MANAGER AND VISITOR ASSESSMENT OF RESOURCE CONDITION AT LEES FERRY, ARIZONA

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ABSTRACT

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Manager and visitor assessments of the severity of biophysical impacts at 49 sites along the 15-mile stretch of the Colorado river from Lees Ferry to Glen Canyon Dam were examined. Manager assessment was determined using data from an on-site biophysical impact survey conducted by Glen Canyon National Recreation Area park managers in 1991. Angler and rafter responses to a visitor use survey questionnaire distributed during the same time period constituted the visitor assessment.

Results of the biophysical survey data analyses revealed that managers rated 84% of the 49 sites as heavily to severely impacted. For seven of the eight individual impact indicators, over 50% of the 49 sites were rated heavily to severely impacted. Analysis of the effect of site type (day-use, campsite, illegal campsite) on site condition revealed that campsites were rated significantly more heavily impacted with respect to soil

disturbance, vegetation damage, trash, and pests and insects than day-use and illegal campsites. Human waste was rated as a significantly heavy impact on day-use sites. Trails and fire impacts were rated heavy to severe on all site types, while site modification was rated light.

Results of the visitor use survey indicated that over 50% of rafters and anglers noticed impacts of soil disturbance, vegetation damage, trash, human waste and fire impacts on three day-use sites and 15 campsites as not a problem or not encountered. Comparing manager and visitor assessments of resource condition, managers perceived biophysical impacts as more severe than visitors.

Although visitors did not perceive biophysical impacts as a problem, rafters indicated they would accept all 11 management actions proposed by managers to mitigate these impacts. Anglers would accept all actions except restricting numbers of anglers per day.

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CHAPTER 1

INTRODUCTION

Lees Ferry in northern Arizona is a significant resource within the National Park Service unit, Glen Canyon National Recreation Area (NRA). The 15-mile stretch of the Colorado River upstream from Lees Ferry is unique, for it is the only remaining component of the now almost completely inundated Glen Canyon. This river segment, with its spectacular, massive Navajo sandstone cliffs, receives some of the most intensive recreational use in the state of Arizona. Commercial day-trip rafting and fishing are the principal uses of the area, which is known nationally for its scenic environment, historic features, and "blue-ribbon" trout fishery.

Recreational use of the area has expanded greatly in recent years. In 1985, 7,546 day-use rafters floated this river segment. In 1989, rafter visitation had increased to 28,115 rafters a year, with 257 boats and 5,600 people travelling downstream to Lees Ferry in the peak month of July. In 1991, the number of rafters floating the river in July had increased to 6,600 (USDI 1991).

Fishing was the dominant use in 1985 with 14,000 anglers visiting Lees Ferry. In 1989, 17,200 anglers fished the area. The total increase in annual visitation, including both rafters and anglers, from 1985 to 1989 was 23,769 visitors (USDI 1991).

This increased popularity has resulted in resource degradation on upriver recreation sites. Resource managers at Glen Canyon NRA, aware of the presence of resultant biophysical impacts, performed a quantitative biophysical impact survey in 1991 on 27 day-use beaches, 15 campsites and 7 illegal campsites to determine site condition. The model for the survey was the Kitchell and Conner Canyonlands Rapid Estimate Procedure (cited in Cole 1989a). This procedure was developed to assess impacts on backcountry campsites in Canyonlands National Park, and was modified to ascertain severity of impacts on river recreation sites at Lees Ferry.

Managers at Glen Canyon NRA also wanted to learn about visitor perceptions of biophysical impacts on some of these same recreation sites. They requested that Northern Arizona University conduct a visitor use survey during the summer of 1991.

Funding for the visitor use survey was provided by the Bureau of Reclamation, Glen Canyon Environmental Studies (GCES) and the survey had a dual purpose. The first goal of the visitor use survey was to determine the recreation carrying capacity for the Lees Ferry area

within the context of varying Colorado River flow levels. Rafters and anglers were questioned about their satisfaction with their river experience, specifically regarding issues of crowding, conflict, and river flow. A second goal of the research was to determine users' perceptions of problems, including biophysical impacts at use sites, and to determine if visitors supported various river management actions to resolve these problems. Results of the biophysical impact survey and the visitor use survey were reported in the Lees Ferry Carrying Capacity Study (Lee and Grover 1992).

In this thesis, data from the Lees Ferry Carrying Capacity Study biophysical impact survey are analyzed to determine manager assessment of the condition of the 49 recreation sites. In conjunction with this analysis, the effect of site type (day-use, campsite and illegal campsite) on site condition is explored. Data from the visitor use survey are compiled to determine rafter and angler perceptions of condition of three day-use sites and 15 campsites. Manager and visitor assessments of site condition on the 18 sites are compared. Finally, visitor acceptance of various management actions proposed by managers to mitigate site impacts, is determined from responses to the visitor use survey.

Findings from these analyses will allow Glen Canyon NRA managers to make educated decisions about managing biophysical river recreation impacts during the river

management planning process. Conclusions from these results will aid managers in their attempt to protect the valuable Lees Ferry resource while continuing to provide a quality recreation experience for visitors.

Objectives

The objectives of this thesis are:

1. to determine manager assessment of the condition of 49 recreation sites located upriver from Lees Ferry. Data from the 1991 biophysical impact survey will be analyzed to determine manager assessment of overall site condition as well as condition with respect to eight individual impact indicators.

2. to examine the effect of site type on the condition of 27 day-use sites, 15 campsites and 7 illegal campsites.

3. to determine rafter assessment of condition of three day-use sites and angler assessment of condition of 15 campsites with respect to five impact indicators using data from the visitor use survey.

4. to compare and contrast manager and visitor perceptions of resource impacts on 18 recreation sites (15 campsites and 3 day-use sites).

5. to determine visitor support for various management actions to mitigate impacts.

Hypotheses

The research hypotheses are:

1. The three types of sites: day-use sites, campsites and illegal campsites, differ significantly in overall site condition and amount of impact as measured by some of the eight impact indicators.

2. Managers perceive resource impacts as more severe than visitors.

3. The majority of visitors accept management actions necessary to mitigate impacts, even though they do not perceive biophysical impacts as a problem.

CHAPTER 2

LITERATURE REVIEW

This chapter is divided into three subsections. The first subsection consists of a review of the literature on manager assessments of biophysical impacts. In the second and third subsections, literature on visitor perceptions of biophysical impacts compared with manager perceptions, and visitor support for management actions is reviewed.

Recreationists involved in activities often disturb and degrade the natural conditions of a site. To determine the amount of impact on a site, managers may chose several impact indicators such as soil disturbance and vegetation damage to represent site condition. These indicators often consist of several measurable parameters. For example, penetration resistance, depth of trails, and percent mineral soil exposed are all measurable parameters of the soil disturbance impact indicator. In the Manager Assessment of Biophysical Impacts section of this chapter, eight impact indicators are described. Studies showing various methods used to measure parameters of these indicators are reviewed.

National Park Service managers are the stewards of the public parks. They are trained to detect resource degradation and are aware of the existence of biophysical impacts in areas where recreation occurs. Visitors, however, are often not cognizant of the detrimental effects of their activities and are not always aware of biophysical impacts on recreation sites. The Visitor Perceptions of Biophysical Impacts Compared with Manager Perceptions section of this chapter reviews the results of studies which were designed to solicit visitor perceptions of recreation impacts. Studies on manager versus visitor perceptions are also included. The literature reveals that visitors experiences are seldom affected by the presence of biophysical site impacts. Trash is the one impact visitors do notice. Managers and visitors differ in their perceptions of biophysical impacts and managers tend to perceive impacts as more severe than visitors.

To mitigate recreation impacts in an attempt to restore natural site conditions, managers often need to employ direct management actions such as restricting use and closing sites and/or indirect management actions such as revegetating and rehabilitating sites. Actions that restrict access or prohibit certain behaviors may negatively affect visitor enjoyment of an area. To determine how various actions will be accepted by recreationists, some managers have solicited visitor

opinions. A review of previous studies on visitor preferences for various management actions can be found in The Visitor Support for Management Actions section of this chapter.

Manager Assessment of Biophysical Impacts

The term resource, or ecological, impact is defined as a disturbance and an undesirable change to a natural area as a result of recreational use (Hammitt and Cole 1987). These types of impacts include degradation to the soil, wildlife, vegetation, geology, water, and air resources of a recreation area. The term biophysical impact encompasses ecological impacts, however it also includes aesthetically displeasing surface impacts such as trash, human waste, and site modifications such as rock tables, log benches and rock rings (Grover 1991).

As part of the Lees Ferry Carrying Capacity Study (Lee and Grover 1992), a biophysical impact survey was performed. Forty-nine day-use sites, campsites and illegal campsites were examined and site condition was determined. Sites were rated with respect to eight impacts: soil disturbance, vegetation damage, trails, human waste, fire, trash, pests and insects and site modification.

Previous studies of the effects of recreation on soils and vegetation are more numerous than studies of the other six indicators. This is primarily due to the

fact that changes in a site which occur as a result of the first two impacts cause substantial ecological changes. Soil disturbance and vegetation damage impacts are also most significant, because they are difficult to ameliorate and sites recover slowly (Cole 1989a).

The various possible measurable parameters of each of the eight impact indicators used in the Lees Ferry Carrying Capacity Biophysical Impact Survey are discussed within the specific impact indicator subsections. Also included is a review of the literature on methods of measuring these parameters.

Soil Disturbance

The impact indicator of soil disturbance may be measured using several parameters. These parameters include changes in soil organic horizons, soil compaction, and soil erosion.

Changes in Organic Horizons. Impacts to soil organic horizons fall within soil disturbance. The loss of surface litter or duff, reduction in organic horizon cover, and reduction in organic horizon depth are all results of site use (Cole 1989a). After light to moderate use of campsites and trails, organic litter is almost totally removed (Leonard and Plumley 1979a).

Trampling exposes mineral soil by eliminating vegetation cover and eroding surface organic horizons. The amount of mineral soil exposed on a site is one

measure of amount of soil disturbance impact. In a study of recreational trampling effects on six habitat types in western Montana, mineral soil exposure increased significantly as number of passes across experimental sites increased (Cole 1985a). In addition soils in some habitat types were found to be more resilient to trampling than others.

On 96 pairs of campsites and controls in the Boundary Waters Canoe Area Wilderness, factors that affected changes in organic horizon thickness and exposed soil associated with campsite use were identified (Marion and Merriam 1985). Level of use and campsite age were the best predictors of amount of exposed soil. Off-site organic horizon thickness and level of use were the best predictors of change in campsite organic horizon thickness.

In his report on the ecological impacts on backcountry campsites in Grand Canyon National Park, Cole (1985b) described the sites as consisting of a core area of mineral soil and some rock. These cores were totally devoid of vegetation and organic litter and he noted that the mineral soil was highly compacted. He also discovered that groundcover and soil deterioration were minimal on the perimeter of the sites due to the presence of thorny plants and rough terrain.

Ecological changes on sites in the Eagle Cap Wilderness in Oregon were examined (Cole and Fichtler

1983). For most parameters measured, "impact on campsites used for only a few nights per year exceeded threshold values beyond which further use had little effect." Only loss of vegetative litter, root exposure and site enlargement continued to increase as amount of use increased.

Impacts to soil organic horizons may be measured as a reduction in organic horizon cover, reduction in organic horizon depth, or as the degree to which litter and duff has been disturbed (Cole 1989a). Mineral soil exposure is inversely related to organic horizon cover, so the most common method of determining the amount of this impact is to estimate the percentage of the site upon which mineral soil is exposed. The percent of mineral soil exposed can be compared to a control site. This method was used in the Bob Marshall Wilderness in Montana (cited in Cole 1989a) and in Coyote Gulch Utah, Glen Canyon NRA (Grover 1991).

Soil Compaction. Trampling can also cause soil compaction, another measurable parameter of soil disturbance. Hammitt and Cole (1987) explain that soil compaction reduces water infiltration rates. Moisture content, organic matter content, and chemical composition of the soil are also altered when the soil is compacted (Cole 1989a). Two quantitative methods of measuring soil

compaction are to measure bulk density and resistance of soil to penetration.

Penetration resistance as a measure of soil compaction was used to measure soil compaction on six habitat types in western Montana (Cole 1985a). Readings from a pocket soil penetrometer were taken on and off-site and compared. Results indicated that as trampling increased penetration resistance increased. The relationship was curvilinear, however, and the most rapid increase occurred within 50 to 75 passes, lessening at 400 passes.

Soil compaction on new sites in the Boundary Waters Canoe Area was also measured with a penetrometer (Merriam and Smith 1974). Penetration resistance readings reached a maximum after two years of site use and did not increase significantly again. Compaction on old, previously used sites did not alter from year to year. This indicated that soil compaction had reached its maximum level before the study began.

Bulk density is the ratio between the dry weight and volume of a soil sample (Cole 1989a). Factors that affected changes in bulk density on 96 campsites in the Boundary Waters Canoe Area Wilderness were campsite age, mineral soil organic content, organic horizon thickness, and off-site bulk density (Marion and Merriam 1985). Bulk density continued to increase with campsite age.

Recreation effects on soil in the Missouri Ozarks were examined by Settegren and Cole (1970). Measurements on sites subjected to years of intensive recreational use were compared with those on undisturbed forest sites. There were no differences in subsoil available moisture, however, "surface soil moisture on the areas compacted by recreation was depleted during the summer months well below the permanent wilting point."

Results of a 5-year long study on campsites in the Eagle Cap Wilderness, Oregon and on a cross-sectional study of campsites in the Boundary Waters Canoe Area, Minnesota indicated that the major types of impact that increase substantially after the first few years of use are size of campsite area, tree damage, loss of organic horizons, exposed mineral soil, and perhaps bulk density (Cole and Marion 1985). Three of these are soil disturbance impacts.

In 1976, Carothers and others reported on natural resources, white water recreation and river management alternatives on the Colorado River in Grand Canyon National Park. Site trampling, resulting in soil compaction and vegetation removal, was one of the two major impacts associated with human activity that caused habitat destruction along the river.

Amount of soil compaction can also be estimated by using categories such "Minimal evidence of surface disturbance," "much of surface compacted or loosened, but

not cementlike," or "most of surface cementlike in appearance" (Cole 1985b). Kitchell and Conner, in Canyonlands National Park in 1984, (cited in Cole 1989a) used the parameter "percent of site which has compacted fine soils or loosened coarse soils" as an evaluation of soil disturbance.

Soil Erosion. Erosion is another measurable parameter of soil disturbance. Erosion occurs because compaction reduces water infiltration rates and increases runoff (Hammitt and Cole 1987).

Kuss (1984) hypothesized that hiking boots with different types of tread would differ in their trampling effect on organic matter and trail erosion. The results of the study showed that there was no significant difference in trampling effect between the two types of boots. The important finding of the study, however, was that different hiking intensities, no matter what boot, affected yields of organic matter and eroded soil collected from trail runoff. Yields from plots receiving 2,400 impacts over a six week period were significantly higher than those receiving 600 impacts.

Erosion is a common human impact in riverine systems The amount of sand displaced into the Colorado River each year from heavy foot traffic along the riparian zone in Grand Canyon was discovered to be 230 m^3 (Valentine and Dolan 1979). Increased visitation lead to increased foot

traffic, trampling along river banks, erosion of campsite soils and the destruction of vegetation. Although some erosion occurs naturally from wind and water, surfaces roughened from foot traffic are more susceptible and each human footstep physically displaces sand downhill. Due to the presence of the Glen Canyon Dam, lost sediment is no longer replaced.

Dolan and others in their 1974 article, "Man's Impact on the Colorado River in the Grand Canyon," reported that after visiting over 100 campsites along the river in the summer of 1973, the most prominent impact was not litter or human waste. Surface erosion of up to two feet on footpaths on the beaches was the most significant degradation. "Heavy foot traffic roughens surfaces that are periodically inundated, contributing to accelerating sediment losses during diurnal high water flows."

Impacts on stream banks caused by inner tube floaters in the Great Smoky Mountains were studied (Hammitt and McDonald 1981). Two forms of impact were obvious, trampling/erosion and changes in stream morphology. Soil disturbance impacts were greatest around access points, bridges, and campsites.

Trail depth is one measure of erosion. In 1970, in a paper birch forest recreation area in the Adirondack Mountains of New York, the increase in trail depth on moderate slope gradients was 2.5 cm annually (cited in

Leonard and Plumley 1979a). In another study in the Green Mountains in Vermont in 1977, average trail cross-sectional area change (soil loss) was found to be 120 cm^2 per year and average trail depth increase was 1.7 cm per year (cited in Leonard and Plumley 1979a).

Maximum trail depth and number of gullies were considered parameters of soil disturbance in the Lees Ferry Biophysical Impact Survey (Lee and Grover 1992). Erosion was heaviest on campsites which were located on upper benches with a vertical climb of more than 10 feet.

Some soil types are more susceptible to disturbance than others. Soils high in either fine-grained, coarse-grained or organic materials were least desirable for trails and campsites (Leeson 1979).

Four dominant soil factors influence the effects of recreational-use on soils (Klock and McCooley 1979). They are: trafficability, depth, drainage and erodibility. They explained that all the factors are interrelated, and that an evaluation of each can help managers plan the location of trails and waste disposal.

Vegetation Damage

Vegetation Damage is another biophysical impact indicator. Measurable parameters of vegetation damage include reduction in on-site plant growth, change in species composition, percent vegetation loss, and injury from physical abuse.

Reduction in Plant Growth. Vegetation can be directly or indirectly damaged during recreation activities. An indirect impact of soil compaction is reduction in plant growth, reduced vigor, and inability of new plants to become established (Hammitt and Cole 1987).

Reduced annual stem and foliage growth of jack pine in highly impacted campsites in a northwestern Ontario park was reported (James and others 1979). Soil compaction increased and litter depth and infiltration rates decreased, growth decreased. "Recreation-intolerant" species were replaced by "recreation-tolerant" species on these campsites. The displacement/replacement was directly correlated to increased soil compaction and vegetative litter loss.

Change in Species Composition. Trampling directly injures and kills existing plants (Hammitt and Cole 1987). Feet, horse hooves, skis and off-road vehicles can all destroy vegetation. On-site species composition will shift toward impact tolerant species, and the age structure of the plant populations will change favoring older plants.

Bates (1935) observed the elimination of certain species of grasses that were "not structurally adapted to withstand the injury of treading and puddling on footpaths" Some species of grasses "by virtue of life

form and leaf and stem structure were able to persist, while others were not."

The effects of trampling on subalpine plants was studied (Holmes 1979). Effects were evaluated in terms of the percent of the original plant cover surviving 100 standard steps. Trampling impacts consisted of several distinct effects including shearing, crushing, gouging, grinding and ripping. Plants with the greatest resistance to trampling were herbaceous with basal leaves. Plants most vulnerable to trampling were those with "woody stems and those with tall, entirely herbaceous and caulescent shoot stems."

Plant species most sensitive to trampling in western Montana were forbs adapted to low sunlight conditions (Cole 1985a). "Thin cuticles, cell walls and stems make them highly susceptible to breakage." The most resistant plants which replaced the first were forbs which had "tough, flexible, straplike leaves and a tufted growth form."

"Limited use on trails can be as damaging to recolonizing plants as increasing levels of use delivered over time" (Kuss and Hall 1991). Recolonization of experimental trail surfaces barren of vegetative cover and hiked at three levels of intensities were studied. Results showed that although soil compaction, measured as penetration resistance, increased with use level, total number of plant species and species diversity declined.

Six major responses of vegetation and soils to wilderness recreation exist (Kuss and others 1986). Summarized, they are: impacts may be direct or indirect; plants and soils vary in their resistance to different forms of impacts; the changed environment selects for plant species best adapted to change; responses of plants and soils are influenced by genetics, "generic considerations" and factors of their immediate environments; the nature and magnitude of the impact on soils and plants varies according to type of recreation activity; and responses may be use intensity dependent or independent. These postulates have many implications for management.

Vegetation Loss. Intensity of trampling is directly correlated with relative cover (where relative cover is a measure of the surviving cover on a subplot after trampling divided by initial cover before trampling) (Cole 1985a). Percent relative cover decreases as amount of trampling increases, therefore, percent relative cover is a measurable parameter of vegetation damage.

Amount of vegetation loss is influenced by amount of use, vegetation fragility, vegetation density, and the degree to which activities are concentrated spatially on the site (Cole 1992). The relationship between amount of use and amount of impact is curvilinear, because

activities tend to become increasingly concentrated as amount of use increases.

Fragile cryptogamic crusts cover the desert floor and surround campsites in the inner canyon of Grand Canyon NP (Cole 1985b). The crusts, composed of algae, lichen, fungi and/or moss, are extremely susceptible to trampling. They have an important role in the ecosystem, improving water relations, site fertility and soil stability, however, 15 people walking over an area of crust will eliminate over one-half of the crust. Cole recommends that this fragility be considered when managers are locating trails and campsites and visitors be educated about the crusts through interpretive programs.

Vegetation damage is a major problem resulting from increased recreational use of rivers in the west (Lewis 1977). "Trampling, compaction, and removal of vegetation for firewood by river uses can cause stage erosion, campsite deterioration, and general reduction of visual attractiveness along rivers." Concentrating visitors in small areas leads to the deterioration of vegetative cover.

Vegetation trampling is "an outstanding direct impact caused by river users along the Colorado river through Grand Canyon." (Aitchison and others 1977) "On use sites, multiple trails are maintained simply by large numbers of people continually trampling the vegetation."

This condition also accelerates soil erosion and changes the plant species in these areas. Beaches, however, would probably be uncampable if the exotic Tamarisk were not "held in check" by trampling.

The effects of recreation on freshwater plants and animals were studied (Liddle and Scorgie 1980). Shore-based activities often associated with water-based activities caused damage to shore plant life. Trampling of vegetation from people walking in and out of the water was one cause of vegetation damage. Deliberate clearing of marginal vegetation to gain access to the water was another. In some areas anglers removed submerged vegetation with a drag line. Another effect on vegetation was a change from tall bank plants to shorter species at access points. This broke up the continuous habitat into smaller units affecting wildlife habitat.

Vegetation damage can be represented as amount of vegetation lost on a campsite in comparison to an adjacent, undisturbed site (Cole 1989a). Both amount of vegetation loss and the aerial extent of the loss together provide the most accurate measure of vegetation damage (Cole 1989b).

Injury from Physical Abuse. Axe marks, lantern burns and nails are often evident on older trees on many campsites (Hammitt and Cole 1987) and the presence of any of these indicates vegetation damage. Vegetation damage

to overstory trees, tree reproduction, shrubs, and ground cover can also be chosen as impact indicators in a biophysical survey (Cole 1989a).

On-site and off-site tree growth, tree mortality, and exposed roots on 33 campsites in the Boundary Waters Canoe Area were compared (Merriam and Smith 1974). No significant differences in tree growth occurred. Exposed roots and tree mortality from physical abuse increased as campsites aged. Tree limbs and roots were chopped and some were burned from campfires.

Several impact parameters including trampling, cutting, carvings, exposed roots and reduced vigor were combined to measure vegetation damage at Lees Ferry, Arizona (Lee and Grover 1992) and in Coyote Gulch, Utah (Grover 1991). Managers assessed if sites had no damage, <5% of the on-site vegetation was damaged, 5-25% was damaged or >25% was damaged.

Trails

Width of trail, width of bare ground on trail, and maximum depth of trail are common measures of trail condition (Cole 1983). These measurements are associated with soil erosion and are sometimes accounted for under soil disturbance impacts.

Changes in trail condition on the Big Creek trail in the Selway-Bitterroot Wilderness from 1978 to 1980 were studied (Cole 1983). Ten permanent transects were

established. A tape was strung flush with permanent stakes on either side of the trail at ground level and vertical measurements across the trail every 6 cm were taken. The cross-sectional area below the tape was calculated each year and compared. Only 4 of the 10 sites lost soil. On the remaining 6 transects the cross-sectional area decreased, therefore deposition exceeded erosion. Slumping of the trail "banks" had filled in the trail.

All of the maintained trails in the Great Smoky Mountains National Park were surveyed (Bratton and others 1979). Width, depth and a variety of signs of erosion on these trails were recorded. Trail impacts were found to be related to vegetation type, elevation, trail slope, and section of the park. Trails in virgin or mature forests were in poorer condition than trails in successional areas. Vegetation types most sensitive to trailing impacts were grass balds and spruce-fir forests while pine types and xeric plants are most resilient. Redistribution of use within the park was suggested to alleviate some of the trail impacts.

The effects of hikers, motorcycles and horses on trails in meadows and forests were summarized by Weaver and Dale (1978) from previous research. First, trail width increases linearly with increasing slope, wetness, roughness and the logarithm of number of users. Second, trail width decreases linearly with the logarithm of the

roughness or trailside vegetation and terrain. Third, trail depths depend on compaction, erosion, climate, vegetation type, soil and substrate type, slope, and type of user.

Hikers are less damaging to trails than horses and motorcycles (Weaver and Dale 1978). Horses and hikers do more damage when traveling downhill, while motorcycles do more damage going uphill. Damage was greater in shrubby vegetation over grassy, and greater on slopes than on level ground.

