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RESEARCH/RESOURCES MANAGEMENT REPORT

ASSESSMENT OF BACKCOUNTRY CAMPSITE CONDITIONS IN BIG BEND NATIONAL PARK



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ASSESSMENT OF BACKCOUNTRY CAMPSITE CONDITIONS IN BIG BEND NATIONAL PARK

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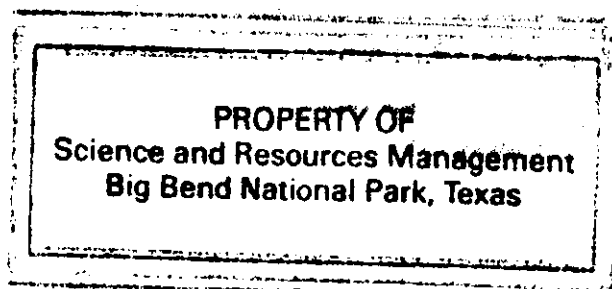
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1. The first part of the paper is a review of the literature on the effects of the 1997 Asian financial crisis on the economies of the Asian countries. The second part of the paper is a review of the literature on the effects of the 1997 Asian financial crisis on the economies of the Asian countries. The third part of the paper is a review of the literature on the effects of the 1997 Asian financial crisis on the economies of the Asian countries.

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The authors thank Big Bend Superintendents Robert Arnberger and Jose Cisneros, in turn, for their support during this effort. Special thanks are extended to the Science and Resources Management Division staff members at Big Bend National Park under the direction of Phil Koepp. Raymond Skiles, Wildlife Resource Management Specialist at the Park, was the project's catalyst and a source of constant support and ideas. Tom and Betty Alex offered this project access to their world of Geographic Information Systems, Big Bend pre-history and archeology, and the Chihuahuan desert, as few others possibly could. Many other unmentioned members of the Big Bend family offered a warm welcome during the field work.

Field work, however, requires staff, and, aside from the authors, this project had but one other person directly involved-- Christine Bianchino. Christine seemed tireless and undaunted in the desert and, later, in the office as she compiled data into initial computer formats. Her work contributed greatly to this assessment of backcountry campsites in Big Bend National Park.

At Virginia Tech, Doctoral candidate Yu Fai Leung was a frequent source of inspiration. His ideas and academic resources greatly helped this work, whether it was searching libraries in Texas with the Internet or contributing insight as we reviewed our results and considered what we had found.

As with any report, however, we authors are solely responsible for any errors in compilation or interpretation that have eluded our attention and remain to be found in this document. We hope there are few.

EXECUTIVE SUMMARY

This report documents an assessment of backcountry campsite conditions in Big Bend National Park completed during the period from September to November of 1993. The assessment adapts a National Park Service procedural manual (Marion 1991a) to Big Bend National Park, the needs of its staff members, and the complexities of the Park's unique qualities.

Two purposes guided this work. First, through close collaboration with Park staff members, the authors were to design a campsite inventory and condition monitoring program applicable to Big Bend National Park. Secondly, we were to implement its first iteration. The resulting program, reported here, includes consistent, repeatable procedures for documenting findings relevant to those making decisions about the backcountry and visitors of Big Bend National Park. Wherever possible and appropriate, comparability is maintained with existing monitoring data sets, reviewed in this document. For example, although improved measurement procedures are applied, many of the same indicators-of-condition are included.

Two primary research interests also have guided this effort (Figure 1). The first is the opportunity to adapt and apply Marion's (1991a) campsite monitoring procedures to a desert environment. The second research interest is the opportunity to evaluate two strategies for camping management practiced at the Park: (a) *designated site camping* and (b) *open camping*.

Although each form of camping management is effective and appropriate in certain situations, success of any single application requires implementation of supporting programs. In addition to providing Park staff members with thorough documentation of a campsite monitoring program, this report examines the management and scientific basis for current management efforts. It then evaluates the effort's effectiveness based on, first, the data collected and, second, review of literature from recreation ecology which is the study of how recreation affects the environment. Lastly, when possible, this report provides recommendations for improving campsite management efforts through alternative and often complementary management strategies or actions.

Because the management of backcountry campsites is part of a park's efforts to implement its management policies, this report contains a review of ideas related to strategic park management. This review draws from earlier work by Williams (1994) who explored and integrated ideas from strategic planning with those of public land policy and management.

The survey evaluated 268 campsites, including 55 along the Rio Grande River, 58 along backcountry roads, 69 in the Chisos Mountains, and 86 along trails elsewhere in the Park. A substantial number of both designated and visitor-selected campsites are "illegal" according to current Park regulations, although designated campsites are legal by definition. Nearly all campsites in areas permitting open camping violate one or more of the site location regulations, principally the minimum setback distance from trails (100 yards). An improved understanding

of the causes of these violations is needed in order to develop effective management responses. A combined program of visitor education, possible regulatory modifications, campsite closure and restoration, and enhanced visitor contact and enforcement is recommended.

Summarizing the findings reported in this work, the most common violation is camping too close to trails (106 sites are located within 100 yards from a Park trail). Other violations included campsites located in restricted camping areas (33 sites), campsites within 100 yards from an archeological site (25 sites), and campsite located within 100 yards from water (22 sites).

Improving compliance with Park regulations governing site location should begin with the designated campsites. We recommend that Park staff members conduct a review of survey findings and site location regulations to determine if and where campsite relocations are needed. Designated campsites violated many of the Park's criteria for selecting an "Open" campsite (Table 6) and raises the concern of inconsistency between designated sites and at-large, dispersed camping criteria. Park staff members may wish to address this inconsistency. One possible option is to relocate those sites that are inconsistent. Another is to review the camping criteria and consider whether any are unnecessary. A third option is to address the inconsistencies as part of an expanded information and education effort directed toward Park visitors and explaining the appropriateness of these apparent discrepancies.

Limited problems with the construction of illegal fire sites, improperly disposed human waste, and litter are also evident from survey results. These problems are more common on designated campsites and on sites along the Rio Grande River. Expanded visitor education efforts, including the development of *Leave No Trace* camping literature, are recommended.

The majority of campsites are in good condition, although possibly excessive size is apparent at some sites. Visitor education and site design/site maintenance actions are recommended as means to contain or reduce campsite sizes if this is a desired objective. Campsite size (median square footage) is greatest for designated campsites (road access and trail access). Vegetation and grass cover loss (median percent of original cover), however, is notably consistent across all types of campsites. Soil exposure (median percent of original cover) is greatest at all campsites located in the High Chisos, most likely because sites located in lower, desert areas begin with more exposed soil.

Combined, these findings suggest surprising conclusions regarding the ecological significance of designating campsites. Specifically, designated campsites in Big Bend National Park are larger than undesignated sites, have greater total amounts of disturbance (sums for entire survey), and may not concentrate camping effects to the degree expected, as shown by the consistent percentages of disturbance across the condition indicators of vegetation, grass, and soil. On the other hand, the expected concentration of effects is shown by the greater increases in vegetation and grass loss when measured in square feet. Also, designated campsites show greater increases in exposed soil whether measured in square feet or as an increase in the percentage of exposed soil as part of the site's area. These findings may be quite related to the larger size of designated campsites more than the actual concentration of effects.

