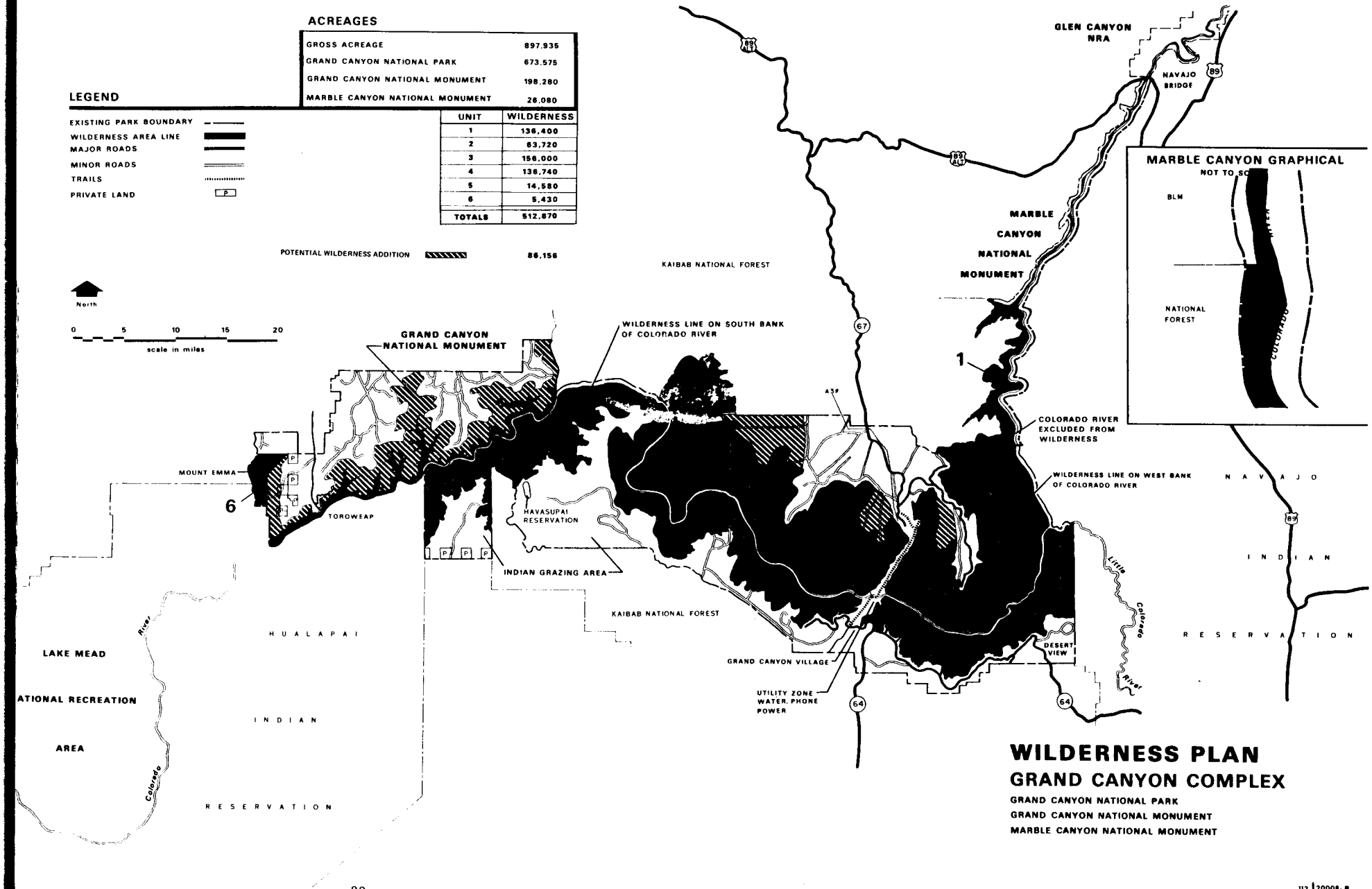
NATIONAL WILDERNESS PRESERVATION SYSTEM

The lands within the current boundaries of the park and the two monuments have been studied and evaluated for placement in the National Wilderness Preservation System. Legislation based on these evaluations has been prepared as has a environmental impact statement (FES 73-68 dated December 7, 1973). Potential wilderness areas in those lands proposed for addition to the national park will be evaluated and recommendations made when they become part of Grand Canyon National Park. The Wilderness Proposal is shown on page 88.

VISITOR USE AND ACCOMMODATIONS

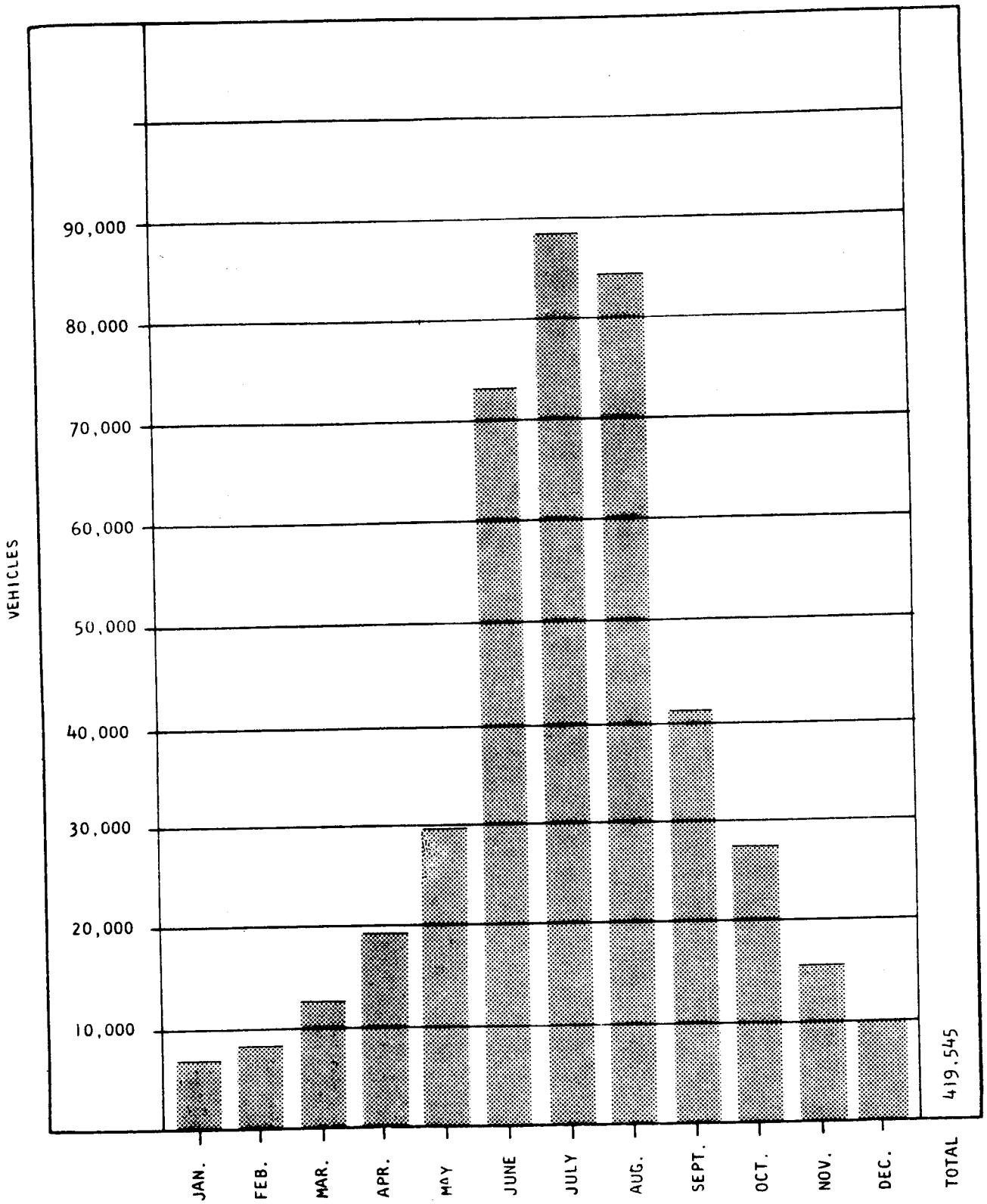
The current use pattern within the complex will change very little as a result of the Master Plan proposals. Heavily impacted areas will receive increasing amounts of visitor use and areas which currently receive little visitor use will continue to be little used by the vast majority of visitors. With increasing visitation, all areas will of course receive greater use but it will be one of degree rather than type.

