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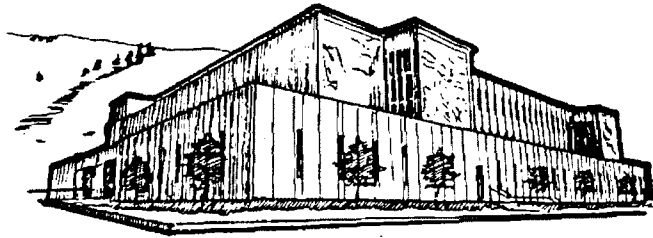
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University of  
**Montana**



A STUDY OF CAMPSITE IMPACTS ON THE  
SAN JUAN RIVER, UTAH

By

Debra Jane Sholly

B.S., University of Utah, 1989

Presented in partial fulfillment of the requirements  
for the degree of  
Master of Science  
University of Montana  
1991

Approved by

Robert R. Ream

Chairman, Board of Examiners

R. C. Murray

Dean, Graduate School

June 12, 1991

Date

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Sholly, Debra J., M.S., June, 1991

Recreation Management

A Study of Campsite Impacts on the San Juan River, Utah (81 pp.)

Director: Robert R. Ream 

A campsite inventory was taken on the San Juan River, Glen Canyon National Recreation Area during the summer of 1990. Forty-one campsites were identified. A number of counts and estimates were taken to establish a database of information on site impacts, including both biophysical and aesthetic site impacts. Included were fire remains, litter, fecal remains, evidence of insects, camp pests and soap or gray water. Biophysical included both vegetation and trails counts and estimates such as vegetation damages, presence of vegetation trampling, and estimates of vegetative cover on-site and on a comparative site nearby. Others included the number of trails in and around campsites, and on-site compaction and landing erosion. Information was gathered on each site for both future comparison and relocation purposes, and sites were then mapped and photographed.

A campsite condition index was then developed for both categories, biophysical and aesthetic. These were based on ten biophysical and ten aesthetic factors, with more weight applied to the biophysical category. These were then added together and an overall index was created. At this time, the index was categorized into five classifications of site damages.

Information gathered on each campsite facilitated comparisons among campsites in terms of site damages. Some comparisons included impacts and site composition, impacts and site size. There were few vegetation damages, however 88% of the sites exhibited trails within the camp area.

Aesthetic impacts and a decrease in aesthetic value is a major consideration along the San Juan, as 83% of the sites displayed some form of litter or garbage remains, and over 80% of the campsites exhibited some sort of fire remains, in the form of ashes or charcoal.

## ACKNOWLEDGEMENTS

I would like to thank my major professor, Dr. Robert Ream, for his assistance and personal support of this study. Dr. Ream helped edit the manuscript, but provided much more than academic help. He provided encouragement and support when I needed it, yet had the unique ability to allow me enough space and solitude to do my own project.

This project was funded by the National Park Service, and I thank the staff at Glen Canyon National Recreation Area, for all the day to day support. I would like to extend special thanks to Rick Harris for supporting the project. He provided shuttles for the river trips, flights to Page for groceries, and in general what I needed to gather the data. Special thanks also goes to ranger J.D. Swed and his wife Maureen at Hall's Crossing, who provided much hospitality in the form of friendship, sleeping space, cold beer and relaxation under their swamp cooler when it was 110 degrees. I would also like to thank John Ritenour, Chief of Resource Management, and the NPS pilot, Tug Kangas, for sharing with me the incredible overflight of the San Juan River and the beautiful area surrounding it.

There is nothing like the companionship of a friend on a river trip. I would like to thank Eric Lonn, who committed his entire summer to helping me with this project. Not only did he provide moral support, but stayed and drew maps for me during a summer so hot, anyone of less character would have deserted. I also have to thank him for helping me get the kinks out of my computer. His patience is astounding.

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## CHAPTER I

### INTRODUCTION

Interest in recreational river floating has increased substantitally over the last two decades. This has created a number of problems for management agencies involved in river management. The reasons for these problems are simple: limited resources and seemingly unlimited numbers of would-be users.

The popularity of river running has increased at an incredible rate over the last century, and has now become a leading recreational activity. For example, before 1966, a total of only 2,068 people had floated the Colorado River through the Grand Canyon, while over 16,000 people floated it in the single year of 1972. The number of people that floated the Snake River in Grand Teton National Park in 1975 was five times greater than the number of people that floated it in 1966 (Huser 1977). Additionally, numerous articles and features on river recreation have appeared in various magazines across the nation, and the industry has emerged with magazines of its own, Canoe, Currents and River Runner, to name a few. People's incomes have increased, as has the amount of leisure time to be spent in the pursuit of recreational activities. Technology has provided better and more affordable equipment, and publications have increased the public's awareness of the

sport, as well as providing instruction for the do-it-yourselfer. The number of commercial operators has increased dramatically, to provide experiences for the customer in search of an outdoor adventure.

An overabundance of recreationists in any area has a direct influence on the resource, including the river and the areas surrounding it. Professor, author and river runner Roderick Nash stated in 1977 that there was a very real possibility that our rivers were in danger of being loved to death. It was at this time, in the 1970's, that the agencies administering our nation's rivers began to realize the importance of saving our rivers. At this point, limits on use were imposed on many rivers, and today, there is much competition for use, and some permits are extremely difficult to obtain, especially on the more popular rivers. For example, one might wait for up to 7 years to obtain a non-commercial permit to float the Colorado River through the Grand Canyon.

Sociological studies of the effects of crowding on rivers have been performed, (Roggenbuck and Schreyer 1977; Pfister and Frenkel 1974) however it is also important to examine the biophysical impacts of floaters on campsites. Many people float rivers to achieve a wilderness-like experience. A natural environment is a major factor, crucial in the achievement of a satisfying experience. The adventure may be undermined by the presence of degradants left behind by other recreationists, such as litter and fire remains. Additionally, the resource itself may be negatively affected by overuse; through the loss

of vegetation and the introduction of exotic species. A loss of habitat and decrease in natural diversity may ultimately lead to a severe disturbance of natural processes. Disturbances at campsites are hereafter referred to as "impacts". The long-term implications of campsite impacts are not fully understood, thus it is necessary to thoroughly analyze an area and establish a monitoring program that will provide continuous information over the long term.

Numerous campsite monitoring processes have been developed for and have been used in wilderness areas. A sourcebook of assessment systems has been written to provide information to resource managers on the various techniques available (Cole, 1989). Additionally, there are a few programs in existence that have been developed for campsites within a riverine environment. However, the ones located have been developed for mountain rivers, and are unable to deal with the unique characteristics of rivers in an arid environment. For example, it is difficult to take a system created for a northern Idaho mountain river and modify it for use on a southern Utah desert river.

There is a shortage of research performed in arid environments, and few publications have been found in the search for research articles that outline studies on campsite impacts on southwest desert rivers. Specifically, a limited amount of research has been done on the San Juan River. Calhoun (Harris, 1990) began a campsite impact study on the San Juan in 1985, but it was not completed, and existing records are fragmentary. Although the amount of research in these areas is limited,

two somewhat similar rivers have been studied; the Colorado River in Grand Canyon National Park, and the Cataract Canyon stretch of the Colorado in Canyonlands National Park, Utah. A campsite survey was performed in Cataract Canyon (Kitchell and Connor in Cole, 1989), and numerous studies have been performed in the Grand Canyon. Glen Canyon Dam has removed the elements of a natural system from the Grand Canyon river corridor, so it is not a perfect model for comparison. Nonetheless, the sandy beach campsites are within a similar environment.

Man-induced changes affect the natural processes and physical topography of a riverine environment, both in soils and vegetation. Dolan, Howard and Gallenson (1974) compared pre-dam conditions in the Grand Canyon with present conditions in terms of water flow and its effect on beaches and high river terraces. They discovered that the changes imposed on the natural river flows have resulted in a number of alterations. At present, great fluctuations in dam discharges result in beach erosion, and the sediment-free water prohibits beach replacement. Additionally, the absence of natural and periodic high flooding disallows the historically occurring "cleansing" of the river corridor. Many studies have been done on forest soils; compaction and loss of the organic layer have been well-documented (Cole and Schreiner 1981; Kuss, Graefe, and Loomis 1977). However, apparently little has been done on sandy beach sites, and beach erosion has been difficult to quantify.

Recreationists negatively affect natural vegetation systems through trampling and tree damage. LaPage (1967) determined that vegetation trampling is a threat to site preservation, and that as a result, species composition undergoes a change to more recreation-tolerant species, while less resistant species tend to decline. A decrease in natural species can encourage growth of and replacement with exotic species. Root exposure has been linked to heavy use of recreational areas (Settergren and Cole 1970; Ripley 1962). Frissell and Duncan (1965) found that tree disease and injury results in occasional tree death and a lack of tree reproduction in forested campgrounds. Little research has been located for high-desert areas, however Cole (1985) found that grassland vegetation is more resistant to trampling loss than forest vegetation. Although river-specific research is lacking, perhaps experience gained in other areas can be adapted to river management (Craig 1977).

Aesthetic degradation can result in more than a loss of aesthetic value. Cole (1982) concluded that in addition to an aesthetic problem, non-contained campfires may lead to eventual soil sterilization. Also, elimination and burning of wood may remove soil microorganisms, which in turn may inhibit revegetation. Human feces in campsites is another aesthetic degradant. While it is aesthetically displeasing, it may also be considered a health hazard. Temple, Camper and Lucas (1982) determined that bacteria can survive over a winter period at an appreciable level,

and that depth of feces burial is not a factor in the dilution of harmful pathogens.

Campsites are areas of concentrated activity in recreation areas. Damages to campsites negatively alter vegetation, soil and aesthetic attraction. It is necessary for the management agency to assess changes in the condition of the resource. Systems should be implemented to provide a database of information and to assess condition changes over time.

The Bureau of Land Management (BLM) controls river use along the 58-mile stretch of the San Juan River from the town of Mexican Hat, Utah, to the take-out at Clay Hills Crossing, Utah. Although the BLM administers this stretch, the majority of the land along the river is owned by or administered by other agencies. The entire southern bank is owned by the Navajo Tribe, and the lower 38 miles of the north bank is part of Glen Canyon National Recreation Area, administered by the National Park Service (NPS). The BLM and NPS work cooperatively to manage this stretch of river.

At the time of this study, there was no river management plan for this lower canyon of the San Juan, although the National Park Service and the Bureau of Land Management plan to develop one cooperatively in the near future. Allocation limits and the rationing of user days have been established however, and permits to float the river are issued through the Bureau of Land Management in Monticello, Utah. The current system will remain in effect, at least until the future river plan has

been completed. In the interim, the National Park Service has sponsored this research project, which describes the current state of riverside campsites in the canyon.

Although use in the canyon has increased overall since 1983, the years of 1986 and 1989 showed a substantial decrease in the number of floaters (Fig. #1). Therefore, it appears that use has leveled off, and if this is true, we can assume that when this study is repeated, changes will indicate the general overall trend of campsite conditions at the current levels of river use.

The topography of the the area is in a constant state of flux, as river levels vary greatly throughout the season and from year to year, thus causing new sand and silt to be brought in, and old beaches and sandbars to be removed and redistributed. Thus, impacts on the campsites along the San Juan are difficult to interpret. However, it is important to collect information on the conditions of these campsites.

The first objective of this study was to collect information and establish a database on existing conditions of riverside campsites. This data will serve as a baseline for future comparisons. The second objective was to develop a monitoring system that could be used to collect information in the future. In order to compare future data with the original data, to observe changes, trends or patterns in the condition of the campsites, consistency in monitoring will be necessary.



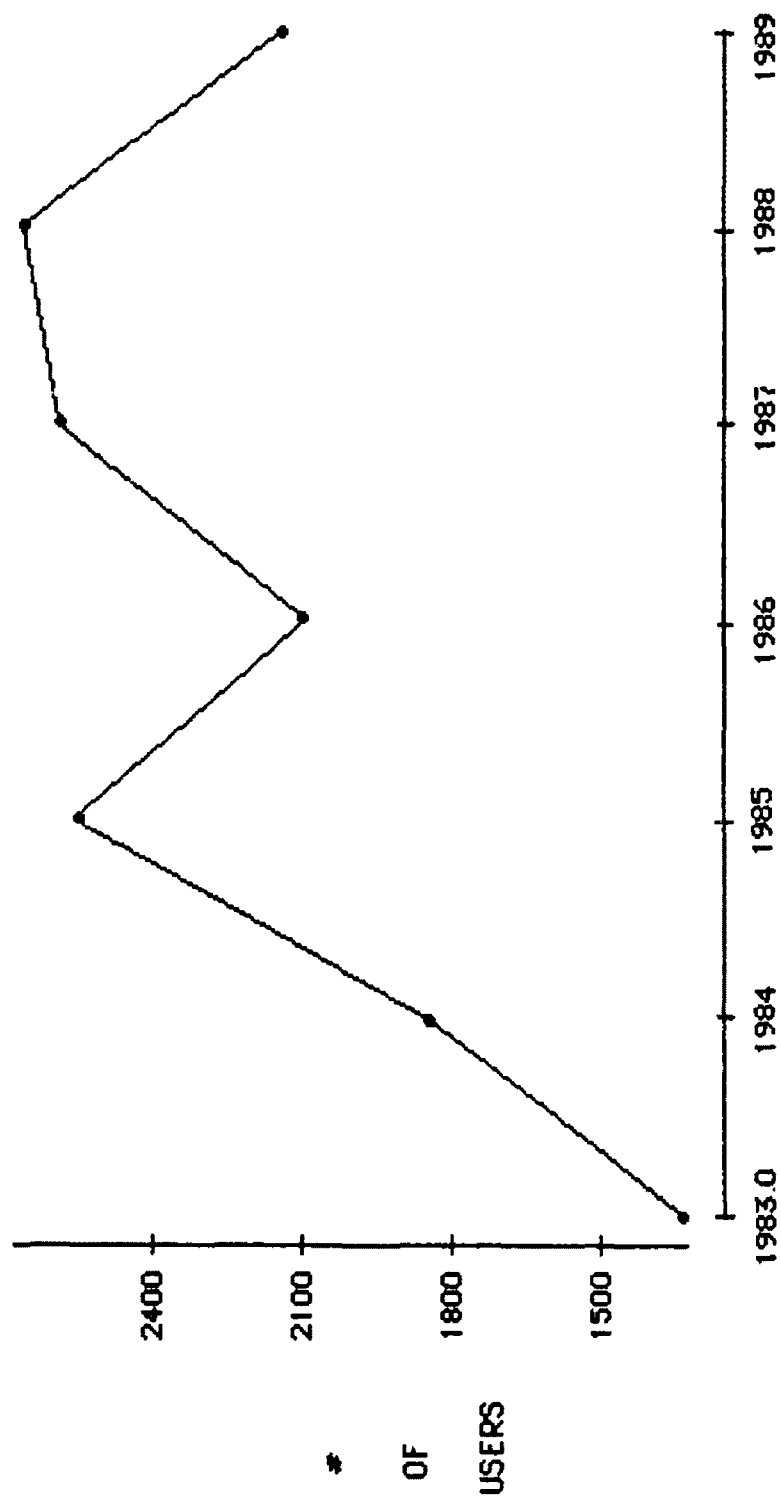


Fig. 1. Total number of users per year, San Juan River, Utah.