The social significance of these surprising findings, however, is perhaps most important and is outside this study's purposes, although some comments are fair. Designated campsites likely provide a camping opportunity that is highly sought by those who visit and stay at them. In

addition, such sites provide a known destination for those visitors who are less familiar with the area. These are among the possible social advantages of designating campsites and requiring visitors to stay at those locations if they wish to camp in the area.

Designated campsites do offer visitors opportunities for more secluded backcountry camping experiences. These opportunities could be enhanced by establishing minimum distances between campsites and roads, campsites and trails, and between campsites. Compliance with resource protection setback distances could also be improved. Management control over such site selection criteria is a principal advantage of the containment strategy. This strategy has concentrated the effects of visitation on a restricted number of campsites, thus minimizing the area of disturbance associated with camping activities.

Many of the Park's campsite management problems are most appropriately addressed through an expanded program of visitor education and communication. Development and widespread distribution of improved *Leave No Trace* literature is recommended. Improved information for desert, riparian, and montane environments now exists and could be easily adapted to Big Bend NP. Improved campsite selection criteria could also be developed and employed to protect sensitive habitats and cultural sites and to promote camping solitude. Campsite maintenance and rehabilitation programs can also help to restore natural conditions and concentrate visitor activities to minimize the area of disturbance. Finally, managers should consider the adoption of a decision framework, such as LAC, to guide decisions about backcountry management. Campsite assessment procedures developed for this survey are recommended as part of an ongoing program of campsite condition monitoring. Such information provides an objective basis for decisions, either within or separate from a formal decision framework like LAC.

Several observations from this study are worth future investigation. One is that the shrink-swell potential for Big Bend soils may lead to more rapid de-compaction of soils following compaction by camping. Several popular camping locations had campsites with remarkably less compacted soils than expected given that no more than a few months of rest had occurred since the previous camping season. This observation is significant because such de-compaction through a natural annual process is not reported in the campsite assessment literature.

The second equally notable observation is that several campsites had some form of cryptobiotic-like crust present *within the boundary of the campsite*. This crust is different from the pedestal version commonly reported on the Colorado plateau. Anecdotal discussions with soil specialists at nearby Alpine State College suggest that this crust is likely a form of cryptobiotic soil. Because cryptobiotic soils are often reported as sensitive to desert camping, this possible observation and documentation of a form of soil present within the boundary of campsites is significant.

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Appendix 1

Big Bend National Park Backcountry Campsite Assessment Manual

Note:

Pagination for this Appendix is distinct from the Report entitled "Assessment of Backcountry Campsite Conditions in Big Bend National Park" so that it can go into the field as a separate document during future assessment efforts. 71

Appendix 2

Big Bend National Park Backcountry Campsite Database Codebook 103

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INTRODUCTION

- "Sacrifice sites"
- interface b/ envoy + preserve.
- LOC?

The Big Bend region of Texas, along the Rio Grande river, is unique. Located in the central part of the Chihuahuan desert, it contains the green island of the Chisos mountains, and, nearly a mile below those peaks, over 100 miles of a green band lies beside the Rio Grande river as it chisels its way in a dramatic bend through mesa and plateau. Between the green island and the green band there is desert with a harshness that is at once unforgiving and beautiful. This region inspires awe about geological forces and the relentless inevitability of sun and water to rework the rock. It also reveals life's tenacious will to adapt and remain, sometimes blanketing the region with color rivaling that of the geology. Quite often, however, life's colors are muted by heat and dryness.

A highlight of the Big Bend region is Big Bend National Park, located in the most southern portion of Brewster county, Texas. It is bordered by the Mexican States of Coahuila and Chihuahua across the Rio Grande. Ever since the United States Congress established the Park in 1944, following a gift of lands from the people of Texas, it has undergone constant change as grasses and other vegetation began to recover from over-grazing. Many of those native animals and plants that had been previously pushed out or suppressed by cattle began returning almost immediately after the Park's establishment (Maxwell 1949). The degree of change and recovery since the area became a Park has been remarkable by many measures. Today, Big Bend National Park's 801,163 acres includes 533,900 acres (67%) that the National Park Service has recommended for admission into the National Wilderness Preservation System. The NPS also has identified another 44,750 acres (6%) as potential Wilderness.

The U.S. Department of Interior's National Park Service (NPS) manages Big Bend National Park. Congress established the agency in 1916, and it is today the premier public land protection agency of the United States federal government. The agency's purpose is:

... to promote and regulate the use of the Federal areas known as National Parks ... by such means and measures as conform to the fundamental purpose of the said Parks ... which purpose is to conserve the scenery and the natural and historic objects and the wildlife therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations (*United States Code*, volume 16, section 1).

These areas derive increased national dignity and recognition of their superb environmental quality.... The authorization of activities shall be construed and the protection,

management, and administration of these areas shall be conducted in light of the high public values and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established (*United States Code* , volume 16, section 1a-1).

For those who visit a National Park, enjoyment often means recreation. Recreation, however, can change a park. At times and in some places, those changes may even impair the park's scenery or natural and historic objects. Park staff members, therefore, must decide whether recreation has led to such impairment that the agency's purpose has been compromised. Today, these decisions are often made in a participatory manner, incorporating the interests and opinions of visitors, local residents, concessionaires, conservation or recreation organizations, and park staff members from every park division, as prescribed in the NPS's Management Policies (USDI 1988). If those participating in the decision process agree that impairment has occurred, they then must select a response that, while remaining sensitive to visitor interests, protects park features, environmental quality, scenery, and natural or historic objects. After all, those features are the preeminent reason Congress establishes National Parks, as clarified in U.S. Code, volume 16, section 1a-1. Without those features, there could be no opportunity for park visitors to enjoy them as Congress and the American people intend.

Project Description

This project addresses backcountry camping, a form of backcountry recreation. Backcountry recreation may be distinguished from frontcountry recreation by the prominence of a natural environment, primarily undisturbed and remote. Such a setting is most important for backcountry activities, whereas, for frontcountry activities, the setting, although still meaningful to the participants, is replaced in significance by the activity itself, the presence of other participants, or modifications to the location, such as a visitor center, campground, or picnic tables. Although facilities and other constructions may exist in backcountry settings, these typically are limited in size and are intended to ensure resource protection or visitor safety. Backcountry facilities and constructions rarely are intended to provide visitors with amenities.

This report documents an assessment of backcountry campsite conditions in Big Bend National Park completed during the period from September to November of 1993. The assessment adapts a National Park Service procedural manual (Marion 1991a) to Big Bend National Park, the needs of its staff members, and the complexities of the Park's unique qualities.

Two purposes guided this work. First, through close collaboration with Park staff members, the authors were to design a campsite inventory and condition monitoring program applicable to Big

Bend National Park; they, secondly, were to implement its first iteration. The resulting program, reported here, includes consistent, repeatable procedures for documenting findings relevant to those making decisions about the backcountry and visitors of Big Bend National Park.