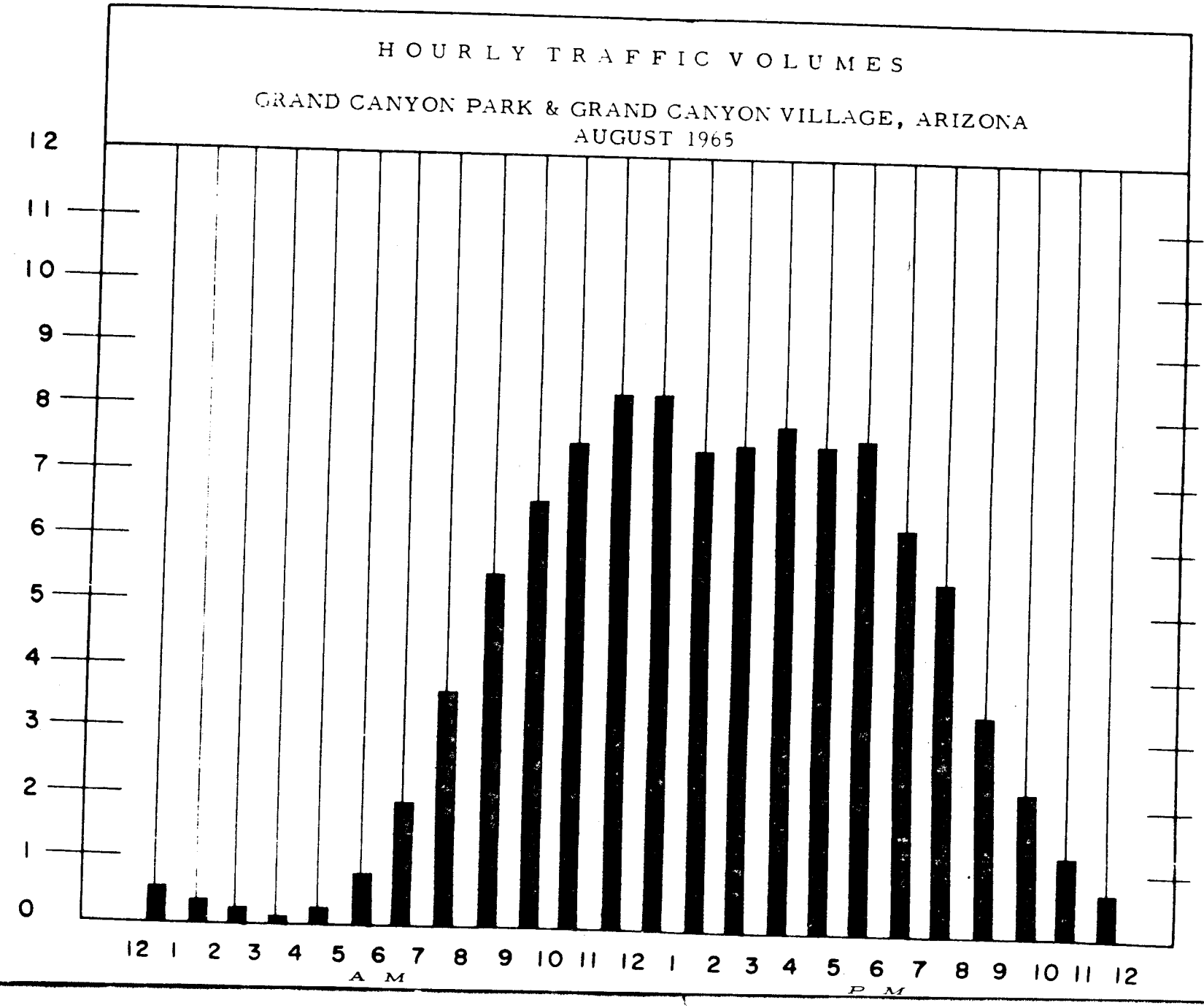
No studies have been done, and thus no data is available for the intensity of the present visitor load upon specific areas within the park. Therefore, no reasonable projection of the amount of visitor use spreading can be made at this time. That the visitor use load is very dependent upon the hour of the day and the season of the year can be seen from the traffic data shown on pages 89 and 90. Utilizing portions of the park in different seasons, than they are currently being used, seldom has the effect of spreading visitor load more evenly as far as impact upon the resource is concerned. The increased visitation in normally slack seasons is not withdrawn from the heavy use season and mearly increases total impact.


ACREAGES
GROSS ACREAGE 897,935
GRAND CANYON NATIONAL PARK 673,575
GRAND CANYON NATIONAL MONUMENT 198,280
MARBLE CANYON NATIONAL MONUMENT 26,080
LEGEND
EXISTING PARK BOUNDARY
WILDERNESS AREA LINE
MAJOR ROADS
MINOR ROADS
TRAILS
PRIVATE LAND
UNIT WILDERNESS
1 136,400
2 63,720
3 156,000
4 136,740
5 14,580
6 5,430
TOTALS 512,870
POTENTIAL WILDERNESS ADDITION 86,156
North
0 5 10 15 20
scale in miles
GLEN CANYON NRA
NAVAJO BRIDGE
MARBLE CANYON GRAPHICAL
NOT TO SC
BLM
NATIONAL FOREST
COLORADO
MARBLE CANYON NATIONAL MONUMENT
KAIBAB NATIONAL FOREST
GRAND CANYON NATIONAL MONUMENT
WILDERNESS LINE ON SOUTH BANK OF COLORADO RIVER
COLORADO RIVER EXCLUDED FROM WILDERNESS
WILDERNESS LINE ON WEST BANK OF COLORADO RIVER
MOUNT EMMA
TOROWEAP
HAVASUPAI RESERVATION
INDIAN GRAZING AREA
KAIBAB NATIONAL FOREST
GRAND CANYON VILLAGE
UTILITY ZONE WATER, PHONE POWER
DESERT VIEW
Little Colorado River
NAVAJO INDIAN RESERVATION
HUALAPAI INDIAN RESERVATION
LAKE MEAD NATIONAL RECREATION AREA
Colorado River
1
6
67
64
89
89T
WILDERNESS PLAN
GRAND CANYON COMPLEX
GRAND CANYON NATIONAL PARK
GRAND CANYON NATIONAL MONUMENT
MARBLE CANYON NATIONAL MONUMENT
113 20008-B
AUG 72 DSC

VEHICLES

PATTERN OF TRAFFIC VOLUMES
MONTHLY MOTOR VEHICLE ENTRIES
SOUTH AND EAST ENTRANCES COMBINED
GRAND CANYON NATIONAL PARK
1965





The facilities within Grand Canyon Village, along the South Rim from Hermits Rest to Desert View, within the Corridor Unit from the South to the North Rim, and on Bright Angel Point are the present areas of large visitation and intensive visitor use. The major impact of the Master Plan will be to spread this visitor use more evenly within these areas and confine it to these areas. The Master Plan seeks to reduce the impact per visitor upon the village by organizing related facilities into clearly and easily defined zones and by tying these zones together with a public transportation system. This will allow for a greater number of visitors to use the area without further degrading its remnant of naturalness.

The impact upon the remnant natural environment within the village area by the large-scale relocation and construction of facilities will be quite devastating. The village is located in an area of both pure and mixed stands of pinyon and juniper woodland and ponderosa pine forest. Both forest types are open and dry with much exposed, bare and rocky ground. Grasses and forbs of several species form the principal ground cover. Irregular patches of Big sagebrush seem to appear as an indicator of past fires or human disturbance. The shallow soils have been formed in place and are derived primarily from the underlying Kaibab Formation. The soils under both forest types are quite similar and differ primarily in water holding capability. The texture of the soil changes with depth from a sandy loam at the surface to a clay loam and then back to a sandy loam near bedrock. The water retention in the soil is determined by the depth to, and the thickness of, this layer of clay loam, the amount of protecting litter on the surface, and the amount of shade provided by trees and other plants.

During the spring and early summer months the soil moisture decreases and may remain below the permanent wilting percentage for several months. In this period the perennial plants must depend upon deep and extensive root systems to provide water as there is no water table near the surface for them to tap. Any disturbance of the clay loam layer, or the removal of surface litter which reduces soil temperatures and controls evaporation, will make the area essentially sterile for perennial plant growth. The movement of heavy construction equipment and the clearing of trees and further opening of the canopy cover will seriously impair natural re-vegetation.

The majority of trees in the South Rim areas where construction activities are planned are relatively young. Although all age groups are represented the average age of the mature pinyons and junipers is about 300 years and that of mature ponderosa pines about 250 years. Thus the present forest established itself during a period of increased precipitation in the southwest in the late 1600's and early 1700's. The adult trees of both species are drought resistant but their seedlings are not and the forest could not establish itself today under the adverse strictures of the present climate on the South Rim.

The biomass present in the pinyon and juniper forest along the South Rim has been estimated as approximately 200,000 kilograms per hectare, with slightly more than three quarters of this being contained in the trees and their root systems. The biomass in the ponderosa forest with its larger trees and greater amount of litter is significantly higher. Man's activities within the area of Grand Canyon Village over the past 100 years have made significant inroads into this forest and continued construction activities and forest clearing will essentially eliminate any remaining regenerative powers.

Only a semblance of a natural environment now exists within the village area and by selectively retaining screens of trees and through artificial revegetation and maintenance the Master Plan seeks to retain an air of quasi naturalness. The area of the village is only 0.3 percent of the total park acreage and thus the impact of construction and relocation activities will be relatively small, even though nearly total in the affected areas. By intensively developing small areas such as the village for visitor use facilities, the remainder of the park may remain free from intensive human use and impact.

The economic cost of redevelopment and construction are, of course, unavoidable impacts as are those disturbences of the human environment normally involved in any construction project. Noise, dust, esthetic impairment, litter, smoke and traffic problems are all impacts commonly associated with construction activities. These disturbences of the human environment will be localized and temporary in any one area but will probably be going on somewhere on an almost continuous basis throughout the life of the plan. No financial estimates have been made for the total cost of the plan.