In the Lees Ferry Carrying Capacity Study biophysical survey (Lee and Grover 1992), trail width, in conjunction with number of social trails, constituted measures of trailing impact. Social trails were defined as "the informal trails that lead from site to water, the main trail, other campsites, or satellite sites." (Cole 1989a). A count of the number of social trails discernible and well-worn is a measure of trailing impact.

The impacts of visitor use in two areas of Yosemite National Park in California were investigated (Foin and others 1977). Emphasis was placed on trailing and campground impacts. Trails were found to be more prominent in forest areas over meadows, because visitors created trails while gathering wood for campfires in the forests.

In the Bob Marshall Wilderness in Montana, Cole (1987) observed that trails were often "calf deep in mud." Visitors, unwilling to walk through the mud and quagmire, created new trails on higher ground to skirt the mud. He concluded that multiple parallel trails are a problem in high elevation meadows due to snowmelt and intense rainfall which muddy the main trails.

A rapid estimate procedure to assess extent of trail impact along the Big Creek and South Fork trails in the Selway-Bitterroot Wilderness in Montana was performed (Cole 1983). Observations on trail impacts were taken every 0.2 miles. Overall trail width, bare ground width, maximum depth, presence or absence of multiple trails, trail deepening, erosion of trail sides, roots, rocks, mud and washboard, along with habitat type and slope were recorded. On 65% of the trails, trail problems were absent indicating that the trail system was in good shape and appeared to be stable.

Fire Impacts

The most significant fire impacts (on backcountry campsites) are aesthetic problems (Cole and Dalle-Molle 1982). These include proliferation of fire sites, elaborate fire ring construction, charred trash, charred rocks, chopped trees and loss of downed logs. Impacts unnoticeable to most visitors include loss of soil microorganisms and mycorrhizal fungi due to the removal

and combustion of large woody material, soil sterilization from the heat of campfires, and trampled vegetation from visitors gathering wood. Undergrowth and small animal populations may also be affected.

Carothers and others (1976) noted two major fire impacts on the beaches along the Colorado river through Grand Canyon NP. They were the removal of driftwood for cooking fires and affects on wildlife through habitat destruction.

Fire was described as "a major protection problem along river corridors in the west where recreation occurs" (Lewis 1977). Visitor desire to use fire generates a variety of management problems. Solutions usually include restrictions on number and types of fires allowed as well as restrictions on the use of driftwood, dead-down, and charcoal as fuels.

Fire impacts on backcountry campsites have been measured by counting the number of fire scars, which include fire rings, on a site (Cole 1989a). This method was used in 1984 in the Bob Marshall Wilderness in Montana. Also in 1984, Kitchell and Conner rated fire impacts on campsites in Canyonlands National Park by counting the number of fire pits, percent of scarred rocks and amount of charcoal and ash on sites (cited in Cole 1989a). Area of fire stain was selected as a fire impact parameter at Lees Ferry, Arizona (Lee and Grover 1992).

The extent of recreational impacts on Colorado River beaches in Glen Canyon was assessed (Carothers and others 1981). Beaches were strewn with trash and human waste and mottled with fire scars because visitors were not using low impact camping techniques. Fire impacts were evaluated using a discoloration rating obtained from sieving a 50ml surface sample of sand from a fire scar onto Fisher Filter Paper. The paper color was matched to a series of colors obtained from sands containing a known charcoal/ash concentration. Fire impacts were found to be severe and fire grates were established on some sites as a result.

Human Waste

Recreationists who fail to properly dispose of human waste can seriously degrade water sources for both drinking and bathing (Craig 1977). Counting coliform bacteria and measuring phosphate concentrations in water bodies adjacent to recreation sites are ways to measure amount of human waste impact.

Coliform bacteria levels in lake water adjacent to campsites in the Boundary Waters Canoe Area in Minnesota were found to be above public health standards and significantly higher than on control sites (Merriam and Smith 1974). Phosphate concentrations and turbidity levels were also affected.

Human waste disposal was studied on backcountry campsites in New Hampshire (Leonard and Plumley 1979b). Soils at campsites located on shallow soil near mountain summits or near pond shores were unable to assimilate human waste when recreation use levels were high. High coliform bacteria counts were the result and pathogens reached the ground water.

On beaches along the Colorado River in Grand Canyon, areas for burial of human waste are limited and decomposer bacteria are scant (Aitchison and others 1977). Fecal coliform bacteria were still present on beaches a year after human waste was buried. River recreationists no longer bury human waste, but are required to carry it out in porta-potties.

Plant damage from human urine has been studied on backcountry campsites as another parameter of human waste impact (Holmes 1979). Leaf contact with urine was the principal cause of plant damage on a majority of 22 low-growing plant species subjected to consecutive 200ml doses of urine. Animals showed a preference for feeding on these plants adding to plant damage.

Counting piles of solid human waste and toilet paper is a commonly used measurable parameter of human waste in biophysical impact surveys. The Delaware Water Gap Rapid Estimate Procedure uses a count of the number of places with evident human waste and/or toilet paper within 100 ft of campsite boundaries as a parameter (cited in Cole

1989a). The Canyonland Rapid Estimate Procedure considers sites with greater than four piles of toilet paper or greater than two piles of human feces severely impacted (cited in Cole 1989a). At Lees Ferry, Arizona, Lee and Grover (1992) rated sites which had greater than two piles of toilet paper, greater than one pile of feces and greater than one area with a strong odor of urine severely impacted.

Trash

The amount of litter some recreationists leave behind is staggering and creates a great impact for resource managers (Craig 1977). Trash, although not as ecologically detrimental to a site as soil disturbance or vegetation damage, is aesthetically displeasing. Litter is the one impact visitors tend to notice (Merriam and Smith 1974). Organic trash, such as rotting fish or fruit juices dumped out of cans onto soils increase populations of noxious insects and vertebrates (Aitchison and others 1977).

Counting the amount of trash on recreation sites is the most common method of determining the level of trash impact. Sites in Canyonlands National Park were rated severely impacted when sites had greater than six pieces of trash (cited in Cole 1989a). An estimate of the amount of litter within the campsite and 100 ft from the campsite boundaries expressed as the number of 40-gallon

garbage bags that could be filled with litter and tied up constituted the measure of trash impact on Delaware Water Gap sites (cited in Cole 1989a). Sites were considered severely impacted at Lees Ferry, Arizona when greater than two pieces of large trash and greater than five pieces of small trash were found on the site (Lee and Grover 1992). Unburned trash in fire grates was included in the count.

Pests and Insects

Unnatural numbers of pests and insects are often associated with degraded sites, particularly those with severe trash impacts (Aitchison and others 1977). In Grand Canyon, heavily used campsites have correspondingly higher densities of harvester ants, flesh fly and blow fly populations. Red ants have a painful, toxic sting and present a minor health hazard to campers. Flies are often the source of fly-vector diseases.

One biophysical impact survey considered pests and insects as an impact indicator. This was the Canyonlands National Park survey conducted by Kitchell and Conner in 1984 (cited in Cole 1989a). Sites were considered severely impacted when greater than one ant colony and numerous signs of rodents: tracks, burrows, and nests were located within 20 ft of the site. Two studies that modified the Canyonlands Rapid Estimate Procedure were the Coyote Gulch Campsite Survey (Grover 1991) and the

Lees Ferry Biophysical Impact Survey found in the Lees Ferry Carrying Capacity Report (Lee and Grover 1992). Pests and insects were considered severe on study sites when the amount of insects associated with trash, human waste, and/or fire grates was extreme, swarms of flies and midges existed, and rodent tracks were seen throughout the site.

Site Modification

Site modification has also been referred to as site development and rock displacement (Cole 1989a). The Bob Marshall Rapid Estimate Procedure uses number of fire rings with associated primitive log seats or other developments to rate sites (cited in Cole 1989a). Severely impacted sites in Canyonlands National Park had greater than five rocks moved, and the construction of tables, seats, and other items on site (cited in Cole 1989a). Lees Ferry upriver recreation sites were considered severely impacted when rock or log seats around a fire ring or rock table, or any unnatural feature such as seats made from milk crates were present (Lee and Grover 1992).

Summary

Many impact indicators to determine recreation site condition exist. To obtain a measure of a specific indicator, one or more parameters may be chosen. Managers performing biophysical impact surveys must

decide on which and how many indicators to use. Glen Canyon NRA managers at Lees Ferry, Arizona used eight indicators to assess upriver recreation site condition.

Visitor Perceptions of Biophysical Impacts Compared with Manager Perceptions

Importance and desirability are two components of recreational impact perception (Lucas 1979). In order for impacts to be perceived during a wildland recreation activity, impact conditions must be important to the user relative to all other aspects of the setting, and an evaluation of the condition must be thought of in desirable versus undesirable terms.

One of the earliest studies performed that gathered information on visitor perceptions of impacts in wilderness areas was in 1962 by the Outdoor Recreation Resources Review Commission (cited in Lucas 1979). Visitors to three study areas were interviewed: The Boundary Waters Canoe Area in Minnesota, the High Sierras Wilderness in California, and the Mt. Marcy Area in New York. Users were asked if littered and rundown campsite conditions affected their enjoyment of the area or influenced their overall satisfaction. Half of the visitors to each of the areas noticed the degraded campsite conditions, however, fewer found them annoying and even fewer reported that they reduced their enjoyment.

Boundary Waters Canoe Area visitors were surveyed again three years later (Frissell and Duncan 1965). This time users were asked what factors influenced their choice of campsite and if site conditions affected their satisfaction with the site. Respondents were little affected by site conditions and presence or absence of impacts did not appear among the reasons for choosing a site. Even though sites had lost an average of 85% of their vegetative cover, the only impact noticed by visitors was trash and debris left by previous campers.

Site impact stage ratings were assigned to campsites in the Boundary Waters Canoe Area based on the severity of impacts present (Merriam and Smith 1974). Campers also rated the physical conditions of the site. No correlation between the researcher and visitor ratings was found. Campers seldom commented on site impact conditions aside from mentioning litter.

Results of many studies reveal that manager and visitor perceptions of biophysical impacts on backcountry campsites and trails differ, and that managers tend to perceive impacts as more severe. Lucas (1979) suggests that differences in perception are due to different training, background, responsibilities and time frames. In general, he states, "visitors' perception of recreational impacts is limited."

The opinions of campers and boaters at the Allegheny Reservoir in Pennsylvania were solicited (Moeller, Larsen

and Morrison 1974). Through mailback survey questionnaires, campers were asked to give their impressions of the severity of four management problems: uncontrolled camping, unsanitary conditions, destruction of vegetation, and littering. While managers thought that littering, unsanitary conditions and destruction of vegetation were serious problems on campsites, visitors did not feel that these were problems. Only uncontrolled camping was viewed as a problem by both managers and campers. It was concluded that the difference in perception was due to the fact that managers are concerned with both meeting present use demands and preserving the resource. Visitors were concerned with the short-term consumption of the resource. The authors state that "the two perspectives must be carefully balanced to make equitable decisions about resource policy."

In a study in the Boundary Waters Canoe Area, (Peterson 1974) manager and visitors shared most perceptions. Visitors, however, perceived water quality as better than managers and visitors were less aware of "the deprecatory consequences of recreational use."

In Yosemite National Park in 1975, Lee compared campers' perceptions of the physical conditions of campsites with expert assessments of camping area physical conditions (cited in Lucas 1979). He discovered that visitors rated amount of litter, groundcover

conditions, and damage to trees as "moderately close to what you would prefer." Experts rated tree damage as worse than ground cover impacts which was rated worse than litter. Visitors and experts were also asked to rank horse manure, litter and physical deterioration of trails in order of how objectionable the impact. Visitors rated horse manure over physical deterioration over litter, while experts rated physical deterioration and manure the same and litter almost absent.

Hiker perceptions of wilderness in Grand Canyon were studied (Towler 1977). The research explored the effect of education and residence on visitor perception of impacts. The survey revealed that less educated visitors were more aware of littered and impacted campsites than visitors with 17 or more years of schooling. Instate visitors and those from small communities noticed and were more annoyed by these same impacts than out of state visitors and visitors from large cities.

Seventy percent of the visitors surveyed in the Selway Bitterroot Wilderness in Idaho and Montana and the Desolation Wilderness in California said that they were well satisfied with trail conditions even though some of the trails were rated severely eroded by managers (Lucas 1979). In this same study, 80% of the visitors to the Idaho and Montana wilderness and 55% of the visitors to the California wilderness rated site impact conditions as good to very good on heavily impacted sites. Litter

conditions, however, were rated worse than overall site condition, suggesting visitors were more aware of litter than ecological site impacts. Lucas concluded that because visitors' satisfaction is not strongly affected by severity of impacts on trails and campsites, management of recreational impacts on wildlands should be based on "professional recognition of long-term consequences of impacts and legal and policy goals that set standards for acceptable impact levels."

User and manager perceptions of dispersed recreation impacts in roaded forest lands was compared (Downing and Clark 1979). Visitors to three National Forests in the Pacific Northwest and managers from the Bureau of Land Management, National Forest Service, Oregon Department of Forestry and Washington Department of Natural Resources were surveyed regarding the benefits and problems with dispersed recreation. Managers rated impacts of litter and garbage, vandalism and theft, danger of fire, danger of accidents from logging traffic, conflicts with other recreationists, and human waste impacts as being more severe than visitors.

A paper by Deans (1979) presented at the Wildlands Recreation Impacts Conference was written from the user's perspective. Deans, the executive director of the Appalachian Mountain Club relayed his opinion that impacts on America's wildlands were not as bad as managers believed. He stated, "I do believe in general

that they (recreational impacts) have been overstated...I would prefer some degree of impact on our wildlands to the alternative of land managers over-reacting and restricting our present freedom of the hills." He suggested that many of the problems found on wildlands were the result of misuse and mismanagement, not overuse.

Questionnaires querrying managers about biophysical impacts in their individual jurisdictions were sent to managers of all National Wilderness Preservation System units (Washburne and Cole 1981). Managers were asked if changes in vegetation and soil characteristics, wildlife impacts, water pollution, litter and improperly disposed of human wastes were a problem. Forest Service and Park Service managers considered human impacts on vegetation to be a problem in over 25% of the areas, mostly in the Pacific and Rocky Mountain States. Human impacts to soil, such as erosion and compaction, were considered a problem in the majority of the areas, but most pronounced on trails in the Northeast. Impacts on large nonpredatory mammals and birds were most commonly cited wildlife problems. Water pollution was thought to be a problem in only 18% of all the areas. Managers from 62% of all the areas felt that litter was a problem. Improper disposal of human waste was said to be a problem in 46% of all the areas with the Forest Service having more problems than any of the other agencies.

Four hundred and five campers in two Indiana state parks were surveyed (Knudson and Curry 1981). Few campers were sensitive to either resource deterioration or crowding. Survey questions asked about campers' awareness of soil disturbance and tree damage and how these impacts affected their enjoyment of the campsite. The majority of the campers rated groundcover as excellent on sites that were almost 100% bare or disturbed. Over two-thirds of the campers reported that they noticed no tree damage when the interviewers rated on-site trees as having extensive damage.

Innertube and non-whitewater river floaters on four rivers were surveyed to determine the effect of past on-site experience on detection of adverse environmental impacts (Hammitt and McDonald 1983). Floaters with more experience were found to be more sensitive to and perceptive of excessive litter on riverbanks and trampling of natural vegetation.

As part of a visitor survey on the Eleven Point River in Missouri, river recreationists were asked their perceptions of problems on the river (Herrick and Everson 1984). Sampled floaters indicated that only a few "slight" problems existed. These were too few garbage cans, too few drinking water sources, litter in the river, insect bites, litter on the riverbanks, obstructions in the river, too few toilet facilities and inadequate toilet facilities. It was found that weekend

users were more likely to perceive impacts than weekday users and the sensitivity stemmed from concentrated use of one section of the river on weekends. Management had begun to consider imposing restrictive controls on river use in response to managers' perceived problems of overuse. Since floaters were satisfied with their experiences and did not perceive problems as severe as managers, inconspicuous management controls to disperse use and relieve congestion were consequently employed.

Manager and visitor perceptions of the acceptability of different levels of campsite impacts and perceptions of amount of impact were studied (Martin and others 1989). Using a series of color illustrations depicting campsites in undeveloped areas, overlays were used to vary types and levels of site impacts. Managers and visitors were shown slides of these illustrations and were asked to assess the acceptability of levels of impacts of bare ground, tree damage and fire rings. Wilderness managers and visitors were found to have different standards of acceptability for the three campsite impacts. Managers were more sensitive to bare ground impacts than visitors, but found tree damage and fire ring impacts more acceptable than visitors. Slides with varying amounts of each impact were also shown to managers and visitors. Results indicated that managers and visitors perceived amount of impact the same, even

though these impacts were unacceptable at different levels.

Currently, Pitt and others (1994) are attempting to develop and test an instrument that measures visitor perception of increments of impacts resulting from visitor behavior on campsites in the Boundary Waters Canoe Area in Minnesota. They want to measure differences in user perceptions of behaviorally-related impacts among different visitor groups: first time vs. return visitors and individuals vs. those traveling in groups. They plan to study the effects of educational treatments on visitor perception. They will use computer-assisted video capture and processing technology to simulate varying increments of soil and vegetation damage on sites.

In summary, visitors and managers perceive biophysical impacts differently. In general, managers assess site impacts as more severe than visitors.

Visitor Support for Management Actions

Reduction of impacts and enhancement of visitor experience are the two main objectives of visitor management (Jim 1989). Park Service managers have a mandate to preserve and protect the resource and provide for the enjoyment of it. To mitigate human caused biophysical impacts, managers need to initiate various management actions. Managers also need to know something

about user preferences for management actions so as not to negatively affect user enjoyment of an area. The literature reveals that visitors generally support management actions aimed at correcting human caused impacts, but wilderness visitors are primarily opposed to developed facilities in the backcountry.

Visitors in the Bob Marshall Wilderness Area, Glacier National Park and the Lewis and Clark Reserve were surveyed (Merriam and Ammons 1968). Users in all three areas were supportive of management actions to increase the number of informational signs in the areas. They were not supportive of decisions to widen trails, erect concession chalets, or create primitive roads. In two of the areas visitors were not supportive of actions to erect trail shelters or put in emergency phones.

River users at Dinosaur National Monument received questionnaires soliciting their opinions of various management actions (Roggenbuck and Schreyer 1977). The majority of users favored management actions to limit group size, to assign parties to campsites, and to establish a seasonal use limit. Users were opposed to campsite development and in support of returning river campsites to a more primitive condition.

Salmon river float boaters responded to a questionnaire that asked their attitudes toward management (Tarbet, Moeller and McLouchlin 1977). Results of the survey revealed that visitors were opposed

to intensive management practices or "development" such as developed campsites, gravel roads and trails, picnic tables, garbage cans, and allowing power boats to use the river. Users were neutral on actions that would "secure wilderness", such as signs and helicopter use, but were supportive of "controlled access" actions such as minimizing trails and putting restrictions on use levels.

The receptivity of backpackers in Mount McKinley National Park to use limitations was explored (Bultena and others 1981). From results of pre-trip questionnaires, the researchers discovered that users solidly supported the idea of rationing. Visitors also supported park policies such as closure of areas to protect wildlife habitat or to protect hikers from unpredictable wildlife, the requirement that campsites be hidden from the road, and allowing unrestricted camping in certain zones. They supported regulations requiring campers to have permits, the prohibition of campfires and having zone capacities reflect number of individuals as opposed to number of parties.

Visitor support for river recreation allocation techniques was studied (Utter and others 1981) (Shelby and others 1982). Both studies revealed that river runners have definite preferences for specific allocation alternatives over others.

The relationship of past experience of river users and their support of management of river resources was

examined (Hammit and McDonald 1983). More experienced users were more supportive than less experienced users of management actions to control littering on the river, provide more garbage containers, and make users responsible for carrying out their own litter. More experienced users were less supportive of regulatory controls and practices aimed at facility development and user services.

Anglers at Lees Ferry, Arizona in Glen Canyon National Recreation Area were surveyed to determine the effect of type of angler and density tolerance of anglers on support for six management actions (Caylor and others 1984). Trophy anglers expressed higher support for increased law enforcement, use rationing, and designation of lure and fly and catch-and-release areas than non-trophy anglers. Respondents with lower density tolerances were more supportive of periodic closures of the fishery, increased law enforcement of fishing regulations, use rationing, reduced creel limits, designation of artificial lure and fly areas, and designation of catch-and-release areas.

Eleven Point River floaters in the Missouri were asked to indicate support or opposition to 14 management alternatives (Herrick and Everson 1984). Floaters were found to be strongly opposed to prohibiting camping along the river, prohibiting wood fires, assigning campsites, limiting group size, restricting camping to designated

places, and restricting number of people on the river. They were supportive of actions to provide more campsites along the river, provide more campsites at access points, develop short hiking trails and prohibiting off-road vehicles.

User preferences for various river facilities on the Hiwassee river was dependent upon user's level of experience (Hammitt and McDonald 1983). On the Big South Fork of the Cumberland River visitors supported management actions aimed to reduce crowding with only 27% of the visitors opposed to the 30-minute interval departure schedule proposal (Hammitt and McDonald 1983).

Recreationists in the Arctic National Wildlife Range in Alaska favored measures that would protect the area from degradation by maintaining wilderness and wildlife values (Warren 1986). Visitors were opposed to facilities including trails, bridges, and aircraft landing areas.

Anderson and Manfredo (1986) analyzed data from previous visitor use studies in many wilderness and wild river areas to determine what kinds of management actions visitors prefer and if visitors to the two types of areas prefer similiar actions. Visitors were asked whether they supported or opposed over 50 different management actions. The results of the study showed that visitors to the two types of areas have similar preferences for management actions and that visitors generally prefer

indirect measures over direct unless overuse is a problem.

Manager and commercial users' perceptions of management policy in the Upper Mississippi River de facto wilderness were studied (Absher and McAvoy 1986). Results of a survey showed that commercial barge operators supported manager proposals to create a wilderness area. Managers and commercial users agreed that expanded commercial activity would negatively impact the wilderness, and both were neutral on proposals to restrict motor boats on the river.

Fee-paying and non-fee-paying hikers in the White Mountains of New Hampshire were surveyed to determine their opinions regarding user fees (Martin 1986). Differences between the two types of hikers were found to be minimal. Out of all the hikers, half responded that the government should continue to fully fund backcountry services. The majority of the hikers felt user fees would negatively affect their experience and most felt that fees should be returned to the local area. Hikers preferred voluntary contributions over all other systems.

Visitors recreating on public lands were more receptive to "new" wilderness fire practices and policies in 1985 than they were in 1975 (Taylor and Mutch 1986). Visitors, however, gave post-fire scenic quality and recreational acceptability low scores. The authors

suggest that managers need to continue efforts to educate the public regarding fire policies.

Visitor reactions to visitor-control measures at the West Beach of Indiana Dunes National Lakeshore were explored (Hultsman and Hultsman 1989). The ecologically fragile environment of the Lakeshore is located within a one hour drive of Chicago, so visitors were primarily from urban residences. The researchers discovered that the majority of visitors agreed with regulations prohibiting them from picking plants, playing with wildlife, and building fires. Visitors were also supportive of proposals to increase development, trails and boardwalks, but were not in favor of increasing law enforcement activities.

Environmental attitudes and the relationship between personal relevance and support for management actions were studied (Noe and Hammitt 1991). Findings of the study supported the hypothesis that as environmental issues become more specific or personally more relevant, users will back off from support of actions despite the benefit the environment will receive. Visitors will more vigorously support management actions if produced changes are more informational and have less of a personal impact on the visitor.

River users and managers of four rivers were surveyed to determine if a difference in preference for recreation rationing policies existed between the two

(Wikle 1991). Significant differences existed for three out of seven proposed policies. River users highly accepted advance reservation and merit systems, while managers favored zoning.

In summary, it appears that visitor support for management actions is site specific. It is wise, then, for managers to determine user preferences for management actions in their individual areas so they will not "make erroneous assumptions and judgements that contradict users' wants and aspirations" (Jim 1989).

CHAPTER 3

METHODS

The methods chapter is divided into four sections. The first section, The Study Area, describes the physical boundaries of the Lees Ferry recreation area. Sites visited by anglers and rafters are shown on maps.

In the Biophysical Impact Survey section, details of the Lees Ferry Carrying Capacity Study Biophysical Impact Survey study plan and data collection methods are presented. Data from this survey were used to determine manager assessment of upriver recreation site condition. These data were also used to explore the effect of site type on condition of sites. Significant differences between site types (day-use sites, campsites and illegal campsites) were tested using the Kruskal-Wallis nonparametric statistic (Conover 1980). The Kruskal-Wallis procedure is discussed in the Data Analysis section.