Formal adoption of the campsite monitoring program offered by this report is at the discretion of Park staff members. However, we--the report's authors--recommend its implementation. Because of our close work with Park staff members while establishing the procedures, we believe it is a program that reflects management needs and constraints, the realities of the Chihuahuan desert, and the interests of Park visitors, as understood through review of existing social science research and the managerial experience of Park staff members.

Research Objectives

Two primary research interests guided this effort (Figure 1). The first was the opportunity to apply Marion's (1991a) campsite monitoring procedures to a desert environment. Prior to this work, Marion's procedures had been tested only in forested settings. The second research interest was the opportunity to

evaluate two strategies for camping management practiced at the Park. Those strategies are (a) *designated site camping* and (b) *open camping*. Park managers have applied designated site camping in the Chisos Mountains (hiking accessed) and along backcountry roads (vehicle accessed). They have applied *open camping* along trails outside the Chisos Mountains (hiking accessed) and along the Rio Grande (boat accessed).

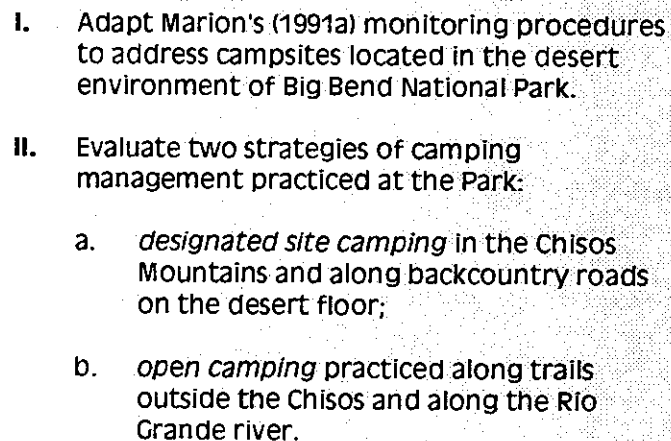
- 
- I. Adapt Marion's (1991a) monitoring procedures to address campsites located in the desert environment of Big Bend National Park.
 - II. Evaluate two strategies of camping management practiced at the Park:
 - a. *designated site camping* in the Chisos Mountains and along backcountry roads on the desert floor;
 - b. *open camping* practiced along trails outside the Chisos and along the Rio Grande river.

Figure 1. Research goals for assessing backcountry campsites in Big Bend National Park.

Although each strategy for managing camping is effective and appropriate in certain situations, success of any single application requires implementation of supporting programs. In addition to providing the Park's staff with thorough documentation of a campsite monitoring program, this report examines the management and scientific basis for the current management efforts. It then evaluates the effort's effectiveness based on, first, the data collected and, second, review of recreation ecology literature. Lastly, when possible it offers recommendations for improving the

effort's effectiveness through alternative and often complementary management strategies or actions.

Research Products

The following products are provided with this report:

- 1) A comprehensive backcountry campsite assessment manual applicable for monitoring conditions over time.
- 2) A dBASE IV computer program database compatible with most DOS and Windows database programs for data entry, storage, analysis, and retrieval.
- 3) The campsite assessment findings, including recommendations regarding current strategies and supporting actions for managing backcountry camping.
- 4) A complete set of USGS topographic maps pertinent to the Park and with all assessed campsites marked.
- 5) All campsite photographs and negatives labeled with campsite numbers and dates of assessment.
- 6) A set of labeled color slides illustrating campsites and campsite conditions in each area of the Park.

LITERATURE REVIEW

This assessment of backcountry campsites contributes to the effort by Big Bend National Park staff members to manage the Park. Such management efforts integrate many disciplines, including recreation ecology, backcountry and wilderness management, and natural resource policy and planning. Specifically, this work provides National Park Service staff members with information that can assist those who make decisions about recreation in Big Bend National Park.

This literature review begins by exploring the effects of desert camping on backcountry settings. It describes the methods and findings of previously published assessments of backcountry campsites located in Big Bend National Park. The review then proceeds to characterize the significance of campsites and campsite conditions for visitors and managers. Lastly, it summarizes the contemporary decision frameworks, including Limits of Acceptable Change (LAC) and Visitor Experience and Resource Protection (VERP). By monitoring conditions of backcountry campsites, implementation of such a framework is assisted.

Campsites and Indicators

Any amount of backcountry camping will lead to changes in vegetation and soil conditions. Those changes are typically limited to the immediate location where that camping occurs (Cole 1988). Repeated camping at the same location eventually will form a recognizable campsite. This occurs as changes to vegetation and soil become significant enough that conditions within the area where camping occurs are distinctly different from those outside that area (Cole and Marion 1986). A useful definition of a campsite, then, is a location where soil or vegetation are visibly different compared with immediately adjacent areas where camping has not occurred. That difference typically is seen as a boundary between the area disturbed by camping and the adjacent undisturbed area. Such boundaries need not be abrupt or sharp; many are quite gradual (Marion 1991a).

Any effort to reduce a campsite to a single, direct measurement is useless because campsites are comprised of *multiple physical components* such as bare soil and vegetation type that reflect its condition. Williams (1994) provides a thorough review of this point. In addition to physical components, a campsite also has *environmental characteristics* associated with its location. For

example, a campsite's location is often characterized by its distance from roads, water, other campsites, and trails, as well as the elevation, type of vegetation, and amount of shade. Camping can change the type or amount of vegetation at a campsite and can determine the distance of the campsite to water or to other campsites.

One most often sees indications that a campsite exists when several physical components have been changed or a great amount or degree of change has occurred in a single component. A change in the single component of grass cover, for example, may indicate the presence of a campsite. Alternatively, changes in the amount of vegetation, bare soil, and vegetative debris can combine to indicate a campsite. On campsites, then, recreational effects are exhibited by changes in *condition indicators* often related to soil or vegetation.

Recreation can change a campsite's condition and determine characteristics of its location. Sometimes the severity of a change is associated with *location indicators*. For example, two campsites found at different elevations can appear quite different even if they began with similar initial conditions and received the same amount of camping. In this example, the difference in condition of the two campsites is most likely due to the difference in elevation, an indicator of location.

Recently, considerable research has gone into improving techniques for assessing backcountry campsite conditions. Researchers have increased the accuracy and precision of monitoring procedures, in part by producing detailed monitoring manuals, by reducing the role of subjective interpretation, and by establishing methods that are consistently repeatable among multiple raters. The distinction between accuracy and precision is that precision reflects the consistency of different surveyors (the closeness of their measurements to each other), while accuracy reflects how close each measurement is to a true value. Because assessments are always affected by various unavoidable sources of error (e.g., differences in opinion between surveyors), the true value can never be known. So, for the purposes of monitoring, it is most important to seek assessment methods that are consistent and emphasize precision over accuracy.

These advancements in monitoring procedures are essential for any effective park management process. They, and numerous other quality assurance protocols, are incorporated into Marion's procedural manual (1991a). A comprehensive review of the literature on campsite monitoring systems is provided in that manual (Marion 1991a), as well as other sources (Cole 1986b, Williams 1994), and will not be repeated here. Rather, this review describes campsite monitoring systems applicable to Big Bend National Park.