By stabilizing the overnight facilities within the park, the Master Plan will eliminate the need for building ever-increasing numbers of motel and lodge units within the park, but will increase the demand for such facilities on the outskirts of the park. A restructuring of the village will also severely alter the historic scene of such railroad-related structures as the Santa Fe train depot and the El Tovar Hotel. Additional impacts upon the historic scene and historic structures are discussed under Historical and Archeological Impacts.

Use restrictions and regulations to protect the environment of the Inner Canyon have been prepared in a River Use Management Plan for the Colorado River. An Environmental Impact Analysis has been prepared for this plan and its impact has been adjudged as minor. A Backcountry Use Plan and a Natural Resource Management Plan are being prepared to insure the proper use and protection of park lands not devoted to intense human activity. A separate Environmental Impact Statement will be prepared for the Natural Resource Management Plan and an Environmental Impact Analysis will be prepared for the Back-Country Use Plan to determine if it needs the full analysis of the more formal impact statement.

The expansion of the campground on Bright Angel Point will result in little damage to the environment as no formal site clearing will be done and all sites will be reached by walking rather than by vehicle.

The Master Plan does not create or encourage increased backcountry use. However, as it does not discourage it, the use of the backcountry for hiking and camping will continue to increase with concommitant increase in the amount of human impact upon the natural environment. This impact is unavoidable if the primitive areas within Grand Canyon are to be utilized for the active recreation of the park visitor. The up-grading of trails and primitive roads for visitor safety will cause little or no impact upon the environment through which they pass and will not be done to the extent that it would encourage increased visitor use.

The Master Plan proposes no action which will increase the risk of natural catastrophes or the probability of man-caused accidents except for those associated with normal construction activities.

EFFECTS OF RESOURCE MANAGEMENT

One of the most significant impacts of the National Park Service resource management programs within the complex is that native plant and animal populations will have a much greater opportunity for survival than would be possible without these programs. Native species such as the prairie dog that have disappeared from the park because of man's activities will be, to the extent possible, reintroduced into their native habitats. Predators will not be reintroduced unless there is sufficient natural prey nor will animals be reintroduced whose natural predators no longer exist to control their population.

The impact of eliminating exotic species, such as the burro, from the park and reestablishing native species is considered to be a beneficial impact in developing a naturally evolving environment. Exotic and feral species compete with the native species and are by definition unnatural within the park. Elimination or reduction of exotic species will not be done when the methods involved are inhumane or endanger native species. Eliminating the feral burros and horses from park lands will not conflict with Public Law 92-195 of December 15, 1971. Commonly known as the Wild Horse Annie Act this law states in Section 2(e) that the public lands under the jurisdiction of this act are "... any lands administered by the Secretary of the Interior through the Bureau of Land Management or by the Secretary of Agriculture through the Forest Service."

The impacts of fire management in the Western Region of the National Park Service are detailed in the Draft Environmental Impact Statement for Integrated Fire Management prepared by the Western Regional Office. More detailed description and analysis of prescribed burning projects within the Grand Canyon Complex will be found in the Draft Environmental Impact Statement for the Natural Resource Management Plan, Grand Canyon Complex. This document is now in preparation and is scheduled for public release in mid-summer 1974.

The goal of ecosystem management is to reestablish the trend the environment of the park would have had if man had not interfered with it. Many of the immediate impacts of ecosystem management will be adverse but the long-term impacts are considered to be beneficial. Controlled burning, for example, will have the immediate destructive appearance of any burned-over area. With the exception of large trees, all vegetation will be burned and ground litter consumed by the fire. All surface mammals, birds, and reptiles will abandon the area or be destroyed in the fire. If the burning is done under properly controlled conditions it will be but a few short years until natural ecosystems are able to establish themselves and the scars of the fire are obliterated. One of the major impacts of controlled burning will be to eliminate excessive fuel buildup and allow for natural fires to run their course in the future without developing into holocausts. A beneficial impact of controlled burning is that it frees vital nutrients that are otherwise locked away in the forest litter.

Bare ground on the South Rim will attain temperatures of 120 to 140°F during the summer and exacerbate evaporation from the soil. Surface litter and the shade from plants ameliorate the rate of evaporation and help retain moisture in the soil. Therefore, controlled burning on the South Rim and allowing natural fires to burn within limited areas could produce severe impacts to the regenerative capability of the forest by creating bare soil areas. Such action will not be done without prior and intensive research studies.

RESEARCH IMPACTS

Research within the complex will provide knowledge of the current condition of the natural environment. From this knowledge the probable primeval condition of these resources can be established and the most feasible methods developed for reestablishing the natural evolution of that earlier state. It is obvious that native species cannot be successfully reintroduced, or habitats restored without significant research programs aimed at determining the probable quality, components, and extent of ecological elements in the park in its naturally evolving state. Trends in resource degradation must be identified as well so they may be halted or minimized.

The major impact of research will be to enable the National Park Service to more accurately, and thus more efficiently, manage the Grand Canyon Complex as a naturally evolving complex of ecosystems.

Park interpretation as well as resource management must be based upon a sound research program. Research will thus have a direct influence upon the validity and effectiveness of the park's interpretive program. Sociological research will add the human element and have the impact of more accurately defining the park visitors' needs and discovering what he obtains from his exposure to the environment of the park.

Another significant impact of ecological and environmental research within the complex will be the proliferation of knowledge that can be the basis for resource management in areas outside of Grand Canyon National Park. Non-resource oriented research is also to be encouraged for the sake of increasing our knowledge of the Earth. The park will thus serve as a great outdoor natural laboratory for research in such fields as geology, meteorology and hydrology which have ramifications far beyond the park's boundaries.

INTERPRETATION

The construction of a multi-media interpretive facility on the South Rim at Yavapai Point and increased emphasis on interpretation by all appropriate means throughout the complex, including the river, will have its greatest impact upon the park visitor. It is through effective interpretation that the National Park Service is able to utilize the prime examples of our natural environment to aid the park visitor in understanding his place and role within that environment. It is assumed that awareness will lead directly or indirectly to wise use of the environment upon which our existence depends. The quantity and quality and thus the effectiveness of this interpretation depend upon both the

EFFECTS ON CULTURAL RESOURCES

The historical scene of the historical structures within Grand Canyon Village has been drastically altered by the construction of newer facilities. The Master Plan proposes that all non-historic structures and non-interpretive facilities be eventually removed from the rim area. The impact of this proposal will be to reestablish many of the historical relationships between these buildings which existed during the founding period of Grand Canyon National Park.

Archeological sites and historic structures outside of the village area will receive additional preservation because of the additional recognition given to their values in the Master Plan. The greatest impact to date of the Master Plan has been to cause historical and archeological surveys to be made at a much earlier date than they normally would have been.

During the restructuring of the Grand Canyon Village there are several elderly structures which will be torn down to make space available for new developments. These will be structures which have been deemed by professional historians to lack the significance for National Register listing. This will be considered an adverse impact by those individuals who consider them vital to the interpretation of the development stages of Grand Canyon Village.

ECONOMIC IMPACT

The Master Plan proposes that overnight accommodations be limited within the complex. This will have the impact of creating a demand for and the construction of similar facilities on the outskirts of the park and in neighboring communities. Development construction within Grand Canyon Village will provide contracts for various construction firms and allied service businesses as well as additional employment within the area. Many of the skilled and semi-skilled workers will be drawn from the nearby Indian population.

The resident service community will increase in size in proportion to increases in park visitor travel. This will create additional income within the area but will also place increased demands and strains upon public utilities and services as well as the local school system.

No estimate of increased management or operating costs has been made for the Master Plan. However, the efficiencies provided through this plan are expected to reduce the cost per visitor served.

The known resources on the land base withdrawn from mineral and fuel extraction and timber harvesting are minor and will result in very little potential economic loss. The grazing potential of the withdrawn lands is poor at best and this will also result in little potential economic loss.

Presently existing restrictions on river and land use prevent full exploitation by various entrepeneurs and thus result in a loss of potential income. It goes without saying that the public lands entrusted to the National Park Service are not to be devoted to the full exploitation or profit of private enterprise. Thus this impact upon potential economic gain is considered to be minor.

The social implications of the park's Master Plan and its impact upon the resident population of Grand Canyon Village and the village of Tusayan are documented in the Draft Environmental Impact Statement for the Development Concept Plan on the Grand Canyon Village. The social and economic impact of the Master Plan upon the people living on the Havasupai Indian Reservation cannot be quantified at this time. The Master Plan supports the study language in S1296 and does not recommend transfer of any park lands to become Bureau of Indian Affairs Trust Lands until adequate studies can be made of the lands in question. Such studies will then enable adequate quantification of impacts upon the Havasupai Tribe to be made. Resolution of the Havasupai desires for a larger land base is now before Congress.

RESOURCE AND ENERGY UTILIZATION

For the most part, resources and energy will be drawn from without the park for the redevelopment of Grand Canyon Village. Fossil fuels and electricity will be used in increasing amounts as the village grows in population and handles more and more day-use visitors. The current water supply delivery and storage system is not expected to meet demands very far into the 1980's. The reclaimed water used in the village will find increasing uses as the amount of available potable water diminishes. By not allowing overnight accommodations to increase the Master Plan has the impact of stretching this valuable, nay essential, resource further into the future and allows for many more day-use visitors to be accommodated.

The Master Plan will have the impact of reducing air pollution, fuel consumption and costs to the park visitor by providing public transportation on the West Rim Drive and within the village. Because of its importance, a separate Environmental Impact Analysis is being prepared for the public transportation system.