The Lees Ferry Carrying Capacity Study Visitor Use Survey was designed for several purposes: to determine visitor opinions on how crowding, conflicts and river flow level affect visitor experiences, to determine user perceptions of problems encountered on the river, and to

assess visitor support for various river management actions. Only responses to questions soliciting visitor perceptions of on-site problems and their support for management actions are reported in the Results Chapter. These data were compiled to represent visitor assessment of resource condition and to reveal which management actions visitors are willing to accept. The Visitor Survey section of this chapter describes the sampling plan, data collection methods and data analysis used in the Lees Ferry Carrying Capacity Study.

The Manager and Visitor Assessment Comparison section of this chapter describes how the data from the Lees Ferry Carrying Capacity Biophysical Impact Survey and Visitor Use Survey (which represent manager and visitor assessments of resource condition) were compared to determine whether or not managers perceive biophysical impacts as more severe than visitors.

Study Area

The study area encompassed the 15-mile segment of "free flowing" Colorado River located downstream from Lake Powell. This area is administered by the National Park Service and lies within Glen Canyon National Recreation Area. This segment of river flows from the Glen Canyon Dam tailwaters downstream to Lees Ferry, the easternmost boundary of Grand Canyon National Park. Fishing and rafting are the primary recreation activities

occurring on the river, although some visitors visit to hike or to hunt waterfowl. Visitors may picnic and camp in the area and evidences of use are found in the form of litter, human waste, campfire scars, soil disturbance, vegetation damage and trails.

Both fly and lure anglers fish a number of sites along the river including several walk-in shoreline sites near the Lees Ferry boat launch and upstream sites accessible only by boat. Table 27 (Appendix A) lists the 49 recreation sites surveyed in the Lees Ferry Carrying Capacity Biophysical Impact Survey by site number giving name, location, and type of use allowed on each site. Figure 3 (Appendix A) is a map of the 49 recreation sites showing their location along the river. Site numbers correspond to those listed in Table 27.

Anglers wishing to camp upriver may do so at a number of designated campsites. Figure 4 (Appendix A) shows the location of the 15 designated upriver camping sites.

During the Lees Ferry Carrying Capacity study, ARA Leisure Services was the National Park Service concessioner that provided float trips from the dam to Lees Ferry through their Wilderness River Adventures Company. Trips ran during March and April on demand and seven days a week from May through September. Trips were either half-day or full-day trips. The trip included stops to view petroglyphs at site #17a and 17b (Table 27,

Figure 3 in Appendix A) and for lunch at site #13 (on full-day trips Table 27, Figure 3 in Appendix A). As a consequence, rafter off-river use has been concentrated at three upriver sites which are impacted by approximately 30,000 visitors a year.

Biophysical Impact Survey

The Lees Ferry Carrying Capacity Study Biophysical Impact Survey was modeled after the Canyonland Rapid Estimate Procedure developed by Kitchell and Conner in 1984 (cited in Cole 1989a). Impact indicators used to determine site condition were chosen by Glen Canyon NRA managers who performed the survey.

Study Plan

During a reconnaissance trip upriver in March 1991, 25 sites were identified for the survey. Within many of the sites several distinct use areas were present. Each distinct use area was considered a separate site. The 25 primary sites were numbered in consecutive order beginning at Lees Ferry and continuing upriver to the dam (Table 27, Figure 3 in Appendix A). Separate use areas within the primary sites were designed by adding an alpha suffix to the number. For example, sites 9A, 9B, 9C, etc. are individual campsites within site #9. A total of 49 sites were surveyed, including 27 day use sites, 15 campsites, and 7 illegal campsites.

Park managers performed the survey during June and July 1991. A 17-foot inflatable Achilles boat with a 55 hp motor was used to access the majority of the sites.

Data Collection

Upon approaching a site, photographs of the access and mooring were taken from the boat using a 35mm camera with a 28mm wide angle lens and Kodachrome color slide film. Roll number, photo number, direction of photo, and description of photo were recorded in a photo log.

Photo points were established at each site making every effort to locate the point near a key feature such as a large rock or tree to facilitate relocation the point during future surveys. A site photo was taken from the photo point and a photo of the photo point was taken with park personnel standing on the spot facing in the direction of the site. Appropriate photo information was recorded in the photo log. Photos of some of the campsites, taken in 1985, were brought into the field and attempts were made to duplicate these photos whenever possible so that change in site condition could be assessed by comparing 1991 photos with those taken six years earlier.

After site photos were taken, one person completed the data sheets (Appendix C). Another person sketched a diagram of the site, including the location of the photo point.

In the office site locations were plotted on a map of the river comprised of a United States Geological Survey (USGS) 7.5 minute Lees Ferry quadrangle, a USGS 7.5 minute Ferry Swale quadrangle, and a USGS 7.5 minute Page quadrangle.

Data from data sheets (Appendix C) were compiled. Spatial calculations were made for size of camp area, barren core, distance to river, and distance to nearest toilet. Site impact values and site impact indices were produced and results were recorded on the data sheets. Impact values were calculated for each of the eight impact indicators (soil disturbance, vegetation damage, trails, fire, human waste, trash, pests and insects, and site modification) by multiplying the impact rating by a factor weighting value. The rating, assigned in the field (Appendix C) reflects the condition of the site with regard to the specific impact indicator. The factor weighting value (FWV) is a weighting value assigned by managers to denote the importance of the impact indicator. Traditionally, higher factor weighting values were assigned to impacts that were more lasting and ecologically detrimental to the site, as opposed to just being aesthetically displeasing to the eye (Cole 1989a). In this study, importance was defined by the effort it would take to ameliorate specific impact from the site. The greater the effort, the higher FWV was given for a specific impact. For example, the trash impact indicator

has a lower FWV than trials because trash can be easily removed from the site and trail revegetation would involve much more work.

The eight impact values for the site were summed to calculate the site impact index and site impact indices were used to classify a site into one of four condition classes ranging from lightly to severely impacted. This procedure follows that developed by Kitchell and Conner in Canyonlands National Park (cited in Cole 1989a). The lowest value the site impact index could be was 18 and the highest was 72. If the site impact index was a value from 18 to 28, the site was considered to be lightly impacted. Impact indices ranging from 29 to 45 fell in the moderately impacted condition class. Sites with an impact index of 46 to 61 were considered heavily impacted, and if the impact index value was 62 to 72, the site was considered severely impacted. These data were put into a dBase III data file using an IBM personal computer.

Data Analysis

The biophysical results from the Lees Ferry Carrying Capacity Study, which represent manager assessment of condition of sites, were analyzed as part of this thesis. A hand held calculator was used to calculate all percentage values.

To determine if differences in impact levels at the three site types (day-use, campsite, and illegal campsite) were significant, a Kruskal-Wallis nonparametric test statistic was performed using the personal computer statistical package, Systat (Wilkinson 1989). This test was chosen, because the data, impact values and impact indices, are ordinal data and the distribution may not be normal. For a detailed explanation of the Kruskal-Wallis test see Appendix E. If a significant difference between the three samples exists and the null hypothesis is rejected, a Multiple Comparison Procedure to determine which samples differ from one another may be performed (Appendix E).

A Kruskal-Wallis test was performed on site impact index data (the sum of the eight impact values for each site) to determine if the overall site condition of the three types of sites differed significantly. A multiple comparison procedure, performed by hand, followed.

To determine if the three site types differed significantly in the amount of impact of each of the impact indicators, a Kruskal-Wallis test was performed. Impact value data (rating multiplied by a factor weighting value for each impact), grouped by site type, were used.

Visitor Survey

The visitor use survey was designed by Dr. Martha Lee of Northern Arizona University in conjunction with Glen Canyon NRA resource managers and was funded by the Bureau of Reclamation, Glen Canyon Environmental Studies. This research focused on two visitor populations: day-use rafters and anglers. Information acquisition objectives of the Lees Ferry Carrying Capacity Study Visitor Use Survey were to:

(1) identify demographic characteristics of the two study subpopulations;

(2) identify numbers of other users encountered by the two subpopulations and their reactions to encounters;

(3) identify the angler subpopulation's perceptions of the impact of river flow levels on the quality of their fishing experience;

(4) identify the river trip characteristics of the two study subpopulations; and

(5) identify the two study subpopulations' perceptions problems on the river and of management of the river.

Only data collected to satisfy objective number (5) are reported in the Results Chapter and used in this thesis.

Sampling Plan

The sampling design used to select individuals was a stratified clustering scheme used to draw a sample from the population of recreationists during the sampling period, April 15 to July 28, 1991. Stratification was used to partition the sampling period into three river flow levels--low flow (5,000 cfs), medium flow (15,000 cfs), and high fluctuating flows (up to 30,000 cfs). These three flow levels were chosen by the Bureau of Reclamation for the Glen Canyon Environmental Studies research. The sample size collected within each stratum was in part a function of estimates of the total population (the number of individuals on the river), both anglers and day-use rafters, of that stratum. The sampling period was further divided by day into clusters of elements. Each cluster (day) consisted of visitors beginning raft trips on the river and/or anglers on the river. Sample clusters were randomly selected and visitors taking river trips and/or anglers were interviewed during those days. The first individual interviewed each day was selected at random and every nth individual was interviewed thereafter. The interview sample size for each subpopulation at each flow level was intended to be roughly equivalent so that comparisons could be made among anglers and rafters for the three flows.

The sampling strategy was based on the assumption that a degree of sampling precision (accuracy of population estimates) is required for any statistic that may be used for management decisions. This value was established as a ± 5% for a true-false type question with 95% confidence when the occurrence of these values was assumed to be .50/.50 in the population, assuming a random sample. In order to meet this objective, a sample size of 1000 was selected with a sample of approximately 333 visitors (153 anglers and 180 rafters) being selected from each of the three flow level strata.

Several problems arose during sampling that made it impossible to obtain an equal number of anglers and rafters from each of the three research flow periods. There were fewer anglers on the river than expected during the high flow period and some confusion over the exact dates when flow levels occurred, resulting in fewer anglers being surveyed during the high flow period. The final sample included 353 anglers (184 low flow, 156 medium flow, and 113 high flow) and 593 rafters (191 low flow, 189 medium flow, and 213 high flow) for a total sample size of 946 visitors. Steps were taken during the analysis to compensate for unequal numbers of respondents for each flow level. These procedures are discussed in the Data Analysis section.

Data Collection

The field data collection period was May through July, 1991 to correspond with research flow levels and was conducted in two phases. Phase one involved an initial on-site face-to-face contact with Glen Canyon rafters and anglers selected to participate in the survey. On-site interviews were conducted at the raft launching point at the base of Glen Canyon dam (rafters) and at the boat ramp accessing upriver fishing locations and the accessible shoreline areas near the boat ramp (anglers).

Phase two involved giving willing participants a postage-paid mail-back questionnaire (Appendix D), the primary data gathering instrument, to be filled out either during or at the conclusion of their rafting or fishing trip on the river. Drop boxes were provided near the boat launch ramp at Lee's Ferry, which is also the raft trip take-out point giving participants the opportunity to drop off the questionnaire on-site or return it by mail.

Interviews were conducted at the raft launching point and Lees Ferry boat ramp during three 1-week time periods during the summer:

May 21-26, 1991	Medium flow period
July 8 - 11, July 21-25, 1991	High fluctuating
July 12-14, July 26-28, 1991	Low flow period

During the on-site phase, initial data on group size and composition were collected along with each participant's name and address. Names and addresses were gathered solely for the purpose of sending subsequent follow-up reminders to those who did not return the mailback questionnaire. Upon completion of the mailing procedures, the name and address files were destroyed and the permanent data were anonymous.

Efforts were made to achieve a maximum response rate for the mailback questionnaire. This was accomplished by sending follow-up materials to respondents to solicit and encourage return of completed mail-back questionnaires. The following were used:

a. If the mail-back questionnaire was not returned within 2-3 weeks' time, a reminder postcard was sent.

b. If there was no response to the reminder postcard, a second follow-up letter and replacement questionnaire were sent.

c. If there was still no response, a third and final follow-up letter and replacement questionnaire were sent.

These efforts resulted in 739 of the 946 questionnaires distributed being returned, a response rate of 78 percent.

Data Analysis

Two types of data analysis were used to meet the objectives of the Visitor Use Survey portion of the Lees Ferry Carrying Capacity study. The first type of analysis involved the use of descriptive statistics to characterize the angler and rafter groups according to use and user characteristics, their experiences on the river, perceptions of problems, opinions toward river management and anglers' perceptions of the impact of river flow level on fishing quality. The second type of analysis investigated the impact of flow level on visitor experiences using analysis of variance and chi-square statistics to look for differences in selected variables among flow levels. Angler and rafter responses were analyzed separately in both analyses. All data were entered onto a microcomputer and analyzed with microcomputer-based statistical software.

To compensate for the unequal sample sizes among the three flow levels for both anglers and rafters, survey data were weighted as part of the analysis process. Weights were computed to equalize responses among the three flow levels. Separate weights were calculated for anglers and rafters and used in all analyses. The sample size values (n) reported in the tables in the Results Chapter are the unweighted sample size and the percentages and means presented are weighted values.

A note of caution is warranted. A primary objective of the Lees Ferry Carrying Capacity Study was to assess the impact of river flow level on visitor experiences. To meet this objective, the sample of anglers and rafters was drawn during the research flow levels and subsequently weighted for analysis. Consequently, these data reflect a somewhat artificial condition at Glen Canyon NRA, because of the research flows, and may not accurately represent all anglers and rafters who use the river during nonresearch flow periods. Care should be taken in generalizing the results of the survey to the entire summer population of river users. The results do, however, represent visitors to the river during the research flow periods. These flows represent a range of managed flow options which could be realized in the future.

Manager and Visitor Assessment Comparison

Lees Ferry Carrying Capacity Study Biophysical Impact Survey data on impact values for trash, human waste, vegetation damage, soil disturbance and fire impacts for the 15 campsites and for the 3 day-use rafter stops were examined. These five impact indicators were chosen because these were the five impacts about which anglers and rafters were questioned. Percentages of sites lightly, moderately, heavily and severely impacted were calculated for each of the five impacts. These

results represented manager assessment of resource condition.

Responses to the Lees Ferry Carrying Capacity Visitor Use Survey question regarding problems anglers and rafters encountered on the river were also examined. Visitors were asked if litter, human waste, vegetation damage, erosion, and fire remains were: not a problem, minor problem, serious problem or did not encounter. To determine visitor assessment of resource condition on the 15 campsites, responses of 36 anglers who camped upriver were tabulated. The percentage of the 36 anglers that felt the impact was not a problem or did not encounter, a minor problem or a serious problem were tabulated. Responses of not a problem or did not encounter were lumped together since visitors appeared to be unable to distinguish the difference between these two responses.

Four hundred fifty-eight rafters gave their perceptions of the severity of the same five biophysical impacts at three day-use sites. These results were tabulated. The percentage of the 458 rafters that felt each of the five impacts was not a problem or did not encounter, a minor problem, or a serious problem was recorded.

A comparison of manager and visitor assessment of campsite condition was then made by comparing the percentage of the 15 campsites rated lightly impacted (manager assessment) with the percentage of visitors who

responded that there was no problem or they did not encounter a problem (visitor assessment). The percentage of moderately impacted sites was compared to the percentage of anglers perceiving the specific impact as a minor problem on the 15 campsites. The percentage of heavily and severely impacted sites was compared to the percentage of anglers who felt the specific impact was a serious problem.

The same procedure was used to compare manager and visitor assessments of resource condition on the 3 day-use sites. Since rafters were asked to comment specifically on litter, human waste and vegetation damage at the rest stop site and the lunch stop site, the average of the two percentages of rafters responding not a problem or did not encounter, minor problem and serious problem were used to calculate rafter assessment for these three impacts.

CHAPTER 4

RESULTS

Results of the data analysis, along with pertinent data from the Lees Ferry Carrying Capacity Study, are reported in four sections. Biophysical survey results are found in The Manager Assessment of Impacts section. Visitor responses to problems they encountered on the river are located in The Visitor Assessment of Impacts section. The Manager and Visitor Assessment Comparison section contains the results of the comparison of manager and visitor perceptions of the extent of five impacts on 15 campsites and 3 day-use sites. The final section, Support for Management Actions, includes angler and rafter opinions toward specific river management actions aimed at mitigating impacts. These results will assist managers in choosing actions which will be most acceptable to visitors.

Manager Assessment of Impacts

This section is divided into three subsections. The Site Descriptions section compares various aspects of the sites according to site type. These data are used in the Discussion section and help explain why the different site types differ in amount of impact (Hypothesis 1.)

Results of the Rapid Estimate Procedure as well as the statistical analysis of differences in amount of impact between site types are reported in the Impact Indicators and Condition Class sections. These results satisfy objectives 1 and 2 of this thesis: to determine manager assessment of the condition of upriver sites and to examine the effect of site type on site condition.

Site Descriptions

In addition to rating impacts on sites, managers collected descriptive and interval data about different aspects of each site. These data were drawn from the first page of the biophysical impact survey form (Appendix C). Explanations for why site types differ with respect to specific impacts can be drawn from comparisons of these descriptions.

Present Use Restriction. The type of user can affect the amount and types of impact found on recreation sites. The majority of the day use sites, 19 out of 27 (70.4%), were used exclusively by anglers. Six (22.2%) of the day use sites were used by a combination of either anglers and rafters or anglers and hikers. Only two (7.4%) of the 27 day use sites were used predominantly by rafters.

Twelve (80%) of the 15 campsites were considered to be used primarily by anglers and three (20%) were used by

both anglers and hikers (Ropes Trail Camps). One day float trip rafters do not use the designated campsites.

The 7 illegal satellite campsites were found on the lower benches below the upper bench designated campsites. All of these sites (100%) were used solely by anglers.

Use Concentration. Use can be concentrated on fragile areas of a site such as talus slopes or grassy vegetation or durable areas of a site on rocky substrate or in thick tamarisk. The type of area can affect the amount of vegetation damage and soil disturbance impacts.

Day use sites had the most varied types of use areas. Ten sites out of 27 (37.0%) had use concentrated on the beach, five sites (18.5%) had use concentrated within the tamarisk, four sites (14.8%) on the lower bench, two (7.4%) on the upper bench, one (3.7%) on both the beach and gravel bar, one (3.7%) on the beach and lower bench, two (7.4%) on the beach and within the tamarisk, one (3.7%) within the tamarisk and on the upper bench, and one (3.7%) on the beach and the upper bench.

Of the 15 campsites, only one (6.7%) had use concentrated within the tamarisk, three (20%) had use concentrated on the lower bench, and 11 (73.33%) had use concentrated on the upper bench. The majority of the campsite use areas are therefore unaffected by river flows.

Four out of 7 (57.14%) of the illegal satellite sites had use located on the lower bench, two (28.57%) on the upper bench, and one (14.29%) on the beach and lower bench.

Associated Attractions. Types of attractions at sites can affect the amount of visitation they receive. The day use sites had the greatest variety of attractions associated with the sites. One site out of 27 (3.7%) offered both fishing and a rapid, eight (29.63%) were near spawning bars, one (3.7%) was near the launch ramp and dock, four (14.81%) were associated with cultural sites, one (3.7%) was near a natural attraction and a good fishing spot, four (14.81%) were near natural attractions, one (3.7%) offered just fishing, two (7.41%) had nice beaches, and three (11.11%) had no observable attractions.

Twelve of 15 (80%) of the designated campsites were considered attractions in themselves. Three (20%) were also located near spawning bars.

All of the 7 illegal campsites were considered to have the adjacent designated campsites as an attraction. Two (28.57%) of the illegal sites were also near spawning bars.

Percent Vegetation Cover. Percent vegetation cover was estimated on the 49 sites. As soil disturbance and vegetation damage impacts increase, percent vegetation

cover decreases. Table 1 shows these results according to type of site.

Table 1
Percent Vegetation Cover

Percent Vegetation Cover	Day Use	Campsite	Illegal
1% - 25%	37.04%	40.00%	71.43%
26% - 50%	25.93%	33.33%	14.29%
51% - 75%	25.93%	6.67%	14.29%
76% - 100%	11.11%	20.00%	0.00%

Distance Core to River. The distance of the center of each site from the river was measured. Sites which are farther from the river tend to have a greater number of social trails associated with them. Multiple trailing is considered a recreational impact. These results are reported in Table 2.

Table 2
Distance Core to River

Distance (ft.)	Day Use	Campsite	Illegal
0 - 25	40.74%	0.00%	0.00%
26 - 50	25.93%	13.33%	57.14%
51 - 100	14.81%	26.67%	28.57%
101 - 150	7.41%	40.00%	28.57%
151 - 200	3.70%	13.33%	0.00%
>200	7.41%	6.67%	0.00%

Vertical Climb. The vertical climb from the river to the site ranged from less than one foot to forty feet. Table 3 shows these results grouped in ranges and by site type. Sites on upper shelves tend to have a greater amount of gullying and erosion.

Table 3
Vertical Climb

Vertical Climb (ft.)	Day Use	Campsite	Illegal
<1	11.11%	0.00%	0.00%
1 - 5	55.56%	6.67%	28.57%
6 - 10	25.93%	13.33%	42.86%
11 - 20	7.41%	26.67%	0.00%
21 - 30	0.00%	33.33%	0.00%
31 - 40	0.00%	20.00%	28.57%

Capacity. Even though camping is not allowed on day-use sites, an estimate of the number of people able to camp was made on all sites for the purpose of comparison. Larger parties tend to do more site damage. Table 4 shows these results.

Table 4
Capacity

# of People able to camp	Day Use	Campsite	Illegal
0	3.70%	0.00%	0.00%
1 - 5	18.52%	33.33%	0.00%
6 - 10	18.52%	33.33%	85.71%
11 - 20	22.22%	26.67%	14.29%
21 - 30	18.52%	6.70%	0.00%
31 - 40	7.41%	0.00%	0.00%
41 - 50	11.11%	0.00%	0.00%

Number of Boats Able to Moor. It is important to know how many boats are able to moor at the various types of sites when considering establishing a party size for these sites. Generally, the greater the number of boats, the greater the impact of erosion on the river bank at the mooring site. Table 5 shows the number of boats able to moor at each of the three site types.

Table 5
Number of Boats Able to Moor

Number of Boats	Day Use	Campsite	Illegal
0	7.41%	0.00%	85.71%
1 - 3	18.52%	53.33%	14.29%
4 - 10	48.15%	46.67%	0.00%
11 - 15	14.81%	0.00%	0.00%
16 - 25	11.11%	0.00%	0.00%

Access. Access to beaches is made more difficult when large rocks and cobbles are present. Sites which have a difficult access tend to have fewer visitors and often fewer impacts. Table 6 shows the percentage of sites, separated by type of site use, which have each of the various types of river bottoms at access points.

Table 6
Access

Access	Day Use	Campsite	Illegal
Cobble Bar	18.52%	26.67%	71.43%
Large Rocks	11.11%	20.00%	42.86%
Shallow	33.33%	33.33%	28.57%
Sandy	18.52%	6.70%	0.00%
Deep Water	40.74%	33.33%	0.00%

percentages do not equal 100, since access could be more than one description.

Toilets. Table 7 lists the percentage of sites within each site type that have toilets within walking distance of the site. All campsites and illegal campsites have toilets. Sites which do not have toilets tend to have greater human waste impacts.

Table 7
Toilets

Toilets?	Day Use	Campsite	Illegal
YES	14.81%	100%	100%
NO	85.19%	0%	0%

Distance to Toilet. All campsites have toilets present on site, but day-use sites are often miles away from a toilet. Table 8 shows these results. In general, sites which have a toilet on site have less of a human waste impact problem than sites which are a great distance from a toilet.

Table 8
Distance to Toilet

Distance to Nearest Toilet (ft)	Day Use	Campsite	Illegal
0 - 25	3.70%	26.67%	0.00%
26 - 100	3.70%	37.04%	57.14%
101 - 500	0.00%	6.70%	42.86%
501 - 1,000	3.70%	0.00%	0.00%
1,001- 5,000	51.85%	0.00%	0.00%
5,001-10,000	18.52%	0.00%	0.00%
>10,000	18.52%	0.00%	0.00%

Fire Grates. All fifteen campsites had fire grates on site. None of the day use sites nor the illegal campsites had fire grates, but a fine for building a fire on these sites exists. If properly constructed, fire grates should contain fire ash. If not maintained, fire ash could be a problem on these sites.

Grazing Impact Present. Cows can increase vegetation damage and soil disturbance impacts adding to

human caused impacts. None of the campsites or illegal satellite campsites exhibited signs of grazing.

Four (14.81%) of the day use sites had cow manure present and four (14.81%) had grazed vegetation. These sites were located on the Navajo Nation side of the river, within the first seven miles upriver from Lees Ferry.

Evidence of Beaver Activity. Presence of beaver indicates that human caused recreation impacts are not annihilating beaver populations. There were signs of beaver activity on ten (37.04%) of the day use sites. Signs included tracks, gnawed vegetation, gnawed NPS signs, and a beaver dam. There were no signs of beaver activity at the designated or illegal campsites.

Size of Use Area. Table 9 shows that day-use sites tend to be much larger than campsites and illegal campsites. Results are grouped in ranges and according to type of site. When use is concentrated on a small area, impacts tend to be greater.