General Effects of Camping

Several thorough reviews of the ecological effects of camping are also available (Cole 1986b, Hammitt and Cole 1987, Marion and Merriam 1985). In general, the degree and duration of any environmental change is influenced by environmental qualities of the campsite and by how often camping occurs, the number of campers involved, and the season they choose to camp.

Ecologically, camping most directly affects soil and vegetation. Soil is affected when it is compacted or abraded. This leads to pulverization or loss of organic materials, lower water infiltration and content, greater surface runoff, and soil erosion. Camping affects vegetation when direct physical contact occurs between campers or their equipment and plants or their growth medium, usually soil. Plant type, environment, and level of stress all combine to govern how a plant will respond to recreation and its effects. In general, grasses and sedges are more resistant than broad-leafed herbaceous plants such as herbs (Marion and Merriam 1985).

Camping also affects the social or psychological atmosphere of an area. For example, Roggenbuck and others (1993) show that visitors consider campsite features and conditions among the most important characteristics of a natural area, greatly influencing their experience. Other work shows that campsite conditions perceived by visitors as most significant include the number or density of nearby campsites (Stewart and Carpenter 1989), trash seen (Roggenbuck and others 1993), and the physical condition of the campsite (Shelby and Harris 1986).

Effects of Camping on Desert Backcountry Settings

Previous studies show that, when compared generally, desert campsites affected by hikers and boaters respond similarly to campsites found in other settings such as woodlands. A major exception occurs when cryptogamic soils are present (Cole 1990). These soil crusts are most commonly reported among sandy soils of areas classified as cold deserts in North America (Belnap 1990). They are formed when bacteria, algae, fungi, lichens, or mosses combine to bind surface soil particles together, often forming raised pedestals. Cryptogamic crusts are important shields against erosion by wind or water, and they are exceptionally fragile. Cole (1990) found that as few as 15 walking passes by a person is enough to destroy a crust and that 50 passes will leave no visual evidence. He also found that much recovery can occur within 1-3 years. He saw no evidence of disturbance after 5 years.

Much of the remaining literature regarding the effects of backcountry recreation on desert environments stems from work completed in Grand Canyon National Park. Cole (1985, 1986a)

found processes at work on desert campsites remarkably comparable to those found on woodland sites. Generally, loss of vegetation and compaction of soil lead to higher soil densities, greater water runoff, and, eventually, can lead to loss of soil through erosion. Of the work completed outside the Grand Canyon area, the largest set of studies have been completed in Big Bend National Park. These studies are reviewed shortly.

Studies of the effects of boaters on desert rivers also stem from work in the Grand Canyon area. Carothers and others (1984) assessed the effects of river recreation, comparing eight beaches in Glen Canyon National Recreation Area with 15 beaches in Grand Canyon National Park. These authors note that flooding along the Colorado river is now limited by dams upstream from these locations, allowing trash, charcoal, and human waste to accumulate instead of being scoured away at regular intervals. The authors did not assess or report responses of visitors or managers to these conditions, instead the authors implicitly assume that aesthetic conditions are affected.

Prior Assessments in Big Bend National Park

This current work builds upon past efforts to assess backcountry campsites in Big Bend National Park. Much of that earlier work applied techniques first instituted during the 1970's and now largely replaced as understanding has expanded. The present effort examined those existing approaches to produce a state-of-the-knowledge system applicable to the Chihuahuan desert of Big Bend and comparable, where possible, with previous efforts.

Several authors report on a broad study conducted in 1976 (Schmidly and Ditton 1976, 1979; Ditton and others 1977; and Ditton, Graefe, and Mertens 1977). Their reports address recreation patterns, biological conditions, and environmental changes attributed to recreation. During field work for the study, surveyors applied a subjective site evaluation form to 64 campsites along the Rio Grande River. The form included 15 condition indicators associated with each of four categories (recreation, livestock, site description, and wildlife characteristics). Investigators, students, and Park personnel independently rated each of the 15 indicators using a scale from 1 to 5. Indicators associated with recreation included litter, trampling, rock-moving, campfires, human waste, and wood-cutting.

Authors of the 1976 study reported that only 15 sites (23%) were greatly disturbed (highly altered). Ten of those were along the River Road and accessed primarily with motor vehicles. That work was not intended as part of a long-term condition monitoring effort. In accordance with the study objectives, the survey's authors designed it as a subjective assessment with no written guidance. For this reason, repetition of the procedures was not possible for the current project.

In 1985, volunteers from Earlham College in Illinois assessed undesignated campsites in the Mesa de Anguila area of the Park (Berglund 1985). Twenty-six campsites were located and inventoried. Resource conditions were assessed with a categorical, multiple-indicator rating approach adapted from Cole (1983). Location indicators included UTM coordinates, elevation, landform and vegetation type, distance to trailhead and water, type of activity, and others. Condition indicators included vegetation loss, mineral soil exposure, site cleanliness, number of social trails, size of the camp area, and size of the barren core area. Surveyors assigned rapid measurements, counts, or estimates to one of three quantitatively described ratings of each indicator. A sketch map and photographs also were included for each campsite. Off-site photopoints were permanently marked with large diameter (0.5"- 0.75") steel pins 6"-8" long.

Berglund's (1985) final report includes a manual with recommendations to guide future assessments. Field forms and photographs are on file in the Park's Resource Management offices. Unfortunately, neither the survey form nor the report defines what constitutes either a campsite or campsite boundaries, so comparing results with those of other studies, including this one, is difficult because consistency with the Earlham study is uncertain.

Also in 1985, Park staff members conducted a survey of the 43 newly designated campsites in the Chisos Mountains. The Mesa de Anguila campsite assessment procedures were modified for this work by either adding or omitting indicators. Surveyors completed sketch maps, photos, and photopoint documentation information for each campsite. Field forms and photographs are on file in the Park Resource Management offices. Data were not placed into a computer or otherwise analyzed.

In 1992 and 1993, Park staff members adapted and applied procedures described in Marion (1991a) to the 43 designated campsites in the Chisos Mountains. They measured 31 indicators. They also assessed campsite boundaries and campsite sizes with the variable radial transect method introduced by Marion (1991a). Centerpoints were permanently established with buried steel pins. The pins were one-half inch thick with no identification tags. Photographs also were taken from permanently established photopoints. Field forms and photographs are filed in the Park's Resource Management offices. Data was computer input in dBASE III Plus, but it was not analyzed.