## CHAPTER II

### THE STUDY AREA

#### Area Physiography

The San Juan River begins in Colorado, and runs southwest into northern New Mexico. It then turns north and west into and across southeastern Utah. Its source is near Wolf Creek Pass in the San Juan Mountains of Colorado, and its mouth is the Colorado River at Lake Powell in southeast Utah. Its total length is 366 miles, and it has an approximate drainage area of 25,800 square miles. Beginning at over 12,000 feet in elevation, it is less than half that by the time it reaches the Colorado/New Mexico border. (Rennicke 1985.)

The San Juan begins as a mountain river, and flows through the San Juan National Forest in Colorado. Along the way, it gathers the West Fork, the East Fork, and Turkey Creek. The Navajo River flows into the San Juan near the Navajo Reservoir on the Colorado/New Mexico border. This Navajo Reservation Project near Aztec, New Mexico, stills and reroutes the waters of the San Juan for irrigation of the San Juan Basin. This affects the study area in that the extreme high water floods which occurred previous to the dam no longer exist. The Piedra and Los Pinos rivers join the San Juan at the Navajo Reservoir. Below this man-made

lake, the Animas River and the Mancos River join the San Juan as it once again begins its journey to the west.

As the river runs through southern Utah, its character changes from that of a mountain river to a desert river, cutting through and creating deep sandstone and limestone canyons. Originally, the San Juan joined the Colorado River and flowed to the Gulf of California and the Pacific Ocean. Now, however, it meets an untimely end, dying at the backwash waters of Lake Powell in Glen Canyon National Recreation Area. The 58-mile stretch of river, upstream from Lake Powell, from Mexican Hat, Utah to Clay Hills Crossing, Utah, has been chosen for this study. This reach is a desert river in its entirety.

In spite of the Navajo Dam upstream, there is still seasonal variation in the river's flow. Spring runoff, especially from the Animas and Mancos rivers, increases the river's flows substantially during May and June. Thunderstorms throughout the summer months of July and August periodically flood Chinle Wash, near the town of Mexican Hat, as well as many of the other numerous side canyon tributaries along the river canyon's length. Some of these within the study area are Johns Canyon, Slickhorn Gulch, Grand Gulch and Oljeto Creek. Although the average gradient of the San Juan is only 7 feet per mile, these tributary canyons generally have much steeper gradients; for example, Slickhorn Gulch has a gradient of 200 feet per mile. (Rennicke 1985) These side canyons receive most of their runoff water from the rainy season in spring, and the torrential thundershowers during the summer months.

These creeks drain large areas and contribute much water to the San Juan River.

River flows, measured as cubic-feet-per-second (cfs) show an incredible variation in the San Juan (Fig. #2). Measurements on this river have ranged from 40 cfs to 24,800 cfs at Mexican Hat during a single season, before the Navajo Dam. (Rennicke 1985, Aitchison 1983.) Since the Navajo Dam was built, typical flows on the San Juan vary from lows of about 200 cfs to highs of well below 10,000 cfs.

### Area Geology

The Colorado Plateau of the four corners area is an example of "*mass denudation of a landscape dominated by essentially flat-lying strata*" (Baars and Molenaar 1971) The canyons have been created by the erosional powers of the Green, Colorado and San Juan Rivers, which have cut deep channels into the sedimentary layers.

The variety of shapes and sizes of the features of the area (Monument Valley, Goblin Valley, arches and windows in Arches and Canyonlands National Parks) has been determined by two major factors. These are the relative hardness of the rock strata, or rather, its resistance to erosive forces, such as running water, and the precise location of the existing structural features underlying the area, such as joints, faults and folds. The shapes of slopes is determined by the type of rock in the strata, while major features such as pinnacles and buttes

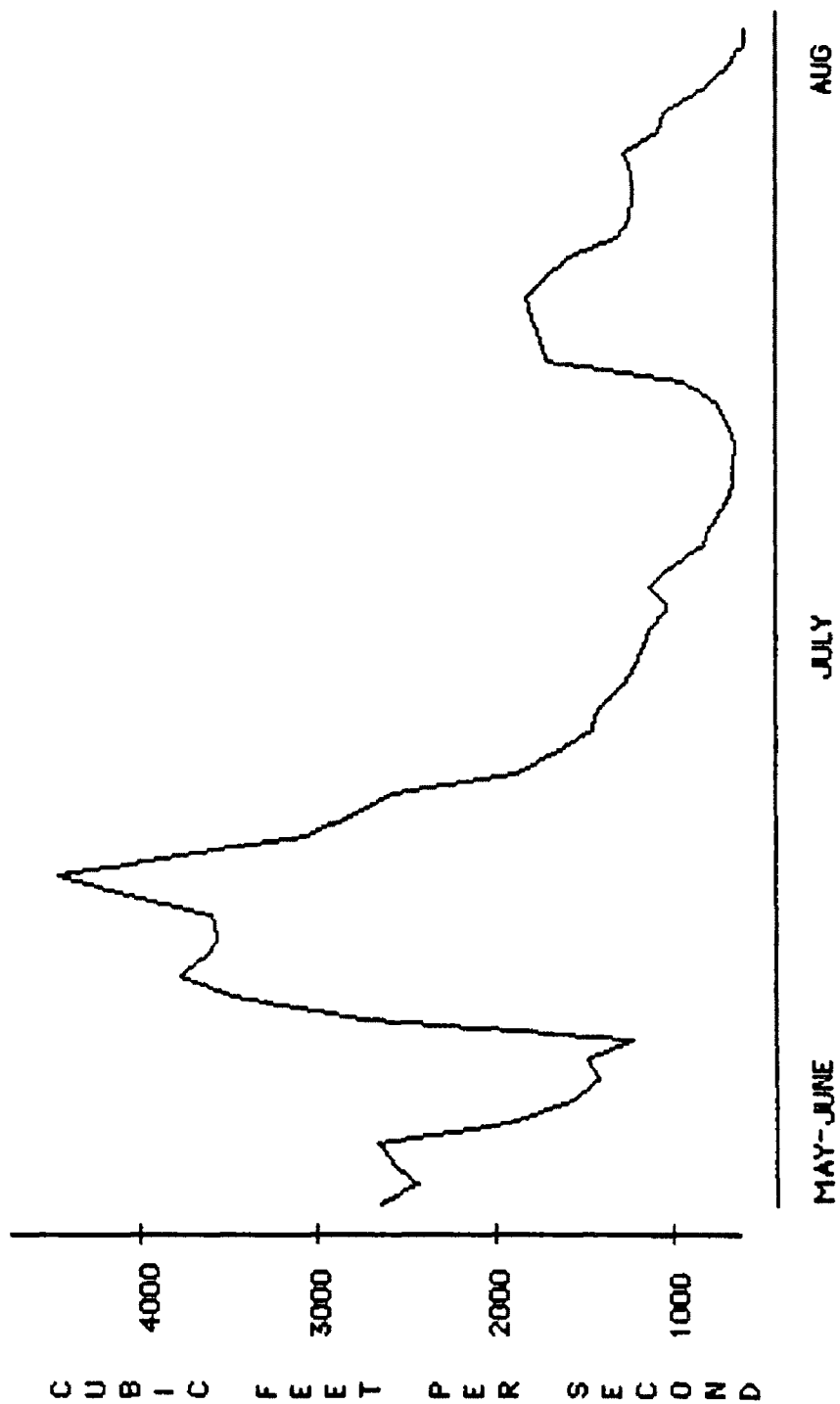


Fig. 2. Flow in cubic feet per second  
 May - August, 1990  
 San Juan River, Utah  
 (Data courtesy of U.S. Weather Service)

are controlled by the pattern of the basic structure of joints. (Baars and Molenaar 1971)

The canyons of the San Juan River are carved across the Monument upwarp, which is defined as "*that region of geological uplift that is surrounded by exposures of the Navajo Sandstone of Jurassic age*". (Four Corners Geological Society 1973). The canyons have cut down into the heart of the Monument upwarp, exposing the Hermosa Group of Pennsylvanian age. This group is characterized by limestones, and is interspersed with layers and slopes of shales and sandstones. (Four Corners Geological Society 1973).

The canyons of the San Juan River are composed of sedimentary rock, exposed to view over time. Originally, these sediments were deposited into a shallow sea some 290-310 million years ago. (Baars and Stevenson 1986) The strata consist of interbedded sandstone, limestone and shale, deposited alternately through time, into this then-marine environment. Sandstone is composed of sand grains of quartz that have been cemented into hard rock with some mineral. In this area, calcite is the most common, however, iron oxide and silica appear as well. The sandstones along the San Juan River run from shades of light tan and gray to white, with coloration of reds and browns, caused from impurities in the rock. A phenomenon known as "desert varnish" causes colored streaks to run over the rocks in shades of black and red. These are caused by the oxidation of manganese and iron in the rock. (Baars and Stevenson 1986)

Limestone particles are composed of lime or calcite. These particles are almost entirely made up of organisms that lived in this shallow marine environment. The shells may be broken down into particles the size of mud or sand grains, then the accumulations are cemented together into hardened rock. Thus, since limestones are made up of fossil material, there are many fossils in these layers.

Shales are the accumulation and cementation of clay, or very fine quartz-muds. Formed in marine waters, these muds settle into a moist environment, then are squeezed into rock by compaction or force of other sediments piled on top. Shales are usually soft rock, and erode easily, thus they are called "slope formers", and form slopes between the limestones and sandstone cliffs. Because they are formed in extremely wet environments, many shales also contain fossils. As the rock around them erodes away, many of these fossils are exposed at the surface, making this area of great interest to geologists.

### Climate

The San Juan country is an arid high desert country of extreme temperatures, hot in summer and cold in winter. Elevations vary throughout the area, averaging about 6000-7000' on Cedar Mesa above the river to the north, 5000' on the plateau, and about 3500-4000' along the river. The landscape appears dry and inhospitable. Receiving only about 6 inches of rainfall per year along the river, summer maximum temperatures remain around and rise well above the 100 degrees

Farenheit mark. Daily temperatures vary widely. Maximum and minimum daily temperatures in the summer range from over 110 degrees Farenheit to less than 60 degrees Farenheit. Winter temperatures can be as extreme, dropping to -20 degrees Farenheit, when it is dry and cold. (Aitchison 1983)

Precipitation occurs mostly during spring, throughout the months of April and May. However, during July and August, desert thunderstorms create gigantic and sometimes devastating flash floods in the canyons, alternating with periods of drought throughout the rest of the year. Within this desert environment, the river is the main key to survival for the species of flora and fauna found in the canyon country.

### Flora and Fauna

There are four main habitats in the San Juan River area, the river community, including the river itself, the riparian community, the river terrace or talus community, and finally, the cliff environment. Only the river community, riparian community and terrace communities will be touched upon here, due to the nature of this study, which concerns only these areas.

In the silty waters of the river community, about 17 species of fish are believed to exist currently, but only 6 of these are considered native, (Aitchison 1983). The native fish are disappearing due to man's interference with the natural system, through damming, diversion, and pollution of the river's waters. Common ducks and other waterfowl are



sometimes seen on the river, and beaver are the most common mammal seen in the river and along the riparian zone.

Along the riparian zone grows a lush growth of vegetation, discordant to the heat-baked communities further back from the water. Typically, this community is composed of native willow and the exotic shrub, tamarisk. Although originally from the Mediterranean area, tamarisk is an incredibly prolific shrub, and has succeeded in virtually taking over river beaches in the canyons of the Southwest. Canyons above the study area are wider, and there are wooded areas of Fremont cottonwood, box elder and the naturalized exotic Russian olive. However, canyons of the study area support very few box elders, virtually no Russian olives, and cottonwoods are seen only near the creeks of the major side canyons, such as Slickhorn Gulch and Grand Gulch. The great blue heron is commonly seen in the riparian zone, and various types of amphibians such as frogs and toads are heard along the river down through the canyons.

Terraced areas along the San Juan River are extremely dry, thus there is much competition for moisture. Plants in this region must rely on rainfall alone, and have adapted to these harsh conditions. Common shrubs found in this community in the study area are Indian ricegrass, four-wing saltbush, Ephedra (Mormon tea), buffaloberry, sagebrush, rabbitbrush, scrub oak and yucca. Some cacti are found in the lower canyon area as well. In these areas, various types of reptiles are at home; for example, desert snakes and a variety of lizards.

The level of Lake Powell has dropped over 50 feet during the past few years, leaving dry silt-beds along the river banks in the lower canyons. These silt banks have now filled in with tamarisk and russian thistle, or tumbleweed, both exotic species that have been introduced to the area, thus creating an unnatural variation on the riparian community.

### San Juan River Area History

The first "scientific" expedition was the fourth party to run the river, the 1921 Trimble Expedition. A geologist, Hugh D. Miser, was on the trip, and the group spent months exploring, surveying and studying the canyon. The geological survey report by Miser, published in 1924, includes information on the geology and climate of the San Juan River canyons, and is still considered mostly accurate today. (Four Corners Geological Society 1973)

Allegedly the first person to traverse the canyon, E.L. Goodridge was an oil prospector and made the run in the spring of 1882, losing one boat to the river. (Four Corners Geological Society 1973) Another historic version reports that Goodridge made the run earlier, in the year 1879-80, and that Bert Loper of Grand Canyon fame made the trip and explored the San Juan during the years of 1893-94. (Four Corners Geological Society 1973). Additionally, Goodridge drilled the oil well at Slickhorn Gulch, which was abandoned some years prior to 1921. However, further attempts were made to obtain oil from the Slickhorn area during the 1940's and 50's. (Swed 1990). The old road cribbing,

parts of the oil wells and some of the equipment remain visible today, in and around the Slickhorn campsites.