Table 9
Use Area

Use Area (sq.ft.)	Day Use	Campsite	Illegal
0 - 500	3.70%	6.70%	0.00%
501 - 1000	14.81%	33.33%	85.71%
1001 - 5000	33.33%	60.00%	14.29%
5001 - 10000	18.52%	0.00%	0.00%
10001 - 15000	14.81%	0.00%	0.00%
15001 - 20000	11.11%	0.00%	0.00%
>20000	3.70%	0.00%	0.00%

Percent Barren Core. Percent barren core is a measure of soil disturbance. The percentage of sites, separated by type of site, within each barren core measurement range is listed in Table 10.

Table 10
Percent Barren Core

Percent of Use Area which is Barren Core	Day Use	Campsite	Illegal
0	3.70%	0.00%	0.00%
1 - 25	48.15%	40.00%	0.00%
26 - 50	14.81%	6.70%	42.86%
51 - 75	11.11%	20.00%	14.29%
76 - 100	22.22%	33.33%	42.86%

Impact Indicators

Eight impact indicators were used to determine site condition. For each impact, sites received a rating of 1, 2, 3 or 4. A rating of 1 meant little or no impact and a 4 meant severely impacted. This rating was then multiplied by a factor weighting value to calculate an impact value.

Impact values calculated for each of the eight impact indicators on day-use sites, campsites and illegal campsites are listed in Tables 28, 29, and 30 (Appendix B). These values were used to determine the percentage of the 49 sites that were lightly, moderately, heavily and severely impacted with respect to each of the eight impact indicators (Table 11).

Table 11
Severity of Impact
with Regard to Eight Impact Indicators
Percentage of 49 Sites

Impact Indicator	Light	Moderate	Heavy	Severe
Soil Disturb	2.0%	28.6%	24.5%	44.9%
Veg Damage	12.2%	28.6%	18.4%	40.8%
Trails	2.0%	10.2%	22.5%	65.3%
Fire Impacts	20.4%	4.1%	22.5%	53.1%
Human Waste	8.2%	18.4%	22.5%	51.0%
Trash	6.1%	14.3%	18.4%	61.2%
Pests/Insects	10.2%	34.7%	38.8%	16.3%
Site Mod	57.1%	20.4%	2.0%	20.4%

Figure 1 shows that the majority of the 49 sites were lightly impacted with respect to site modification. Trails, trash, fire impacts and human waste impacts were severe on greater than 50% of the 49 sites.

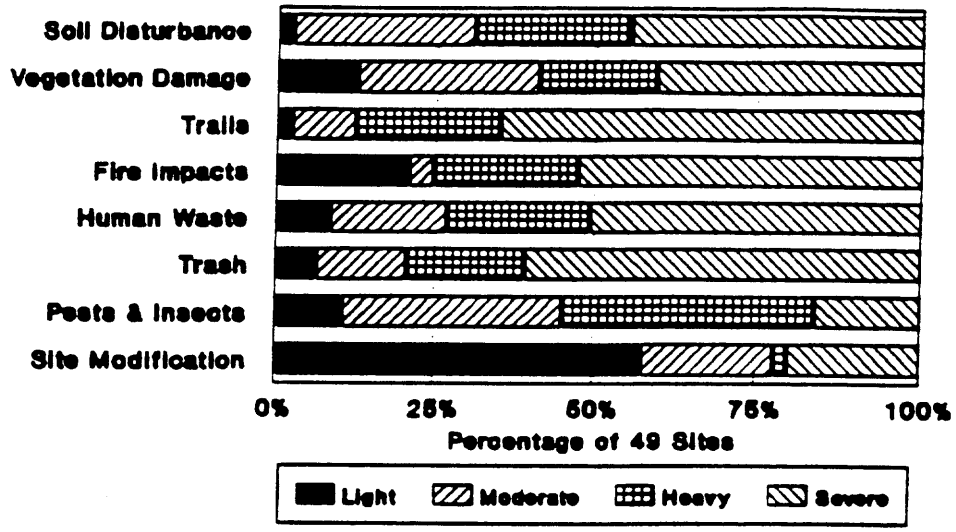

Figure 1.
Comparison of Severity of Impacts
with Regard to Eight Impact
Indicators Over 49 Sites

Impact values were also used to compare the severity of each of the eight impacts on the three site types: day-use sites, campsites and illegal campsites. Each impact indicator was examined separately.

The percentage of the 27 day-use sites, 15 campsites and 7 illegal campsites which had light, moderate, heavy, and severe soil disturbance impacts was calculated using impact values from Tables 28, 29 and 30 (Appendix B).

Table 12 shows that when examined for soil disturbance, campsites and illegal campsites were most heavily impacted. Seventy-three percent of the campsites and 57.1% of the illegal campsites were severely impacted. In comparison, close to half of the day-use sites were moderately impacted.

Table 12
Comparison of
Soil Disturbance Impact

Site Type	Light	Moderate	Heavy	Severe
Day-use	37.0%	48.2%	22.2%	25.9%
Campsite	0.0%	6.7%	20.0%	73.3%
Illegal Campsite	0.0%	0.0%	42.9%	57.1%

Vegetation damage impact value comparison results are reported in Table 13. Vegetation damage was greatest on campsites. Sixty-six percent of the campsites were severely impacted. Day-use sites had the greatest number of moderately impacted sites, 41%.

Table 13
Comparison of
Vegetation Damage Impact

Site Type	Light	Moderate	Heavy	Severe
Day-use	14.8%	40.8%	14.8%	29.6%
Campsite	6.7%	6.7%	20.0%	66.6%
Illegal Campsite	14.2%	28.6%	28.6%	28.6%

The impact of trails was great on all site types. The majority of day-use and campsites were severely impacted, 67% and 73% respectively (Table 14). Fifty-seven percent of the illegal campsites were heavily impacted.

Table 14
Comparison of
Trails Impact

Site Type	Light	Moderate	Heavy	Severe
Day-use	3.7%	14.8%	14.8%	66.7%
Campsite	0.0%	6.7%	20.0%	73.3%
Illegal Campsite	0.0%	0.0%	57.1%	42.9%

Similar to trails, fire impacts were great on all site types. Trail impacts were severe on 67% of the day-use sites and campsites as shown in Table 15. Forty-two percent of the illegal campsites were severely impacted. However, it is interesting to note that almost a quarter of the day-use sites, 13% of the campsites, and 29% of the illegal campsites were lightly impacted.

Table 15
Comparison of
Fire Impact

Site Type	Light	Moderate	Heavy	Severe
Day-use	22.2%	3.7%	14.8%	66.7%
Campsite	13.3%	0.0%	20.0%	66.7%
Illegal Campsite	28.5%	14.3%	14.3%	42.9%

Table 16 shows that day-use sites were the most heavily impacted with respect to human waste. Sixty-six percent of the day use sites had impact values which fell into the severe range. Only 14% of the illegal campsites were severely impacted.

Table 16
Comparison of
Human Waste Impact

Site Type	Light	Moderate	Heavy	Severe
Day-use	0.0%	14.8%	18.5%	66.7%
Campsite	13.3%	20.0%	26.7%	40.0%
Illegal Campsite	28.6%	28.6%	28.6%	14.2%

Campsites has the greatest trash impact (Table 17). However, more than half (52%) of the day-use sites were also severely impacted. In comparison, only 29% of the illegal campsites were severely impacted.

Table 17
Comparison of
Trash Impact

Site Type	Light	Moderate	Heavy	Severe
Day-use	7.4%	14.8%	25.9%	51.9%
Campsite	0.0%	6.7%	0.0%	93.3%
Illegal Campsite	14.2%	28.6%	28.6%	28.6%

Table 18 shows that 43% of the illegal campsites were lightly impacted with respect to pests and insects and no illegal campsites were severely impacted. Forty-five percent of the day-use sites were moderately impacted and 47% of the campsites were heavily impacted. Campsites had the greatest pests and insects impact.

Table 18
Comparison of
Pests and Insects Impact

Site Type	Light	Moderate	Heavy	Severe
Day-use	7.4%	44.5%	33.3%	14.8%
Campsite	0.0%	26.7%	46.6%	26.7%
Illegal Campsite	42.8%	28.6%	28.6%	0.0%

The majority of day-use sites, campsites and illegal campsites were lightly to moderately impacted with respect to site modification. Seventy-four percent of the day-use sites, 43% of the illegal campsites, and 33% of the campsites were lightly impacted (Table 19). The type of site with the greatest site modificaton impact was the illegal campsite.

Table 19
Comparison of
Site Modification Impact

Site Type	Light	Moderate	Heavy	Severe
Day-use	74.0%	11.1%	14.9%	0.0%
Campsite	33.3%	33.3%	6.7%	26.7%
Illegal Campsite	42.8%	28.6%	0.0%	28.6%

A Kruskal-Wallis test was performed for each impact indicator. Impact values for each site, grouped by site type, were used to determine if the amount of impact differed significantly between site types. The impact indicator was the dependent variable and site type was the grouping variable. Table 20 shows the Kruskal-Wallis test results.

Table 20
Kruskal-Wallis Test Results
Indicators

Dependent Variable	Test Statistic	p value	Significant at p
Soil Dist	12.7	.002	< .01
Veg Dam	6.6	.037	< .05
Trails	1.2	.543	not
Fire	1.9	.385	not
Hum Waste	8.8	.012	< .05
Trash	9.7	.008	< .01
Pests	8.5	.014	< .05
Site Mod	5.5	.063	not

The null hypothesis that there was no difference in the amount of impact on the three site types was rejected ($p<.01$) for soil disturbance and trash (Table 20). The null hypothesis was rejected ($p<.05$) for vegetation damage, human waste, and pests and insects. Therefore, some of the site types were significantly more heavily impacted than others with respect to soil disturbance, trash, vegetation damage, human waste and pests and insects impacts.

Condition Class

Condition class, a measure of overall site condition, was calculated for each of the 49 sites from the sum of the eight impact values. Sites with indices ranging from 18 to 28 were considered lightly impacted, from 29 to 45 moderately impacted, from 45 to 61 heavily impacted, and from 62 to 72 severely impacted. Condition class values for day-use sites, campsites and illegal campsites are listed in Tables 31, 32 and 33 (Appendix B).

Out of 49 total sites, 0 had an impact index less than 32, so there were no lightly impacted sites (Figure 2). The percentage of moderately impacted sites was 16.3% (8 sites), heavily impacted sites was 57.1% (28 sites), and severely impacted sites was 26.5% (13 sites).

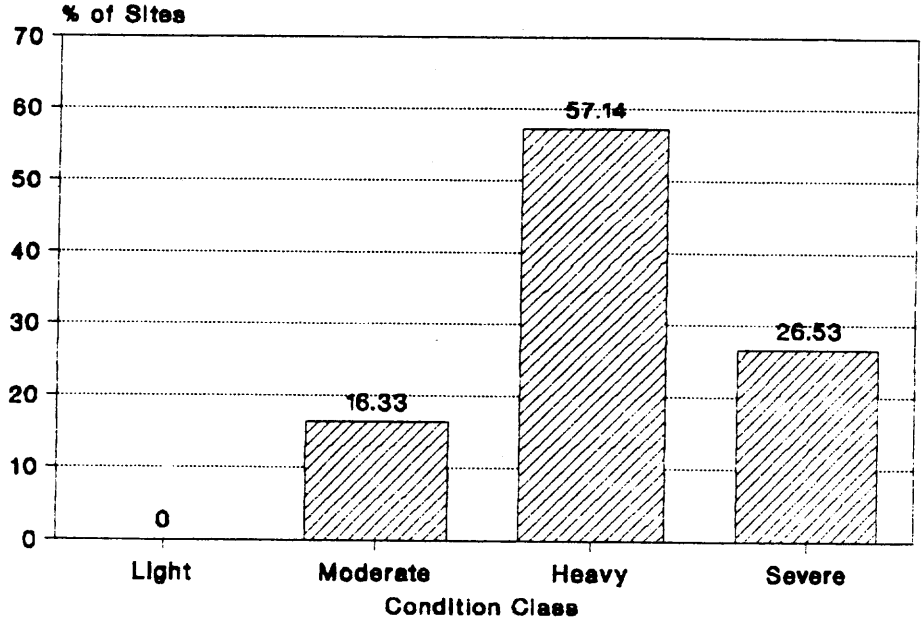

Figure 2.
Percentage of 49 Sites
within Each Condition Class

Therefore, the majority of the 49 sites were heavily impacted with regard to overall condition.

Sites were grouped by site type and overall condition was compared. Table 21 shows that the majority of day-use sites, 63% were heavily impacted. Ninety-three percent of the campsites were heavily to severely impacted. Illegal campsites were in better condition than the other site types, but 43% of the illegal campsites were heavily impacted.

Table 21
Condition Class of Sites
by Type of Site Use

Site Type	Light	Moderate	Heavy	Severe
Day-use	0.0%	18.5%	62.9%	18.5%
Campsite	0.0%	6.7%	46.7%	46.7%
Illegal Campsite	0.0%	42.9%	42.9%	14.3%

Using the value of site impact index for each site and grouping the sites by site type, a Kruskal-Wallis test was performed to determine if the overall impact on some types of sites was significantly greater than on others. The null hypothesis: there is no difference between the amount of impact on the three types of sites, was rejected ($p<.01$) (Table 22).

Because the null hypothesis was rejected, a multiple comparisons test was performed to determine which pairs of populations tend to differ. The test revealed that all three populations differ from one another. Results

Table 22
Kruskal-Wallis Results
Site Type Condition Class

Site Type	Count	Rank Sum
Day-use	27	581.0
Campsite	15	517.5
Illegal Camp	7	126.5

Kruskal-Wallis test statistic = 9.897
X^2 (p=0.007, DF=2)

from Table 22 suggest that campsites are the most heavily impacted and illegal campsites are the least heavily impacted when overall condition is examined.

Visitor Assessment of Impacts

The Visitor Assessment of Impacts section is divided into two subsections. The Lees Ferry Carrying Capacity Visitor Use Survey was distributed to both anglers and rafters recreating on the river. Socio-demographic characteristics of these visitors are reported as background in the Visitor Profile section. Results of the visitor survey question which queried visitors as to problems they encountered during their visit are reported in the Problems Encountered section. A portion of these results were used to determine visitor perceptions of biophysical impacts at campsites and day-use sites.

Visitor Profile

Two types of visitors to Lees Ferry were surveyed, anglers and rafters. The Visitor Profile section

presents some of the demographic characteristics of these two types of users.

Age. Anglers range in age from 17 to 86 years, with an average age of 44.2 years. More than half of the anglers surveyed were between 30 and 50 years old (59%). Six percent of anglers surveyed were older than 70 years old.

Visitors of a variety of ages take raft trips down the Glen Canyon NRA reach of the Colorado River. Those interviewed ranged in age from 15 to 81 years and averaged close to 48 years old. The largest group of rafters were between 40 and 50 years old (30%), followed by those 31 to 40 years old (19%).

Gender. The overwhelming majority of anglers at Lees Ferry are male. Among those surveyed, 92% were male and 8 percent were female.

Rafting visitors to Glen Canyon NRA are fairly evenly split between male and female. Among those surveyed, 51% were male and 49% were female

Education. Anglers at Lees Ferry tend to be well educated, with 87% having had at least some college, 21% of whom were college graduates and 18% who had at least a master's degree. Among the remaining anglers surveyed, 12% were high school graduates and 1% had less than a high school education.

Rafters are well-educated, with close to half (49%) having some college or are college graduates and another one-third (31%) having a graduate a professional degree. Eleven percent had some graduate school work, and only 8% had a high school education or less.

Marital status. Married anglers outnumber unmarried anglers. Seventy-two percent of those surveyed were married, 17% were single, having never married, 9% were divorced, 2% were separated, and less than 1% were widowed

Married visitors outnumber unmarried visitors among rafters. Seventy-four percent of those surveyed were married, followed by single, never married visitors (13%), divorced (7%), widowed (3%), and separated (1%) visitors.

Race or ethnic group. There are very few minority groups represented among anglers at Lee's Ferry. Among anglers surveyed, 95% were White, 3% were Native American, 2% were Hispanic, less than 1% were Asian or Pacific Islander, and there were no Blacks.

The large majority of rafters are White (94%), followed by Asian (2%), Hispanic (2%), Black (1%), and American Indian (less than 1%).

Employment. The majority of anglers are employed full-time (74 %). There is a fairly large proportion of

retired individuals (15%). Students and homemakers each make up 1% of anglers, part-time employees make up 4%, less than 1% were unemployed, and 4% classified themselves in some combination of categories.

More than half of Glen Canyon rafters are employed full-time (60%). Individuals who considered themselves retired made up 21% of the rafters. Homemakers make up 6% of rafters, as do part-time employees, followed by students (3%), unemployed individuals (1%), and those who classified themselves as some combination of the other classes (2%).

Income. The largest proportion of anglers have a total household income of 100 thousand dollars or more a year (16%). The next largest group of anglers (15%) reported incomes between 30 and 39,999 dollars, followed by incomes between 40 and 49 thousand dollars (13%), 50 to 59 thousand dollars (11%), and 20 to 29 thousand dollars (10%). Only 2% of anglers reported a yearly income of less than 10 thousand dollars.

There is substantial wealth distributed among Glen Canyon rafters. Twenty-one percent of rafters reported a yearly household income between $70,000 and $100,000 and another 21% have an income of $100,000 or more. An additional 43% had incomes ranging between $30,000 and $70,000 a year and the remaining 15 % of rafters had household incomes of less than $30,000 a year.

State of residence. Lees Ferry primarily attracts regional visitors. More than three quarters of anglers live in Arizona (76%), followed by California (6%), Nevada (5%), Utah (4%), Colorado (1%), Florida (1%), and New Mexico (1%). Fewer than 1% of anglers were from countries outside the U.S.

Rafters are largely out-of-state residents, coming from throughout the United States. A substantial number come from California (12%) and eastern states such as New York (12%), New Jersey (8%), and Florida (8%). Twelve percent of rafters are foreign visitors. Relatively few rafters (6%) live in Arizona.

First-time visitors. Anglers tend to be return visitors to Glen Canyon NRA. Close to three-quarters (73%) of those surveyed indicated this was not their first visit. The majority of anglers (64%) had visited between 1 and 4 times. Seven anglers reported having visited Glen Canyon 100 or more times within the past year. Five of those anglers were guides who work on the river and the other two live at Marble Canyon. Excluding those seven responses, prior visits within the past year ranged from 1 to 30, with an average of 4.7 prior visits.

The river rafting trip is their first exposure to Glen Canyon NRA for the large majority of visitors (91%). Nine percent of rafters had previously visited Glen Canyon NRA. Among that group of repeat visitors, 43% had

visited the area once within the past 12 months, 18% had visited twice, and 13% had visited three times. Others had visited 4, 5, 7, 8, and 20 times during the past year.

Problems Encountered

In the original Lees Ferry Carrying Capacity Study, the intent of this question was to identify any problems that visitors may have encountered on the river during their stay at Glen Canyon NRA. Visitor responses to the question are listed in their entirety. Portions of these data were used in the analysis described in the Manager and Visitor Assessment Comparison section and satisfy objective number 3.

Potential problems included situations caused by the behavior of others such as wakes caused by passing boats, noise, litter, human waste, graffiti, or vessels passing too close. Other problems related to natural and dam-related processes such as water temperature, flow level, safety, beach erosion, and access to fishing and camping sites. Management-related problems included poorly maintained toilets and difficulty finding parking spaces. Response categories included "encountered but not a problem," "a minor problem," "a serious problem", and "did not encounter."

Anglers were by and large not very critical about conditions they encountered on the river. Table 34 (Appendix B) shows that the majority of anglers (more than 50%) said they did not encounter the following problems: human waste at campsites (51%), finding a campsite upriver (57%), remains of illegal fires on beach or at campsites (58%), boat swamped while tied up on beach (62%), damage to raft and/or motor (52%), lots of unburned trash in fire grates at campsites (57%), graffiti on petroglyph panels (57%).

Items that anglers said they did encounter but a majority said were not a problem include: water too clear (84%), waiting at boat launch ramp (70%), finding a space to park my vehicle/trailer (74%), water too cold (69%), within sight and sound of wading or bank anglers too often (65%), accessing desired fishing spots (61%), did not feel safe while wading (60%), water too warm (59%), litter at fishing spots (52%), inability to fish in solitude (52%), within sight and sound of boats too often (52%), human waste at fishing spots (50%), boats running over fishing line (50%), people shouting and yelling (50%).

There were a number of issues that at least 40% of anglers said were either not a problem or not encountered. These included things such as inconsiderate anglers, rafters, and guides, litter at campsites, noisy motorboats, boats or rafts blocking river channels, water

too low and too slow, water too muddy, toilet facilities poorly maintained, too often within sight and sound of rafts, boat getting beached, and vessels passing too close to one another.

There were a several problems that emerged as being of particular concern to anglers, mentioned as either a minor or serious problem. These included: wakes created by rafts motoring upriver (52%), wakes created by passing boats (49%), erosion of beaches (39%), within sight and sound of rafts too often (38%), noisy motorboats (35%), and vegetation damage at fishing and camping location (27%).

Rafters were even less critical than anglers of conditions they encountered during their raft trip. Table 35 (Appendix B) shows that for all but nine of the 35 problem items listed, 90% or more of the rafters said they either did not encounter that condition, or they encountered it and it was not a problem. Because of the large percentage of rafters who indicated that the majority of conditions presented were "not a problem", rafters may not have clearly distinguished between the response categories "Did encounter and it was not a problem" and "Did not encounter." Thus, for the purposes of this discussion, a clear distinction between conditions rafters said they did not encounter, and those they said were not a problem will not be made.

There were seven conditions that at least 18% of rafters said were either a minor or serious problem during their river trip. These included: toilet facilities poorly maintained (39%), graffiti on petroglyph panels (34%), water too cold (31%), noisy motorboats (23%), wakes created by passing boats (18%), water too low and too slow (18%), human waste at rest stop site (18%).

Rafter use of the river environment is concentrated primarily at the launch site, the rest stop site, and, for rafters on full-day trips, the lunch stop site. Litter and vegetation damage at the lunch and rest stop sites are not seen as problems although human waste at the rest stop site appears to be a problem associated with poorly maintained toilet facilities. The petroglyph panels are located at the rest stop site and rafters see the graffiti on the panels as a problem, and a serious problem according to 18% of rafters.

Manager and Visitor Assessment Comparison

To satisfy research objective 4, manager and visitor assessments of resource condition on selected sites were compared. A comparison of angler versus manager perceptions of litter, human waste, vegetation damage, soil disturbance, and fire is examined in the Manager vs. Angler Perceptions of Condition of Campsites section. A comparison of rafter vs. manager perceptions of these

same five biophysical impacts is examined in the Manager vs. Rafter Perceptions of Condition of Three Day-use Sites section.

Manager vs. Angler Perceptions of Condition of Campsites

Anglers who camped overnight at one of the upriver campsites were separated from those who did not camp. Responses of these 36 anglers to the Problems Encountered question with respect to litter, human waste, vegetation damage, erosion and fire remains at campsites were tabulated (Table 23).

Table 23
Camping Anglers Opinions
of Biophysical Impacts (n=36)

Impact at Campsite	Not a Problem or Did not Encounter	Minor Problem	Serious Problem
Litter	52.8%	41.6%	5.6%
Human Waste	75.0%	22.2%	2.8%
Veg Damage	58.4%	33.3%	8.3%
Erosion	66.6%	16.7%	16.7%
Fire Remains	75.0%	22.2%	2.8%

Impact value data from the biophysical survey for the 15 campsites were compiled (Table 24). Only ratings for the same five impacts evaluated by anglers in the visitor use survey were used. Impact values of 3, 6, 9, 12 for soil disturbance and vegetation damage, correspond to a lightly, moderately, heavily, and severely impacted

condition with respect to the specific indicator. Impact values of 2, 4, 6, 8 for fire impacts, human waste and trash correspond to a lightly, moderately, heavily

Table 24
Impact Value Data for 5 Impacts and 15 Campsites

Site # n=15	Soil Disturbance	Vegetation Damage	Fire	Human Waste	Trash
9A	12	9	8	4	8
9B	12	9	8	2	8
14A	6	6	6	2	8
14B	9	3	8	6	4
14C	9	9	8	6	8
15A	12	12	8	6	8
15B	12	12	2	8	8
16A	12	12	2	4	8
16B	12	12	6	4	8
19A	12	12	8	8	8
19B	12	12	8	8	8
19C	9	12	8	8	8
23A	12	12	6	6	8
23B	12	12	8	8	8
23C	12	12	8	8	8

and severely impacted condition with the specific indicator. These data constitute manager assessment of the condition of the campsites.

Percentages of the 15 campsites rated lightly, moderately, and heavily or severely impacted with respect to each of the five impact indicators examined were calculated from Table 24. Percentage of the 36 camping anglers rating the five impacts at the campsites as minor problem, severe problem, and did not encounter or not a problem was calculated from Table 23. Table 36 (Appendix B) compares manager and angler assessment of the

condition of the campsites, evaluating the five specific biophysical impacts.