Stewart, Yarborough, and Skiles (1994) report on a 1992 study of river boaters. Stewart, Anderson, and Dunfee (1993), of Texas A&M, produced that study's final investigator's report to Big Bend National Park. Their study includes trends in the number of visitors, a survey of boaters who obtained non-commercial river permits, a survey of visitors who camped at designated sites along the river, and a survey of visitors who participated in commercial float trips on the Rio Grande through Big Bend National Park. The authors grouped boaters

according to river section, primarily Boquillas canyon, Mariscal canyon, and Santa Elena canyon. They found that visitors consider campsite characteristics important to varying degrees. Specific findings of these authors are reviewed in following sections of this report. The authors also note that summer rains renew vegetation and scour the river corridor, in effect annually eliminating many indicators of campsite condition. This observation suggests that efforts to assess the effects of Rio Grande camping should not focus on indicators susceptible to these overwhelming natural events. For example, a monitoring program must take into account that Rio Grande campsites are likely to experience several floods and growing seasons between monitoring assessment iterations. Such a monitoring program must carefully avoid assessing indicators that are far more greatly affected by flooding and annual vegetation growth than by recreation, otherwise the reported results for recreation effects are actually confounded with and even superceded by the effects of natural events.

Backcountry Camping and Its Management

Policies for managing backcountry camping often are based on campsite conditions. Campsites and trails are two primary locations where wildland recreation occurs. Yet, there are important differences between the two that affect perceptions of visitors and managers and, in turn, affect park policies, as discussed by Williams (1994).

Earlier in this review, backcountry campsites were defined as locations where visitors have stayed overnight frequently enough that conditions exist different from similar, adjacent areas where no camping has occurred. Implicitly, not all locations where visitors camp become discernable campsites. Backcountry trails, on the other hand, are routes, as opposed to locations, often facilitating travel between views, trailheads, summits, or overnight areas. Not all routes visitors travel become discernable trails.

Camping and hiking both cause changes to vegetation and soil. Those changes often lead campers, hikers, and protected-area staff members to respond by forming opinions about the area's aesthetic qualities, other people who visit the area, and the state or federal agency responsible for managing the area. These opinions are changes in the social environment and may influence a person's experience, a group's attitude, or a park's policy.

Alternative Strategies for Managing Backcountry Campsites

Camping can affect physical and biological qualities of a backcountry area, as well as affecting opinions or experiences of visitors or managers. Some of these effects may be deemed undesirable from one perspective or another. To reduce undesired effects of backcountry camping, managers may select from many alternatives. Options include camping management

strategies, locational restrictions, permit systems, reservation systems, no-fire policies, Leave-No-Trace educational programs (NOLS 1994), and campsite maintenance or rehabilitation programs.

There are several common camping management strategies. One approach requires visitors to camp at formally designated locations, a strategy called *designated site camping*. Another allows visitors to camp where they wish with the limitation that they do not camp in a location that shows signs of previous camping, a strategy called *dispersed site camping*. A third instructs visitors to camp at informally established locations, a strategy called *established site camping*. A fourth allows visitors unrestricted choice to camp where they wish with only the most basic restrictions, a strategy referred to as *at-large, open-site, or unrestricted camping*. And, lastly, a fifth approach is to completely close specific areas or zones to camping so as to protect soil, vegetation, wildlife, or cultural resources. That strategy is called *area closure*.

Understanding Strategy

Williams (1994) discusses strategic planning and management ideas in conjunction with those of public land policy. A strategic approach to management and planning allows a park's staff members to think critically about their actions (**Figure 1**). To select a strategy, one should begin with an effort to understand the current situation. An assessment of campsite conditions can provide some of this understanding, especially when combined with a survey of visitors as part of a participatory planning effort to identify stakeholders and their needs, interests, or concerns. A visitor survey was not part of this particular project.

Once the current situation is understood, one should begin a process of deciding whether the current situation is acceptable to those who are responsible for managing an area and those who recreate there or who care about the area. If the people involved in that process decide some or all of the situation is

unacceptable, then they must select a response. When more people are involved in such an effort, more ideas become available to address the issues or concerns. Although complete

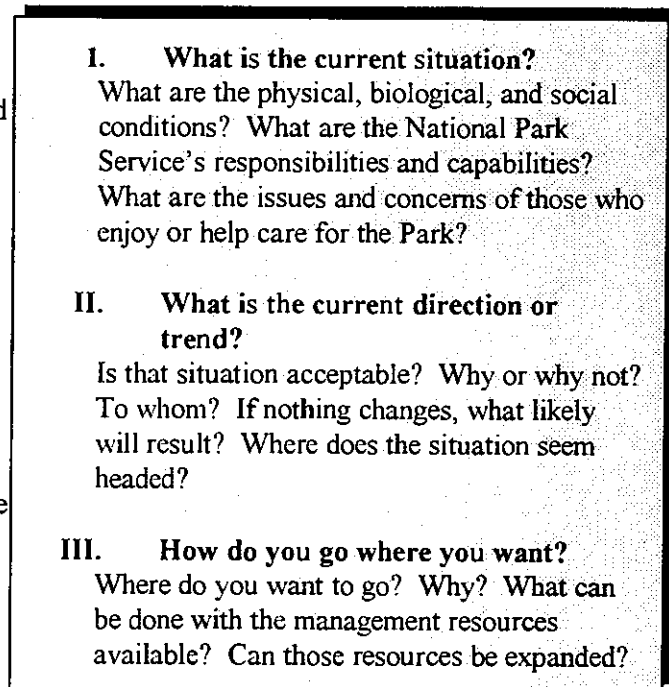


Figure 2. Three steps of planning a strategy.

resolution of some problems may never occur, an open, participatory approach to the issues will address many issues and concerns of even the most complicated situation.

Campsite management and strategy

Two purposes commonly guide a campsite management strategy. The first is to reduce the environmental effects of camping activities; the second is to address reasons people camp in a backcountry setting. These purposes mirror the two goals of the NPS's single purpose provided by the Organic Act (*U.S. Code*, volume 16, sections 1 and 1-a).

Work by Cole (1986b) and Marion and Merriam (1985) shows that, when viewed generally, the environmental effects of camping at any location progress in a curvilinear manner, as opposed to linear (Figure 2). This means that each additional visit contributes to the aggregate effects to vegetation and soil and that those effects accrue most rapidly when camping is infrequent. Stated plainly, the more visits a campsite receives, the less amount of change added by each additional visit.

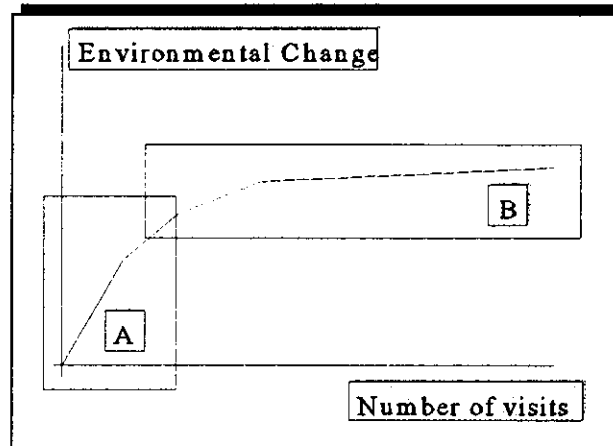


Figure 3. General relationship between campsite condition and number of visits. Changes occur most rapidly early in the campsite's life when the total number of visits remains low (region A).