The Master Plan recommends that legislation which enacts the boundary proposal also repeal the reclamation provision in the Act of February 29, 1919, which established Grand Canyon National Park. This provision now allows the Secretary of the Interior to permit utilization of areas within the park for the development and maintenance of a government reclamation project. However, Section 605 of Public Law 90-537, approved September 30, 1968, provides that Part I of the Federal Power Act shall not apply to the portions of the Colorado River between Hoover Dam and Glen Canyon Dam unless otherwise provided by Congress. Public Law 90-537 precludes the Federal Power Commission from licensing construction and operation of non-Federal hydroelectric power developments in the same area which includes all of the Grand Canyon Complex.

The effect of Public Law 90-537 is to preclude construction of hydroelectric dams in the Grand Canyon Complex without specific consent of Congress. As a result, the repeal of the reclamation portions of the Act of February 26, 1919, would have no impact on future hydroelectric dam construction in the area affected by the Master Plan.

Non-utilization of the hydroelectric potential of the Colorado River, as it flows through the Grand Canyon Complex is an irreversible impact only in the sense that the power that could be generated from it is not utilized at this point in time and at this specific geographic location. As long as the hydrologic cycle continues to function and as long as the Colorado River is allowed to flow into the canyon, the potential for hydroelectric generation exists. Should Congress decide that the national need to consume energy is greater than the national need for this national park to remain in a natural and unimpaired state then the Grand Canyon could be utilized as an energy resource.

Should the Congress of the United States so decide, then the permanent, long-term adverse environmental impacts of proposed dams and their benefits to the human environment would be properly weighed in the appropriate impact statements which would be required. As the physical resource remains untouched by the proposal of the Master Plan, its potential use as an energy producer remains unaffected - only its current legal status is affected.

4. MITIGATING MEASURES INCLUDED IN THE PROPOSED ACTION

Information will be provided at regional information centers located at major arterial junctions near the park as well as at the major developed areas within the park. The information provided will enable the park visitor to avoid many of the vacation conflicts which mar an otherwise enjoyable trip. Information will be provided on backcountry use of the park where the environment can present a hazard to the inexperienced or uninformed. Both resource protection and visitor safety will be enhanced through properly oriented educational and interpretive programs within the park.

Use limitations, carrying capacities, and regulations for visitor use of the park resources have been and are currently being developed. These carrying capacities and use limitations are designed to provide protection and to mitigate visitor use of the resource within the complex. They will be mollified only as a result of sound ecological and sociological research studies. It is not anticipated that these restrictions against overuse will have an adverse effect upon the resource or upon the park visitor.

For the park visitor who wishes to do more than just view the canyon from one of the overlooks, but who is unable or unwilling to hike into the backcountry, there will be many options. Beyond the motor trails, paths, and interpretive programs on the rims, commercial river trips will continue to provide access through the center of the Inner Canyon wilderness. Mule rides in the Corridor Unit, concession operated 4-wheel drive trips in certain backcountry areas, and scenic air flights will provide the non-hiker with additional opportunities to experience the canyon. The heart of the canyon, the Colorado River and the backcountry have not been reserved for the exclusive use of the hiker or backpacker.

Scientific studies will continue to be permitted by non-service scientists. The ongoing ecological and sociological studies on the river will be expanded both in scope and in intensity. Research data gathered each season will be analyzed and evaluated so that visitor/use quotas for the coming season can be established in the autumn of each year. Indications of environmental degradation will be cause for immediate cut-backs on an annual, monthly, or daily basis so that environmental values can be maintained.

Efforts will continue to be made to reduce the effects of scenic air flights on the backcountry and wilderness areas of the complex. River running concessioners will be encouraged to phase out the use of motors on river craft as soon as is economically feasible.

This reduction in motor use will enhance the wilderness and backcountry experience for both the river runners and the hikers and backpackers near the river.

Endemic infestation of forest insects or diseases and wildfires that threaten an unacceptable loss of environmental values, loss of life, damage of property, or which threaten to spread to adjacent public or private lands, will be controlled under National Park Service management policies. Where such occurs on areas designated as wilderness, they will be controlled under provisions of the Wilderness Act of 1964, subject only to any Secretarial limitations imposed.

Archeological surveys have been made and archeological clearance obtained from the Chief of the Arizona Archeological Center for several projects and plans for the park. These include a school residence; the public transportation route; the Grand Canyon Village as outlined in its Development Concept Plan (under contract no. CX800030014(9), Museum of Northern Arizona); a helicopter landing pad; and the wilderness plan. The National Park Service will continue to have surveys made and archeological clearance granted prior to any plan or action which might involve archeological values. Should archeological values be discovered through an action, all work will cease on the project until the significance of the values can be ascertained and the archeological site avoided, if possible. If a newly discovered site has significant historic or archeological merit it will be considered for nomination to the National Register. Salvage archeology will be undertaken only as a last resort.

The Master Plan for the Grand Canyon Complex does not propose to transfer, sell, demolish, or substantially alter sites of archeological or historical significance. The Master Plan does propose to continue to conduct historical and archeological research in accordance with the Administrative Policies for the Historical Areas of the National Park Service, Historic Preservation Policy and the Activity Standards, National Park Service, Part IV Professional Services, Historic Resource Studies and Management. Historic and archeological stabilization and repair will be accomplished at significant sites in accordance with Historic Structures Handbook, Part II, Ruins Stabilization; the Administrative Policies for the Historical Areas of the National Park System Preservation Policy; and Act to provide for the Preservation of Historic American Sites, approved August 21, 1935, (49 Stat. 666); an Act for Preservation of American Antiquities, June 8, 1906, (34 Stat. 225). All stabilization and repair work will be accomplished under the direct supervision of professional archeologists or historic architects of the National Park Service.

An Executive Order 11593, consultation under Section 106 of the National Historic Preservation Act of 1966 has been initiated with the Advisory Council on Historic Preservation and the Arizona State Historic Preservation Officer on the Master Plan proposals affecting cultural resources.

The approval and implementation of this Master Plan will be in accordance with Executive Order 11593, Protection and Enhancement of the Cultural Environment, May 13, 1971, and the National Historic Preservation Act of 1966, with the Criteria for Effect of Section 106 being applied to Federal actions affecting historic or archeological sites or properties.

All of the major development projects within Grand Canyon Village will be built upon or within areas which are already under some degree of development. Insofar as possible, utility lines and roadways will also follow old scars or disturbed areas. This will minimize the number of trees which must be removed from the area and the amount of ground cover which is altered. In all areas where the shade canopy is broken through the removal of trees or where the soils and ground cover are disrupted by construction and construction equipment movement, the ground cover will be replaced with a suitable material and in many instances revegetation procedures instigated. All revegetation work will be maintained for a number of years until the growth has taken and can survive and evolve without further help. This will in many cases require the use of reclaimed water during drought periods, surface mulching and the importation of commercially imported but native species of plants. Plants for revegetation purposes will not be obtained from less visited portions of the park but may be obtained from sites to be cleared for construction.

Construction projects such as those on Bright Angel Point will not only observe the protection of the natural environment and the esthetics involved in building within a natural area, but will also attempt to retain the traditional aspects of rustic cabin camping within the national parks. This has been a long-established facet of the visitors' experience on the North Rim, and is an historic aspect which is fast disappearing from the National Park System.

5. ADVERSE EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

At some time in the future, it is possible that there will be overflow camping and overnight accommodation pressures thrown on the areas surrounding the park. This would be as a direct response to camping and overnight limitations within the park. To the amount that this increased demand exceeds the ability of the nearby communities and camping areas to support such increased demands this would be an adverse impact and one which is hardly unavoidable if the park is not to become overrun with campgrounds and overnight facilities.

The option of constructing dams across the Colorado River within the Grand Canyon Complex for hydroelectric, flood-control, revenue-producing, or recreational purposes will be foregone if the recommendation of the Master Plan is followed. Existing legislation has revoked the authority to construct such dams, and the authority can be restored only by new legislative action. The revocation of the reclamation portion of the act establishing the park will reinforce the intent of Congress and undoubtedly be considered by many an adverse effect which could be avoided, but is considered unavoidable by the National Park Service to protect the natural aspect of Grand Canyon National Park.

The costs of operating and constructing an enlarged and renovated village are quite unavoidable as is the utilization of materials and energy involved in this increased operation. Although mitigated, there will be loss to the forest and woodland in the Grand Canyon Village area. This is quite unavoidable as the most functional placement of a facility will often not coincide with a previously disturbed area.

Short-term disturbances from construction activities are unavoidable in any plan which proposed redevelopment. Noise from such activities will be localized but still quite disturbing to those in the immediate vicinity. Dust and smoke abatement activities cannot be 100 percent effective and localized air pollution will certainly occur. The visual esthetics of construction areas will be impaired by construction activities and by litter related to those activities. Small amounts of vegetation will be destroyed surrounding the construction sites and the areas will have a raw or scalped appearance until natural or assisted revegetation can cover it. The movement of heavy, slow moving construction equipment will occasionally have to be done along the main roads of the park. Such movement will cause traffic congestion and concomittant irritation for the entrapped park visitor. Although these are short-term impacts for any single area, there will be a project going on some place in the park at almost any given time throughout the life of the Master Plan.