For each of the five impacts, greater than 60% of the sites were considered in heavy to severe condition according to managers. For each of the five impacts, greater than 50% of the anglers reported that these impacts were not a problem or that they did not encounter them at the campsites they visited. These results suggest that managers view campsites as more heavily impacted with respect to trash, human waste, vegetation damage, soil disturbance, and fire impacts than anglers.

Manager vs. Rafter Perceptions of Condition of Three Day-use Sites

Responses of 458 rafters to the Problems Encountered question with respect to litter, human waste, vegetation damage and erosion at the lunch stop site and rest stop site, and fire remains on both sites were tabulated (Table 25).

Table 25
Rafters Opinions of
Biophysical Impacts (n=458)

Impact	Not a Problem or Did not Encounter	Minor Problem	Serious Problem
Litter at lunch stop	95.9%	4.1%	0.0%
Litter at rest stop	93.8%	5.7%	0.5%
Human Waste lunch stop	90.7%	7.4%	1.9%

Table 25 cont.

Impact	Not a Problem or Did not Encounter	Minor Problem	Serious Problem
Human Waste rest stop	81.8%	11.8%	6.4%
Veg. Damage lunch stop	90.6%	8.9%	0.5%
Veg. Damage rest stop	89.4%	9.6%	0.5%
Erosion lunch stop	91.2%	7.1%	1.8%
Erosion rest stop	88.3%	9.9%	1.8%
Fire Remains	96.9%	2.9%	0.3%

Impact value data from the biophysical survey for sites #13 (lunch stop), #17A and #17B (rest stop) were compiled (Table 26). Data on five of the impacts are reported, since these are the impacts rafters were queried about. As explained earlier, impact values of 3, 6, 9, 12 for soil disturbance and vegetation damage, correspond to a lightly, moderately, heavily, and severely impacted condition of the specific indicator. Impact values of 2, 4, 6, 8 for fire impacts, human waste, and trash correspond to a lightly, moderately, heavily and severely impacted condition of the specific indicator. These data constitute manager assessment of the condition of the three day-use sites.

Table 26
Impact Value Data for 5 Impacts
and 3 Day-use Sites

Site # n=3	Soil Disturbance	Vegetation Damage	Fire	Human Waste	Trash
13	12	12	8	8	8
17A	12	12	8	8	8
17B	12	12	2	4	4

Percentages of the three day-use sites rated lightly, moderately, and heavily or severely impacted with respect to each of the five impact indicators examined were calculated from Table 26. Results of Table 25, (percentage of rafters rating the five impacts at the rafter stops as minor problem, severe problem and did not encounter or not a problem), were averaged over the two types of stops. Table 37 (Appendix B) compares manager and rafter assessment of the condition of the three day-use sites with respect to the five specific biophysical impacts.

For each of the five impacts, at least 85% of the rafters reported that these impacts were not a problem or did not encounter. For each of the five impacts, at least 65% of the sites were considered heavily to severely impacted by managers. These results suggest that managers view these three day-use sites as more heavily impacted with respect to trash, human waste, vegetation damage, soil disturbance, and fire impacts than rafters.

Support for Management Actions

To satisfy research objective 5, anglers and rafters were asked to comment on specific river management actions such as requiring permits to camp upriver or closing fishing or cultural sites. Response categories included "favor," "do not favor but would accept," "would not accept," and "no opinion." Results are presented separately for anglers and rafters in Tables 38 and 39 (Appendix B).

River management strategies favored by anglers included restricting the number of rafters per day (50%), implementing a permit system for upriver camping (46%), closing stressed fishing areas (41%), and restricting the use of campfires (40%) (Table 38). Actions that anglers generally would not accept include restricting the number of bank anglers per day (46%) and requiring all boats to carry "porta-potties" to carry out human waste (33%). They also were reluctant to restrict the number of motorboats on the river (27% not accepting), limit party sizes (27% not accepting), and close certain beaches (24% not accepting). The remaining restrictions such as requiring upriver campers to carry out fire ash, closing certain archeological sites, and restricting the number of rafters per day were either favored or at least accepted by a majority of anglers.

Rafters were supportive of virtually all the management actions presented (Table 39). At least 50% of rafters favored all but four of the 11 river management actions. They are obviously concerned about the fishery, with 75% in favor of closing stressed fishing areas. Like the anglers, they also favor implementing a permit system for upriver camping (72%), restricting use of campfires (62%), and restricting the number of rafters per day (52%). However, unlike anglers, rafters favor restricting the number of motorboats per day on the river (66%), and requiring all boats to carry porta-potties (49%).

CHAPTER 5

DISCUSSION AND RECOMMENDATIONS

This section contains three subsections. The first subsection, Hypotheses Reviewed, contains a discussion of the research findings and proposed management actions that pertain to each of the research hypotheses. In the Limits of Acceptable Change (LAC) section, LAC is presented as a framework for Glen Canyon NRA managers to use to manage river recreation impacts. Results of both manager and visitor assessments of resource impact at Lees Ferry can be incorporated into this management strategy. The Research Recommendations subsection contains suggestions for future research.

Hypotheses Reviewed

In this subsection, the three research hypotheses are revisited. A discussion of research results associated with each and recommendations for management follow.

Hypothesis 1

The first hypothesis of this research was that the results of the quantitative manager assessment of resource impacts would show that the three types of

sites: day-use, campsite, and illegal campsite, differ significantly in overall site condition and amount of impact of some specific impact indicators. The three site types did differ significantly in overall site condition and in amount of impact of soil disturbance, vegetation damage, human waste, trash, and pests and insects. This was most likely due in part to the different management policies in effect on the different site types.

Users typically visit day-use sites for just a few hours to picnic, hike, fish, urinate and defecate. Except on sites #17 and #24, toilets are not provided, so human waste accumulates. Camping is not allowed at day-use sites. A fine of $100.00 exists for camping on these sites. Typically, law enforcement officers will ask illegally camped visitors to relocate to a designated campsite. Fire rings are found on these sites although fires are prohibited and a $100.00 fine is associated with building a "campfire." There are no trash receptacles at these sites and day visitors are asked to carry out their trash. The fine for littering is $50.00.

Day-use sites are large in comparison to campsites and illegal campsites. Fifty percent of the sites are greater than 5,000 ft^2, therefore, use is dispersed on these sites. The majority of the sites are located 0 to 50 ft from the river. Most are located on the lower

bench with a rise of only 1 to 10 vertical ft, so erosion impacts are not obvious.

Designated campsites were established for overnight camping, so use is concentrated on these 15 sites. Campers may spend up to 14 days camped at one site. These sites are equipped with toilets which are poorly maintained and there are no trash receptacles. Trash is often not carried out and unnatural levels of pests and insects result. A fire grate is associated with each campsite. However, due to weathering they no longer properly contain ash.

Designated campsites average 2,000 ft^2 in size and 15 people, on average, can camp upon the site. The majority of these sites are located 100 to 150 ft from the river, and most are located on the upper bench on older alluvial deposits. The average range of vertical climb to these sites is 20 to 40 ft. Because of this, campers are required to haul their gear some distance, up slope to the site. Trail impacts, soil disturbance and vegetation damage are the result.

Illegal campsites are all satellite sites in the vicinity of a designated campsite. They have been created by visitors as "alternate" campsites when designated sites are full or because access to these satellite sites is more convenient. They are usually located between the designated campsite and the mooring and about half are on the lower bench and half on the

upper bench. Toilets and fire grates are within walking distance of the illegal site, but with a vertical climb of 20 to 40 ft. No toilets or fire grates are directly associated with these illegal sites, so the potential for fire and human waste impacts exists. A fine of $100.00 is associated with building a campfire. There are no trash receptacles on site. The fine for littering is $50.00.

Illegal campsites are relatively small, 700 ft^2 on average, and most allow less than 10 people to camp comfortably. The fine associated with camping illegally is, however, $100.00. It is uncertain exactly how much use these illegal sites receive, however, the duration of stay is far less than on the designated campsites giving campers less time to modify the site. The majority of the sites are 25 to 100 ft. from the river, so a network of trails to the river and the designated campsites exists. Site "soil" is often a mixture of sand and large river cobble.

Because of these differences, it is not surprising that the site types significantly differ in overall site condition ($p<.01$). The data reveal that campsites were the most heavily impacted, with 93.4% of the sites falling in the heavy and severe condition classes. Amount of use, type of use, duration of use, concentration of use, soil composition, and distance of site from the river appear to be important variables

causing the difference in site condition. The first four variables are directly associated with site management policies.

It is interesting to note that none of the 49 sites were lightly impacted. This suggests that unacceptable levels of change in site condition from the natural condition may have already occurred on all site types.

When comparing individual impact indicators, campsites and illegal campsites were significantly more heavily impacted with soil disturbance impacts than day-use sites. Most of the designated campsites and some of the illegal campsites are located on the upper bench. Erosion in the form of gullies and deep cut trails is prevalent. Trampling by campers exposes mineral soil, and compacts and loosens soil. Soil compaction increases as number of passes over a site increase. The core area of the site receives the greatest use and since visitors stay over night (and possibly up to 14 days), many passes over the same area are made in one visit. This is opposed to use at day-use sites where visitors stay briefly, and move on. Also, most day-use sites are sand dunes adjacent to the water's edge. The sand erodes into the river, but deeply cut trails from foot traffic, cementlike soil compaction, and gullies do not occur.

Campsites were significantly more heavily impacted with vegetation damage impacts than both day-use sites and illegal campsites. Length of stay, concentration of

use, party size and possibly user behavior, appear to be the explanations for the difference. The greatest damage to the vegetative groundcover occurs within the first few uses of the site, but recovery is inhibited with prolonged use. Concentration of use increases soil compaction which indirectly affects plant growth, reproduction and vigor.

Since no limit on party size exists, large parties that require greater space, tend to expand sites by trampling perimeter vegetation. Vegetation on campsites is cut for firewood, is used to hang food sacks, and secure tents. Plant roots become exposed as soil erodes away around them due to heavy foot traffic. Vegetation is trampled as campers create trails to access toilets, the river and other campsites.

Campsites were also significantly more heavily impacted with trash and pest and insect impacts than day-use and illegal campsites. Here length of stay and use behavior appear to be important factors. The longer a person camps, the more trash that is likely to accumulate. The presence of fire grates encourages campers to attempt to burn trash and discard waste on-site as opposed to carrying it out. When trash accumulates on sites, especially rotting food, pests and insects are attracted to these sites.

Day-use sites were significantly more heavily impacted with human waste impacts than the other site

types. This is not surprising, since the average distance to the nearest toilet from a day-use site was 5,000 ft as opposed to an average distance to the nearest toilet on campsites and illegal campsites of 50 ft. Day-use sites associated with attractions such as fishing spots, caves, archeological sites, large sandy beaches and waterfalls tend to have greater human waste accumulations than other day-use sites. These sites tend to have higher pest and insect ratings also.

Site type does not significantly affect trails, fire or site modification impacts. Multiple trailing and wide trail widths are prominent on all site types. Severe fire impacts on campsites are primarily due to dilapidated fire grates that can no longer contain the ash. Fire rings are present on all site types, even though a fine exists for illegally located fires. Site modification was light on 57% of the 49 sites, suggesting that even when campers stay for extended lengths of times, sites are seldom modified.

In summary, campsites were more heavily impacted with respect to soil disturbance, vegetation damage, trash, and pest and insects than the other site types. Day-use sites were significantly more heavily impacted with human waste impacts. All site types were heavily impacted with trails and fire impacts, but lightly impacted with the impact of site modification.

Recommendations 1

Managers should consider mitigation actions at campsites such as: revegetating multiple trails and signing rehabilitation areas, rocklining main trails and site boundaries, and moving campsites from upper benches to lower benches. These actions should improve soil disturbance, vegetation damage and multiple trailing. Although the literature suggests that visitors tend to oppose site developments, since toilets and fire grates already exist, trash receptacles may reduce litter and pest and insect impacts. Toilet facilities and fire grates need to be better maintained, however, for them to be beneficial in reducing impacts. If these facilities can not be adequately maintained, managers should consider requiring all boats to have porta-potties to carry out human waste and for all campers to carry out ash along with their trash. These regulations would also benefit day-use sites. In order for these regulations to help reduce impacts, regulations would need to be enforced. At present, fines for littering, making illegal campfires and camping illegally do not deter visitors from these actions. Implementation of a permit system might hold campers accountable for their waste. The application for a permit would require campers to leave a name and address. Impacts of litter, fire ash, human waste, and some forms of vegetation damage could be traced to a specific camper.

Since toilets already exist and are being maintained on campsites and two day-use sites, a few more toilets, especially one between one mile and six mile might mitigate some of the human waste impact on day-use sites. Day-use boaters could also be made to carry out their human waste in porta-potties.

Hypothesis 2

The second hypothesis of this research was that managers perceive resource impacts as being more severe than do visitors. Managers did perceive impacts of trash, human waste, vegetation damage, soil disturbance, and fire as more severe than rafters on 3 day-use sites and anglers on 15 campsites.

Assuming that the results of the biophysical impact survey reflect manager perceptions of site condition, managers perceived the impact condition of the three rafter day-use sites as heavy/severe with respect to five of the indicators, while the majority of rafters perceived these same impacts as not a problem. Managers likewise assessed campsite impact condition as heavy/severe while the majority of the anglers reported impacts as not a problem.

Managers performing the biophysical survey were trained to detect impacts. The purpose of their site visits was not to recreate, but to examine sites for impacts and assess site condition. Managers were

probably more cognizant of impacts than visitors and this difference in awareness caused the extreme difference in perceptions.

The majority of the rafters were experiencing their first trip into the canyon. For most, the outing was a unique wilderness experience which they paid money to enjoy. Awed by towering Navajo sandstone cliffs and a sense of journeying into the past, most rafters were not concentrating on human caused impacts when they stopped briefly at the two sites. Human waste was the only biophysical impact that received attention and only 18% of the rafters considered it a problem.

The small sample of anglers that camped overnight appeared to be more aware of impacts at the campsites than rafters at the day-use sites. The difference was most likely due to the fact that most anglers were return visitors who spent more time recreating at the site they were evaluating. For each of the five impacts, greater than 50% of the anglers reported that the impacts were not a problem at the campsites. Litter and vegetation damage, however, were a problem for 47.2% and 41.8% of the anglers respectively. It is interesting to note that campsites were significantly more heavily impacts with trash and vegetation damage impacts than day-use sites. Anglers may have been more aware of these two impacts, because trash and vegetation damage were more pronounced on campsites.

Also, 16.7% of the anglers reported that erosion impacts were serious. Because of the type of activities in which anglers were involved, fishing, boating and camping, impacts may be more visible to them than to the rafters. Some impacts directly affect their activities. For example, erosion at moorings makes it more difficult for the angler to tie up his/her boat and access the shore. Many anglers are also better educated about the effects of fluctuating flows and dam releases which affect their fishing and boating, and also cause erosion of beaches.

Recommendations 2

The difference in visitor and manager perceptions of impacts should not keep managers from initiating actions to mitigate impacts and attempt to restore natural conditions. Politically an argument can be made that if visitors do not notice impacts, and their enjoyment is not affected, management actions are not needed. Managers are the stewards of the parks and have a responsibility to protect the resource from extreme degradation. The uniqueness of the resource is what attracts visitors to the area and is why the lands have been designated for preservation. Impact mitigation projects should aim to minimally affect visitor activities. Interpretive services should be utilized to educate visitors about the benefits of the projects. If

visitors are made aware of the effects of recreation on the resource they may actually support management actions which restrict their ability to use the area in order to mitigate impacts.

Hypothesis 3

The third hypothesis of this research was that the majority of visitors accept management actions necessary to mitigate impacts even though they do not perceive impacts as a problem. Research results support this hypothesis.

Specifically, visitors said they would accept the following management actions: regulations requiring all boats to have porta-potties to carry out human waste; implementation of a permit system for upriver camping; limitation on party sizes; regulations requiring campers to carry out fire ash; restrictions on use of campfires; and closure of beaches and archeological sites. Many of these were recommended as ways to reduce biophysical impacts at campsites and day-use sites under hypothesis 1. These results imply that visitors would not be opposed to the implementation of these specific management actions and that managers have the support of visitors in their efforts to mitigate impacts. One management action was not favored. Anglers were not supportive of management actions that would reduce the number of anglers allowed to fish per day.

Recommendations 3

Managing for numbers of visitors is an antiquated carrying capacity management strategy and is only recommended if it can be determined that levels of social impacts are unacceptable, so reducing numbers of anglers allowed to fish per day is not recommended. The greatest biophysical site degradation occurs within the first few uses, so management actions to limit party size and length of stay, and to alter type of use and user behavior would be more beneficial at reducing impacts than reducing numbers of visitors.

All of the management actions accepted by both anglers and visitors are recommended to mitigate impacts at Lees Ferry. Closing some sites during rehabilitation projects was supported and is recommended. However, total, prolonged closure of sites is not recommended. This action would impede the public from using the recreation area and allow exotic plant species to take over the disturbed sites.

The Limits of Acceptable Change

National Park Service managers are charged with preserving and protecting the resource as well as providing for its enjoyment by visitors. Recreation, a legitimate use of National Parks and National Recreation Areas, changes natural resource conditions. The resultant resource degradation could be curtailed if use

was prohibited, but closing these public lands to visitors is not possible or wise. Even limiting use will do little good, since the research shows that the greatest amount of soil disturbance impact and vegetation damage impact occurs within the first few uses. Managers must realize that some change will occur and must decide how much change is acceptable.

The Limits of Acceptable Change System (LAC) (Stankey and others 1985), is a framework for managing recreation impacts developed for wilderness management. This process has been successful in many National Forest Service and National Park Service areas including Grand Canyon NP (Hoffman 1988), The Bob Marshall Wilderness Complex (Stankey and others 1986), Mount St. Helens National Volcanic Monument (Ewert 1990), and several National Forest Service units in the Southeastern Region (Watson and others 1992). It has been adapted to manage river recreation in Hells Canyon NRA on the Snake River (University of Idaho 1990) and in the Oregon State Parks on the Deschutes River (Shelby 1987).

The basic assumption of this framework is that recreation activities will change the natural conditions of the resource, and that there is some level beyond which this change is unacceptable and detrimental. In LAC, the amount of change allowed to occur, without serious detriment to the resource, is defined explicitly by quantitative standards. When levels of impact exceed

acceptable levels, appropriate management actions to prevent further change are identified. Finally, recreation sites are monitored and the success of implemented management actions evaluated. The LAC process consists of 9 steps. They are:

Step 1. Identify area concerns and issues.

Step 2. Define and describe opportunity classes.

Step 3. Select indicators of resource and social conditions.

Step 4. Inventory resource and social conditions.

Step 5. Specify standards for resource and social indicators.

Step 6. Identify alternative opportunity class allocations.

Step 7. Identify management actions for each alternative.

Step 8. Evaluate and select an alternative.

Step 9. Implement actions and monitor conditions.

Biophysical impact indicators identified by managers in the Lees Ferry Carrying Capacity Study Biophysical Impact Survey may be used in Step 3 of the LAC process as indicators of resource condition. Results of the manager and visitor assessments of resource condition may be used in Step 4 to determine present resource conditions. The condition classes from the biophysical survey (light, moderate, heavy, severe) may be used in Step 5 to identify standards for resource indicators. When

identifying standards, "public information, research information, and managerial experience" should be incorporated (Stankey and others 1985). Visitor support for management alternatives can be used in the decision making process at Step 7.

Glen Canyon NRA managers can use the specific results of the manager and visitor assessments and support for management actions survey in the LAC process. Biophysical survey results revealed that only one site was lightly impacted with respect to the soil disturbance impact indicator, which includes soil compaction, loosening, and erosion. Twenty-nine percent were moderately impacted, 24% heavily impacted, and 45% were severely impacted. In total, 70% of the 49 sites were heavily to severely impacted according to managers. Greater than 50% of the visitors said soil disturbance was not a problem. Managers would need to give value to both sets of information and depending upon the park's management objectives, determine realistic long-term site condition goals. If the goal is to reduce the impact of soil disturbance to continue to offer quality camping experiences for recreationists, then acceptable impact levels might be to have 25% of sites lightly impacted, 25% moderately impacted, 25% of sites heavily impacted, and 25% of sites severely impacted. Management alternatives to accomplish this goal might include relocating campsites from upper benches to lower benches

to reduce erosion and numbers of gullies, or reduction of party size or control of use by a permit system. Results of the support for management actions revealed that the majority of anglers and rafters would accept the closure of beaches and the implementation of a camping permit system. Public opinion supports management actions to reduce impacts of soil disturbance.

Managers rated 26% of the sites lightly to moderately impacted with human waste impacts and 73% heavily to severely impacted. Visitors indicated that human waste was not a problem at sites. Managers need to weigh the data from the two surveys when deciding on acceptable standards for the human waste impact. Should the acceptable level of human waste impact be to have 75% of sites lightly to moderately impacted and 25% of sites heavily to severely impacted, for example, one management action to accomplish this goal could be to require all boaters to have a porta-potty and carry out human waste. Fifty-nine percent of the anglers and 78% of the rafters were willing to accept the management action requiring boaters to have porta-potties.

Fifty-three percent of the sites inventoried sites by managers had severe fire impacts: fire rings, fire stains, ash across site, burned vegetation and stained rocks. If a management objective is to protect beaches and soil microbes while providing a quality recreation experience, one objective may be to reduce fire impacts

even though visitors did not perceive fire impacts as a problem. Results of the support for management actions survey question revealed that two-thirds of both groups would accept a management action that would require upriver campers to carry out fire ash. These two management action alternatives would likely reduce fire impacts and would be consistent with the above management goal. Managers may wish to set acceptable levels of fire impacts on sites using impact values or impact classes calculated in the biophysical survey.

Applying the Limits of Acceptable Change System for Wilderness Planning to the management of river recreation in Glen Canyon NRA will provide managers with a detailed, step-by-step management planning process. It will enable managers to monitor and curtail impacts caused by recreational activities.

Research Recommendations

This subsection contains three suggestions for future research aimed at designing surveys which would better suit the objectives of this thesis. Recommendations for designing a visitor use survey include surveying managers and visitors with the same questionnaire and surveying camping anglers during the peak fishing season. A recommendation designed to make the statistical analysis of the biophysical survey more powerful is to collect interval-level data on site impacts.

Survey Managers and Visitors with Same Instrument

The first recommendation for research is to design a new questionnaire to be distributed to both managers and visitors. The questionnaire would solicit manager and visitor perceptions of several biophysical impacts on sites they would visit. Natural resource managers from many agencies would be invited to participate. These managers would be randomly assigned to two groups, "campsite" and "day-use" in proportion to the estimated number of angler and rafter visitors using the river daily during the sampling period. The "campsite" group would be taken upriver in a motor boat to a randomly chosen designated campsite as an overnight trip for the purpose of recreating. The "day-use" group would float down from the dam and visit the three rafter day-use sites. Upon completion of their designated river experiences, they would receive the short mail-back questionnaire. Questionnaires would be distributed to visitors, camping anglers and rafters at the Lees Ferry dock as visitors would get off the river. Only anglers who camped upriver would receive a questionnaire.

All persons surveyed would be unaware of the purpose of the questionnaire. Only questions to determine the demographic characteristic of the respondent and a question to determine if the respondent thought several specific biophysical impacts at the site visited were

non-existant, light, moderate, heavy or severe would be included. Manager and visitor responses to amount of impact at campsites and at day-use sites would be tested statistically for significance differences.

Survey During Peak Season

The Lees Ferry Carrying Capacity Study Visitor Use Survey was performed during the summer months in order to correspond to dam-regulated research flows. The sampling period was during the one-day float trip rafting peak season, but the off-season for angling. Because of this, the sample size of camping anglers was only 36. To increase the camping angler sample size, a study design such as the one suggested above, but where "campsite" grouped managers and camping anglers would be sampled during the spring, winter or fall is proposed. Rafters and "day-use" grouped managers would be sampled in the summer. Since the comparison is between managers and visitors and not between campsite and day-use site impacts, sampling at during different seasons should not affect survey results.

Collect Interval Data

If Biophysical Impact Survey is performed in the future, managers should collect interval-level data so that more powerful parametric statistical tests can be used to compare the effect of site type on site condition. Soil disturbance impacts on day-use sites,

campsites and illegal campsites could be compared using the value of the trail depth measurement and the number of gullies. Differences in impacts between the three site types could be tested using parametric statistics. The Delaware Water Gap Rapid Estimate Procedure (cited in Cole 1989a) is one biophysical impact survey method that collects only interval level data.

Some interval-level data were collected during the Lees Ferry Carrying Capacity Study Biophysical Impact Survey including trail depth, number of trails, trail width, number of fire rings, area of fire stain, piles of human waste, piles of toilet paper, number of areas with odor of urine, number of small pieces trash, and number of large pieces of trash. Parametric statistical tests could have been performed using these values to test if differences in amount of impact between the three site types were significant.