The second run through the San Juan canyons was by Walter E. Mendenhall in 1894, in search of gold. Mendenhall allegedly made the run in a hand-made boat the first trip, then ran the canyon again in 1895 with six other people. Mendenhall lived in the canyon while prospecting for gold, and the remains of his cabin and storehouse are still in existence today, a popular site to visit while on the river. Another historic report states that Mendenhall made three trips, not two, during the years of 1894-95. (Four Corners Geological Society 1973)

Gold prospecting began in the San Juan canyons in about 1892. At this time, wild tales of gold spread about, bringing around 1200 men into the canyon. They left empty-handed, but attempts at prospecting continued until about 1915.

The Honaker Trail was built about 1904, for the purpose of bringing supplies down into the canyon to the gold prospectors. However, the first packhorse to attempt the descent fell off a cliff and died, thus proving the precipitous trail too difficult for pack animals. The Honaker Trail was then abandoned, except as a hiking trail, and is still usable to hikers today.

March 1934, began the era of running the San Juan river for recreation, when Norman and Doris Nevills, and Jack and Nana Frost ran the river from Mexican Hat to Copper Canyon. The Nevills and Frosts then began commercial river-running in the late 1930's, and continued

through the 1950's. (Baars and Molenaar 1971, Four Corners Geological Society 1973) They carried tourists and geologists alike through the canyons. This was the introduction to the now-popular activity of river-running for fun on the San Juan.

The number of users on the Mexican Hat to Clay Hills stretch has increased substantially over the past few years. The number of users on this stretch in 1983 was 1326, and had increased to 2139 users in 1989.

The main attractions of the San Juan area are the high desert scenery and deep sandstone canyons. The river does include a few small rapids that require some basic boating skills, especially during the spring runoff or "highwater" season, which is during the months of April, May and early June.

#### Present-day Use

This 58-mile reach of river is administered by three government agencies. Along the north bank for the first 18.5 miles below Mexican Hat, Utah, the land is administered by the Department of the Interior, Bureau of Land Management, out of Monticello, Utah. The entire length of the river on the south side is owned by the Navajo Tribe. The remaining land of 38.5 miles on the north bank is administered by the Department of the Interior, National Park Service, Glen Canyon National Recreation Area, headquartered in Page, Arizona.

The Bureau of Land Management in Monticello, Utah administers this stretch of the San Juan River. Currently, there is a permit system in

existence for floating the canyon. Permits are issued through advance reservation only.

The summer season is May 1 through September 30, and there are four ways to obtain a launch reservation:

- 1) through a pre-season drawing
- 2) through a post-drawing telephone reservation
- 3) through the waiting list
- 4) through a cancellation

The current established limits to users are as follows. The number of people launching per day may total up to 50, or the number of trips launching per day may be up to 5. When either limit has been reached (whichever one is first), no more permits or users are allowed for any given day, except in the case of cancellations. When cancellations occur, permits may be given to users on the waiting list.

There is a user fee established for multi-day users on the San Juan. For the reach from Mexican Hat to Clay Hills Crossing, a fee of \$5.25 is assessed per person, which is paid to the Bureau of Land Management upon receipt of a river use permit.

There are specific requirements for multi-day users on the San Juan River. In addition to the Utah state regulations requiring spare oars or paddles, first aid kits and personal floatation devices, all solid human body waste must now be carried out of the canyon, as there are no portable or pit toilets along the river. The exception to this rule is for unsupported kayak groups of less than 5 boats.

This is an extremely isolated area, and there is no vehicular access along this stretch of river. The put-in is at the Bureau of Land Management ramp above the town of Mexican Hat, Utah, and the take-out is at Clay Hills Crossing, Utah, 58 miles downstream. Once in the canyon, the only way in or out is by primitive trail through a few sidecanyons. Honaker Trail, Grand Gulch, and Slickhorn Canyons are the major ways into the canyon, and these accesses are achieved only by a distant, 4-wheel drive road across Cedar Mesa, then a steep climb by foot down into the canyon; or as in the case of Grand Gulch, about a 50-mile hike from the road to the river.

## CHAPTER III

### METHODS

#### Process Selected for the Study

The purpose of this study was twofold. The first objective was to establish a baseline of informational data for the river corridor and second, to develop a system for monitoring the condition of campsites in the future. Quantitative data was desired, in order to view the river corridor in a thorough statistical manner. However, in the interest of cost-effectiveness, the creation of a practical monitoring system necessitated an average of 30 minutes or less per site. Additionally, descriptive information on the river corridor and its campsites was a desirable quality, for viewing by off-site managers. This, in conjunction with the quantitative information required and the desired data collection time, put some constraints on the process, and there are trade-offs in the attempt to achieve both ends. Thus, a rapid estimation process with some quantitative counts was deemed a desirable system for the study.

A search was conducted for a process usable for this study, both in terms of the above requirements of a rapid estimation procedure and in terms of acquiring the amount and type of information desired. The Wilderness Campsite Monitoring Methods: A Sourcebook (Cole, 1989) is

the most up-to-date handbook of campsite monitoring systems, and was examined for a process usable for this study. However, most of the described processes are area-specific, and cater to other types of environments, and a process with all the desired characteristics was unavailable.

Four river managers were contacted and questioned as to the types of monitoring systems in place in their areas. Two situations occurred: either there was no monitoring system in place at the present time, or the existing system was created for a specific area, and was inapplicable to this area. Thus, the following procedure was developed for the San Juan River and its particular desert-environment characteristics.

#### Impact Factors and Variables Selected

Ideally, a system will provide two things: quantitative and descriptive information to managers not on-site, and quick examination of sites while in the field. The field process in this study included both categorical questions to be answered yes or no, and numerical counts. In the final analysis, this provided a mixture of both frequencies and contingency tables, which allowed for an overview of descriptive information on riverside conditions and existing campsite impact conditions. Some counted variables were selected in the interest of accuracy and statistical analyses, and some estimates were made, based



on the desire to acquire as much information as possible while spending little time per site.

In an attempt to present a complete descriptive view of the river corridor off-site, factors were selected in two areas: impacts and descriptive site information.

### IMPACTS

Impacts have been divided into two types; biophysical and aesthetic. Biophysical impacts within campsites have been further subdivided into vegetation variables and erosion/trails variables. Although there is little vegetation along the San Juan, the National Park Service is curious to see if users are damaging the existing flora. Floaters and backpackers are not required to carry stoves, therefore there is the possibility of tree damage due to firewood demand. Consequently, vegetation damage and trail observations were made and documented in two ways; in counts and in assignment to categories.

### Biophysical

#### Vegetation

Vegetation impact was recorded in a number of different ways. Two variables were the presence or absence of:

- 1) vegetation damage at landing
- 2) trampled vegetation on-site.

Other types of vegetation impact consisted of numerical counts. Counts were made of the following:

- 1) the number of tree stumps or dead trees
- 2) the number of trees with scars or broken limbs
- 3) the number of trees with exposed roots.

Finally, estimates of vegetation cover on-site and at a comparable undamaged site were used to assess:

- 1) the current amount of on-site vegetation, which was recorded to the closest 5%
- 2) the amount of vegetation lost as a result of recreational use

This latter parameter was obtained by subtracting on-site cover from the cover on the undisturbed sites.

Estimates are subject to inter-observer variation. This reduces the precision of these estimates. We tested the precision of cover estimates by having two observers estimate cover independently on 10 sites. On 9 of the 10 sites, estimates were within 5-10% of each other, suggesting a moderately high level of precision.

Additionally, frequencies were calculated on the categorical variables, and some summary statistics were calculated for the numerical factors, including the mean, median and range.

### Trails

Trail damages were also observed and recorded in different ways. Two variables were the presence or absence of:

- 1) landing erosion

2) compaction present in the campsite core.

No measurements of compaction were taken. The estimate was easy to judge, as campsites were soft or hardpacked sand. Any compaction was obvious to the observer.

Other types of trail damages consisted of numerical counts. Counts were made of the following:

- 1) the number of trails from landing to site
- 2) the number of trails within camp
- 3) the number of trails to features of interest nearby.

### Aesthetic

Aesthetic factors are those variables that, while perhaps not physically damaging to the resource, are visually displeasing, and detract from the aesthetic quality of a campsite. When calculated and developed into the aesthetic index, this information will provide managers a view of impermanent impacts that may be rectified by management or user actions.

This information pinpoints specific sites that are prone to aesthetic problems, such as excessive fire remains and litter. At this point, information on site use may be brought into play to determine possible causes. For example, if the majority of fire remains are only at sites accessible to backpackers, management actions might be concentrated towards those users. These variables were recorded in various ways. Four variables were the presence or absence of:

- 1) charcoal and ashes on-site
- 2) soap or grey water
- 3) camp pests
- 4) ants and/or flies

Aesthetic factors included fire remains and fecal matter. Counts were made of the following:

- 1) the number of campfire pits
- 2) the number of campfire rock rings
- 3) the number of rocks charred or scarred per site.
- 4) piles of human feces
- 5) piles of toilet paper.

Although human waste is not necessarily biophysically damaging, its presence at a campsite is distasteful. Also, although litter might seem only aesthetically objectional, fecal matter presents potential health dangers through fecal bacteria. (Temple, Camper & Lucas, 1982)

The aesthetic index ends with a count of:

- 1) the number of pieces of litter (foil, cans, paper, etc.) per site.

#### DESCRIPTIVE SITE INFORMATION

Although not an indicator of damage, information factors were selected for two reasons. First, these provide the off-site manager descriptive information on the river corridor itself. Second, these information variables may be cross-tabulated with impact variables to

determine if there is any obvious correlation, trend or pattern to the impacts along the river.

As with the aesthetic and biophysical factors, the descriptive variables were both categorical and numerical, and were subdivided into categories. The more general information was gathered by categories for ease in the field, while counts that varied largely from site to site were individually tabulated. Descriptive site information was divided into two categories: general area information and specific site information. Site numbers were given, and river miles were calculated from the river map, for relocation purposes.

#### Area Information

General area information included:

- 1) site number
- 2) rivermile
- 3) bankside (right or left).

#### River Information

Information was gathered on river conditions at each site. For example, river information placed into categories was:

1) river conditions (rapids, flatwater, eddy, riffles). This will aid in both future relocation and changes in river topography, helping managers keep up-to-date on their resource.

Estimates were made on:

2) current flow in cfs. Official flows were obtained and documented at the start of each trip, in order to estimate flows at each

site. This information is important in the interest of future monitoring. Some campsites may be flooded and thus "cleansed" at periodic intervals, or may be underwater at some levels and unusable, and thus subject to less use and less impact.

#### Site Landing Information

In order to map more accurately, relocate sites easier, and view changes over time, information was gathered at each site's landing area. Accessibility from the river was placed into categories of:

- 1) easy, moderately easy, difficult and very difficult.

Measurements were taken of:

- 1) landing length
- 2) distance from landing to site core

Estimates were made of:

- 1) vertical climb to site and
- 2) slope from landing to site core

#### Riparian Zone

Although the National Park Service desired information on the types of vegetation along the river corridor, specific studies were beyond the range of this project. Additionally, there is little diversity in the riparian vegetation along this stretch of river, and there are approximately three to four species that dominate in the river corridor. Therefore, a basic list of the principal species in the riparian zone was compiled at each site.

#### Campsite Information

Unlike the riparian vegetation, which is similar throughout the river corridor, on-site vegetation varied between sites, so a list of these dominant species was also compiled.

Additionally, other site-specific information was gathered. Site use was gathered into categories of

- 1) floaters only or floaters and backpackers

Site composition was placed into categories by type:

- 1) beach, rock ledge, or terrace (sand or soil bank)

Site size was documented by category, and an estimate of site capacity was also taken. Size categories were:

- 1) small, medium, large, and extra-large sites

Site size was defined by the number of two-man tent spaces available. For example, a site might accomodate 5 tents, and would be placed into the "large" size category, which ranges from 5 to 9 tents. This provides an idea as to the physical size of the site, but as this size site can accomodate anywhere from 1 to 18 people, it does not give a clear idea of actual capacity. Thus, the estimate of capacity was added to provide more accurate information and consisted of a numerical count.

A count was also entered for:

- 1) number of satellite bedrooms in a site, if any.

This was to offer further information as to the "spread" of sites with regards to trails and to help map the site.

A measurement was taken on

- 1) the areal size of the site core, if any.

This was taken with a tape measure. The site core was sometimes difficult to establish. River parties use different areas for their activities and there is no established center site with picnic tables and firegrates. Additionally, the choice of the central area sometimes changes with the water level. For example, in low-water levels, beaches are exposed and used for kitchen activities, while the area higher up on the terrace might or might not be used for sleeping purposes. At high water levels, some beaches will be underwater so the terrace will be used for kitchen activities and sleeping. However, there are sites with obvious "core" areas, some with logs for benches and perhaps with leftover charcoal and/or ashes from firepans. These areas may also be used for other purposes, but the ones selected to be counted were obvious centers of concentrated use. Defined by rock or vegetation boundaries, these areas generally exhibited the widest and most obvious trails from the landing site, and were among the ones with soil compaction present. Additionally, the core sites tended to be the areas one gravitated to first upon leaving the boat in search of a "kitchen" spot. The majority of these were permanent areas up on the terrace, were selected as "core" areas, and were marked on the site map. However, conditions are ever-changing along the river, and users have different preferences as to the placement of their central gathering areas. Additionally, this is subject to change on beach sites, which makes precision more difficult. At the sites where there was any doubt as to



the core area, this part was left blank, and the site was considered to be without a central core site.

### Campsite Condition Index

Two campsite condition indices were developed from the information collected. One was for biophysical impacts, and the other for aesthetic impacts. These were then added together to obtain an overall rating. This index rating does not indicate deterioration over time, but only the present variation among sites. It offers a baseline, and if monitored steadily and consistently over time, will provide a measure of change throughout the years.

In the formulation of these indices, all categorical and numerical impact variables played a part. A rating scale was developed and weights were applied to each answer in order to create both the biophysical and aesthetic indices, which may be viewed individually or together as the overall index.

The decrease in vegetative cover percentage was developed separately and was not calculated into either index. Some of the older campsites that were discarded from the original list showed indications of revegetation. The estimates of this variable will provide information on the degradation and recovery rates of vegetative cover. This should be monitored and calculated separately over time.

Biophysical impacts are more of a concern to the National Park Service than aesthetic impacts, due to their permanency and ecological

considerations, so more weight was applied to the vegetation and trails variables than the aesthetic variables.