The loss of non-park uses such as mining, grazing, timbering, and hunting on lands added to the Grand Canyon Complex is unavoidable, but minor when viewed in the light of the amount of such resources or activities involved. This impact will be considered to be adverse by a few hunters, prospectors, and timber merchants.

The increased demands for public services and utilities caused by an expanding park support and service base are unavoidable. These demands are adverse, only to the extent that they exceed the availability of these resources in the region and the region's tax base.

The elimination of feral burros and free-roaming horses from the park will have an unavoidable impact upon the population of animals involved and the impact that these animals are how having upon the natural environment of the area. Direct reduction is a doubtful method at best for eliminating the entire population of these animals. Chemosterilents offer the best and most humane solution to this problem. The impacts upon the soil, biota and air quality by the proposed program of controlled burning will be unavoidable but will be short term.

6. THE RELATIONSHIP BETWEEN LOCAL, SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

The preservation of the unique combination of scenic, biotic, geologic, archeologic, and historic values in the areas covered by the Master Plan for the Grand Canyon Complex is a long-term gain for the environment and for this and future generations of Americans. Short-term, consumptive uses such as revenue-producing hydroelectric sites, lumbering, mining, or intensive visitor use and facility development would severely curtail long-term productivity of its educational and inspirational resources as well as its natural recreational resource.

Necessary roads, trails, buildings, and other developments designed to make the park accessible constitute a commitment to visitor convenience and may be looked upon as short-term uses. However, the small amount of land devoted to this purpose does not overshadow the long-term productivity potential of the complex as an outstanding scientific, educational and recreational resource. The long-term productivity potential of the area can only be fully brought out through certain short-term uses which maintain the resource, interpret it, and facilitate its use by the park visitor.

The short-term unavoidable disturbances from construction activities will be off-set by the long-term gains of a more functionally flowing visitation pattern and use within the areas of construction and the more adequate housing provided park employees.

As the Master Plan for the Grand Canyon Complex is, in the main, a conceptual document there is no data base from which to postulate detailed, quantitative estimates of the trade-offs involved between short-term use and long-term enhancement of the natural resource's productivity. This relationship will be more readily perceived as the detailed planning stimulated by the concepts in the park's Master Plan evolve.

7. ANY IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES WHICH WOULD BE INVOLVED IN THE PROPOSED ACTION SHOULD IT BE IMPLEMENTED

The proposals in the Master Plan result in few irrevocable uses of resources except where new facilities are proposed. New roads, buildings and other facilities brought about by the relocation and enlargement activities in Grand Canyon Village will disturb the native plant cover and the soils. The possibility of returning any abandoned or disturbed site to its original condition is remote.

Those lands proposed for acquisition would be permanently unavailable for multiple use or development for strictly economic benefit. This is an irreversible commitment of resources unless Congress later reverses its action.

There is no commitment of nonrenewable resources such as historic sites, rare plant or animal communities, animal habitats, minerals or mineral fuels. If archeological salvage is undertaken, loss of some cultural information is inevitable, which constitutes an irreversible commitment.

8. ALTERNATIVES TO THE PROPOSED ACTION

During the Master Plan studies and after public hearings on the Master Plan, various alternatives were investigated and analyzed. It is evident that the permutations of proposals for an area as large and complex as the Grand Canyon can be practically limitless. Only significantly different alternatives will be considered in this impact statement.

A. NO ACTION

The major elements of this alternative are:

--Maintain the present boundaries and management policies at Grand Canyon National Park, Grand Canyon and Marble Canyon National Monuments and Lake Mead National Recreation Area;

--Retain visitor and park support facilities in their present locations with necessary replacement and improvement to maintain a standard of adequate quality;

--Continue to implement changes in operational procedures in response to observed needs to preserve resources and to better serve visitors. These changes would be restricted within present broad management policy;

--Continue to coordinate and consult with others in the management of park resources and the provision of visitor services within the present framework.

IMPACTS

The lands that are part of the "Grand Canyon of the Colorado River" and not a part of Grand Canyon National Park would remain outside national park boundaries. This would result in continuation of difficulties in managing this ecological and geophysical entity and managing the use of the Colorado River through the canyon. Research programs, resource management practices, visitor and public use regulations would continue to be discontinuous across the various boundaries. This will result in delay or impossibility in discovering needed changes in resource management causing unknown and unquantifyable harm to ecosystems. The establishment of visitor use monitoring and control will be hampered causing over and under utilization of various areas of the Grand Canyon. These impacts can be mitigated somewhat through close cooperation among the land managers to coordinate activities such as funding of research, implementation of common resource management practices and visitor use regulations, and surveillance. However a degree of inefficient, redundancy and conflict will continue.

Retention of visitor and park support facilities in their present locations will result in a continuing increase in present impacts.

--The visitor experience would continue to be compromised and lessened due to improper location of facilities.

--Land presently impacted by heavy use would continue to be opened to heavy use.

--No new areas would be opened to heavy use.

--Disruption of soils vegetation and wildlife due to construction and new and increased use would not occur.

--No increase in day-use capacity with resultant increase demand on water supply, sewage disposal and other supporting land use would occur.

--Social conflict among park day users, park overnight users and park residents would continue.

--Aesthetically and physically intrusive development would continue to restrict visitor use and enjoyment of the canyon rim.

Implementation of the no action alternative will cause a continuation of present resource management practices with only some change. Irreversible major resource damage caused by overuse would not be permitted to occur. Visitor use would be restricted to ensure resource preservation. Increased levels of maintenance funds would be expended to compensate for or ameliorate resource damage.

Unavoidable impacts to the park resources would be:

--The integrity of historical and other cultural resources would continue to be compromised by noncompatible and conflicting use. Recreation of the historic scene would not be possible.

--Deterioration of the river ecosystem that cannot be mitigated without major change in present practices would continue.

--Failure to accelerate elimination of adverse management practices would result in irretrievable damage. E.g. present fire policy and ferral burro control policy would continue causing unquantified harm to vegetation, soils and wildlife.

Coordination with others inside and outside park boundaries would continue within present framework.

Use of park land would not be proposed for transfer to the Havasupai. Present limited use of park lands would continue and less restrictive use of present park lands, by the Tribe would not occur.

Encouragement of development outside the park would continue, however, without definite criteria resulting in less orderly and poorly planned private development.

B. REMOVAL OF SOUTH RIM VILLAGE ACCOMMODATIONS AND SUPPORT FACILITIES

The principal elements of this alternative are removal of all visitor and park support facilities except those directly related to rim access, interpretation or protection and relocating them outside the park boundary. Historic building and interpretive structures, that are required for the effectiveness of visitor appreciation of resource values would remain. Mass transit using existing roads would be the only means of mechanized access to the rim.

Relocation of government facilities would occur on public land (U.S. Department of Agriculture, Forest Service) outside the park. Most concessioner facilities would also relocate to public land, however, some of the presently provided services may relocate to private land, e.g. in Tusayan or Williams.

IMPACTS

Removal of development and associated relatively intensive use directly affect the land area presently occupied.

Resource management techniques will permit this land through time to revert to a natural or near natural state.

--Facilities and uses that presently conflict with visitor resource appreciation will be eliminated. This includes automobile traffic with its visual, noise and air pollution intrusions; lodging housing and food service with its visual intrusions and its use conflict;

--Relocation of the development and associated use would affect receiving land and its present use. The magnitude of this impact would obviously depend upon where it would occur. U.S. Department of Agriculture, Forest Service land within the Kaibab National Forest and private land in Tusayan are closest to the South Rim and would probably be most heavily impacted.

--Land in a relatively natural state would be developed with resultant impacts of vegetation, soil, water runoff, and wildlife.

--Domestic water is not available in any appreciable quantity on the South Rim or adjacent to it. Water would either be shipped from where it is available or the present South Rim supply from Roaring Springs extended to serve the new community.

--The economy of Tusayan would be stimulated principally through the supply of services to park visitors.

--The permanent and transient population of Tusayan would greatly increase causing an increase in the need for community services such as schools, police and fire protection.

Most of the structures and the existing utility infrastructure and many of the roads on the South Rim would be obliterated and new construction provided at the new location. Economic inefficiency would result causing an increase in Federal concessioner and other private spending. Economic impact on the Federal Government will be relatively minor. However, the impact upon the concessioner and private sector would be sever resulting in a lesser quality and quantity of service and in higher costs to park visitors.

Transporting visitors from the area of relocation to the canyon rim would result in additional impacts.

It is estimated that by 1980, 40,000 visitors will arrive daily at peak periods. It would require a fleet of 21-100 passenger buses, operating on 1.5-minute intervals to adequately accommodate the visitation, during the busiest period. Operation on a reduced schedule would be required for an additional eight hours per day. Total bus-miles per day to transport the 1980 projected visitation would be 5,500. The cost of 21 buses would be approximately $1.4 million. Additional equipment and operating facilities would bring the initial expenditure to at least $2 million. The annual operating expense would be about $900,000.

At present day visitation annual operating costs would approximate $675,000.

C. REMOVAL OF ACCOMMODATIONS AND SUPPORT FACILITIES FROM THE NORTH RIM

An alternative similar to alternative B. was considered for the North Rim. Part, or all, of the developments could be removed from Bright Angel Point and reestablished outside the park on what is presently national forest land. The North Rim would then be managed for day-use only.