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APPENDIX A

LIST OF SITES

MAPS OF SITES

Table 27
The 49 Surveyed Recreation Sites

Site	Site Name	Mile	Type of Use
0A	Below Confluence of Paria	-2.5	Day-use
0B	Above Confluence of Paria	-2.0	Day-use
01	Landing for Raft Trips	0.2	Day-use
02	Old Ferry Site	1.0	Day-use
03	Falls Canyon	2.5	Day-use
4A	Cave Canyon Beach	3.0	Day-use
4B	Cave Canyon Directly Over Dune	3.0	Day-use
4C	Cave Canyon Near Giant Tamarisk	3.0	Day-use
05	4 Mile Bar Fishing Spot	4.0	Day-use
06	5 Mile Day-use	5.0	Day-use
07	Big Sandy	5.7	Day-use
08	Little Sandy	5.8	Day-use
9A	Hidden Slough Camps West Camp	6.0	Campsite
9B	Hidden Slough Camps East Camp	6.0	Campsite
9C	Hidden Slough Camps Lower West	6.0	Illegal Camp
9D	Hidden Slough Camps Lower Center	6.0	Illegal Camp
9E	Hidden Slough Camps Lower East	6.0	Illegal Camp
10A	Upper Hidden Slough Day Beach	6.2	Day-use
10B	Hidden Slough Day/Illegal Camp	6.1	Illegal Camp
11	GCES Well Site	6.5	Day-use
12	Float Trip Alternate Lunch Stop	7.0	Day-use
13	Float Trip Lunch Stop	7.2	Day-use
14A	Finger Rock Camps West Camp	7.5	Campsite
14B	Finger Rock Camps Middle Camp	7.5	Campsite
14C	Finger Rock Camps East Camp	7.5	Campsite
14D	Finger Rock Camps Far East Site	7.5	Illegal Camp
14E	Finger Rock Camps Far West Site	7.5	Illegal Camp
15A	8 Mile Bar Camps West Camp	8.0	Campsite
15B	8 Mile Bar Camps East Camp	8.0	Campsite
16A	Twin Stripes Camp SW Camp	9.0	Campsite
16B	Twin Stripes Camp NE Camp	9.0	Campsite
16C	Twin Stripes Camp Lower SW Site	9.0	Illegal Camp
16D	Twin Stripes Camp Lower NE Site	9.0	Illegal Camp
17A	Petroglyph Access	10.0	Day-use
17B	Petroglyph Panel	10.0	Day-use
18A	Faatz Inscription Beach	10.5	Day-use
18B	Faatz Inscription Old Camp	10.5	Day-use
19A	Ferry Swale Camps North Camp	11.0	Campsite
19B	Ferry Swale Camps Middle Camp	11.0	Campsite
19C	Ferry Swale Camps South Camp	11.0	Campsite
20	Upper Ferry Swale	11.2	Day-use
21A	Twelve Mile Beach	12.0	Day-use
21B	Twelve Mile Old Camp	12.0	Day-use
22	Thirteen Mile Bar Waterfall	13.0	Day-use
23A	Ropes Trail Camps SW Camp	14.0	Campsite
23B	Ropes Trail Camps Middle Camp	14.0	Campsite
23C	Ropes Trail Camps NE Camp	14.0	Campsite
24	Water Plant/ USGS Cable	14.5	Day-use
25	Fifteen Mile	15.0	Day-use

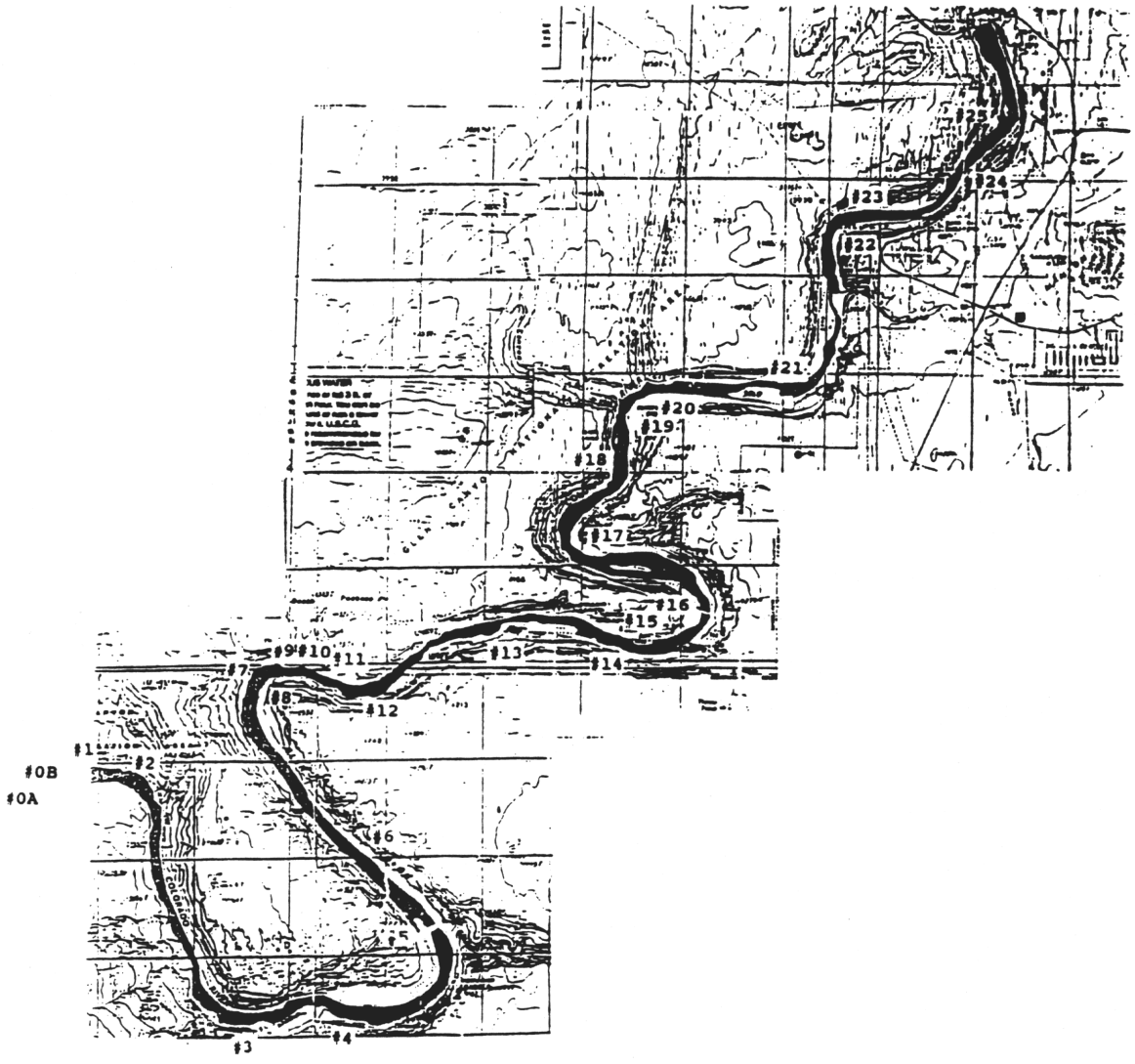


Figure 3.
Map of 49 Sites

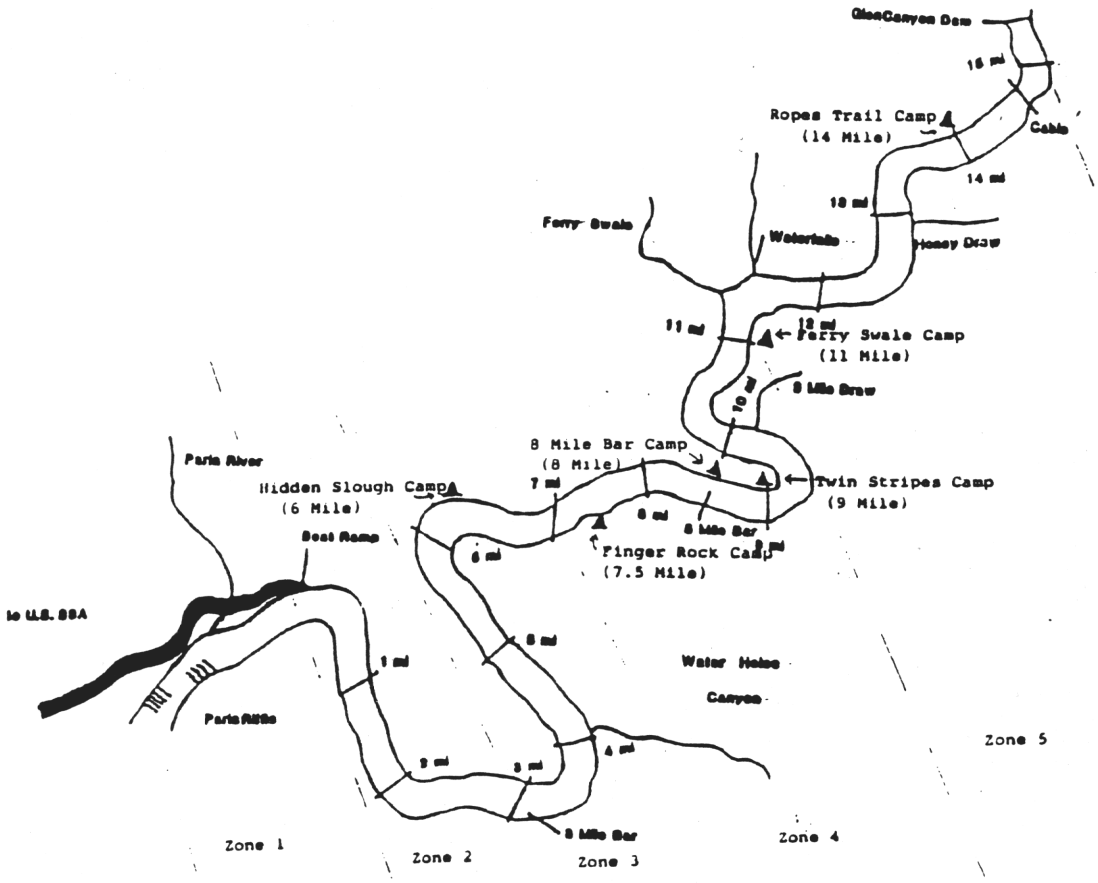


Figure 4.
Map of Campsites

APPENDIX B

VARIOUS TABLES

Table 28
Day-use Site Impact Values

Site # n=27	Soil Dist.	Veg. Dam.	Trails	Fire	Human Waste	Trash	Pest	Mod.
0A	12	12	12	2	8	8	2	1
0B	12	6	12	2	6	4	4	1
1	12	6	12	2	6	8	2	1
2	9	6	12	6	8	8	4	1
3	9	9	12	8	8	8	8	1
4A	6	12	12	8	8	8	4	2
4B	9	12	12	8	8	6	6	1
4C	12	9	9	8	4	2	8	1
5	6	3	6	2	6	2	6	1
6	6	6	9	6	8	8	4	1
7	6	3	12	6	8	6	6	1
8	6	6	12	8	8	8	4	1
10A	6	3	6	4	4	4	4	1
10B	6	6	9	8	6	8	4	2
11	6	6	12	6	4	4	4	2
12	3	3	3	8	6	6	4	1
*13	12	12	12	8	8	8	8	4
*17A	12	12	12	8	8	8	6	1
*17B	12	12	12	2	4	4	4	1
18A	6	6	12	6	8	6	4	1
18B	9	9	9	8	8	8	6	1
20	6	6	12	8	8	8	6	4
21A	9	12	6	2	8	6	6	1
21B	6	9	12	6	8	8	6	1
22	6	6	12	8	8	6	8	4
24	9	12	12	8	8	6	6	4
25	6	6	6	6	8	8	4	1

*Rafter Stops.

Table 29
Campsite Impact Values

Site # n=15	Soil Dist.	Veg. Dam.	Trails	Fire	Human Waste	Trash	Pest	Mod.
9A	12	9	12	8	4	8	6	2
9B	12	9	12	8	2	8	6	3
14A	6	6	6	6	2	8	6	1
14B	9	3	12	8	6	4	6	1
14C	9	9	9	8	6	8	4	4
15A	12	12	12	8	6	8	8	4
15B	12	12	12	2	8	8	8	2
16A	12	12	9	2	4	8	8	2
16B	12	12	12	6	4	8	4	1
19A	12	12	12	8	8	8	8	2
19B	12	12	12	8	8	8	6	1
19C	9	12	12	8	8	8	6	4
23A	12	12	9	6	6	8	4	2
23B	12	12	12	8	8	8	4	1
23C	12	12	12	8	8	8	6	4

Table 30
Illegal Campsite Impact Values

Site # n=7	Soil Dist.	Veg. Dam.	Trails	Fire	Human Waste	Trash	Pest	Mod.
9C	12	12	9	4	6	4	4	4
9D	9	9	12	8	4	4	4	2
9E	9	6	9	6	4	2	2	1
14D	12	9	9	8	2	8	2	2
14E	12	6	9	2	2	6	2	1
16C	12	12	12	8	6	8	6	4
16D	9	3	12	2	8	6	6	1

Table 31
Day-use Site Index and Class

Site # n=27	Site Impact Index	Condition Class
0A	57	Heavy
0B	47	Heavy
1	49	Heavy
2	54	Heavy
3	63	Severe
4A	60	Heavy
4B	62	Severe
4C	53	Heavy
5	32	Moderate
6	48	Heavy
7	48	Heavy
8	53	Heavy
10A	32	Moderate
10B	49	Heavy
11	44	Moderate
12	34	Moderate
*13	72	Severe
*17A	67	Severe
*17B	51	Heavy
18A	49	Heavy
18B	58	Heavy
20	58	Heavy
21A	50	Heavy
21B	56	Heavy
22	58	Heavy
24	65	Severe
25	45	Moderate

*Rafter Stops.

Table 32
Campsite Site Index and Class

Site # n=15	Site Impact Index	Condition Class
9A	61	Heavy
9B	60	Heavy
14A	41	Moderate
14B	49	Heavy
14C	57	Heavy
15A	70	Severe
15B	64	Severe
16A	57	Heavy
16B	61	Heavy
19A	70	Severe
19B	67	Severe
19C	67	Severe
23A	59	Heavy
23B	65	Severe
23C	70	Severe

Table 33
Illegal Campsite Site Index and Class

Site # n=7	Site Impact Index	Condition Class
9C	55	Heavy
9D	52	Heavy
9E	39	Moderate
14D	52	Heavy
14E	40	Moderate
16C	68	Severe
16D	47	Heavy

Table 34
Problems Encountered by Anglers(n=371)

Problem encountered	Not a problem	Minor problem	Serious problem	Did not encounter	Missing Cases
	- - - - - - - percent - - - - - - -				
Waiting at boat launch ramp	69.7	4.2	0.9	25.2	15
Finding a space to park my vehicle/trailer	73.8	11.3	0.6	14.3	13
Accessing desired fishing spots	61.3	18.7	6.9	13.1	17
Litter at fishing spots	51.8	25.2	4.1	18.9	11
Human waste at fishing spots	50.3	8.8	2.4	38.5	14
Litter at campsite	35.5	16.8	2.8	44.8	17
Human waste at campsite	36.1	10.6	2.1	51.1	23
Vegetation damage at fishing and camping location	37.4	15.8	11.6	35.2	17
Boats running over fishing line	49.6	6.5	1.2	42.8	12
People shouting and yelling	50.5	12.2	3.0	34.3	13
Inconsiderate anglers	48.3	18.1	1.4	32.1	13
Wakes created by rafts motoring upriver	33.9	42.5	10.0	13.6	9
Noisy motorboats	47.6	28.2	6.5	17.6	10
Finding a campsite upriver	33.3	7.0	2.6	57.0	26
Boats or rafts on the river blocking channels	41.1	17.9	4.0	37.0	14
Inconsiderate rafters	48.5	12.4	4.7	34.4	14
Wakes created by passing boats	36.9	45.3	3.9	14.0	9
Inconsiderate guide	44.0	5.7	1.6	48.7	17
Water too warm	59.0	1.3	0.9	38.7	12
Water too low and too slow	42.4	16.9	8.2	32.5	15
Remains of illegal fires on beach or at campsites	30.9	9.3	1.6	58.2	20
Water too high and too fast	30.3	20.2	27.2	22.4	14
Water too clear	84.3	4.9	0.5	10.2	20
Boat swamped while tied up on beach	35.4	1.5	1.2	61.9	18
Erosion of beaches	23.0	15.3	23.9	37.8	14
Water too muddy	40.0	10.2	2.5	47.4	19
Inability to fish in solitude	52.4	21.2	4.5	22.0	16
Did not feel safe while wading	60.4	9.4	1.9	28.3	16
Damage to raft and/or motor	31.2	14.0	2.7	52.1	17
Within sight and sound of boats too often	52.3	20.9	3.0	23.8	17
Lots of unburned trash in firegrates at campsites	29.3	11.1	2.4	57.2	19
Within sight and sound of wading bank anglers too often	64.7	9.9	1.2	24.2	16
Toilet facilities poorly maintained	39.8	16.9	6.1	37.2	16
Graffiti on petroglyph panels	25.8	11.7	5.8	56.6	18
Within sight and sound of rafts too often	45.9	30.0	7.7	16.4	16

Table 35
Problems Encountered by Rafters (n=458)

Problem encountered	Not a problem	Minor problem	Serious problem	Did not encounter	Missing Cases
	percent				
Waiting to launch rafts	79.4	4.9	0.0	16.7	12
Litter at lunch stop sites	65.6	4.1	0.0	30.3	29
Vegetation damage at lunch stop site	60.7	8.9	0.5	29.9	33
Human waste at lunch stop site	54.9	7.4	1.9	35.8	29
Human waste at rest stop site	50.6	11.8	6.4	31.2	23
Vegetation damage at rest stop site	63.7	9.6	1.0	25.7	23
Litter at rest stop site	67.7	5.7	0.5	26.1	23
Anglers fishing in path of raft	68.5	4.7	0.0	26.8	17
People shouting and yelling	66.5	0.8	0.7	32.0	19
Inconsiderate anglers	65.0	1.2	0.2	33.6	18
Water too low and too slow	60.0	14.0	4.1	22.0	17
Wakes created by passing boats	68.8	16.2	1.4	13.6	15
Noisy motorboats	59.6	19.3	3.5	17.6	17
Inconsiderate guide	61.4	2.6	0.5	35.6	20
Vessels passing too close to one another	63.3	4.0	0.7	31.9	15
Raft stuck on beach	62.9	3.7	0.2	33.1	17
Water too cold	56.0	24.2	6.9	12.9	16
Graffiti on petroglyph panels	37.8	16.5	17.8	27.9	14
Water too warm	48.8	0.3	0.0	51.0	21
Inconsiderate rafters	51.9	1.3	0.2	46.6	17
Remains of illegal fires on beach	45.0	2.9	0.3	51.9	16
Water too high and too fast	50.8	0.4	0.2	48.6	16
Water too clear	80.0	0.0	0.5	19.3	19
Raft swamped while tied up on beach	49.8	0.4	0.0	49.8	17
Erosion of beach at rest site	53.3	9.9	1.8	35.0	18
Water too muddy	53.0	2.4	0.3	44.4	16
Erosion of beach at lunch site	51.4	7.1	1.8	39.8	28
Feeling unsafe on the raft	60.7	1.1	0.5	37.7	16
Within sight and sound of bank or wading anglers too often	62.4	2.3	0.7	34.6	16
Wakes created by rafts motoring upriver	64.7	6.6	0.7	27.9	18
Guide had difficulty landing raft on a beach	60.2	4.0	0.0	35.8	15
Within sight and sound of other rafts too often	62.3	8.9	1.2	27.6	18
Damage to raft and/or motor	51.3	3.0	1.8	43.8	16
Within sights and sounds of boats too often	62.5	7.9	1.6	28.0	19
Toilet facilities poorly maintained	35.9	23.0	15.0	25.4	18

Table 36
Comparison of Campsite Condition
Manager vs. Angler Assessment

	M: Light Impact V: Not a Problem		M: Moderate Impact V: Minor Problem		M: Heavy/Severe Impact V: Serious Problem	
	Manager	Visitor	Manager	Visitor	Manager	Visitor
Trash/Litter	0.0	52.8	6.7	41.6	93.3	5.6
Human Waste	13.3	75.0	20.0	22.2	66.7	2.8
Vegetation Damage	6.7	58.4	6.7	33.3	86.6	8.3
Soil Disturbance/Erosion	0.0	66.6	6.7	16.7	93.3	16.7
Fire Impacts/Fire Remains	13.3	75.0	0.0	22.2	86.7	2.8

M: Manager, % of 15 sites.
V: Visitor, % of 36 anglers.

Table 37
Comparison of Day-use Site Condition
Manager vs. Rafter Assessment

	M: Light Impact V: Not a Problem		M: Moderate Impact V: Minor Problem		M: Heavy/Severe Impact V: Serious Problem	
	Manager	Visitor	Manager	Visitor	Manager	Visitor
Trash/Litter	0.0	94.6	33.3	4.9	66.6	0.3
Human Waste	0.0	86.3	33.3	9.6	66.6	4.2
Vegetation Damage	0.0	90.0	0.0	9.3	100.0	0.8
Soil Disturbance/Erosion	0.0	89.8	0.0	8.5	100.0	1.8
Fire Impacts/Fire Remains	33.3	96.9	0.0	2.9	66.6	0.3

M: Manager, % of 3 sites: #13, 17A, 17B.
V: Visitor, % of 458 rafters averaged over lunch stop & rest stop results.

Table 38
Angler Opinions Toward Specific River Management Actions (n=281)

Management Action	Favor	Do not favor but would accept	Would not accept	No opinion	Missing Cases
	percent				
Require all boats to have a "port-a-potty" to carry out human waste	26.2	32.6	33.1	8.2	10
Implement a permit system for upriver camping	46.1	29.8	14.7	9.4	7
Limit party sizes	32.9	30.4	26.7	10.1	8
Require upriver campers to carry out fire ash	33.1	33.6	18.4	14.8	11
Restrict use of campfires	40.4	32.5	16.2	10.9	9
Close stressed fishing areas	41.4	29.5	20.9	8.1	12
Close certain beaches	24.8	37.2	24.1	13.8	11
Close certain archeological sites	30.2	35.2	19.9	14.6	9
Restrict number of motorboats per day	32.7	33.6	27.2	6.4	7
Restrict number of bank anglers per day	18.2	28.7	46.0	7.0	9
Restrict number of rafters per day	49.8	23.6	14.9	11.7	10

Table 39
Rafter Opinions Toward Specific River Management Actions (n=458)

Management Action	Favor	Do not favor but would accept	Would not accept	No opinion	Missing Cases
	percent				
Require all boats to have a "port-a-potty" to carry out human waste	55.2	23.3	8.4	13.1	21
Implement a permit system for upriver camping	72.4	11.9	3.0	12.7	21
Limit party sizes	58.1	20.9	8.3	12.8	21
Require upriver campers to carry out fire ash	48.7	20.1	12.0	19.2	22
Restrict use of campfires	62.2	21.3	5.4	11.1	24
Close stressed fishing areas	75.5	9.0	3.5	11.9	22
Close certain beaches	47.6	25.8	8.7	17.9	28
Close certain archeological sites	43.1	25.8	19.0	12.1	22
Restrict number of motorboats per day	65.9	19.3	5.1	9.7	18
Restrict number of bank anglers per day	46.0	28.1	10.4	15.5	19
Restrict number of rafters per day	51.7	29.3	7.9	11.2	22

APPENDIX C

BIOPHYSICAL IMPACT SURVEY

DATA SHEETS AND EXPLANATION

SITE FORM: CAMPSITES AND DAY USE AREAS UPRIVER FROM LEES FERRY

Site No.: River Mile: UTM Coordinates:

Site Name: River Side: Left/Right

Coded by: Flow level: Date:
Time of Day:

SITE DESCRIPTION:

Present Use Restriction:

Day Use Only/ Campsite/ Illegal Satellite Campsite

Dominant User Type:

Angler/ Rafter/ Hiker/ Combination/ Uncertain

Use Concentrated On:

Beach/ Within Tamarisk/ Lower Bench/ Upper Bench/ Gravel Bar

Attraction:

Spawning Bar/ Cultural/ Natural/ Hiking Trail/ Designated Camp

Prominent Vegetation and Proportion:

Total Percent Vegetation Cover:

Distance Core from River: **Vertical Climb:**

Capacity: # of People: # of Tents:

Proximity to Other Sites:

Toilets Present?: Yes/No **How Far to Nearest Toilet?:**

Fire Grates Present?: Yes/No

Number of Boats Able to Moor at Landing:

Description of Access:

Cobble Bar/ Extremely Shallow/ Sand Bar/ Deep Water/ Large Rocks

Grazing Impacts Present: Manure/ Grazed Vegetation/ None

Evidence of Beaver Activity:

Camp or Day Use Area (sq. ft.): **Barren Core Area:**

RECREATIONAL USE IMPACT INDICATORS

Site No.: River Mile: Date:

1. Soil Disturbance: Compaction/Loosening/Erosion
% Disturbance _____ Average Trail Depth _____

1	2	3	4
None Apparent	<30% of soils show compaction of fine soils or loosening of coarse soils. Trail depth <1°	30-60% of soils show compaction or loosening Gullying in 1 location. Trail depth 1° to 3°.	>60% of soils show compaction or loosening. Gullying in >=2 locations. Trail depth >3°.