For example, in this study, there were 20 total variables in the beginning. There were 10 Aesthetic and 10 Biophysical variables. Within these categories, there were 6 numerical and 4 categorical in each. The following are the categories selected for the San Juan River study:

	<u>AESTHETIC</u>	<u>BIOPHYSICAL</u>
<u>NUMERICAL</u>	1) litter 2) fire pits 3) fire rings 4) rocks scarred 5) fecal matter piles 6) toilet paper	1) trees dead 2) trees scarred 3) exposed roots 4) trails/landing 5) trails/camp 6) trails/features
<u>CATEGORICAL</u>	1) ants, flies 2) charcoal, ashes 3) soap, gray water 4) camp pests	1) landing erosion 2) riparian vegetation 3) compaction 4) vegetation

There is subjectivity in the creation of any scale, when numbers and weights are applied to non-quantifiable objects and occurrences in the natural world. The following scale is no exception, however, if used consistently, will provide some idea as to changes occurring over time. The rating scale and weights applied are as follows:

#### AESTHETIC IMPACTS INDEX

<u>Categorical variables:</u>	No = 0
	Yes = 1
<u>Numerical variables:</u>	0 = 0
	1-3 = 1
	4-6 = 2
	7-9 = 3
	>10 = 4

#### BIOPHYSICAL IMPACTS INDEX

<u>Categorical variables:</u>	No = 0
	Yes = 2
<u>Numerical variables:</u>	0 = 0
	1-2 = 1
	3-4 = 2
	5-6 = 3
	7-8 = 4
	9-10 = 5
	> 10 = 6

To see how the results were obtained, here's an example. Let's say we have four variables:

Variable A: aesthetic (categorical)

Variable B: aesthetic (numerical)

Variable C: biophysical (categorical)

Variable D: biophysical (numerical).

Let's say that both numerical variables are a "6" (in other words, we counted 6 of whatever it was we were counting in the field), and that both categorical variables are answered with a "yes". Here's how to add them up:

Variable A = 1 (A categorical "yes" under the aesthetic scale = 1)

Variable B = 2

Variable C = 2

Variable D = 3

8

Since the weights are already added in (biophysical weighing more heavily for a "yes" than an aesthetic "yes", we now just add them together to get the final index, therefore, the index is an "8".

Applying weights, and therefore a judgement, to any aspect of the natural world is surely subjective, and obviously has its limitations. For example, this "scale" cannot be applied to another area or across the board to other studies. There is no "grand scale". However, if used consistently within this particular group of campsites, it will provide a measure of deterioration over time. Again, the numbers don't "mean"

anything, (i.e., that campsite # 14 is rated as a "7" on the index) but act simply as a comparison from year to year to see how campsite deterioration is changing in terms of these given variables with their applied values.

For this study, a numerical total for each campsite was obtained for both the biophysical and aesthetic indices. These were then added together to get the overall index rating for each campsite.

Numerical counts are more accurate and thus more important than the categorical variables. Discrete variables can be placed into ordinal classes, but have the advantage of being broken down later and viewed individually, to obtain specific information on each site. Qualitative variables are non-numerical and will not provide as accurate a measure as the quantitative counts.

The overall index ratings ranged from 0 to 30, and were then re-coded into five categories to determine the condition of campsites. These categories are as follows:

- A) 0 impact rating, no damages
- B) 1-10 impact rating, least damaged
- C) 11-20 impact rating, moderately damaged
- D) 21-30 impact rating, more severely damaged
- E) > 30 impact rating, most severely damaged

This may also be calculated for the separate indices, biophysical and aesthetic, however, it must be taken into account that the spreads will vary between the indices. When calculating an individual index, the

spread must be divided into five categories individually for each index. In the calculation of the overall index, however, the impact numbers must be added together first, then placed into the five categories.

### Campsite Selection and Inventory

One of the objectives of this study was to establish a baseline of information on the condition of campsites on the lower San Juan. All campsites were selected for examination.

There is no BLM or Park Service campsite inventory. Baars and Stephenson marked 26 campsites (25 medium-sized and 1 large) on their river guide. This guide was used as a starting point. A pilot trip was then run through the canyon, and all the Baars sites were examined to determine their condition, in terms of present usability. "Usability" was defined by areas that were accessible by boat and that held enough clear space to sleep and perform kitchen duties. Areas that were wildly overgrown with willows or tamarisks were not considered usable as campsites unless there were existing and/or obvious trails to the site.

After examination of the Baars sites, it was determined that 7 of these campsites should be removed from the inventory. Two sites (miles 31.5 and 44.8), were no longer in existence, possibly due to side-canyon flash floods or high river floods. One site was only possibly usable in extremely high water, (mile 48.4), and appeared as though there was a very small open area up against the cliff. This area was too far from the river to be a feasible camping site, and appeared as though it had not

been used for a very long time. Three sites were cancelled due to overgrowth of vegetation. (Miles 37.0, 49.5, and 65.9) After a thorough examination, vestiges of old trails were found, but the sites were not usable due to vegetation regeneration. The remaining site was in a side canyon, and was eliminated due to its inaccessibility by boat. Upon the drop of Lake Powell, (the level has dropped from 3700' to less than 3650') the mouth of the canyon was left with a 2' deep layer of sediment, effectively blocking access to this inner-canyon campsite. This site might possibly be accessible again, if Lake Powell ever rises above 3700'.

At this point, the inventory totaled 19 sites. Another pilot trip was run, to add sites that were 1) obvious campsites, new since the river guide, 2) "micro-camps", usable for 1 or 2 people, and 3) split sites, large sites that have been divided into two or more camps since the river guide was published. Twenty-two more sites were added for a new total inventory of forty-one (41) sites. All 41 sites were inventoried, mapped and photographed for this report.

#### Data Collection Methods

All trips on the river were run in an inflatable kayak, so all campsites were accessible and all forty-one were examined.

As previously stated, two pilot trips were run prior to data collection. On these two trips, the overall area and individual campsites

were examined for possible factors to be observed in the study. Additionally, the total inventory was completed on these trips.

Following the first trip, a preliminary field form was developed to gather information on-site. On the second trip, an assistant came along to assist in the gathering of data.

At this point, the preliminary data sheet was field-tested for convenience, some sites were mapped and photographed, and the entire process was timed. Both individuals completed data sheets on each site, to examine precision and consistency of answers. Then they were compared and discussed on-site, to discover and correct any complications. This was done to determine where the discrepancies were, either in the observations themselves, or in the data sheets. In some cases, questions on the field form were unclear and produced inconsistent ratings.

On this second trip, vegetative cover percentages were also estimated and compared for precision. It was determined that even with two people estimating percentages, results were close, within approximately 10-15%.

Upon return from the second pilot trip, the data sheet was reviewed and changes were made. Some variables were eliminated and some re-worded for clarification and better comprehension. The entire field form was then rearranged for ease of information collection on-site.



At this point, data collection began. Three trips were scheduled, of six-day length each. All data-collection trips consisted of a party of two, myself and an assistant. Twenty-four sites were examined during the first collection trip.

Site examination consisted of the following: Upon landing, the entire site would be covered on foot, before committing anything to paper. It was necessary to get an idea of the layout of the site, its size and spread, and the type of terrain and vegetation on-site. At this point, one person would obtain graph paper and begin the map drawing. The other individual completed the datasheet. The drawing of the site map was the more time-consuming of the two, thus the individual completing the datasheet would then photograph the site. The rate of four to five sites per day was comfortable for two kayakers. This is attributed partly to the size of the party (two people) and to the lack of many detailed camp chores and duties. The final seventeen sites were examined on the second six-day trip. At this time, the summer thunderstorms were in full swing, and the river's flow increased considerably. As a result, the trip moved speedily along, and the collection of data was completed on this second run.

### Photographs

A 35mm camera was used to photodocument the main aspects of each campsite. Each shot taken at a campsite was marked on the

datasheet for that site. Photos taken were marked on the site map with a triangular-shaped arrow, indicating the direction of the shot.

Photographing each site was difficult and produced some problems. The National Park Service did not want any permanent photopoints established. Due to the fluctuating nature of the river, this would be infeasible as well. As a result, the landing sites were photographed, to view the sizes and types of vegetation. Core sites, if any, were photographed, and major satellite bedroom sites as well as indications of major damage to vegetation were photographed. Areas with severe erosion were photographed and documented as well.

A 50mm lens was used for close-ups of small areas, such as the smaller satellite sites and core areas. In most sites, additional photos were shot with a wide-angle 28mm lens, to incorporate large areas.

Where possible, a cliff above the campsite was climbed so an overall view of the site and trails could be obtained from above. At these locations, a wide-angle lens was used.

Upon return from the final data collection trip, the National Park Service provided an overflight of the San Juan corridor to obtain aerial photographs, and in September, a solo four-day trip was run to reshoot some photographs.

### Maps

Maps were sketched on graph paper in the field, and campsites were measured or paced off. Each graph paper drawing was marked with

the river mile, bankside and date. Each 1/4 inch square on the graph paper equals approximately ten feet on a side. Some extra large sites required use of a different scale and are so noted on the map. Features marked on each map are the river, its direction of flow and the direction north. Features differ from site to site, but those generally drawn in were clumps of vegetation, trails, and satellite bedroom sites. Basic site composition, such as beach, rock ledge or terraces was marked as well.

## CHAPTER IV

### RESULTS

Although data was collected on twenty variables, and all data was used to calculate tables and plot graphs, some variables will be eliminated from the results and discussion phase, or will be touched upon only briefly. Generally, these results presented numbers small enough to be considered non-repeatable. These were the following:

- Landing erosion
- Vegetation damage at landing
- Compaction present in site core
- Presence of ants, flies
- Presence of camp pests
- Presence of soap, gray water
- Numbers of tree stumps/dead trees
- Piles of human feces
- Amounts of toilet paper

Although all information was gathered for the original study, it is advisable that on future monitoring trips, only the following variables be selected for data gathering:

- 1) Vegetation trampling
- 2) Presence of charcoal, ashes

- 3) Litter
- 4) Fire remains (# of campfire pits, rings and rocks scarred combined into one numerical variable)
- 5) Tree damages (# of trees scarred and trees with exposed roots combined into one numerical variable)
- 6) Social trails (# of trails from landing, within camp and to features combined into one numerical variable)

This will be a total of six variables, two aesthetic and four biophysical, three categorical and three numerical, which should greatly simplify the data gathering process on future monitoring trips, and reduce the time consumed by paperwork off-river.

### Use

There is presently no way to determine the amount of use at each campsite, however, the Bureau of Land Management has kept daily visitor use records on the river based on the number of permits issued. Although there is a ranger to check permits during most days at the launch ramp, there is an alternate launch point at the Mexican Hat Bridge, and thus most likely not a 100% compliance in the launch check rate. Additionally, this stretch is seldom patrolled, and there is a possibility that use is actually higher than permit records indicate.

Visitor use peaks during the spring months of May and June. During this time, the water's flow reaches its yearly high, and temperatures in the area are hot, but do not reach the extremes recorded in the months of July and August. The summer of 1990 was no exception. The total

number of users in May was 468, with 469 total users in June. (Fig. #3) These figures include all use; commercial, private and educational. As of August 31, the total number of users for the year was 1,645. Use on this stretch of the San Juan has declined since 1988, at which time totals reached their highest since 1983, with 2,664 river visitors.

### Campsite Distribution

There were forty-one campsites inventoried and examined during this study. The stretch of river observed was approximately 57 miles in length.

To view the campsite distribution, the river corridor was divided into six 9.5-mile stretches and four 14.25-mile stretches. These were selected because trips through this canyon run from four to six days in length.

There are relatively few campsites in the lower canyon. For example, over 90% of the total number of campsites are in the first three 14.25-mile increments. Since there are only four campsites in the last 15 miles, there is competition between groups for a campsite prior to the take-out day. This suggests that the campsites contained within the section prior to the last day might sustain greater overall impacts than the other sections of river. This will be examined further under the section on Impact results.

Numerous observations were taken at each site, to obtain an overall view of the river corridor. The following sections will briefly discuss the findings of these examinations. An overall "site profile" will

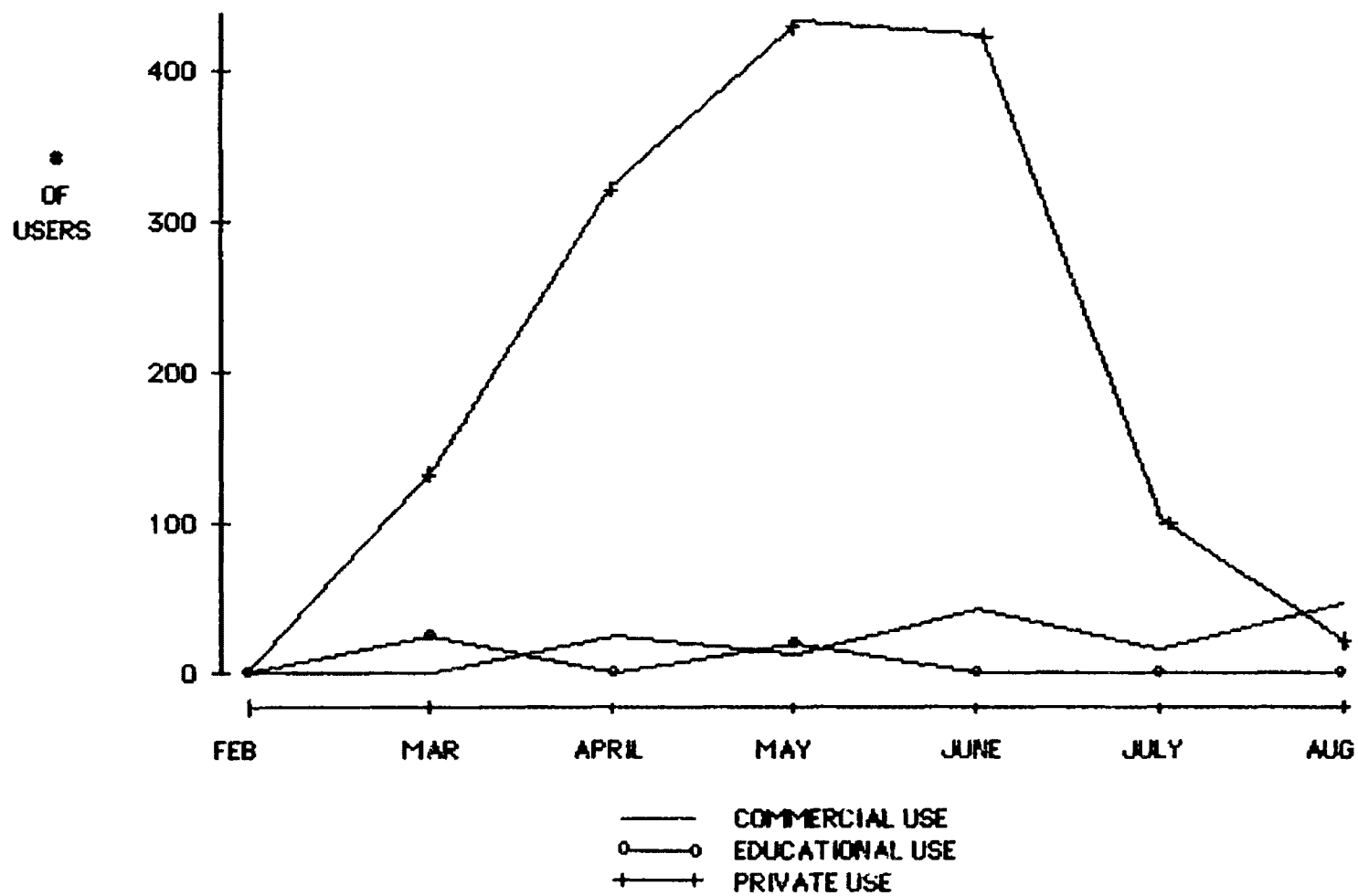


Fig. 3. San Juan River visitor use from Mexican Hat to Clay Hills Crossing, Summer, 1990.  
(Data courtesy of Bureau of Land Management)

then be presented, which will provide a view of an "average" riverside campsite along the San Juan River.