This idea was rejected on grounds similar to those for rejecting the alternative of moving Grand Canyon Village outside the park boundary. Such wholesale movement and relocation of developments and facilities would be almost prohibitively expensive and little would be gained from such a massive relocation. Potable water would have to be pumped at least an additional 17 miles to the new development from Bright Angel Point. Park visitors would be denied the opportunity of staying overnight on the rim of Grand Canyon. The scars left behind would be difficult to revegetate, and it would be many years before any semblance of a natural environment reestablished itself on the point. If the relocation were total, it would mean that the North Rim Lodge would be razed. This is one of the few remaining "Grand" lodges in a National Park Service area.

The Forest Service was unable, at that time, to participate in joint planning with the National Park Service to establish possible site locations for this alternative. However, the destruction and disruption of the natural environment caused by such a massive relocation of developments and facilities to any reasonable site would be quite severe.

D. INTENSIFY USE OF PARK

A greater utilization of the park for visitor use and accommodations can be made than is proposed in the Master Plan for the Grand Canyon Complex. Overnight accommodations could be allowed to meet increasing demands, entertainment facilities could be developed, the number of paved roadways increased, mechanical transportation to the bottom of the canyon attained, developed areas such as Bright Angel Point and Desert View expanded and new development areas created along the rims, unlimited motorized access allowed on the Colorado River and aircraft restrictions lifted.

Increasing developments outside the currently developed areas would consume and impact upon increasing amounts of the natural and human environment of the park. Even if the developments are kept small and the access roads to them narrow they cut the natural environment into smaller and smaller pieces and destroy its integrity as a viable ecological unit. Any development or facility which would detract from the natural scene of the canyon as viewed from the rims or from within

the canyon would be considered undesirable and destructive to the resource protected within the park. Motors both on the river or in the air detract from the natural wilderness preserved in the canyon and are perhaps worse than visual impacts as you cannot simply close your ears to escape from their noise. Unrestricted use of the back-country and the river would soon produce problems in sanitation, human health, and resource degradation. None of the many environments preserved within the complex can be considered sturdy and capable of withstanding heavy visitor impact without degradation.

1. The North Rim

If the developments and facilities on Bright Angel Point were to be expanded apace with those in Grand Canyon Village, then some method of increasing and encouraging travel to the North Rim would have to be found. Some form of mass transit system could be developed from Jacob Lake to Bright Angel Point. There are no major cities nearby from which to draw visitors; therefore, it is unlikely that such a transit system would be effective in increasing travel to the North Rim. At the present level of visitation, and in view of projected trends, it is doubtful if the expense of a lengthy transit system could be justified on the grounds of efficiency, economy, or protection of the natural environment.

Assuming that an effective means of encouraging visitation to the North Rim were devised and that increased visitation warrented expanded services and support facilities, the resultant developments would totally change the character of the North Rim. Its value as an out-standing scenic resource, with opportunities for both relaxed viewing and the more primitive backcountry experience, would be lost.

2. The Canyon

It has been suggested that an increase in the use of the canyon could be accomplished by some efficient type of people-moving device such as a cog railway, a tramway, or an elevator. The only means of access into the canyon, at present, is by foot or mule.

A tram was considered for the South Rim, beginning at Yaki Point, just east of the Kaibab Trail, and terminating across the river ¼ mile from Phantom Ranch. The two-car tram system would follow the Kaibab Trail to the Tonto Plateau, halfway down the canyon, continue along the trail alignment, and cross the river to shore level. The system would require 4 towers: the first, recessed in the rim, a second on the Tonto Plateau, another below, and the last across the river. Major construc-tion would be necessary to house the cable and power source at the rim and for the tower and viewing platform on the plateau, as well as for the anchorages below.

A tramway would impinge upon the naturalness of the canyon view for the majority of park visitors. Although only slightly visible from the South Rim development and the Bright Angel Trail, it would be impossible to hide even in the recess of a side canyon as it would, of necessity, have to cross the broad and open Tonto Plateau to reach river level. It would be highly obtrusive to those hiking the Kaibab Trail. It is assumed that the tram would allow many more people to experience the inner canyon and to bring the visitor closer to the resource. However, the tram itself could become the attraction, rather than the opportunity of viewing the resource.

The concept of a tram in Grand Canyon National Park is in conflict with National Park Service policies for the administration of natural areas in that only those recreational activities "that can be accommodated without material alteration or disturbance of environmental characteristics or the introduction of undue artificiality into a natural environment are to be encouraged." The canyon is the prime resource, in terms of both esthetics and naturalness. Towers, cables and scars were not considered appropriate in this instance. A more appropriate use of a tramway was considered for the Glen Canyon NRA. The tram system for Glen Canyon was proposed to originate below the dam. The visitor, in this instance, would view the manmade structure, as well as experience the ride from the rim to the river. In terms of regional planning, the opportunity of providing the visitor with this specific experience would not be lost if the tram in Grand Canyon were not constructed.

Further advantages of the tram, however, were considered. In the event that the tram were constructed, the possibility of phasing out or eliminating mule use along the Kaibab Trail would become feasible.

At present, the requests for mule trips each year outstrip their capability. The trip by muleback is strenuous, and those not in good physical condition, the poor, the young, and the heavy are prohibited from making the trip.

On the other hand, hiking use has increased and a conflict between these uses has arisen. The environmental condition of the trail does not always meet the expectations of the visitor. An obvious solution is that of the tramway. Not only could the same or a greater number of persons be accommodated, but supply to Phantom Ranch could be achieved without the use of the mule. Eliminating mules from the canyon would also remove two concessioner barns, a blacksmith shop, and 34,000 square feet of corral space from Grand Canyon Village. The National Park Service would be able to eliminate a barn, a blacksmith shop, and 7,400 square feet of corral space. The accident potential between mules and automobiles in the village or between mules and hikers on the trails would be eliminated. Resupply to Phantom Ranch which is now done by mule strings could easily be done by tram which could operate during the night.

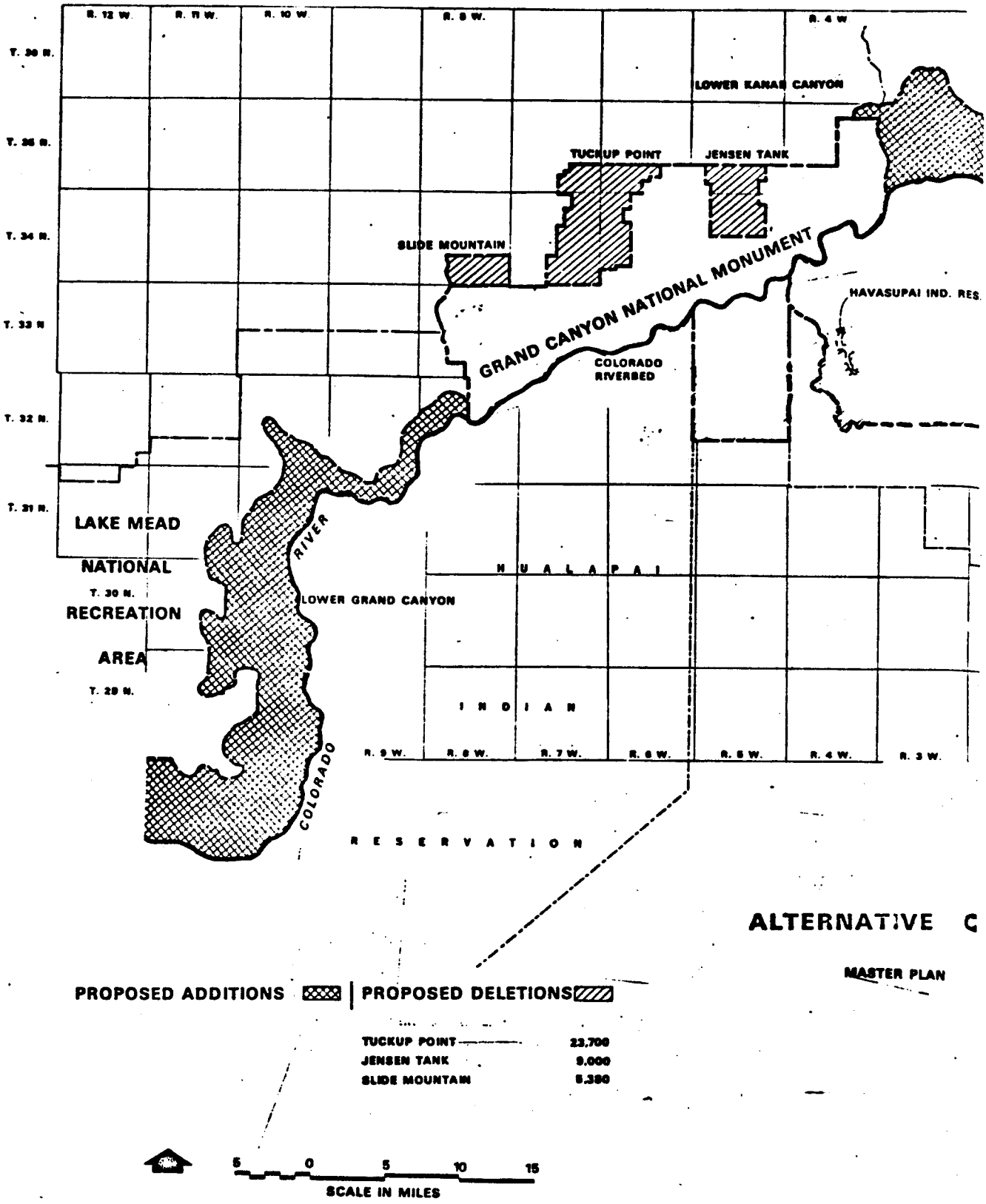
However, with all advantages in mind, the mule trip to the bottom of the canyon is still considered an unusual experience and one not readily provided in other units of Federal, State, or local park systems. Further consideration of the mule problem will be discussed in the development concept plan for the North Rim.