Rating: _____

2. Vegetation Damage: Trampling/Cutting/Carvings/Exposed Roots/ Reduced Vigor
% Damaged Vegetation _____

1	2	3	4
No Damage Apparent	<5% of vegetation is damaged	5-25% of vegetation is damaged	>25% of vegetation is damaged

Rating: _____

3. Trails: Site to Site/Site to Toilet/Site to Attraction
# of Trails _____ Average Trail Width _____

1	2	3	4
1 trail from landing to use area. Trail width <=12"	1 trail off main trail leading to attraction or toilet. Trail width 12" to 18"	2-3 trails off main trail. Trail width 18" to 24"	>3 trails off main trail. Trail width >24"

Rating: _____

4. Fire Impacts: Illegal Fire Rings/Fire Stains/Ash Across Site/ Burned Vegetation/Stained Rocks
# of fire rings _____ Total Area of fire stain _____

1	2	3	4
None Apparent	1 fire stain area <=1 sq.ft. no fire rings	1 fire ring and/or total area of fire stain >1 sq.ft. but <9 sq.ft.	>1 fire ring and/or fire stain >=9 sq.ft.

Rating: _____

RECREATIONAL USE IMPACT INDICATORS (continued)

Site No.: River Mile: Date:

5. Human Waste: Fecal Matter/Toilet Paper/Odor of Urine
Piles of Human Waste ____ Piles of Toilet Paper ____
Areas with odor of urine _____

1	2	3	4
None Present	1 pile of toilet paper	1-2 piles of toilet paper 1 pile feces 1 area with odor of urine	>2 piles of toilet paper >1 pile feces >1 area with odor of urine

Rating _____

6. Trash: Unburned in Fire Grates/Across Site
small pieces ____ # large pieces ____

1	2	3	4
None Present	<= small pieces of trash (gum wrappers, bottle tops)	1-2 large pieces of trash or <=5 pieces small & large	>2 large pieces of trash or >5 pieces small & large

Rating _____

7. Pests & Insects: Flies/Midges/Ants/Rodent Tracks/Ravens

1	2	3	4
None or if present not associated with human impact	Very few insects or rodent tracks. 1 or 2 flies near toilet or fire grate. Ants near edge of site.	Insects are present but associated with human impacts on portion of site. Groups of flies. A swarm of midges. Isolated rodent tracks.	Amount of insects associated with trash, human waste, fire grates is extreme. Swarms of flies and midges. Rodent tracks throughout site

Rating _____

8. Site Modification: Rock or Log Seats/Rock Table/Other
Specify other:

1	2	3	4
No Site Modification	Rocks used to stabilize tents or as seats	Rock table. Log bench. Other: using natural materials (stick as TP holder)	Rock or log seats around fire ring or rock table. Any unnatural feature like seats made from milk crates.

Rating _____

CALCULATION OF SITE IMPACT INDEX

Site No.: River Mile: Date:

Impact	Rating	X	Factor Weighting Value	=	Impact Value
Soil Disturbance	_____	X	3	=	_____
Vegetation Damage	_____	X	3	=	_____
Trails	_____	X	3	=	_____
Fire Impacts	_____	X	2	=	_____
Human Waste	_____	X	2	=	_____
Trash	_____	X	2	=	_____
Pests & Insects	_____	X	2	=	_____
Site Modification	_____	X	1	=	_____

Site Impact Index (Total) = _____

Condition Class = _____

Explanation of Data Sheet (Page 1)
SITE FORM: CAMPSITES AND DAY USE AREAS UPRIVER FROM LEES FERRY

Site No.: Sites were assigned consecutive numbers in ascending order beginning at Lees Ferry and continuing upriver to the Dam. Each distinct numeral (#1, #2, etc.) is associated with a distinct mile. Alpha suffixes were assigned to sites with two or more separate use areas. For example, site #9 is at 6.0 mile. Sites #9A, #9B, #9C, etc. are individual camp areas within site #9.
River Mile: River mile upstream from Lees Ferry. Lees Ferry is Mile 0.0 and the Dam is considered Mile 15.5.
UTM Coordinates: Report in the format seven digits north, six digits east.
Site Name: Sites were named according to river mile or after some outstanding quality of the site.
River Side: River right or river left as you are standing facing downriver.
Coded by: Last names of persons recording data.
Flow level: Approximate the flow level of the River at the time you start recording data.
Date: Month/Day/Year
Time: Time of day when you begin taking data. Report in military time.
Present Use Restriction: Circle appropriate use.
Dominant User Type: Circle appropriate user type.
Use Concentrated On: Circle area where use is concentrated.
Attraction: Circle any that apply. If an attraction exits that is not listed, write it in.
Prominent Vegetation and Proportion: Record the predominant species of vegetation on the site and along the edge of the site. Approximate the percentage of each species out of 100%. That is, if the site were denuded except for a small patch of atriplex, we would not record percent vegetation cover, but instead we would record that the atriplex was the only species on site and say 100%. If the site had many atriplex plants and only a tiny patch of ephedra, we might record: atriplex 90%, ephedra 10%.
Total Percent Vegetation Cover: Percentage of live vegetation on site. Do not include dead trees/shrubs or duff. The area a tree covers is determined by the area the trunk fills not the canopy cover.
Distance Core from River: Record in feet and obtain by pacing. Pace from the center of the core area to the river's edge. Obviously this measurement will change at different flow levels.
Vertical Climb: Standing at the river's edge, estimate how high the site is above the river. Record in feet.
Capacity: # of People: Approximate the number of persons that could comfortably camp in the use area. It may be easier to estimate the number of tents that could be erected and then multiply by two to get number of people. This was approximately the technique we used.
Capacity: # of Tents: Approximate the number of two-person tents that could be erected in the use area.

Proximity to Other Sites: For campsites or day use sites with more than one separate use area, record the distance from site to site in feet by pacing. For all sites, record the distance in miles to the nearest site upriver and downriver.
Toilets Present?: Is there a porta-john within walking distance of the use area? Circle yes or no.
How Far to Nearest Toilet?: If there is a porta-john adjacent to the site, pace the distance from the core of the use area to the toilet. Record in feet. If there is no toilet within walking distance of the use area, record how far to the nearest toilet upriver or downriver in miles.
Fire Grates Present?: Is there an NPS fire grate on site? Circle yes or no. Some of the day use sites have remnants of fire grates present. Circle no for these sites.
Number of Boats Able to Moor at Landing: Consider the number of fishing boats, not one-day float trip rafts, that could moor at one time at the landing closest to the site being recorded.
Description of Access: Circle the responses which best describe boat access to the site at the water level you experienced as you approached the site. Two additional responses can be added: shallow and sandy.
Grazing Impacts Present: Circle appropriate response(s).
Evidence of Beaver Activity: Write in any evidence of Beaver activity such as tracks, gnawed signpost, dam. If there is no evidence, write no. You may also want to record evidence of other significant animal activity, eg. Coyote or Badger.
Camp or Day Use Area: Pace the area of the site, length X width, and record in square feet. An edge of a site is where undisturbed vegetation and soil begins. If portions of the site are separated by large islands of vegetation, add the areas of the portions of the site together. For day use areas which are strictly beach, the area of the site will vary according to water level. Just record the site area at the water level you are experiencing.
Barren Core: Pace all the bare areas on the site, length X width, and add the areas together. Record in square feet. Do not include areas with scattered vegetation or duff.

Explanation of Data Sheet (Page 2)
RECREATIONAL USE IMPACT INDICATORS

To assess recreational use impacts on site, eight impact indicators were chosen. Modifying the methods used by Kitchell and Conner in Canyonlands National Park in 1984 (Cole, 1989), site condition was determined by calculating a site impact index from the impact indicators.

Completing the Data Sheet:
Site No.: Use the number assigned to the site on Page 1.
River Mile: Same as on Page 1.
Date: Month/Day/Year

1. **Soil Disturbance:** Indicate if soils on site exhibit compaction of fine soils and/or loosening of coarse soils by circling the appropriate responses. If eroded trails or gullies are present, as in many upper bench sites, circle erosion. Exposed plant roots due to foot traffic also constitute erosion.
% Disturbance: Estimate the total percentage of compacted and/or loosened soils on site.
Average Trail Depth: Measure the depth of all trails leading away from the site using a measuring tape and record the average depth in inches.
Rating: Using percent disturbance and average trail depth, determine which description of soil disturbance, column 1,2,3 or 4, most accurately describes the condition of the site. Assign the site a rating of 1,2,3 or 4, the number which corresponds to the column, for the impact indicator of soil disturbance. As a rule, percent soil disturbance and trail depth should determine the rating when no gullies were present.
2. **Vegetation Damage:** Indicate if vegetation on site and along the edge of the site is trampled, has cut branches, carvings in the bark, exposed roots, and/or is exhibiting reduced vigor by circling the appropriate responses.
% Damaged Vegetation: Estimate the percentage of the vegetation recorded under Total Percent Vegetation Cover on Page 1 that is damaged (exhibits the impacts circled above).
Rating: Using percent damaged vegetation, determine which description of vegetation damage, column 1,2,3 or 4, best describes the condition of the site. Assign the site a rating of 1,2,3 or 4, the number which corresponds to the column, for the impact indicator of vegetation damage.
3. **Trails:** Indicate the types of trails present which lead away from the site by circling the appropriate responses. Cultural sites, natural phenomenon, hiking trails and spawning bars are considered attractions.
# of Trails: Count the number of trails leading away from the site. Include both barely discernable and well-worn trails.
Average Trail Width: Measure the width of all of the trails leading away from the site using a measuring tape and record the average trail width in feet.

Rating: Using number of trails and average trail width, determine which description of trailing, column 1,2,3 or 4, best describes the condition of the site. Assign the site a rating of 1,2,3 or 4, the number which corresponds to the column, for the impact indicator of trails. As a rule, rating should be determined by the worse of the two impacts. The number of trails should determine the rating if the number of trails is greater than three, but average trail width is less than 2 feet. If the number of trails is two, but the trail width is 3 feet or greater, rating is determined by trail width. In both cases the site rating would be a "4".

4. Fire Impacts: Indicate the types of fire impacts present on site by circling the appropriate responses.

# of Fire Rings: Count the number of rock rings encircling fire pits found on site.

Total Area of Fire Stain: Pace the area of each individual fire stain found on site, length X width. Add all of the areas together to get total area of fire stain.

Rating: Using number of fire rings and total area of fire stain, determine which description of fire impacts, column 1,2,3 or 4, best describes the condition of the site. Assign the site a rating of 1,2,3 or 4, the number which corresponds to the column, for the impact indicator of fire impacts. As a rule, area of fire stain determines the rating when no fire rings were present.

5. Human Waste: Indicate evidence of human waste impacts on site or adjacent to site by circling the appropriate responses. For many sites, stands of Tammarisk adjacent to the site serve as "latrine" sites. It is appropriate to consider evidence of human waste impacts in these stands to be associated with the site.

Piles of Human Waste: Count the number of piles of solid human waste located on site, in adjacent stands of Tammarisk associated with the site or on a trail leading to the site.

Piles of Toilet Paper: Count the number of piles of toilet paper on site, in adjacent stands of Tammarisk associated with the site, or on a trail leading to the site.

Areas with Odor of Urine: Count the number of areas on site or adjacent to site from which a strong odor of urine emanates.

Rating: Using the number of piles of human waste, toilet paper and areas with odor to urine, determine which description of human waste impacts, column 1,2,3 or 4, best describes the condition of the site. Assign the site a rating of 1,2,3 or 4, the number which corresponds to the column, for the impact indicator of human waste. As a rule, number of piles of toilet paper determines site rating when no feces or areas with urine are found. When one pile of feces is present but no piles of toilet paper, feces is the impact that determines the rating.

6. Trash: Indicate if the trash present on the site was found in the firegrate and/or strewn across the site by circling the appropriate responses.

 # Small Pieces: Count the number of small pieces of trash on site, in firegrate, and adjacent to site on trails or in stands of Tammarisk. Small pieces of trash include cigarette butts, pop tops, rubber bands, gum wrappers, pieces of glass, etc.

 # Large Pieces: Count the number of large pieces of trash on site, in firegrate, and adjacent to site on trails or in stands of Tammarisk. Large pieces of trash include soda cans, beer cans, bottles, rags, pieces of clothing, soap, paper plates, paper cups, outboard lubricant containers, styrofoam coolers, etc.
Rating: Using the number of small and large pieces of trash, determine which description of trash impacts, column 1,2,3 or 4, best describes the condition of the site. Assign the site a rating of 1,2,3 or 4, the number which corresponds to the column, for the impact indicator of trash.
7. Pests & Insects: Indicate presence of pests or evidence of pests on site by circling the appropriate responses. Ravens should be displaying scavenging behaviors before considering them as pests.
Rating: Determine which description, column 1,2,3 or 4, best describes the condition of the site. Assign the site a rating of 1,2,3,or 4, the number which corresponds to the column, for the impact indicator of pests & insects.
8. Site Modification: Indicate disturbance of rocks or logs for use as seats, tables, tent stabilizers, stepping stones, fire rings, etc. by circling appropriate responses. Write in uses not listed under "specify other." Also record presence of unnatural features such as seats made from milk crates, nails in trees creating a soap dish, fire poker in tree used as backpack hanging rack, etc. under "specify other."
Rating: Using types of site modification present, determine which description, column 1,2,3 or 4, best describes the condition of the site. Assign the site a rating 1,2,3 or 4, the number which corresponds to the column, for the impact indicator of site modification.

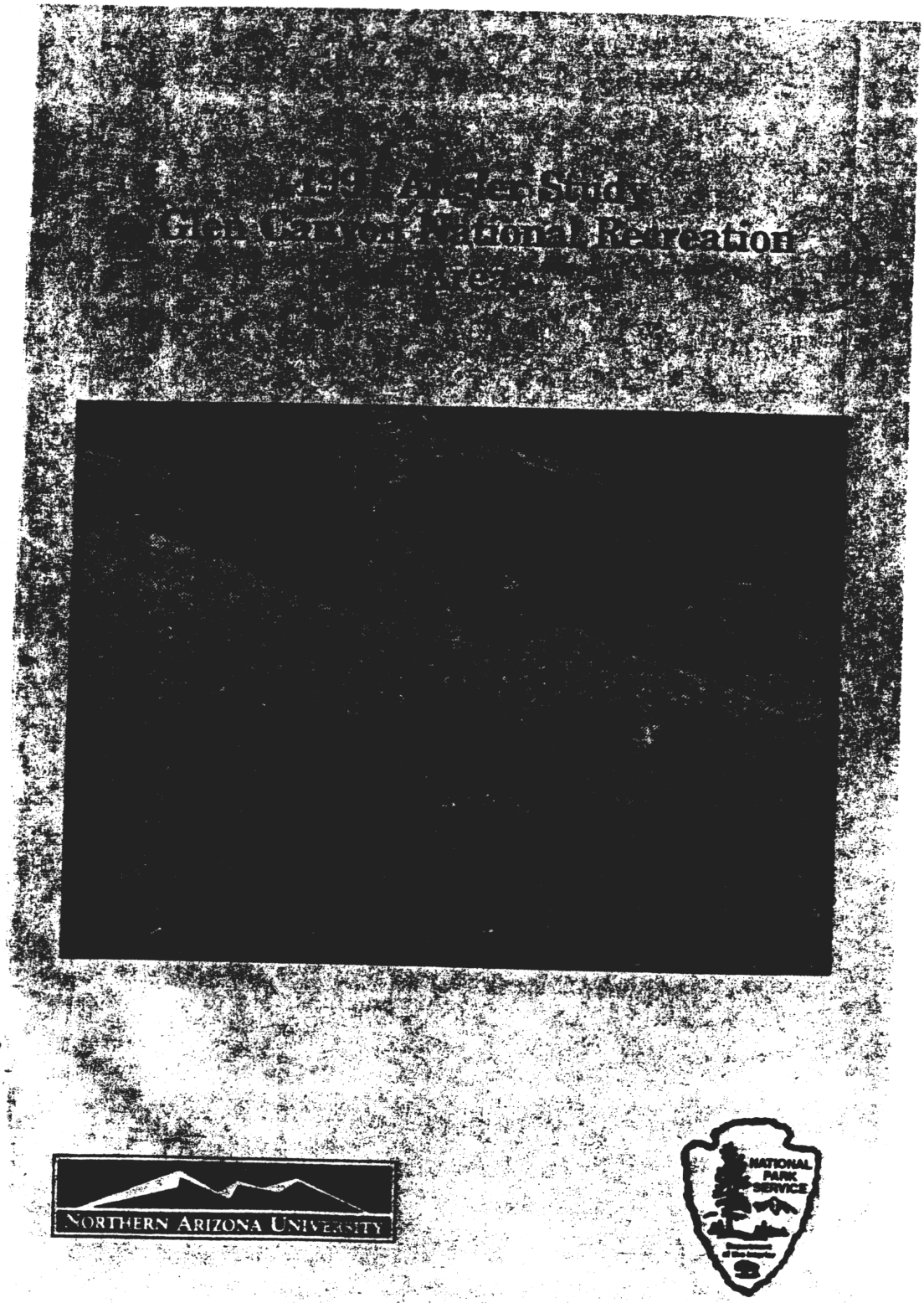
CALCULATION OF SITE IMPACT INDEX

To get an **Impact Value** for each of the eight impact indicators, multiply the **Rating**, assigned above, by the **Factor Weighting Value**, assigned by managers in accordance with the importance managers have given to the impact indicator. Traditionally, higher Factor Weighting Values (FWV) are assigned to impacts which are more lasting and are biophysically detrimental to the site as opposed to just aesthetically displeasing to the eye (Cole, 1989). In this survey, importance was defined by the effort it would take to ameliorate the site with regard to the specific impact. The greater the effort, the higher FWV for the specific impact. For example, the trash impact indicator has a lower FWV than trails, because trash can be easily removed from the site where trail revegetation would entail much more work.

To calculate the **Site Impact Index**, sum the eight **Impact Values**. The lowest value the Site Impact Index can be is 18 and the highest is 72. If the Site Impact Index is a value from **18 to 28**, the sight is considered to be lightly impacted. If the Site Impact Index is a value from **29 to 45**, the site is considered to be moderately impacted. If the Site Impact Index is a value from **46 to 61**, the site is considered to be heavily impacted and if the value is from **62 to 72**, the site is considered to be severely impacted. **Lightly Impacted, Moderately Impacted, Heavily Impacted and Severely Impacted** are called the **Condition Classes.**

APPENDIX D

VISITOR USE SURVEYS


NORTHERN ARIZONA UNIVERSITY
NATIONAL PARK SERVICE

United States Department of the Interior
NATIONAL PARK SERVICE
Glen Canyon National Recreation Area
Box 1507
Page, Arizona 86040
602/645-2471

IN REPLY REFER TO:
A5427

Dear Park Visitor:

Many people visit Glen Canyon National Recreation Area each year. You come from many different places and have a variety of reasons for visiting Glen Canyon. To assist in the management decision process, more information is needed about visitor experiences and activities. To this end, I have asked researchers at Northern Arizona University to conduct a survey of Glen Canyon visitors.

You have been selected as part of a sample of visitors to participate in the survey. In order for the results to be truly representative of all visitors, it is important that you take the time to complete the enclosed questionnaire. When you have finished, please place it in one of the survey drop boxes located in the Lees Ferry boat launch area, or seal it and drop it in the nearest mailbox. It is pre-addressed and the postage is paid.

An identification number is included on the questionnaire so we may check your name off the mailing list when the questionnaire is returned. Your name will not be placed on the questionnaire.

We greatly appreciate your cooperation in this study. I hope that you enjoyed your visit to Glen Canyon National Recreation Area.

Sincerely,

John O. Lancaster
Superintendent

Enclosure

OMB Approval 1024-0078
Expires 10/31/91

INSTRUCTIONS: When answering the following questions, please refer to the stretch of the Colorado River between Glen Canyon Dam and Lees Ferry. If you are on a multi-day trip, please complete the questionnaire on the SECOND DAY of your trip.

Q-1. When did you first enter Glen Canyon National Recreation Area on this trip?

DATE _____
TIME _____ am pm (circle one)

Q-2. When do you expect to leave for the last time on this trip?

DATE _____
TIME _____ am pm (circle one)

Q-3. What type of trip are you on while visiting Glen Canyon National Recreation Area? (circle number)

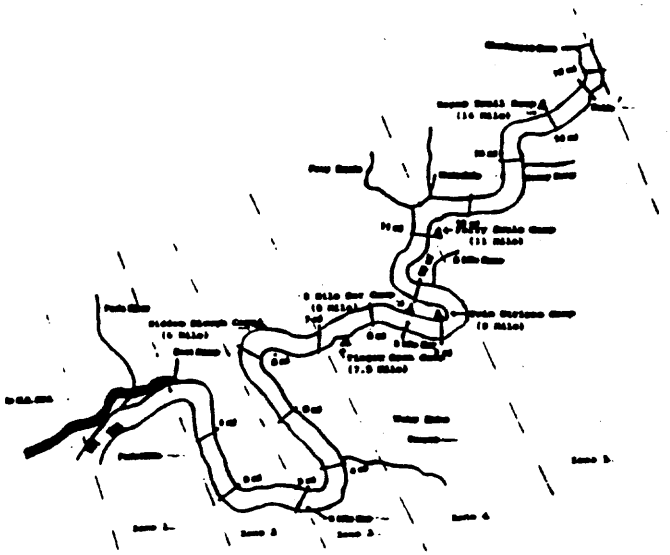
1 VACATION TO GLEN CANYON NATIONAL RECREATION AREA
2 VACATION WITH GLEN CANYON NATIONAL RECREATION AREA AS PART OF TRAVEL PLAN
3 WEEKEND OR MULTI-DAY TRIP
4 DAY OUTING
5 VISIT FOR SEVERAL HOURS OR LESS THAN A DAY
6 WORK ON THE RIVER

Q-4. Are you travelling with family, friends, or what? (circle one number)

1 ALONE
2 A COUPLE
3 FAMILY
4 TWO OR MORE FAMILIES OR RELATIVES TOGETHER
5 FAMILY AND FRIENDS
6 TWO OR MORE FRIENDS TOGETHER
7 SPECIAL INTEREST GROUP (tour group, others)

Q-5. Where did you stop to fish on the river? (See map below, circle all that apply)

1 ZONE 1 (PARIA BEACH TO LEE'S FERRY LAUNCH RAMP)
2 ZONE 2 (LAUNCH RAMP TO 3-MILE BAR)
3 ZONE 3 (3-MILE BAR TO 7.5 MILE FINGER ROCK)
4 ZONE 4 (7.5 MILE, FINGER ROCK TO 11-MILE, FERRY SWALE)
5 ZONE 5 (11-MILE, FERRY SWALE TO GLEN CANYON DAM)



Q-6. Which of the zones is your first choice for a fishing spot?

ZONE _____.

If you didn't fish at your first choice spot, why didn't you? (circle one number)

1 ALREADY TAKEN
2 TOO CROWDED
3 INACCESSIBLE BECAUSE WATER WAS TOO HIGH
4 INACCESSIBLE BECAUSE WATER WAS TOO LOW
5 OTHER REASON _____
6 I WAS ABLE TO FISH AT MY FIRST CHOICE SPOT

We are interested in how you feel about seeing other users on the river.

Q-7. Overall, do you feel that the river is: (circle number)

1 2	3 4	5	6 7	8 9
Not at all crowded	Slightly crowded		Moderately crowded	Extremely crowded

Q-8. Estimate the number of RAFTS you saw during the course of one day?

I saw about _____ RAFTS in a day.

Q-9. How did you feel about the number of RAFTS you saw in a day?

1 WOULD LIKE TO HAVE SEEN A LOT MORE RAFTS
2 WOULD LIKE TO HAVE SEEN A FEW MORE RAFTS
3 NEITHER TOO MANY NOR TOO FEW
4 A FEW TOO MANY RAFTS
5 FAR TOO MANY RAFTS
6 I DON'T KNOW

Q-10. Estimate the number of MOTORBOATS you saw in a day.

I saw about _____ MOTORBOATS in a day.

Q-11. How did you feel about the number of MOTORBOATS you saw in a day?

1 WOULD LIKE TO HAVE SEEN A LOT MORE MOTORBOATS
2 WOULD LIKE TO HAVE SEEN A FEW MORE MOTORBOATS
3 NEITHER TOO MANY NOR TOO FEW
4 A FEW TOO MANY MOTORBOATS
5 FAR TOO MANY MOTORBOATS
6 I DON'T KNOW

Q-12. Estimate the number of bank or wading ANGLERS you saw in a day.

I saw about _____ ANGLERS in a day.

Q-13. How did you feel about the number of bank or wading anglers you saw in a day?