### Accessibility

Camps were divided up into four categories of accessibility by raft from the river; easy, moderately easy, more difficult and very difficult. Results indicated that 76% of the sites were easily accessible, 12% were moderately easy, 7% were more difficult, and only 5% were considered very difficult.

### River Information

The majority of campsites, 54%, were located on a flatwater stretch of water. 34% were located on a stretch of quickwater or riffles, and only 12% were situated nearby a rapid. This is not indicative of a preference for camping on a flatwater stretch, however. The San Juan has only about three to four rapids, and the majority of the trip is scenic flatwater.

### Site Use

Campsites along the corridor are accessible only by floaters and backpackers. About three quarters of the sites are accessible to floaters only, while 26% are reachable by backpackers. No backpackers were seen in the canyon on any of the trips run by this observer. Most backpacking trips in this area are done during the spring months, before the summer's heat, when there is water available .



### Site Composition

The campsites in the canyon were categorized into three types: beaches, upper terrace soil/sand sites, and rock ledges. If a site was observed during a low-water period, and there was a dry camping beach available, the upper terrace was examined for a higher-water campsite. In this situation, the upper terrace site was considered the more permanent campsite, and it was counted and examined. The sites counted as beach sites did not contain any upper bench site; they were only beach sites. Thus, some of these will disappear during extremely high flows. Only 10% were beaches, 12% were rock ledges, and the remaining 78% were upper bench or terrace sites.

### Landing Areas

The campsites had an average of a 104' landing length. The average distance from the landing to the center of the site was 66'. The average climb from the river to the campsite was almost 9 vertical feet. This was calculated on an observation of 38 of the 41 total sites and will vary with river level.

### Site Size

Sites were categorized into four sizes. Microsites were small sites for 1-2 tents; the medium size was 3-4 tents; large sites could accomodate 5-9 tents and an extra-large site would hold more than 9 tents. Overall, 51% of the sites were large, and 22% fell into the extra large category. Seventeen percent were considered micro-sites for the smallest groups, and only about 10% of the campsites were in the

category considered medium-sized. Average capacity of the camp areas was 14 people, and the campsites averaged 4 additional satellite bedrooms.

#### Proximity to other campsites and features

Eighty-five percent of the campsites do not provide a view of the next campsite from the landing area, and 81% of the campsites do not provide a view of the closest campsite from the center of the site, or the site core.

There are a number of attractions near the river. Features of interest were defined by an attraction where one might spend time in recreation activities separate from the river. For example, there are canyons that contain swimming potholes and scenic areas for day hikes. Campsites tend to concentrate near these areas. For example, 63% of the total sites had a feature of interest or attraction nearby, while only 37% offered no off-river activity.

#### Site Profile

Most campsites along the San Juan River are in a flatwater area, with easy access to the landing. The landing area has space for plenty of boats and the distance from the boats to the campsite center averages 66 feet. Most sites are on a sandy/soil bank or terrace, and will accomodate from 5 to 9 tents, and about 14 people. Most sites have extra satellite bedrooms (an average of 4) aside from the main area. Most campsites cannot be seen from other sites, are used only by river floaters, and have a feature of interest nearby.

### Impact Results

As previously stated, impacts have been divided into two categories, biophysical and aesthetic. Biophysical impacts have been further broken down into vegetation damage and trail damage.

### Biophysical Impacts

#### Vegetation

Overall, vegetation damage along the river does not seem to present a problem. In general, most vegetation damage occurs when campers chop, cut, break, or in some other way damage a tree in order to obtain firewood. The San Juan differs from other areas in two main respects. First, there is not any shortage in available firewood along the San Juan River. The river drains a large area, from the mountains to the desert, and there is a surplus of driftwood. There are numerous large piles of dried wood washed ashore in much higher-water days, and driftwood and pine cones are frequently washed in to flood the beaches during the flash floods caused by the summer thunderstorms.

Additionally, there is not much vegetation other than the tamarisk and willow, and these are not prime choices for firewood. Tamarisk is a hard wood, difficult to break or split, and most of the existing willows are too small to realistically consider as firewood.

#### Tree Damage

Less than 10% of the sites exhibited any dead trees or tree stumps. Over a third of the sites exhibited scarred trees or those with broken limbs, and almost a quarter of the camps had exposed tree roots. For future monitoring purposes, number of dead trees/stumps should be eliminated and trees scarred and those with exposed roots should be combined into one variable.

### Trampling

Forty-four percent of the sites showed on-site vegetation trampling. Over half the terrace sites showed evidence of on-site vegetation trampling. Almost half of the large and extra-large sites indicated trampling on-site as well. Additionally, of the sites exhibiting trampling, only 50% (22% of the whole) had measurable site cores, however, of these, 67% (15% of the whole) were smaller than 1000 square feet, while only 33% (7% of the whole) were larger than 1000 square feet. Sites with smaller core sites were more likely to display vegetation trampling on-site than those with larger center cores.

### On-Site Cover and Cover Loss

Campsites along the San Juan River averaged a 23% on-site vegetative cover, ranging from 5% to 75% throughout the river corridor.

Seventy-eight percent of the sites showed some cover loss (Fig. #4). Eighty-six percent of the sites with nearby features of interest showed some cover loss, while 77% of the sites that were of easy or moderately easy accessibility indicated some cover loss as well.

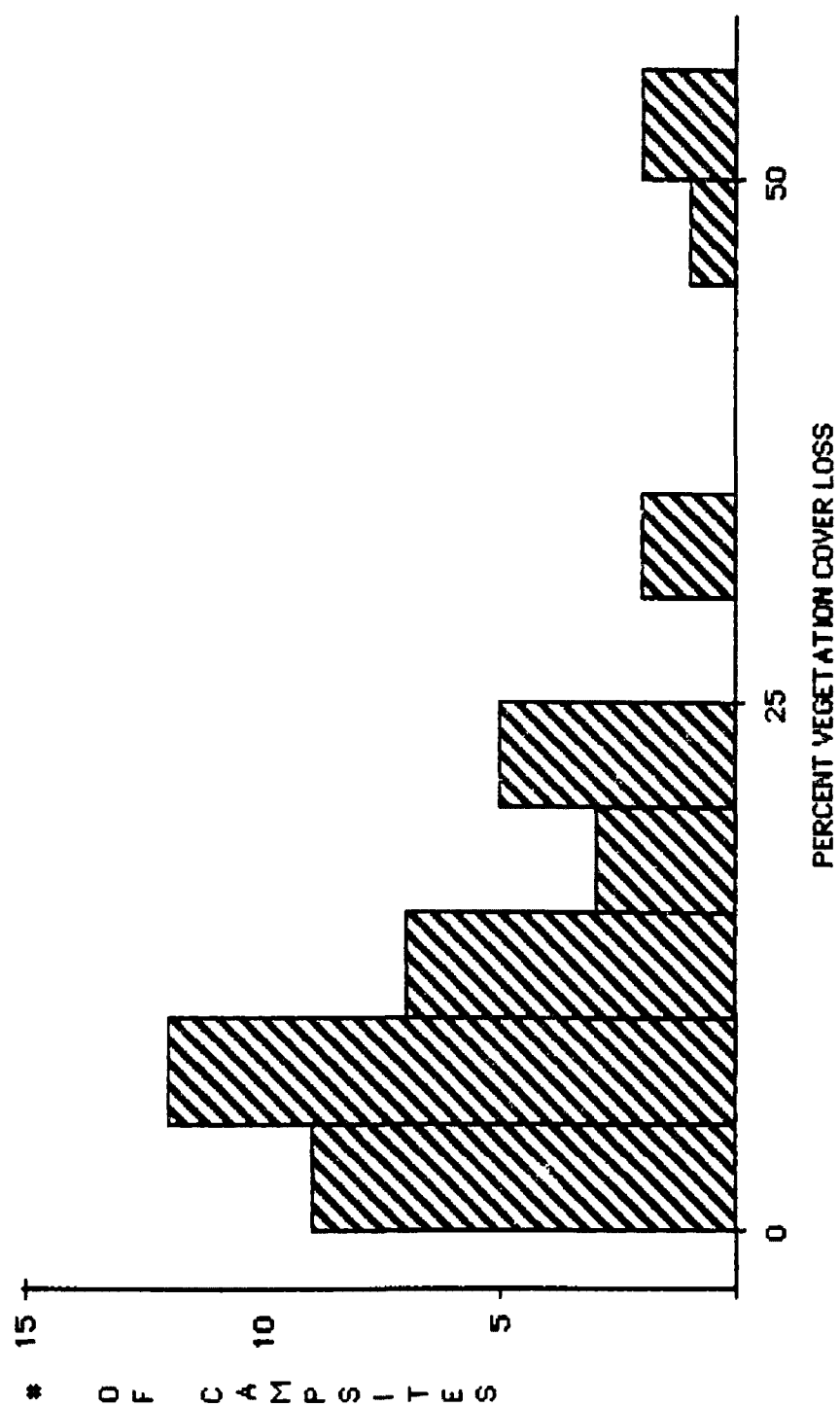


Fig. 4. Percent vegetative cover loss  
San Juan River campsites  
Summer, 1990.

Eighty-seven percent (68% of the whole) were terrace sites; and 85% (66% of the whole) were on sites of large and extra large size.

Although 78% of the campsites showed some loss of vegetative cover, 60% of those sites showing loss revealed a loss of less than 10%, and there was a small percentage of overall cover loss.

The majority of sites showing losses had nearby features of interest, which are generally the more popular campsites, are of easy accessibility, and are terrace or the more permanent campsites. Type of user (floater or backpacker) does not appear to affect the amount of vegetation damage. There is little evidence of vegetation damage on sites throughout the corridor.

#### Compaction

Campsites with any type of soil compaction are few and far between, but those that have been affected are terrace sites, large sites, and those used by both floaters and backpackers.

#### Trails

As with tree damage, it should be noted here that in the field, a campsite that contained more than ten trails of a type was marked only as >10 trails.

Sixty-three percent of the river campsites had trails from the boat landing to the campsite. Only about half of the sites had trails to features, however, 88% of the sites contained trails within the camp

itself. Ninety-four percent of the terrace sites exhibited trails from the landing area to the campsite. The number of landing trails rises slightly with the increase in vertical climb. Eighty-eight percent of the sites had at least one trail and 27% had more than 10 trails in camp. All camps used by backpackers and floaters had at least one trail within camp, while there were five campsites used by floaters only that exhibited no trails within the camp.

Ninety-six percent of the large and extra large campsites had at least one trail within the camp area, while 97% of the terrace campsites contained at least one trail within the campsite. Ninety-seven percent of the sites with features nearby exhibited trails within camp. The number of trails within camp increases with the number of satellite bedrooms in the site.

Over half of the sites (51%) displayed trails to nearby features. Eighty percent of these (41% of the whole) were on terrace sites; 86% (44% of the whole) were on large and extra large sites, and as expected, the entire 51% of these sites had nearby features of interest.

On campsite trails, as with tree damage, particular sites have coincided with the most damage displayed. The following campsites stand out: the Honaker Trail sites, two unnamed, extra-large sites, the two John's Canyon campsites, Government Rapid camp, three of the four Slickhorn Canyon campsites, and the Trimble camp in the lower canyon.

The campsites most likely to exhibit compaction and largest number of trails are large and extra large sites and terrace sites.

Additionally, the number of landing trails appears to increase with the vertical climb from the river to the campsite, and as expected, the number of trails within camp increases with the number of satellite bedrooms.

### Aesthetic Degradation

#### Fire Remains

On sites with fire remains, we recorded the presence of charcoal and ashes, the number of campfire rings and campfire pits in evidence, and the number of rocks that were charred and/or scarred due to fire damage. These counts were then compared to the site information variables to try to understand which sites had the most fire remains.

#### Charcoal and Ash Litter

Eighty-one percent of all sites had charcoal/ash litter. Eighty-three percent of the terrace campsites exhibited this characteristic, as well as 84% of the sites with features nearby. Ninety percent of the large and extra-large sites exhibited charcoal litter. Additionally, over half (58%) of the campsites that contained charcoal/ash litter will accomodate more than 10 people. While only 27% of all river campsites are accessible to backpackers, 100% of those sites exhibited charcoal and ash litter.



### Campfire Rings, Campfire Pits and Scarred/Charred Rocks

Only 39% of the campsites had campfire rings. Fifty-nine percent of the sites displayed campfire pits, and 66% of the sites exhibited some charred or fire scarred rocks.

Less than half of the large and extra-large sites had a campfire ring. The same holds true for the sites with features nearby and terrace camps, and type of use does not appear to matter.

Fifty-nine percent of the sites displayed campfire pits. Sixty-five percent of the terrace sites exhibited fire pits. Sixty-seven percent of the large and extra large sites had fire pits. Slightly over half of the sites with nearby features of interest contained some form of fire pit, and 61% of the sites used by floaters only had fire pits on-site as well.

Sixty-six percent of the campsites contained rocks that had been scarred through fire damage. Seventy-four percent of the large and extra large sites exhibited charred rocks, while 78% of the sites with nearby features of interest displayed this characteristic. Sixty percent of the campsites that are used only by river floaters contained charred rocks on-site, as well as 76% of the terrace sites.

All these figures indicate some basic points. The terrace sites are more visibly littered with fire remains, and there is very little evidence of fire remains on beaches or rock sites. Presumably, charcoal and ash are either blown or washed away from these sites; there is no evidence. The majority of sites had nearby features of interest, and again, the large and extra large sites were the most visibly degraded.