An elevator was considered as a compromise to an exposed tramway. This elevator would utilize the shaft of the Little Orphan Mine just west of Grand Canyon Village. The shaft would be deepened to the base of the Redwall Limestone and a lateral tunnel driven to gain access to the Tonto Plateau. Used primarily for access to the rim from the canyon, it would eliminate 3,300 feet of climbing for the hikers, and thus, encourage many more people to enter the canyon on foot. The exit at the base of the Redwall would be hidden from all South Rim viewpoints, and because of the distance, from the North Rim as well. It would, thus, not be intrusive upon the canyon view. The technology is available for this project at the present time; however, the Little Orphan Mine property will not be available until 1987 when it will become the property of the National Park Service.

E. LESSER LAND ACQUISITION AND DELETIONS

The boundary realignment proposed in the Master Plan was made with the view that the Grand Canyon is the resource that is to be protected within the park. The minimum requirement for this is the 277 miles of river canyon from near Lees Ferry Arizona to the Grand Wash Cliffs with all of the land included from rim to rim. Land is required back from the rims on which to view the canyon and the maintenance of a natural park environment is necessary here as well. This means that the rim lands must extend back from the rim a sufficient distance to provide protection from man's other intrusions and a sufficient distance so that the natural environment of the rims can maintain itself against man's actions without the boundaries. Lands not having National Park quality and not required for access, interpretation, protection or any of the above reasons should be deleted from the park and put to more suitable purposes.

One of the possible configurations for the park boundary is shown as alternative C. on page 114. This was considered as a viable alternative to the present plan during the preparation of the preliminary Master Plan. This alternative would delete three parcels of land totaling 38,080 acres from Grand Canyon National Monument from the enlarged national park.


R. 12 W.
R. 11 W.
R. 10 W.
R. 9 W.
R. 4 W.
T. 36 N.
T. 35 N.
T. 34 N.
T. 33 N.
T. 32 N.
T. 31 N.
T. 30 N.
T. 29 N.
LOWER KANAB CANYON
TUCKUP POINT
JENSEN TANK
SLIDE MOUNTAIN
GRAND CANYON NATIONAL MONUMENT
COLORADO RIVERBED
HAVASUPAI IND. RES.
LAKE MEAD
NATIONAL
RECREATION
AREA
RIVER
COLORADO
LOWER GRAND CANYON
H U A L A P A I
I N D I A N
R E S E R V A T I O N
R. 9 W.
R. 8 W.
R. 7 W.
R. 6 W.
R. 5 W.
R. 4 W.
R. 3 W.
ALTERNATIVE C
MASTER PLAN
PROPOSED ADDITIONS
PROPOSED DELETIONS
TUCKUP POINT 23,700
JENSEN TANK 9,000
SLIDE MOUNTAIN 5,380
5 0 5 10 15
SCALE IN MILES

IATIVE C

ASTER PLAN

Jensen Tank (9,000 acres), Slide Mountain (5,380 acres) and Tuckup Point (23,700 acres) are upland areas well back from the main canyon. The vegetation is dominantly composed of stands of pinyon and juniper trees with intervening areas of sagebrush and grass. Portions of all three areas are currently being grazed under lifetime permits. In the early planning stages for the Grand Canyon Complex it was felt that this land was better suited for grazing and other multiple uses than as part of the Grand Canyon Complex. The majority of the land would be placed under the jurisdiction of the Bureau of Land Management which presently controls the adjacent land use. Some of the land would be traded with individuals for inholdings within the monument.

Archeological surveys and preliminary excavations, however, indicate that these areas are very rich in Pueblo cultural remains. These studies have been done, and are being done, primarily by archeologists and students from the College of Southern Utah. As an example of the site density in these areas, eighty-five sites have been found in the fifteen percent of the Jensen Tank area that has been surveyed. There are no comparable sites in the rest of the Complex which provide information on this particular time span of human occupation in the area. Significant sites can be excavated, stabilized and interpreted to the park visitor.

Studies of bighorn sheep indicate that these upland areas are crossed and used by these animals. Deletion and boundary fencing of these lands would deny the bighorn access to these areas. This was not known during the earlier stages of master planning. As shown in the map of Alternative C, Tuckup Point and Slide Mountain would be shaved from the edge of the monument. However, Jensen Tank would protrude as a salient of non-confirming uses into the proposed enlarged park. Thus, any incompatible use such as vegetation chaining, rodent extermination, hunting, would have far more impact upon the surrounding park lands than it would if this boundary were tangential to the park.

It is felt that the archeological resources in these areas warrant their retention within the enlarged park. Not only do these sites provide an additional interpretive resource within the monument area and provide information vital to the understanding of human occupancy of the Grand Canyon but they also fill in a regional blank-spot in the archeological story of the southwestern United States.

The Lower Grand Canyon Addition shown in Alternative C does not extend down the Colorado River beyond river mile 234. This was also an alternative provided by the preliminary Master Plan. Stopping the addition at this point would not place all of the Grand Canyon within a natural

area unit of the National Park Service. The downstream lands would remain in Lake Mead National Recreation Area. Recreational uses of the land bordering the river would thus remain more flexible than they would be if placed in the natural area category of Grand Canyon National Park. However, the goal of the Master Plan for the Grand Canyon Complex is to place all of Grand Canyon within natural area classification so that it can be managed as an ecological whole. Stopping the enlarged park at river mile 234 would not accomplish this goal. The proposed addition to river mile 277 extends back from the river only to the inner rim of the canyon and as the river downstream from Separation Rapids will remain within the recreation area. Thus, the current recreational uses of the area such as motorboating and hunting will continue without impairment or restriction due to the expanded park.

F. BY-PASS ROAD

A by-pass road, outside the park, from near Desert View to the village of Tusayan was proposed as an alternative to allowing private automobiles on the East Rim Drive. This by-pass road could not follow any presently established primitive or secondary roads for any appreciable distance, and would cut through heavy stands of ponderosa pine in the Kaibab National Forest. The road would be nearly 30 miles long and have to cut through the 800-foot rise of the Grandview Monocline. Those visitors who wished to view the eastern portion of the park and travel east-west across the park as well would have to leave their automobile at one end of the East Rim Drive, make the trip out and back by a public transportation system, and then take the by-pass road in their automobile.

This alternative was not considered feasible because of the expense of such a by-pass road, the loss in time and energy created by making the trip a triple-transit of the 30-mile stretch of country, and the necessity of needlessly destroying 30 miles of the natural environment by a new roadway. Also, as has been discussed under alternative B. above, mass transit is a significant economic burden that should not be undertaken unless amply justified. If the State of Arizona desires a road to link east-west traffic which is not park bound, then a much better route may be found a number of miles to the south of this area. A 16- to 17-mile-long road could link Routes 89 and 180 just north of the San Francisco Peaks. It would cross relatively level country covered dominantly by grassland and lava flows. This route would link east-west traffic and provide for a scenic loop drive from the city of Flagstaff around the San Francisco Peaks.

Close examination of the East Rim Drive reveals that of the twenty-three miles between Desert View and the South Rim Village only about three miles actually encroach on the Rim. This does not seem excessive for a scenic drive. However, if vehicle congestion became intolerable in the future, short individual by-pass roads could be constructed at each problem area. All encroachments could be removed with about six or seven miles of road construction. Existing overlooks could then be reached by short spur roads such as those already existing at Yaki Point and Grand View Point. If increasing future traffic caused serious overflow of these areas including Desert View, they could be served by short, relatively economical shuttles from parking areas constructed along the main road.

9. CONSULTATION AND COORDINATION WITH OTHERS

1. Consultation and Coordination in the Development of the Proposal and in the Preparation of the Draft Environmental Impact Statement

Public hearings on the preliminary Master Plan proposal were held in Phoenix, Arizona on May 14, 1971, and at Grand Canyon National Park on May 17, 1971. In addition, public comment was solicited by legal notice in the local newspapers of Williams and Flagstaff, Arizona and of Kanab, Utah. The preliminary plan was mailed to organizations and individuals to solicit their comments and/or attendance at the public meetings. The proposal was also available for public inspection at the following locations: Grand Canyon National Park, National Park Service Southwest Regional Office, and in the National Park Service offices in Washington, D.C. The proposal has been coordinated with the Bureau of Indian Affairs through correspondence and meetings between the Park Superintendent and the BIA. The Bureau of Reclamation was contacted, and their correspondence indicated no conflict with the proposed Master Plan. In addition, the authority to construct dams within the Grand Canyon Complex can only be invoked by Congressional action. As a result, further coordination with the Bureau of Reclamation was not considered to be necessary.

Participation in the meetings was good with 52 organizations responding and 602 individuals making written or oral comments. Many of the individual responses were of a finer nature than the concepts and directions given in a Master Plan document and will be more fully responded to in the more detailed planning of park actions and facilities. All responses to concepts and actions proposed in the preliminary Master Plan have been taken into consideration in the preparation of the final Master Plan on which this Environmental Impact Statement is written.