The curvilinear relationship between the number of visits and environmental change leads to several implications. One is that a designated site strategy can concentrate the effects of camping, whereas a dispersal strategy, to be most effective, requires visitors to camp only where there are no indications that camping has occurred before. A designated site strategy, however, has associated costs. Perhaps most significant is that visitors lose some of their freedom to camp wherever they wish. This desire for freedom is a primary reason many people visit wilderness and backcountry areas (Lucas 1990). To lessen that cost, agency staff members may select locations for designated campsites that promote sociological reasons for dispersal, such as solitude, by positioning campsites away from each other.

Each strategy for managing camping has associated advantages and disadvantages depending upon one's perspective. For example, some people might be more concerned about providing visitors with opportunities for enjoyment, reducing the ecological or sociological effects of camping, or implementing the strategy in a workable and meaningful way. These concerns are neither exclusive nor required.

To see how a strategy can have an advantage from one perspective and a disadvantage from another, the following three possibilities. A dispersal strategy will provide visitors with opportunities to freely choose where they camp, but a knowledgeable visitor is most capable of complying with the strategy's requirement to camp only in previously undisturbed locations. Therefore, a dispersal strategy will not work well unless visitors are knowledgeable about how to camp in an appropriate manner for the specific area. Likewise, an established site strategy will provide visitors with opportunities to freely choose where they camp and to more easily locate existing sites, but new sites may appear in locations that ought not receive camping. In this case, an established site strategy is less likely to successfully meet the needs and expectations of some visitors. Similarly, an at-large strategy will provide visitors with more complete freedom to select where they sleep, but a sensitive location may change as a result of any camping that occurs there. Again, knowledgeable visitors are necessary for the strategy to meet the expectations of area managers.

The effectiveness of these strategies and actions depends upon the manager's resources, the area's natural qualities, the visitors' understanding of their responsibilities, and their willingness to comply. Wildland management literature contains many references to these strategies and their application in park and wilderness areas; yet, until recently no research specifically evaluates and compares the strategies' effectiveness. This current project is intended to accomplish such a comparison.

Visitors' Response to Campsite Conditions

Williams (1994) provides a review of literature related to how visitors respond to conditions of campsites and trails. Visitors respond to backcountry campsite conditions differently than they respond to conditions of backcountry trails. Because campsites are specific locations, as opposed to linear corridors, visitors spend more concentrated time at a campsite. This greater concentration of time may explain, in part, why visitors' perceptions of campsite conditions, as opposed to their perceptions of trail conditions, have been shown to affect their experience more significantly (Roggenbuck and others 1993).

Additionally, visitors prefer backcountry campsites that they perceive as remote (Stewart and Carpenter 1989), a quality distinct from frontcountry campsites and essential for backcountry recreation. They may perceive many backcountry trails, however, as only slightly different from frontcountry trails, if the difference is even noticed. The sense of remoteness, a central quality of backcountry, and the sense of difference between frontcountry and backcountry campsites makes management of campsites important when one seeks to provide opportunities for recreation in protected areas.

Stewart, Anderson, and Dunfee (1993) recently surveyed responses of both river-access and road-access campers in Big Bend National Park. Their work shows that, for example, the typical visitor to any one of the three major canyons along the river regards solitude differently from those visiting either of the other two canyons. In general, visitors floating the Rio Grande do not regard crowding as an issue. Specifically, more than two-thirds of the respondents in any given canyon did not feel crowded at camp or while floating on the river. Other campsite characteristics these authors assessed included the degree of apparent damage attributed to livestock and the perceived presence of manure. Many rafters rarely noticed manure and the majority were not disturbed by any manure they did see. Similarly, most rafters did not notice much litter. The report does not address possible visitor responses to human waste or fire sites that might be found at a campsite.

Just as desert locations respond only slightly differently than woodland ones when camping occurs, one might expect that a camper's response to campsite conditions is comparable. This possibility has not been explored directly, although speculation is common. For example, campsite conditions likely remain important, but the lack of vegetation on desert campsites may elevate the importance to campers of soil conditions, as when surface rocks are removed to make a location more comfortable for camping. Also, sparse vegetation may not obscure as many signs of trash or human waste. Compared with a woodland campsite, campers might be aware of--and perhaps distressed by--lesser total amounts of trash or human waste seen at a desert campsite because any trash or waste present is also more likely visible.

Managers' Response to Campsite Conditions

Managers of protected areas also respond differently to campsite conditions than to trail conditions. The concentrated time and visitor activity at campsites often alters the natural setting managers are attempting to protect, compromising a portion of their mandate. Additionally, managers recognize that most environmental change at campsites builds gradually over time, whereas most change associated with trails occurs during initial construction (Hammitt and Cole 1987).

Although proactive management of campsites is becoming more common, most efforts are reactions to existing concerns. Exceptions to this generalization may occur when a managing agency either constructs campsites, designates existing sites as appropriate for camping, or operates a campsite maintenance program to mitigate the effects of visitor behavior. However, these efforts are not universal. Many examples of a manager-determined system of campsites began as reactions to existing problems with camping, often utilizing sites first created by visitors.

Recent trends notwithstanding, most backcountry campsites result from overnight recreation, not direct management action. For this reason, most characteristics of a backcountry campsite result originally from visitor behavior. Because visitors choose where and how they camp, these choices most often determine the location and condition of backcountry campsites. Even campsites designated by park managers, for example, are often ones that had been earlier established by visitors.

The action that precipitates or causes a campsite is, most often, camping, in contrast to direct management action. For trails it is construction, a direct management action. That the precipitating actions producing trails and campsites are different may partially explain why actions to manage conditions also are different. Traditional trail management efforts tend to focus on trail construction, as opposed to regulating people. For example, consider the emphasis on construction, reconstruction, and maintenance. For campsites, however, management actions tend to focus on people and are often designed to regulate visitor activities, as shown in a survey of managers conducted by Marion and others (1993).

Examples of common camping management policies include prohibitions and requirements. Visitors could be prohibited against having axes, saws, or fires, or against camping in designated areas. On the other hand, they could be required to camp at certain designated locations, or to remove all trash and bury all biodegradable waste, such as food scraps or human waste. As a third or fourth option, a camping management policy could incorporate either an educational strategy or a maintenance program.

The Influence of Policies

Management decisions and policies also play a crucial role in establishing conditions of trails and campsites. For example, a management decision may alter the aesthetics of a campsite by affecting whether a visitor perceives a policy to influence, intrude upon, or restrict his or her experience either directly and overtly, or indirectly and transparently (Lucas 1990). Decisions to improve sites, restrict access, or limit activities often produce different responses in individual visitors (Shindler and Shelby 1993). Some visitors may support an action against which others rebel. Likewise, an individual may object to conditions in an area protected for one purpose, while accepting similar conditions in an area protected for a different purpose.

A backcountry recreation management policy, then, affects campsites by influencing how visitors respond to it or other decisions. Management decisions also influence how visitors respond to campsite conditions. Managers must establish administrative policy in a manner sensitive to the special nature of backcountry campsites (Mitchell and others 1993). If visitors perceive management actions as inappropriately constraining or otherwise detracting from a backcountry experience, they may become dissatisfied and uncompliant, or simply choose to pursue their

intended activity elsewhere (Frost and McCool 1988). These reactions are lost opportunities for otherwise acceptable activities.