On future monitoring trips, fire remains should be combined into one numerical variable.

### Litter

In this section, litter is defined as garbage left behind, such as aluminum cans, foil, paper, etc. A full 83% of the campsites contained some form of litter or garbage, ranging from 1 to 16 pieces. (Fig. #5.) Eighty-nine percent of the sites with features of interest nearby, 91% of the terrace sites, and 93% percent of the large and extra large size sites are littered. Probably due to the high percentage of flatwater sites, more of these are littered than any other, but sites situated by rapids have the largest amount of litter.

### Feces and Toilet Paper Litter

There was little evidence of this type of degradation. Users on the San Juan are required to carry out human waste, which most likely accounts for the small numbers.

Only 12% of the riverside campsites exhibited any amount of surface-level human waste. These ranged from 0 to 6 occurrences. All were at large and extra large size sites, at sites with nearby features of interest, and at terrace sites. Only 27% of the backpacker-accessible sites exhibited any surface-level feces, while 68% of the floaters-only sites displayed surface-level human waste.

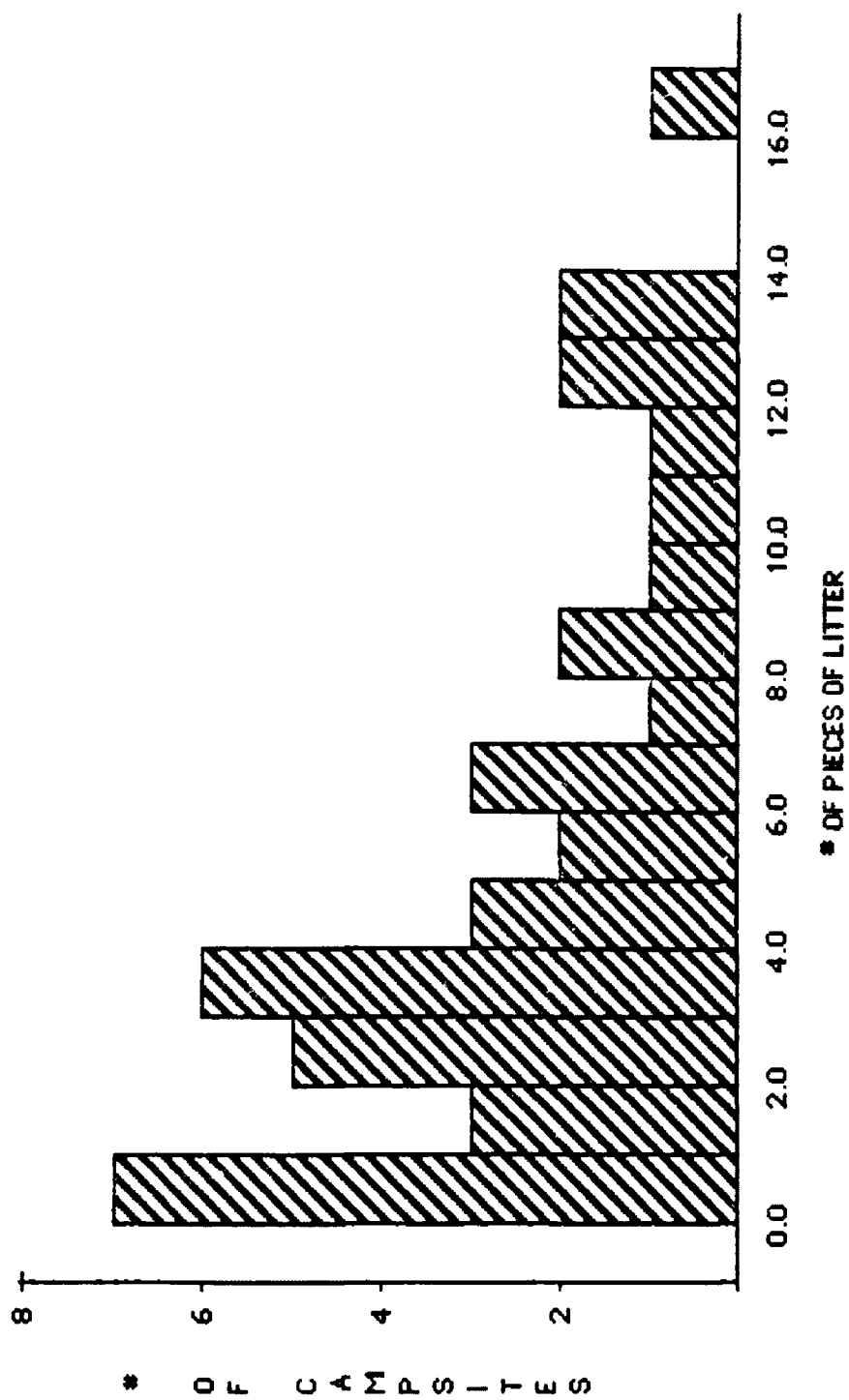


Fig. 5. Amount of litter on riverside campsites  
San Juan River, Utah.

However, almost half of the sites, 46%, contained surface toilet paper litter. Of these, there was an even distribution between sites used by floaters only and those used by both floaters and backpackers. Less than half the terrace sites and less than half the large and extra large campsites exhibited any toilet paper litter, so site size and composition were not a factor.

#### Camp Pests, Ants, Flies, Soap and Gray Water

Although not necessarily an indication of degradation, the presence of large quantities of these entities indicates that users may not be complying with the regulatory methods of removing their garbage and camp waste. Data collected on these variables revealed numbers small enough so that these might be eliminated from future monitoring trips.

The campsites on this stretch of the San Juan appear to be most affected by litter left behind by campers, but of an easily removable type, such as cans, paper and foil.

#### Campsite Condition Indices

An overall index number was obtained for each campsite. This was accomplished by assigning a weight to each numerical impact variable counting aesthetic and biophysical damages. An index was arrived at for both aesthetic and biophysical impacts, individually (Fig. #6 and Fig. #7.) These were then added together to reach the overall index number.

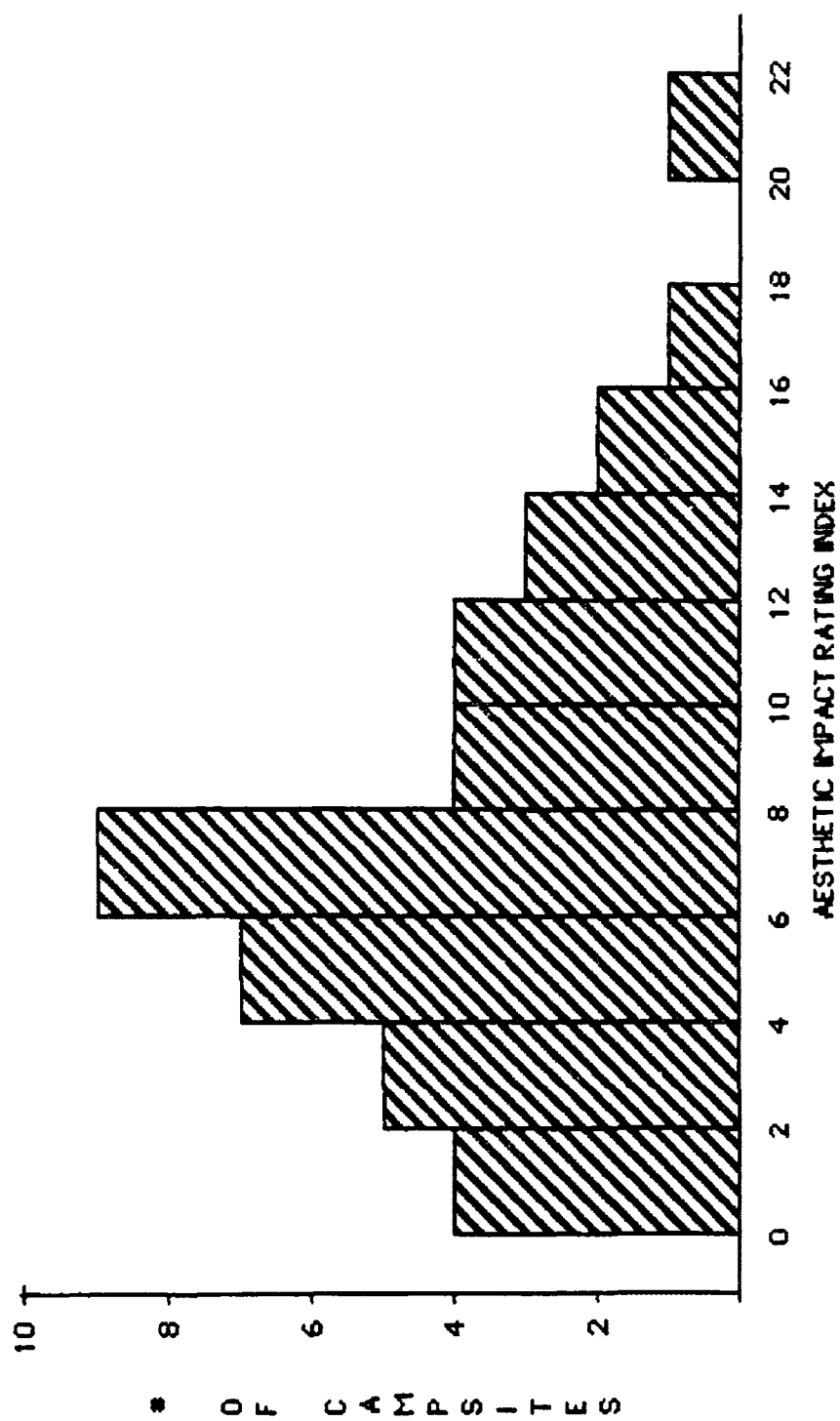


Fig. 6. Aesthetic impacts index  
San Juan River campsites  
Summer, 1990

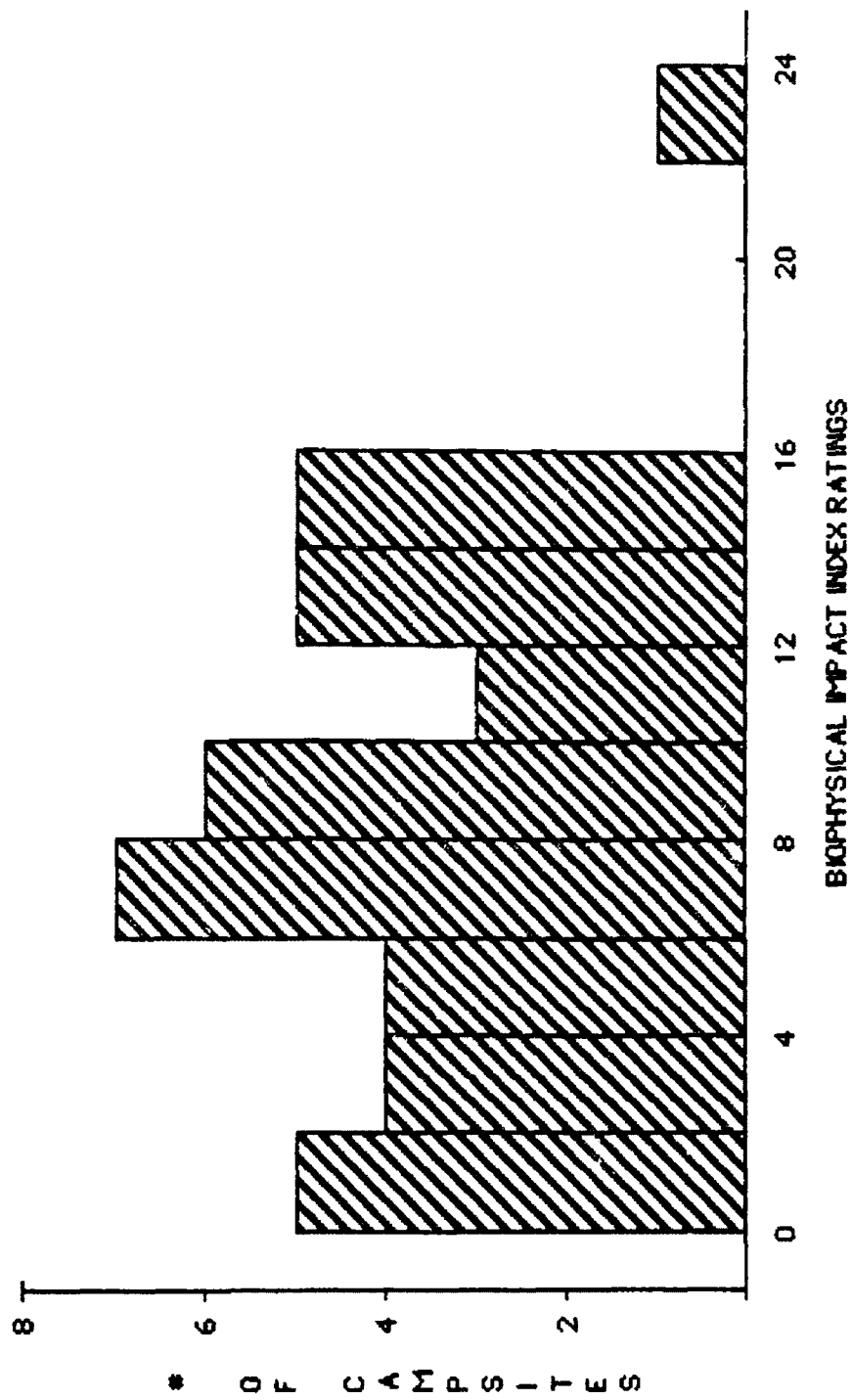


Fig. 7. Biophysical impact index  
San Juan River campsites, summer, 1990.

The overall impact index spread was from 0 to 30. The overall index mean is 14.6, or almost in the center of the impact index (Fig. #9).

These were then recoded into five categories, and labeled as follows:

- A = 0 = no damages
- B = 1-10 = slightly damaged
- C = 11-20 = more damaged
- D = 21-30 = more severely damaged
- E = > 30 = most severely damaged

Five percent fall into the "A" category, 27% fall into the "B" category, 44% fall into the "C" category, 19% fall into the "D" category, and 0% fall into the "E" category as of this study (Fig. #9).