Statements made at the public hearings on the preliminary Master Plan by the Governor's Office, State of Arizona indicate that the State of Arizona opposes any redesignation of portions of Lake Mead National Recreation Area to that of a natural area such as Grand Canyon National Park. The State fears a loss of hunting lands and revenue and decries the potential loss of the Hualapai (Bridge Canyon) dam site. The State is very much in favor of constructing this dam to provide money for other water development projects in the state such as the Central Arizona Project. A dam and a recreational reservoir would provide income for the Hualapai Tribe, increase tourism into the state, and increase recreational expenditures within the state. The State is also opposed to controlled burning on the North Rim and prefers instead to harvest the mature stands of trees.

The Hualapai Tribe shares the Governor's feeling about the Hualapai (Bridge Canyon) dam. The tribe feels it is a partner with the Arizona Power Authority and, "insists upon reserving the right to construct, or allow to be constructed, a dam across the Colorado River at the Bridge Canyon dam site." The primary concern of the Navajo Nation at the

preliminary Master Plan hearings was to preserve traditional religious uses of the eastern side of Marble Canyon. The primary concern of the Havasupai Tribe was to preserve the beauty of Cataract Canyon and to incorporate park lands into the reservation.

To incorporate the responses of the 52 organizations and more than 650 individuals within the body of this statement or to attach them as an appendix would result in an unwieldy and redundant document. Ample opportunity for further comment by these and other organizations, agencies, and individuals is provided by the exposure of intent and public availability of the Master Plan for the Grand Canyon Complex and this Environmental Impact Statement. The Final Environmental Impact Statement will address itself to these further comments.

Additional meetings have been held between the park superintendent and members of his staff with the Havasupai Tribal Council and members of the Tribe at Supai and at Williams, Arizona. The actions and intent of the Master Plan for the Grand Canyon Complex were explained at these meetings and the Havasupai voiced their opinions for consideration and inclusion in the plan. The Havasupai do not consider the park lands under their present special use permit for grazing to have been part of the Indian Claims Commission settlement of $1.24 million. They feel they retain ancestral rights to approximately 175,000 acres of park land and a similar amount of Forest Service land. They strongly oppose any study language in S1296. They feel that enough "studying" has been done and that the lands in question should be added to the reservation as Bureau of Indian Affairs Trust land.

Requests for written responses and public testimony at the public hearings resulted in participation from the following agencies and organizations:

State of Arizona, Governor
U.S. Department of Agriculture
  Forest Service, Region 3, Albuquerque, New Mexico
  Forest Service, Kaibab National Forest, Williams, Arizona
U.S. Department of the Interior
  Bureau of Indian Affairs
Aircraft Owners and Pilots Association, Glendora, California
American River Touring Association, Oakland, California
Appalachian Mountain Club, Boston, Massachusetts
Arizona Cattle Growers Association, Phoenix, Arizona
Arizona Conservation Council, Tucson, Arizona
Arizona Department of Aeronautics, Phoenix, Arizona
Arizona Game and Fish Commission, Phoenix, Arizona
Arizona Mountaineering Club, Scottsdale, Arizona
Arizona River Runners, Marble Canyon, Arizona
Arizona Wildlife Federation, Phoenix, Arizona
Arizonans for Quality Environment, Tucson, Arizona

Citizens Committee, Tusayan, Arizona
Colorado River Outfitters, Washington, D.C.
Desert Protective Council, Banning, California
Desmount Club, Laguna Beach, California
DNA Legal Services, Tuba City, Arizona
Environmental Conscience, Inc., Phoenix, Arizona
Grand Canyon Airlines, Tusayan, Arizona
Grand Canyon Expeditions, Phoenix, Arizona
Grand Canyon Helicopters, Tusayan, Arizona
Hatch River Expeditions, Vernal, Utah
Havasupai Tribe, Supai, Arizona
Heaton Livestock Company, Cedar City, Utah
Honeywell Hikers Club, Phoenix, Arizona
Hualapai Tribe, Peach Springs, Arizona
Issue, Cedar City, Utah
National Aviation Trades Association, Washington, D.C.
National Parks and Conservation Association, Washington, D.C.
National Pilots Association, Washington, D.C.
National Wildlife Federation, Washington, D.C.
Navajo Tribe, Window Rock, Arizona
Phoenix Meeting of the Religious Society of Friends, Phoenix, Arizona
Sanderson Brothers River Runners, Page, Arizona
Save the Grand Canyon Committee, Albuquerque, New Mexico
Scenic Airlines, Inc., Las Vegas, Nevada
Sierra Club, Grand Canyon Chapter, Phoenix, Arizona
Sierra Club, Rio Grande Chapter, Albuquerque, New Mexico
Sierra Club, Southwest Office, Tucson, Arizona
Southern Arizona Hiking Club, Tucson, Arizona
Stanford Conservation Group, Stanford, California
Tri-State Flight Operators Association, Tusayan, Arizona
Tucson Audubon Society, Tucson, Arizona
Western River Expeditions, Vernal, Utah
West Slope Environmental Coordinating Center of Colorado, Gunnison, Colorado
Wilderness Society, Washington, D.C.
Wildlife Research Council of Arizona, Phoenix, Arizona

2. Coordination in the Review of the Draft Environmental Statement

a. The Draft Environmental Impact Statement has been mailed to each of the organizations and individuals listed below for their review and comment:

Advisory Council on Historic Preservation
Department of Agriculture
  Forest Service
  Soil Conservation
Department of the Interior
  Bureau of Indian Affairs
  Bureau of Mines
  Bureau of Outdoor Recreation
  Bureau of Sport Fisheries and Wildlife
  Bureau of Land Management
  Bureau of Reclamation
  U.S. Geological Survey
Department of Transportation
  Federal Aviation Administration
Federal Power Commission
Arizona State Clearinghouse
  State Liaison Officer for Historic Preservation
Havasupai Tribal Council
Hualapai Tribal Council
Navajo Tribal Council

b. Information copies of the Draft Environmental Impact Statement have been mailed to the following:

State of Arizona, Office of the Governor
State of Utah, Office of the Governor
State of Nevada, Office of the Governor
Mayor, City of Flagstaff, Arizona
Mayor, City of Kanab, Utah
Mayor, City of Page, Arizona
Mayor, City of Williams, Arizona
Department Army, Corps of Engineers
Department Commerce
Department Housing and Urban Development
Advisory Commission on Arizona Environment, Phoenix, Arizona
Aircraft Owners and Pilots Association, Glendora, California
American River Touring Association, Oakland, California
Appalachian Mountain Club, Boston, Massachusetts
Arizona Cattle Growers Association, Phoenix, Arizona
Arizona Conservation Council, Tucson, Arizona
Arizona Department of Aeronautics, Phoenix, Arizona
Arizona Game and Fish Commission, Phoenix, Arizona
Arizona Mountaineering Club, Scottsdale, Arizona
Arizona Power Authority, Phoenix, Arizona
Arizona River Runners, Marble Canyon, Arizona
Arizona Wildlife Federation, Phoenix, Arizona
Arizonans for Quality Environment, Tucson, Arizona

Citizens Committee, Tusayan, Arizona
Coconino County Planning Commission, Flagstaff, Arizona
Colorado River Outfitters, Washington, D.C.
Desert Protective Council, Banning, California
Desmount Club, Laguna Beach, California
DNA Legal Services, Tuba City, Arizona
Environmental Conscience, Inc., Phoenix, Arizona
Friends of the Earth, Arizona Chapter, Tempe, Arizona
Grand Canyon Airlines, Tusayan, Arizona
Grand Canyon Expeditions, Phoenix, Arizona
Grand Canyon Helicopters, Tusayan, Arizona
Hatch River Expeditions, Vernal, Utah
Havasupai Tribe, Supai, Arizona
Heaton Livestock Company, Cedar City, Utah
Honeywell Hikers Club, Phoenix, Arizona
Hualapai Tribe, Peach Springs, Arizona
Issue, Cedar City, Utah
National Aviation Trades Association, Washington, D.C.
National Parks and Conservation Association, Washington, D.C.
National Pilots Association, Washington, D.C.
National Wildlife Federation, Washington, D.C.
Navajo Tribe, Window Rock, Arizona
Phoenix Meeting of the Religious Society of Friends, Phoenix, Arizona
Sanderson Brothers River Runners, Page, Arizona
Save the Grand Canyon Committee, Albuquerque, New Mexico
Scenic Airlines, Inc., Las Vegas, Nevada
Sierra Club, Grand Canyon Chapter, Phoenix, Arizona
Sierra Club, Plateau Group, Flagstaff, Arizona
Sierra Club, Rio Grande Chapter, Albuquerque, New Mexico
Sierra Club, Southwest Office, Tucson, Arizona
Southern Arizona Hiking Club, Tucson, Arizona
Stanford Conservation Group, Stanford, California
Tri-State Flight Operators Association, Tusayan, Arizona
Tucson Audubon Society, Tucson, Arizona
Western River Expeditions, Vernal, Utah
West Slope Environmental Coordinating Center of Colorado, Gunnison, Colorado
Wilderness Society, Washington, D.C.
Wildlife Research Council of Arizona, Phoenix, Arizona