A backcountry recreation management policy may also affect physical conditions at a campsite and in the overall protected area. For example, a policy requiring visitors to camp only at designated sites should lead to a concentration of effects at the designated locations and a dilution of aggregate effects overall in the larger protected area because the number of non-designated campsites will become reduced. One also expects to see a recovery of many non-designated sites from previous conditions because those sites become visited far less frequently.

Management Decision Frameworks and Processes

To produce and implement policy that responsibly and defensibly addresses a particular issue requires a process that focuses on the issue, promotes greater understanding of it, and leads to thoughtful action. For example, scientists, visitors, or members of a protected area's staff commonly make statements about the significance of backcountry campsite conditions. Typically, some statements are quite subjective, while others are substantiated with objective information. Sometimes the statements disagree completely. A flexible, yet consistent policy process is most suited to resolving these differences because it can clarify the concerns that lead to different opinions and identify existing or needed information in response to those concerns.

Several contemporary frameworks are available to guide people through such

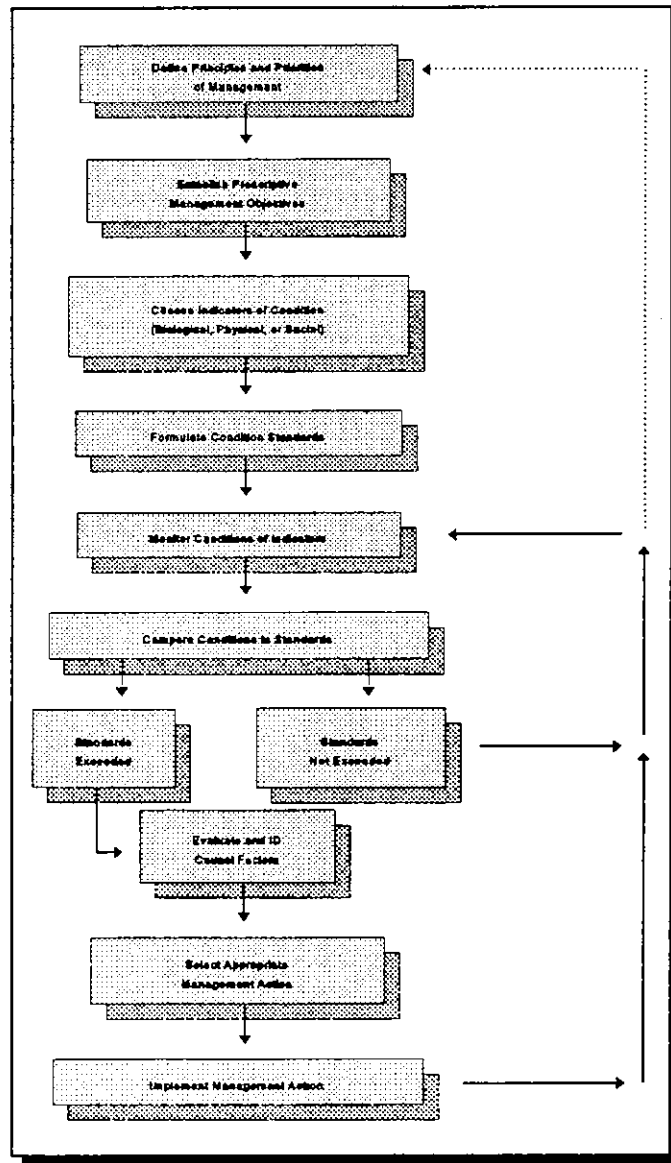


Figure 4. Schematic illustrating LAC/VIM planning and management (Williams 1994).

a policy process, including the Limits-of-Acceptable-Change (LAC) and the Visitor Experience and Resource Protection (VERP) frameworks, shown in **Figure 4**. LAC, however, may be a preferable approach because it does not rely upon the language of *carrying capacity*--a very subjective and easily misunderstood concept that is central to VERP. In addition, more people have had experience with LAC and, thereby, have had opportunity to contribute towards making it a more mature process than VERP. For a more detailed discussion of these frameworks, see Williams (1994).

Management and planning frameworks assist park staff members by guiding decisions about natural areas. When guided by a framework, a decision process simultaneously becomes more comprehensive and comprehensible. Ideas that underlie contemporary decision frameworks evolved from--and largely have replaced--approaches based upon "carrying capacity" models, in part because those earlier models were easily misunderstood as implying that the number of visitors is more important than how and where they act (Williams 1994). In contrast to typical carrying capacity conceptions, studies over the past several decades consistently show that, when seeking to describe the effects of recreation on any area that is primarily influenced by natural processes, the number of people recreating is less important than other considerations. Criteria that are more important than the number of people commonly include the seasonal distribution of visits, the type of activities that occur, the behavior of individual visitors, or characteristics of the locations that are visited (Cole 1986b, Cole and Marion 1986). In addition, "carrying capacity" suggests an emphasis upon regulatory responses to limit or control visitors. Such responses conflict with several important reasons that people visit natural areas, such as escaping the rules of everyday life or enjoying the freedom of being in a mostly wild area. VERP, with its emphasis upon defining carrying capacities, is subject to these preconceptions, despite its authors best efforts to more plainly define the term.

The Importance of Monitoring Programs

Programs that monitor resource and social conditions are critical to such frameworks and to park management efforts in general. There are many reasons to monitor backcountry campsite conditions, including providing information about the current condition of park resources, about trends in condition, or for identifying whether those conditions or trends compromise legislative mandates or administrative policy (Marion 1991a, Williams 1994).

Monitoring data are particularly valuable to those working for the National Park Service. If staff members of an NPS unit are to know whether they are conserving that unit's features unimpaired, as mandated by the agency's Organic Act, they must know the current conditions, understand how those conditions compare to previously documented ones, and anticipate future

conditions, especially those that may constitute impairment. To accomplish these steps, staff members may establish a monitoring program, perhaps in cooperation with scientists, as with this effort.

Decision frameworks and processes, when fully implemented, do not end. Each follows a sequence of steps that loop back to each other. The process begins with establishing meaningful **management objectives** and then choosing relevant physical, biological, and social **indicators** of change or condition. Once those participating in the process have selected indicators, they establish **standards** of acceptable conditions. Also, after selecting indicators, participants are prepared to **monitor** actual conditions to determine where conditions meet acceptable standards. Williams (1994) provides a detailed review of indicators, standards, and monitoring as part of an LAC effort.

Management Objectives

The first step of a strategic policy process is to define management objectives. Management objectives are distinct from management goals. Wheelen and Hunger (1992) define an objective as stating "*what* is to be accomplished by *when* and should be quantified if possible" (p.15). Objectives are specific, while goals are intentionally more broad and open-ended. Review of the management objectives found in Big Bend National Park's Statement for Management (USDI 1991) reveals objectives that are more accurately described as management goals. For example, the single management objective under the category of natural resources reads:

Actively manage park resources based upon sound scientific knowledge and National Park Service policies, so as to maintain a dynamic Chihuahuan Desert ecosystem while minimizing impacts.