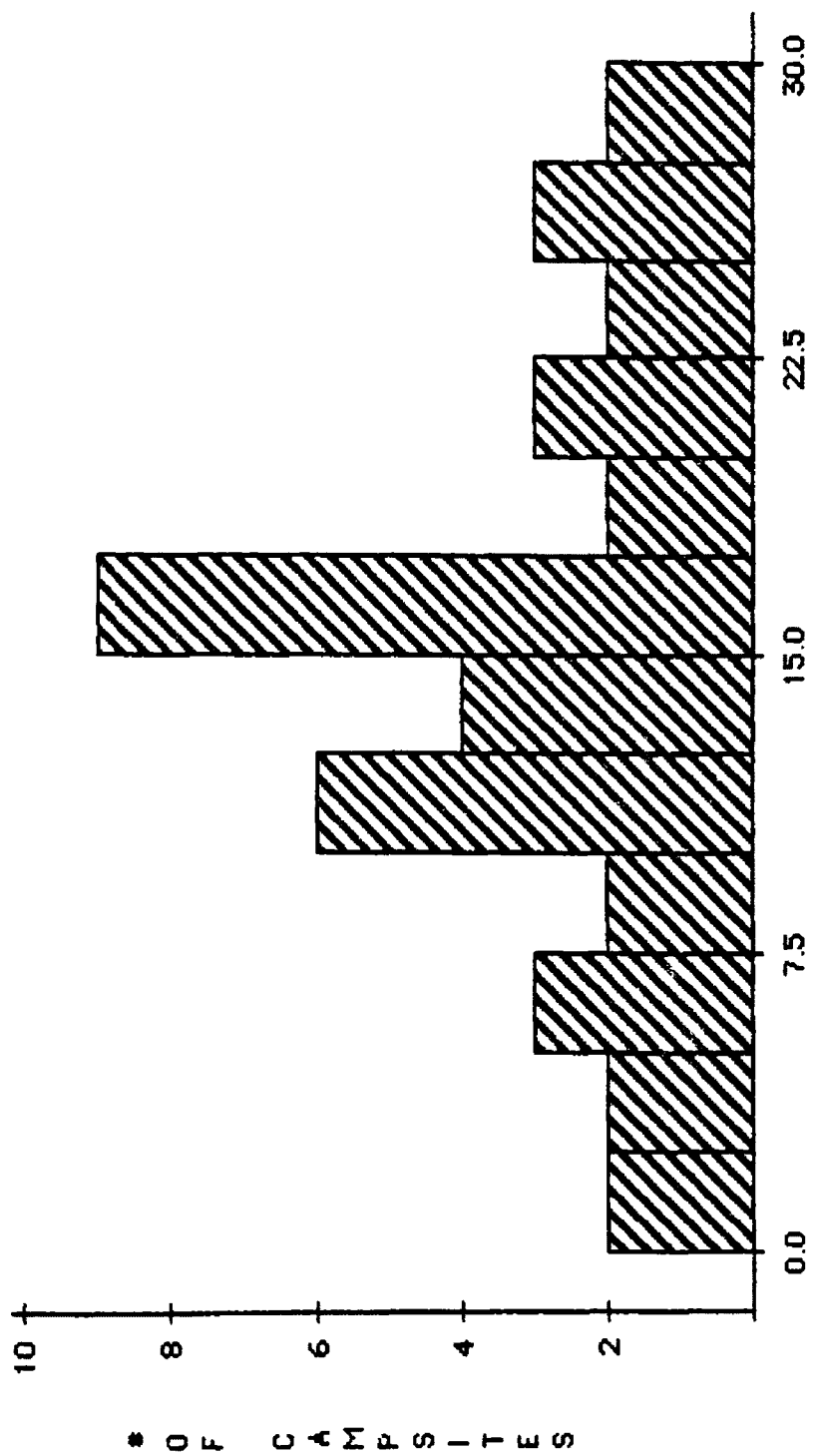


Fig. 8. Overall impact index ratings, San Juan River, Utah.



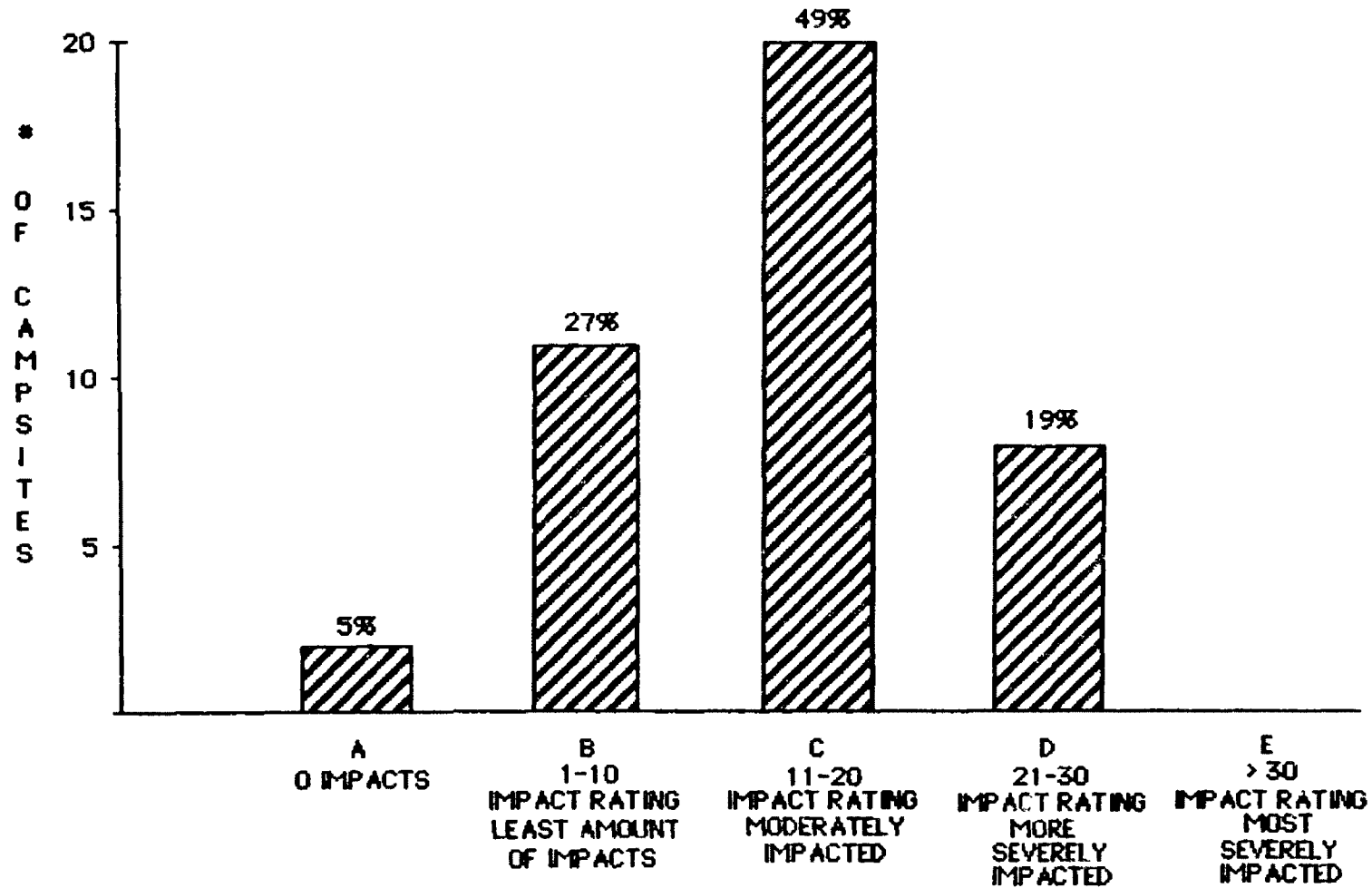


Fig. 9. Campsite condition categories  
San Juan River campsites, summer, 1990.

### Limitations of Study

Estimates will vary somewhat between observers, so the level of precision should be tested between observers for consistency. For example, on vegetative cover, an assistant and myself were close in our estimates only after we practiced with the chart to estimate cover in various types of areas. This chart should be used for practice before actual data collection begins.

One flaw in this process concerns examination time. Even with two people collecting data, drawing maps and photographing, examination time averaged thirty minutes per site. Unless a shorter field form is developed for future monitoring, the process will be too time-consuming for one person.

## CHAPTER V

### DISCUSSION

Vegetation and trails impacts appear few when compared to aesthetic degradation, such as litter. Variations within campsite conditions are more visibly marked when viewed with site information such as site composition and site size. For example, in viewing the overall index as compared to site composition by boxplot, it is obvious that the bank/terrace campsites have a higher rate of overall impact, as is indicated by the level of the interquartile range (Fig. #10). Several factors most likely accounted for the lesser resistance to damages on these sites. As previously stated, the San Juan River is continuously in a state of change. Beach sites are few, and those that do exist will most likely be "cleansed" of litter during times of floods and high water. Additionally, due to flooding, these beach sites are underwater a great deal of the time and are thus not usable as campsites. Consequently, they most likely receive less use than the always-available terrace sites. Also, the rock ledge sites are less likely to receive major biophysical damages, due to the resistant nature of the rock to vegetation growth.

Additionally, upon comparison of campsite condition and site size it appears that the large and extra large sites have slightly higher impact ratings as well (Fig. #11). Large groups of users camping on the

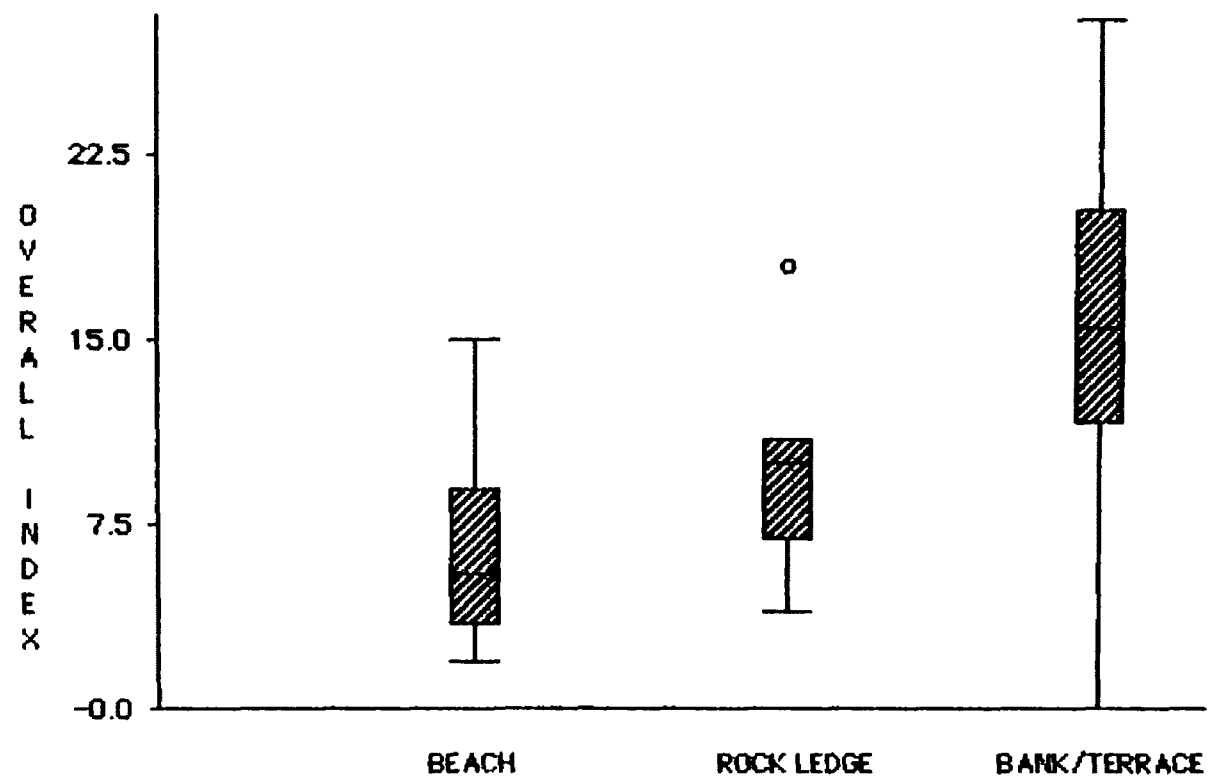


Fig. 10. Campsite condition by site composition. Variation in campsite condition indices among campsites and in relation to campsite composition.

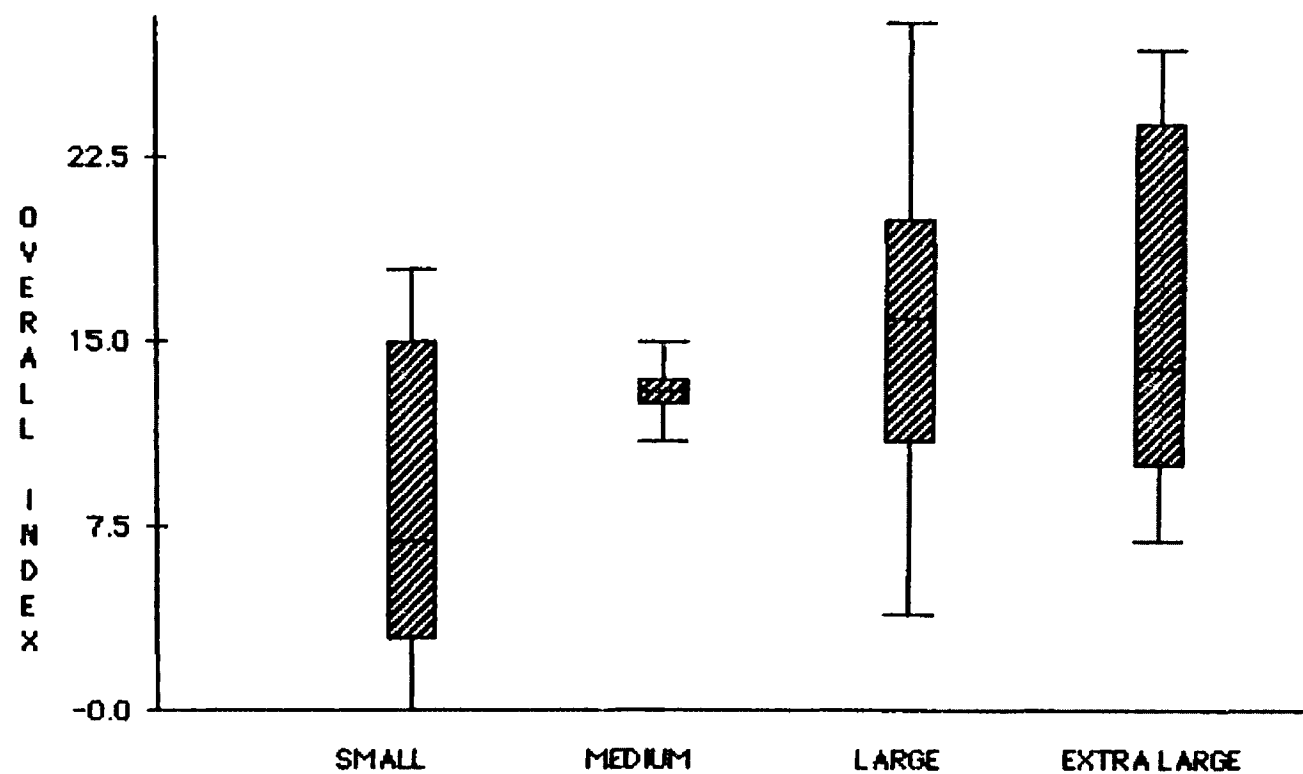


Fig. 11. Campsite condition and size. Variation in campsite condition indices among campsites and in relation to campsite size.

larger sites will impose more damage on an area, both through sheer numbers of users, and through physical enlargement or spread of a site.