1 WOULD LIKE TO HAVE SEEN A LOT MORE ANGLERS
2 WOULD LIKE TO HAVE SEEN A FEW MORE ANGLERS
3 NEITHER TOO MANY NOR TOO FEW
4 A FEW TOO MANY ANGLERS
5 FAR TOO MANY ANGLERS
6 I DON'T KNOW

Q-14. Did you camp overnight on the river? (circle one number)

1 NO (Skip to Q-19)
2 YES (Please proceed)

Where did you stay? (refer to map, circle one or more)

1 6-MILE, "HIDDEN SLOUGH"
2 7.5-MILE, "FINGER ROCK"
3 8-MILE, "8-MILE BAR"
4 8.5-MILE, "TWIN STRIPES"
5 11-MILE "FERRY SWALE"
6 13.5-MILE "ROPES TRAIL"

Q-15. How many nights did you camp on the river?

_____ NIGHTS

Q-16. Overall, did you feel your camping location was:

1	2	3	4	5	6	7	8	9
not at all crowded		slightly crowded		moderately crowded			extremely crowded	

Q-17. Were you within sight and sound of other campers? (circle one number)

1 NO
2 YES

(If yes) How many other groups could you see or hear?

_____ GROUPS

Q-18. How did you feel about the number of groups you saw at your camping location?

1 WOULD LIKE TO HAVE SEEN A LOT MORE PEOPLE
2 WOULD LIKE TO HAVE SEEN A FEW MORE PEOPLE
3 NEITHER TOO MANY NOR TOO FEW
4 A FEW TOO MANY
5 FAR TOO MANY
6 I DON'T KNOW

River flows on this section of the Colorado River are affected by the operation of Glen Canyon Dam. River flows, in turn, may have an impact on the quality of a fishing trip. Fish might be easier or harder to catch, access along the banks may be better or worse, or boats may be easier or harder to handle. We would like you to tell us how the river flow affected your fishing trip.

Q-19. Indicate what effect the water level had on each of the following items. Please circle the number that best describes your feelings.

What effect did the water level have on:	INCREASED	DECREASED	NO EFFECT	DON'T KNOW
a. Your chances of catching fish	1	2	3	4
b. Your chances of catching a trophy fish	1	2	3	4
c. Amount of time you spent fishing	1	2	3	4
c. Your ability to safely wade the river	1	2	3	4
d. Access to preferred fishing sites on the river	1	2	3	4
e. Access to desirable camping sites	1	2	3	4
f. Chances of damaging your boat and/or motor	1	2	3	4
g. Chances of your boat being beached at a camping or fishing site	1	2	3	4
h. Availability of suitable fish habitat	1	2	3	4
i. Chances of your boat being swamped at a camping or fishing site	1	2	3	4
j. Your ability to navigate through narrow channels	1	2	3	4

Q-20. Information about problems you may have experienced while on the river would be helpful to Glen Canyon managers. To what extent did you find each of the following to be a problem:

Circle the number that best describes how serious you found EACH to be.

	DID ENCOUNTER AND IT WAS:			
	NOT A PROBLEM	MINOR PROBLEM	SERIOUS PROBLEM	DID NOT ENCOUNTER
a. Waiting at boat launch ramp	1	2	3	4
b. Finding a space to park my vehicle/trailer	1	2	3	4
c. Accessing desired spots	1	2	3	4
d. Litter at fishing spots	1	2	3	4
e. Human waste at fishing spots	1	2	3	4
f. Litter at campsite	1	2	3	4
g. Human waste at campite	1	2	3	4
h. Vegetation damage at fishing and camping location	1	2	3	4
i. Boats running over fishing lines	1	2	3	4
j. People shouting and yelling	1	2	3	4
k. Inconsiderate anglers	1	2	3	4
l. Wakes created by rafts motoring upriver	1	2	3	4
m. Noisy motorboats	1	2	3	4
n. Finding a campsite upriver	1	2	3	4
o. Boats or rafts on the river blocking channels	1	2	3	4
p. Inconsiderate rafters	1	2	3	4
q. Wakes created by passing boats	1	2	3	4
r. Inconsiderate guide	1	2	3	4
s. Water too warm	1	2	3	4
t. Water too low and too slow	1	2	3	4

	DID ENCOUNTER AND IT WAS:			
	NOT A PROBLEM	MINOR PROBLEM	SERIOUS PROBLEM	DID NOT ENCOUNTER
u. Remains of illegal fires on beach or at campsites	1	2	3	4
v. Water too high and too fast	1	2	3	4
w. Water too clear	1	2	3	4
x. Boat swamped while tied up on beach	1	2	3	4
y. Erosion of beaches	1	2	3	4
z. Water too muddy	1	2	3	4
aa. Inability to fish in solitude	1	2	3	4
bb. Did not feel safe while fishing	1	2	3	4
cc. Damage to raft and/or motor	1	2	3	4
dd. Within sight and sound of boats too often	1	2	3	4
ee. Lots of unburned trash in firegrates at campsites	1	2	3	4
ff. Within sight and sound of wading or bank anglers too often	1	2	3	4
gg. Toilet facilities poorly maintained	1	2	3	4
hh. Graffiti on petroglyph panels	1	2	3	4
ii. Within sight and sound of rafts too often	1	2	3	4
jj. Water too cold	1	2	3	4
kk. Boat getting beached	1	2	3	4
ll. Vessels passing too close to one another	1	2	3	4

Next, we would like to as you about your overall experience on the river.

Q-21. Overall, how satisfied were you with your trip to Glen Canyon National Recreation Area? (circle number)

1 VERY DISSATISFIED
2 DISSATISFIED
3 SATISFIED
4 VERY SATISFIED
5 DON'T KNOW

Q-22. Was there anything you expected to do during your visit to Glen Canyon but were not able to do? If Yes, what?

Another important purpose of this study is to learn more about how people feel about the management of this area.

Q-23. Demand for use of the river in Glen Canyon National Recreation Area has been increasing. If increased use becomes a problem, please tell us how you would feel about restricting use on the river for the purposes listed below.

(Please circle the number that best describes your position).

Restrict use to:	WOULD SUPPORT	WOULD NOT SUPPORT	DON'T KNOW
a. Maintain a trophy trout fishery	1	2	3
b. Preserve native fish	1	2	3
c. Preserve food sources for the trout fishery	1	2	3
d. Protect cultural sites	1	2	3
e. Improve upriver campsites	1	2	3
f. Create a wilderness experience	1	2	3
g. Increase boating safety	1	2	3
h. Increase peace and quiet	1	2	3

Restrict use to:	WOULD SUPPORT	WOULD NOT SUPPORT	DON'T KNOW
i. Protect beaches from erosion	1	2	3
j. Reduce human impacts (litter, human waste)	1	2	3
k. Reduce number of anglers at fishing sites	1	2	3
l. Reduce number of anglers at campsites	1	2	3
m. Reduce number of day-use rafters on the river	1	2	3
n. Decrease crowding	1	2	3

Q-24. Would you be willing to pay $15.00 to buy an annual pass to Glen Canyon National Recreation Area? (circle one number)

1 YES
2 NO

(If no) Why would you choose not to pay? (circle one number)

1 DON'T USE PARK ENOUGH TO JUSTIFY BUYING A PASS
2 THERE ARE TOO MANY OTHER PLACES TO GO THAT ARE CHEAPER
3 CAN'T AFFORD THAT MUCH
4 IT IS UNFAIR TO ASK MONEY TO ENTER A PUBLIC PLACE

Q-25. If increasing use becomes a problem, please tell us how you feel about each of the following management actions for managing the river.

(Please circle the number that best describes your position).

Management actions:	FAVOR	DO NOT FAVOR BUT WOULD ACCEPT	WOULD NOT ACCEPT	NO OPINION
a. Require all boats to have a "porta-potty" to carry out human waste	1	2	3	4
b. Implement a permit system for upriver camping	1	2	3	4
c. Limit party sizes	1	2	3	4
d. Require upriver campers to carry out fire ash	1	2	3	4
e. Restrict use of campfires	1	2	3	4
f. Close stressed fishing areas	1	2	3	4
g. Close certain beaches	1	2	3	4
h. Close certain archeological sites	1	2	3	4
i. Restrict number of motorboats per day	1	2	3	4
j. Restrict number of bank anglers per day	1	2	3	4
k. Restrict number of rafters per day	1	2	3	4

Finally, we would like to ask a few questions about yourself to help interpret the results.

Q-26. What is the year of your birth? 19 ___ ___

Q-27. What is your sex? (circle number)

1 MALE
2 FEMALE

Q-28. What is the highest educational level you have attained? (please circle one number)

1 8TH GRADE OR LESS
2 9TH-11TH GRADE
3 12TH GRADE - HS GRADUATE
4 13-15 YEARS - SOME COLLEGE, BUSINESS, TRADE SCHOOL
5 16 YEARS - COLLEGE/UNIVERSITY GRADUATE
6 17 YEARS+ - SOME GRADUATE WORK
7 MASTERS, DOCTORAL OR PROFESSIONAL DEGREE

Q-29. What is your present marital status: (circle number)

1 SINGLE, NEVER MARRIED
2 MARRIED
3 WIDOWED
4 DIVORCED
5 SEPARATED

Q-30. Which number indicates your race or ethnic group? (circle one)

1 AMERICAN INDIAN OR ALASKAN NATIVE
2 ASIAN OR PACIFIC ISLANDER
3 BLACK, NOT OF HISPANIC ORIGIN
4 HISPANIC
5 WHITE, NOT OF HISPANIC ORIGIN

Q-31. Which of the following describes your present employment status? (circle number)

1 HOMEMAKER
2 UNEMPLOYED
3 STUDENT
4 RETIRED, NOT WORKING
5 RTIRED, BUT WORKING FULL TIME
6 RETIRED, BUT WORKING PART TIME
7 EMPLOYED FULL TIME
8 EMPLOYED PART-TIME
9 OTHER _____

Q-32. Which of the following income levels best describes your total household income before taxes? (circle one number)

1 0 to $9,999
2 $10,000 to $19,999
3 $20,000 to $29,999
4 $30,000 to $39,999
5 $40,000 to $49,999
6 $50,000 to $59,999
7 $60,000 to $69,999
8 $70,000 to $79,999
9 $80,000 to $89,999
10 $90,000 to $99,999
11 $100,000 or more

Q-33. Is there anything else you would like to tell us about your visit to Glen Canyon NRA?

16 U.S.C. 1a-7 authorizes collection of this information. This information will be used by park managers to better serve the public. Response to this request is voluntary. No action may be taken against you for refusing to supply the information requested. Your name is requested for follow-up mailing purposes only. When analysis of the questionnaire is completed, all name and address files will be destroyed. Thus the permanent data will be anonymous. Please do not put your name or that of any member of your group on the questionnaire. Data collection through visitor surveys may be disclosed to the Department of Justice when relevant to litigation or anticipated litigation, or to appropriate Federal, State, local or foreign agencies responsible for investigating or prosecuting a violation of law.

Public reporting burden for this form is estimated to average 22 minutes per response. Direct comments regarding the burden estimate or any other aspect of this form to the Information Collection Clearance Officer, National Park Service, P.O. Box 37127, Washington, DC 20014-7127; and to the Office of Management and Budget, Paperwork Reduction Project 1024, Washington, DC 20503

1991 Rafter Study
Glen Canyon National Recreation Area

NORTHERN ARIZONA UNIVERSITY

NATIONAL PARK SERVICE

United States Department of the Interior
NATIONAL PARK SERVICE
Glen Canyon National Recreation Area
Box 1507
Page, Arizona 86040
602/645-2471

IN REPLY REFER TO:
A5427

Dear Park Visitor:

Many people visit Glen Canyon National Recreation Area each year. You come from many different places and have a variety of reasons for visiting Glen Canyon. To assist in the management decision process, more information is needed about visitor experiences and activities. To this end, I have asked researchers at Northern Arizona University to conduct a survey of Glen Canyon visitors.

You have been selected as part of a sample of visitors to participate in the survey. In order for the results to be truly representative of all visitors, it is important that you take the time to complete the enclosed questionnaire. When you have finished, please place it in one of the survey drop boxes located in the Lees Ferry boat launch area, or seal it and drop it in the nearest mailbox. It is pre-addressed and the postage is paid.

An identification number is included on the questionnaire so we may check your name off the mailing list when the questionnaire is returned. Your name will not be placed on the questionnaire.

We greatly appreciate your cooperation in this study. I hope that you enjoyed your visit to Glen Canyon National Recreation Area.

Sincerely,

John O. Lancaster
Superintendent

Enclosure

1916 • 1991

OMB Approval 1024-0079
Expires 10/31/91

INSTRUCTIONS: When answering the following questions, please refer to the stretch of the Colorado River between Glen Canyon Dam and Lees Ferry.

Q-1. When did you first enter Glen Canyon National Recreation Area on this trip?

DATE _____
TIME _____ am pm (circle one)

Q-2. When do you expect to leave for the last time on this trip?

DATE _____
TIME _____ am pm (circle one)

Q-3. What type of trip were you on while visiting Glen Canyon National Recreation Area? (circle number)

1 VACATION TO GLEN CANYON NATIONAL RECREATION AREA
2 VACATION WITH GLEN CANYON NATIONAL RECREATION AREA AS PART OF TRAVEL PLAN
3 WEEKEND OR MULTI-DAY TRIP
4 DAY OUTING
5 VISIT FOR SEVERAL HOURS OR LESS THAN A DAY
6 WORK ON THE RIVER

Q-4. Are you travelling with familly, friends, or what? (circle one number)

1 ALONE
2 A COUPLE
3 FAMILY
4 TWO OR MORE FAMILIES OR RELATIVES TOGETHER
5 FAMILY AND FRIENDS
6 TWO OR MORE FRIENDS TOGETHER
7 SPECIAL INTEREST GROUP (tour group, others)

Q-5. How many other people are you traveling with on this raft trip?

_____ PEOPLE

We are interested in how you feel about seeing other visitors on the river.

Q-6. Overall, do you feel that the river is:

1 2	3 4	5	6 7	8 9
Not at all crowded	Slightly crowded		Moderately crowded	Extremely crowded

Q-7. Estimate the number of RAFTS you saw during your trip down the river.

I saw about _____ RAFTS at any one time during the raft trip.

I saw about _____ RAFTS total during the raft trip.

Q-8. How did you feel about the number of RAFTS you saw during your trip?

1 WOULD LIKE TO HAVE SEEN A LOT MORE RAFTS
2 WOULD LIKE TO HAVE SEEN A FEW MORE RAFTS
3 NEITHER TOO MANY NOR TOO FEW
4 A FEW TOO MANY RAFTS
5 FAR TOO MANY RAFTS
6 I DON'T KNOW

Q-9. Estimate the number of BOATS (not rafts) you saw during your trip down the river.

I saw about _____ BOATS total during the trip.

Q-10. How did you feel about the number of BOATS (not rafts) you saw during your trip down the river?

1 WOULD LIKE TO HAVE SEEN A LOT MORE BOATS
2 WOULD LIKE TO HAVE SEEN A FEW MORE BOATS
3 NEITHER TOO MANY NOR TOO FEW
4 A FEW TOO MANY BOATS
5 FAR TOO MANY BOATS
6 I DON'T KNOW

Q-11. Estimate the number of bank or wading ANGLERS you saw during your trip down the river.

I saw about _____ ANGLERS total during the trip.

Q-12. How did you feel about the number of bank or wading anglers you saw during your trip down the river?

1 WOULD LIKE TO HAVE SEEN A LOT MORE ANGLERS
2 WOULD LIKE TO HAVE SEEN A FEW MORE ANGLERS
3 NEITHER TOO MANY NOR TOO FEW
4 A FEW TOO MANY ANGLERS
5 FAR TOO MANY ANGLERS
6 I DON'T KNOW

Q-13. Information about problems you may have experienced while on the river would be helpful to Glen Canyon managers. To what extent did you find each of the following to be a problem:

Circle the number that best describes how serious you found EACH to be.

	DID ENCOUNTER AND IT WAS:			
	NOT A PROBLEM	MINOR PROBLEM	SERIOUS PROBLEM	DID NOT ENCOUNTER
a. Waiting to launch rafts	1	2	3	4
b. Litter at lunch stop site	1	2	3	4
c. Vegetation damage at lunch stop site	1	2	3	4
d. Human waste at lunch stop site	1	2	3	4
e. Human waste at rest stop site	1	2	3	4
f. Vegetation damage at rest stop site	1	2	3	4
g. Litter at rest stop site	1	2	3	4
h. Anglers fishing in path of raft	1	2	3	4
i. People shouting and yelling	1	2	3	4
j. Inconsiderate anglers	1	2	3	4

	DID ENCOUNTER AND IT WAS:			
	NOT A PROBLEM	MINOR PROBLEM	SERIOUS PROBLEM	DID NOT ENCOUNTER
k. Water too low and too slow	1	2	3	4
l. Wakes created by passing boats	1	2	3	4
m. Noisy motorboats	1	2	3	4
n. Inconsiderate guide	1	2	3	4
o. Vessels passing too close to one another	1	2	3	4
p. Raft stuck on beach	1	2	3	4
q. Water too cold	1	2	3	4
r. Graffiti on petroglyph panels	1	2	3	4
s. Water too warm	1	2	3	4
t. Inconsiderate rafters	1	2	3	4
u. Remains of illegal fires on beach	1	2	3	4
v. Water too high and too fast	1	2	3	4
w. Water too clear	1	2	3	4
x. Raft swamped while tied up on beach	1	2	3	4
y. Erosion of beach at rest site	1	2	3	4
z. Water too muddy	1	2	3	4
aa. Erosion of beach at lunch site	1	2	3	4
bb. Feeling unsafe on the raft	1	2	3	4
cc. Within sight and sound of bank or wading anglers too often	1	2	3	4
dd. Wakes created by rafts motoring upriver	1	2	3	4
ee. Guide had difficulty landing raft on a beach	1	2	3	4
ff. Within sight and sound of other rafts too often	1	2	3	4
gg. Damage to raft and/or motor	1	2	3	4
hh. Within sight and sound of boats too often	1	2	3	4
ii. Toilet facilities poorly maintained	1	2	3	4

Next, we would like to ask you about your overall experience on the river.

Q-14. Overall, how satisfied were you with your raft trip experience? (circle number)

1 VERY DISSATISFIED
2 DISSATISFIED
3 SATISFIED
4 VERY SATISFIED
5 DON'T KNOW

Q-15. Was there anything you expected to do during your visit to Glen Canyon but were not able to do? If Yes, what?

Another important purpose of this study is to learn more about how people feel about the management of this area.

Q-16. Demand for use of the river in Glen Canyon National Recreation Area has been increasing. If increased use becomes a problem, please tell us how you would feel about restricting use on the river for the purposes listed below.

(Please circle the number that best describes your position).

Restrict use to:	WOULD SUPPORT	WOULD NOT SUPPORT	DON'T KNOW
a. Maintain a trophy trout fishery	1	2	3
b. Preserve native fish	1	2	3
c. Preserve food sources for the trout fishery	1	2	3
d. Protect cultural sites	1	2	3
e. Improve upriver campsites	1	2	3
f. Create a wilderness experience	1	2	3
g. Increase boating safety	1	2	3
h. Increase peace and quiet	1	2	3

Restrict use to:	WOULD SUPPORT	WOULD NOT SUPPORT	DON'T KNOW
i. Protect beaches from erosion	1	2	3
j. Reduce human impacts (litter, human waste)	1	2	3
k. Reduce number of anglers at fishing sites	1	2	3
l. Reduce number of anglers at campsites	1	2	3
m. Reduce number of day-use rafters on the river	1	2	3
n. Decrease crowding	1	2	3

Q-17. Would you be willing to pay $15.00 to buy an annual pass to Glen Canyon National Recreation Area? (circle one number)

1 YES
2 NO

(If no) Why would you choose not to pay? (circle one number)

1 DON'T USE PARK ENOUGH TO JUSTIFY BUYING A PASS
2 THERE ARE TOO MANY OTHER PLACES TO GO THAT ARE CHEAPER
3 CAN'T AFFORD THAT MUCH
4 IT IS UNFAIR TO ASK MONEY TO ENTER A PUBLIC PLACE

Q-18. If increasing use becomes a problem, please tell us how you feel about each of the following management actions for managing the river.

(Please circle the number that best describes your position).

Management actions:	FAVOR	DO NOT FAVOR BUT WOULD ACCEPT	WOULD NOT ACCEPT	NO OPINION
a. Require all boats to have a "porta-potty" to carry out human waste	1	2	3	4
b. Implement a permit system for upriver camping	1	2	3	4
c. Limit party sizes	1	2	3	4
d. Require upriver campers to carry out fire ash	1	2	3	4
e. Restrict use of campfires	1	2	3	4
f. Close stressed fishing areas	1	2	3	4
g. Close certain beaches	1	2	3	4
h. Close certain archeological sites	1	2	3	4
i. Restrict number of motorboats per day	1	2	3	4
j. Restrict number of bank anglers per day	1	2	3	4
k. Restrict number of rafters per day	1	2	3	4

Finally, we would like to ask a few questions about yourself to help interpret the results.

Q-19. What is the year of your birth? 19 ___ ___

Q-20. What is your sex? (circle number)

1 MALE
2 FEMALE

Q-21. What is the highest educational level you have attained? (please circle one number)

1 8TH GRADE OR LESS
2 9TH-11TH GRADE
3 12TH GRADE - HS GRADUATE
4 13-15 YEARS - SOME COLLEGE, BUSINESS, TRADE SCHOOL
5 16 YEARS - COLLEGE/UNIVERSITY GRADUATE
6 17 YEARS+ - SOME GRADUATE WORK
7 MASTERS, DOCTORAL OR PROFESSIONAL DEGREE

Q-22. What is your present marital status: (circle number)

1 SINGLE, NEVER MARRIED
2 MARRIED
3 WIDOWED
4 DIVORCED
5 SEPARATED

Q-23. Which number indicates your race or ethnic group? (circle one)

1 AMERICAN INDIAN OR ALASKAN NATIVE
2 ASIAN OR PACIFIC ISLANDER
3 BLACK, NOT OF HISPANIC ORIGIN
4 HISPANIC
5 WHITE, NOT OF HISPANIC ORIGIN

Q-24. Which of the following describes your present employment status? (circle number)

1 HOMEMAKER
2 UNEMPLOYED
3 STUDENT
4 RETIRED, NOT WORKING
5 RTIRED, BUT WORKING FULL TIME
6 RETIRED, BUT WORKING PART TIME
7 EMPLOYED FULL TIME
8 EMPLOYED PART-TIME
9 OTHER _____

Q-25. Which of the following income levels best describes your total household income before taxes? (circle one number)

1 0 to $9,999
2 $10,000 to $19,999
3 $20,000 to $29,999
4 $30,000 to $39,999
5 $40,000 to $49,999
6 $50,000 to $59,999
7 $60,000 to $69,999
8 $70,000 to $79,999
9 $80,000 to $89,999
10 $90,000 to $99,999
11 $100,000 or more

Is there anything else you would like to tell us about your visit to Glen Canyon NRA?

APPENDIX E

KRUSKAL-WALLIS TEST

The Kruskal-Wallis test is an extension of the Mann-Whitney test for two independent samples and can be used to analyze k independent samples, for k > or = 2 (Conover 1980). There must be k random samples, one from each of K populations. The null hypothesis to test is that all of the populations are identical. The research hypothesis is that one of the populations tends to furnish observed values that are greater than the others. The test statistic is a function of the ranks of the observations in the combined sample. Observations with small values receive a lower rank than those with large values. The Kruskal-Wallis test compares the sum of the ranks from each of the samples to determine if the difference between the samples, and therefore populations, is significant (Conover 1980).

The test statistic T is defined as

$$T = \frac{1}{S^2}\left(\sum_{i=1}^{k}\frac{R_i^2}{n_i} - \frac{N(N+1)^2}{4}\right)$$

where S^2 is defined as

$$S^2 = \frac{1}{N-1}\left(\sum_{\substack{\text{all}\\ \text{ranks}}} R(X_{ij})^2 - N\frac{(N+1)^2}{4}\right)$$

and N denotes the total number of observations.

$$N = \sum_{i=1}^{k} n_i$$

R(Xij) represents the rank assigned to Xij. Assign rank 1 to the smallest of the totality of N observations, rank

2 to the second and so on. Let Ri be the sum of the ranks assigned to the sample.

$$R_i = \sum_{j=1}^{n_i} R(X_{ij}) \qquad i = 1, 2, \ldots, k$$

If ranks are equal to each other, assign the average of the ranks to each of the tied observations. Approximate quantiles may be obtained from the chi-square distribution with k-1 degrees of freedom. Reject Ho at alpha equal to .05 if T exceeds the 1-.05 quantile.

If the null hypothesis is rejected, one can conclude that some of the populations differ. To determine which of the populations tend to differ, one can perform a multiple comparisons procedure.

$$\left|\frac{R_i}{n_i} - \frac{R_j}{n_j}\right| > t_{1-(\alpha/2)}\left(S^2 \frac{N-1-T}{N-k}\right)^{\frac{1}{2}}\left(\frac{1}{n_i} + \frac{1}{n_j}\right)^{\frac{1}{2}}$$

where Ri and Rj are the rank sums of the two samples.

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