The National Park Service is interested in campsite distribution along this stretch of river. Due to the shortage of campsites in the lower canyon, there is concern that competition for sites directly above the last-day stretch might place undue stress on the resource in this area, resulting in more severe damages. Because of this concern, the impact indices have been viewed in two ways, in 9.5-mile increments and 14.25-mile increments. (These are based on the distance an average river party might travel in one day on this river, approximately ten to fifteen miles. These segments have been chosen because most river parties run trips of four to six days' length.) Both the 9.5-mile river increments and the 14.25-mile river increments have then been crossed with the impact index to examine the site conditions within each stretch. When the 14.25-mile increment stretch is crossed with the impact index, no interval stands out significantly above the others (Fig. #12). However, when the river is broken down into 9.5-mile blocks and then cross-tabulated with the impact index, the next-to-last stretch stands out somewhat above the others (Fig. #13). This stretch contains the campsites with the highest impact ratings, as well as the largest range of impacts.

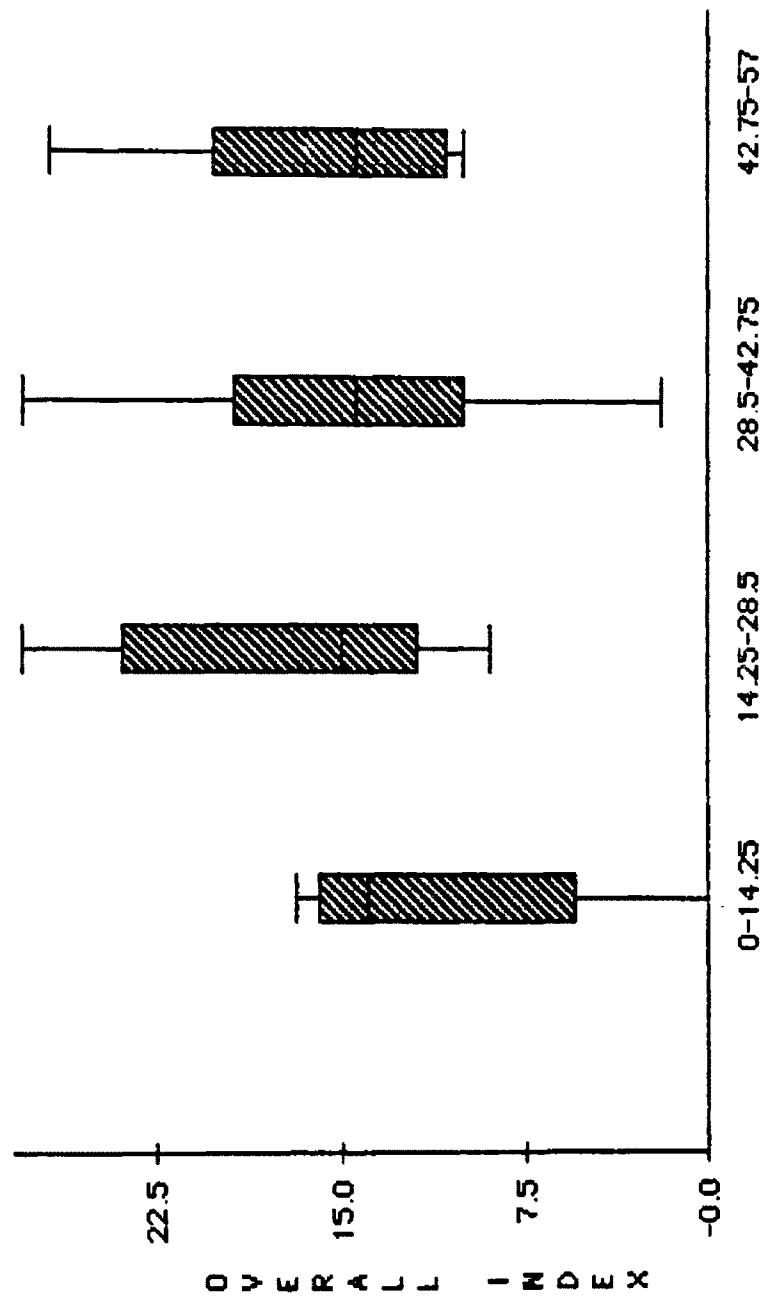


Fig. 12. Impact index by four 14.25-mile travel increments.

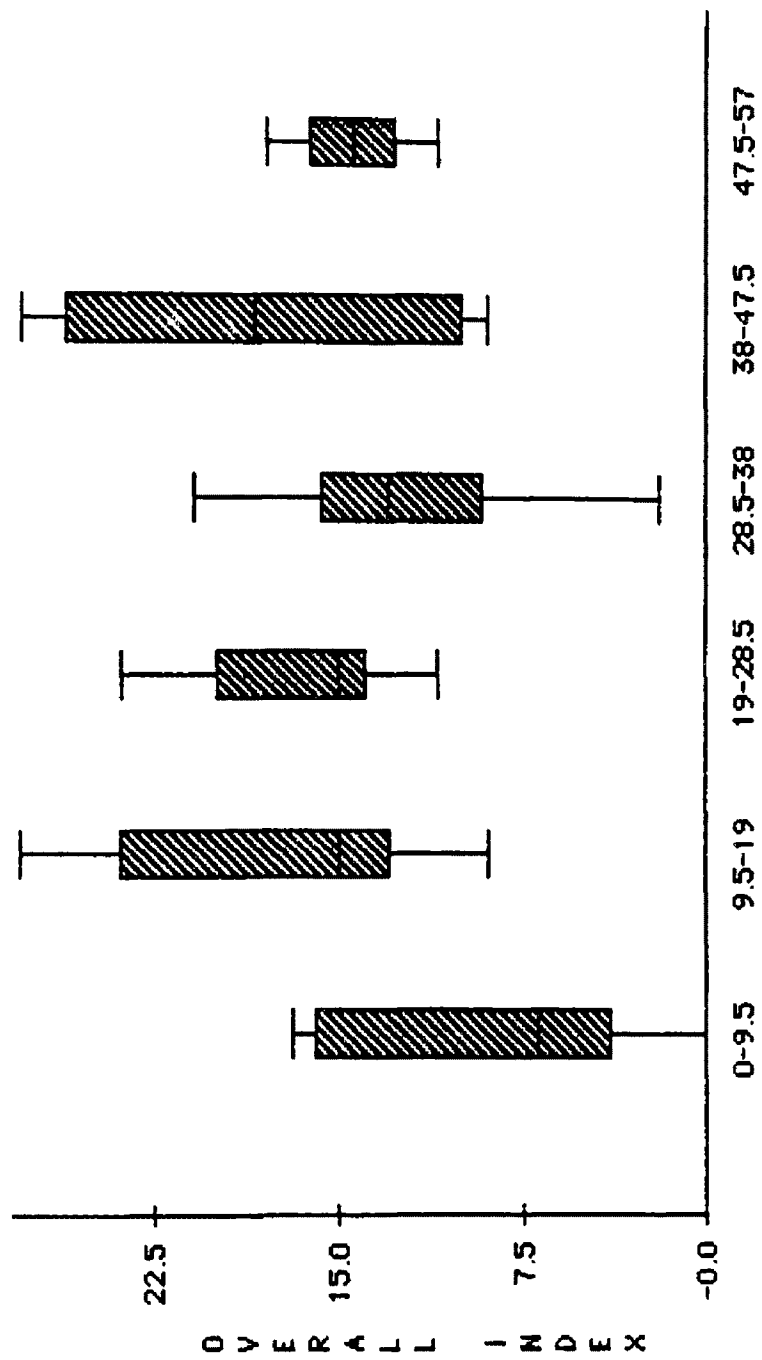


Fig. 13. Impact index by six 9.5-mile travel increments.



One particular factor probably accounts for this. Two of the most popular areas along the San Juan River, Slickhorn Gulch and Grand Gulch are within this next-to-last stretch. Slickhorn Gulch has five campsites within view of the canyon. Four of these are at the mouth of the canyon itself, and are accessible by boat. The Bureau of Land Management states specifically in its river permit instruction pamphlet that only one night's camping is allowed at the mouths of Slickhorn and Grand Gulch. Additionally, there is an on-river campsite register whereby a river party registers for these campsites for one specific night. However, this observer has spoken with and observed river parties that have chosen to ignore these regulations, and have stayed in these areas for two and three nights. The fact that there are very few campsites downstream serves to increase their attractiveness as a last-night place to stay before the take-out day. These sites are very popular, due to existing on-site features, and are also in the next-to-last day stretch. Therefore, the high incidence of impacts in this area may partly be attributed to the popularity of the Slickhorn and Grand Gulch areas. The same is true for the Honaker Trail area. Although there is no limit on the number of nights a party is allowed to stay at Honaker, there are four campsites within walking distance of the trail, and this is a popular area for early-morning hikes.

There is little evidence of compaction along the river. Only 7% of the sites show any indication of soil hardening at all. This is most likely

due to the nature of the campsite composition. All sites, including upper terrace sites, are composed of either sand or rock.

In conclusion, there is a higher degree of aesthetic degradation than biophysical degeneration.

## CHAPTER VI

### CONCLUSIONS

A new riverside campsite inventory revealed a total of forty-one campsites on this 57-mile stretch. An examination was performed on each campsite, to provide a baseline of information. Periodic reassessment of these sites will provide information by which to assess trends in campsite conditions.

A campsite condition index was obtained for these sites. An index rating was obtained for each site on both aesthetic and biophysical impacts, and the two were then combined. Condition indices were developed for the aesthetic and biophysical damages separately as well, for individual comparison.

Campsites that appeared most damaged overall were of large and extra large size, and were of upper terrace, soil/sand bench composition. Additionally, there are a few specific locations that have sustained the most damage, and these are the popular sites of Slickhorn Gulch and Honaker Trail.

Dividing the river into specific travel increments indicated that there is an area with slightly higher impacts, which is the next-to-last-day stretch before the take-out at Clay Hills Crossing. The above-mentioned Slickhorn Gulch falls into this travel stretch, presumably for two reasons: there are few campsites below this site, and Slickhorn is a

popular place to stay. It is accessible to both floaters and backpackers, and provides off-river recreational activities, in the form of canyon hiking and swimming.

Little vegetation damage has occurred. The river provides driftwood for campfires, and the type of vegetation in the canyons (tamarisk and willow) is not conducive to firewood gathering. Soil compaction is almost nonexistent. Campsite composition (sand or rock) most likely precludes hardening of sites.

The most severe biophysical damages are in the form of trails. Most of the campsites contained trails within the camp, and these are usually located on sandy terraces and high banks. Due to the fluctuation of the San Juan River, there are few beach impacts. The San Juan has a high silt content, and therefore, the question of beach loss through erosion is not a concern.

Final results indicate that the amount of visible litter might become a major consideration. Some is left behind by floaters, and there are vast amounts washed in by floods from upstream in the form of tires, oil cans, etc. However, in viewing this stretch of the San Juan River as a whole, there appears to be little biophysical damage

## MANAGEMENT RECOMMENDATIONS

1. Campsite conditions should be monitored every two to three years. Many changes have occurred in the past four seasons since the 1986 publication of the Baars' river map, so monitoring should be done more often than every four years to maintain a current inventory and assure relocation of sites. However, if monitoring is performed every year, small changes will most likely not show up, due to the nature of the rapid estimation procedure. The aesthetic and biophysical indices will allow for off-site inspection of overall conditions to view any trends in campsite condition.
2. A re-inventory of campsites should be performed every five to seven years. Campsites have changed between the time the river map was published in 1986 and the time this investigation was performed in 1990. Re-vegetation and changing river and lake levels affect availability of campsites, thus a new study should be performed periodically, to update the inventory.
3. A change should be made to a shorter field form. Information baselines have been established, thus the monitoring process need not be as detailed as the original procedure, and information collected should be cut to erosion/trails and vegetation information, that which is needed to develop the condition indices, and basic details necessary for relocation purposes. In the determination of trail impacts, a measure of depth and/or width should be added to the format, and consequently be

calculated into the impact index. This should increase depth of knowledge.

4. A study on user behavior and user perceptions should be considered. To date, no such study has been performed on this stretch of river. A sociological study would provide further information for the agencies. This would be useful for decision-making regarding river regulations, and in the preparation of the proposed river management plan.

5. Non-manipulative techniques should be used to rejuvenate the resource. This may be accomplished by educating and thus changing user behavior, and by cleaning up campsites. There are numerous ways to do this:

- a) An informational brochure should be developed to educate users as to the responses of campsites to damaging user behavior. This should then be distributed to all permit-holders, both backpackers and river users.

- b) Create a new river map to be distributed to permit holders. Include newly-inventoried campsites and information on site size and conditions. Advocate use of small and medium-sized sites for smaller groups.

- c) It is doubtful that use can be restricted at the campsites at Slickhorn Gulch. This may be desirable only as a last resort. Compliance is an issue, especially considering the scarcity of campsites below this area. However, if levels of site damages become unacceptable in the

future, closure of one site at a time is a possibility. In the event this becomes a reality, users should be informed of the reasons for closure, and suggestions for alternative campsites should be provided.

d) Agencies should increase the number of river patrols and the percentage of compliance checks at launch points. This will provide in-the-field information and better assurance of regulation compliance. Presence of river rangers at launch points and on the river will promote relations and contact with the public, and will stimulate the concept that the administering agencies are concerned with both the resource and its recreational users. During the summer of 1990, there was an obvious deficiency of agency personnel on this stretch of river.

e) Cleanup of campsites will lessen aesthetic degradation. This may be accomplished by running river cleanup patrols. Litter can be removed and fire remains can be cleaned up by screening ashes and charcoal, by removing rock fire rings and cleaning scarred and blackened rocks.

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