This statement does not specify a time-frame, delineate specific components of the ecosystem, define *dynamic* or what constitutes an *impact*, nor does it mention the possible sources of impact that are a concern. It is too broad to be quantified. Progress, therefore, is not measurable. While it states an admirable goal, it does not serve as an objective because it is ambiguous.

Shomaker (1985) recommends five characteristics for a useful management objective.

Characteristics of a strong management objective ought to include the following: it is specific, not vague; it is objective oriented, not method oriented; it is quantifiable, not subjective; it is time-bounded, not limitless; and it is attainable, not unrealistic.

Indicators and Standards

The next step of a policy process is to select indicators and standards. An *indicator* is any component of the natural setting that changes in response to a process or activity of interest. Some potential indicators are better than others. Qualities of a strong indicator are shown in

Figure 4. When considering the effects of recreation, the condition of an indicator provides a gauge of how and where recreation has changed a setting.

A *standard* is a specific condition of an indicator or a rate of change in an indicator's condition. Standards typically represent a point when a management action will be taken. Standards do not describe preferred conditions; they describe unpreferred, undesired conditions. Management efforts may be facilitated if a management action is selected earlier--predetermined--in anticipation of possibly reaching the point when some standard is violated. By plainly stating a likely management action before conditions actually exceed standards, and stating it as only necessary should conditions exceed standards, people have an incentive to avoid contributing to those undesired conditions.

Selecting and Implementing Actions

Those participating in a policy process should consider possible actions even as they consider indicators and standards, instead

of waiting until a standard is exceeded. If they recognize that

it is difficult to respond to a proposed indicator should its conditions exceed standard, then they

CRITERIA	CONSIDERATIONS
Quantitative	Can the indicator be measured accurately?
Relevant	Does the indicator change as a result of the process or activity of interest?
Feasible	How complex are the measurements? Can the measurements be taken by available personnel? Can the required measurements be taken within available funding limits?
Reliable	How precise are the measurements? Will different individuals consistently obtain similar data when measuring the same indicator?
Responsive	Will management actions affect the indicator? Will visitor actions affect the indicator?
Sensitive	Will the indicator reveal change occurring in one sampling cycle?
Integrative	Does the indicator reflect only its condition or is its condition related to that of other, perhaps less feasibly measured, elements?
Significant	Does the indicator reveal relevant environmental or social conditions?
Accurate	Will the measurements be close to the indicator's true condition?
Understandable	Is the indicator understandable to people who do not have specialized training in monitoring of natural areas?

Figure 5. Criteria for selecting indicators of resource condition. See Williams (1994).

are also in a position to recognize that the indicator's application value is questionable. Good standards, produced with public participation, establish commonly shared and unambiguous statements of when resource conditions become unacceptable. Responses to an unacceptable condition should be considered when indicators and standards are selected, perhaps defined with the participation and agreement of those involved in the LAC process. In this way, greater incentive is established for avoiding a situation where conditions exceed standards.

Monitoring

Once the management objectives, indicators, and standards are defined, it is necessary to monitor existing conditions. By *monitoring* indicator conditions, those deciding how to manage an area are provided with quantified assessment of existing conditions. A monitoring program usually has raters measure conditions at multiple locations and, eventually, at different times. Those conditions are compared so that changes and trends become recognizable. During a strategic policy process, monitoring allows those involved to gauge the effectiveness of management actions, as well as to comprehensively "see" backcountry conditions via the monitoring results. Effective monitoring must be well designed, efficient, and scientifically valid.

Unfortunately, few monitoring projects have assessed and reported the consistency of their different raters. This is because methods for such an assessment did not exist until recently. Without an understanding of rater consistency, it is difficult to interpret assessment results. For example, an apparent change in condition may be an actual change or it may be simply the effect of having different people with slightly different perceptions assess the site. Cole (1989) suggests a method based upon an unpublished report by Steele (1987). Williams (1994) suggests alternatives. Those alternatives are also presented by Williams and Marion (1995), who applied Williams' (1994) methods in Shenandoah National Park in 1993 during an assessment of backcountry campsite conditions.

A strategic planning effort coupled with a decision framework incorporates monitoring studies so as to provide information to those who are participating in its open, participatory process. With an open process and quality information, participants in such an effort may understand a park's current backcountry situation and then work to promote future conditions that are mutually acceptable to those who care about the park and its visitors, contents, and character. By implementing an LAC process, park staff members can better understand and explain current conditions, whether they find those conditions acceptable, by what criteria they make that determination, and how they might respond (Marion, Cole, and Reynolds 1985). These are the components of a strategic process.

Monitoring Program Justifications

Monitoring backcountry campsites, as with other programs designed to assess changes in park resources, are justified by various legislative mandates. Several reviews of legislation relevant to monitoring efforts are available, including Marion (1991a) and Williams and Marion (1995). For Big Bend National Park, primary legislative mandates include the National Park Service Organic Act of 1916 (*U.S. Code*, volume 16, sections 1 and 1-1a), partially shown in the introduction of this report; the Wilderness Act of 1964 (P.L. 88-577); the National Environmental Policy Act of 1969 (*U.S. Code*, volume 42, section 4321 *et seq.*). Agency mandates also are found in the National Park Service's *Management Policies* (USDI 1988), its *NPS-75: Natural Resources Inventory and Monitoring Guideline* (USDI 1992), and its *NPS-77: Natural Resources Management Guideline* (NPS 1991). Other important sources include Big Bend National Park's establishing legislation, *General Management Plan* (USDI 1980), *Statement for Management* (Big Bend N.P. 1991), *Resource Management Plan* (USDI 1993) and *Backcountry Management Plan* (Big Bend N.P. forthcoming).

Although Big Bend National Park contains no formally designated Wilderness, the National Park Service in 1973, recommended 67% of the Park's acreage for designation as federal Wilderness. Because only Congress has the authority to accept or reject an area as part of the National Wilderness Preservation System, the Wilderness Act and National Park Service policy require that an area recommended for designation as Wilderness must be managed as Wilderness until Congress acts to formally designate it or to release it for other purposes. Monitoring programs can play an important role in assessing whether Big Bend National Park maintains the status of lands recommended for Wilderness designation and, in doing so, protects Congressional authority.

STUDY AREA

The U.S. Congress authorized Big Bend National Park in 1935 and established it with a formal Act in 1944 (USDI 1980). The Park today includes 801,163 acres, including 533,900 acres proposed for federally designated Wilderness with an additional 44,750 acres recommended for potential Wilderness. Congress has not acted to designate any of the Park as Wilderness, nor has the land been released for other purposes.

Big Bend National Park is located in Brewster County, Texas, along 118 miles of the Rio Grande river that forms the border between the Park and the Mexican states of Coahuila and Chihuahua. Elevations within the Park range from about 1,700 feet along the Rio Grande to 7,835 feet atop Mount Emory in the Chisos mountains. In three places along the river, Mexico and the United States are separated by steep, nearly vertical walled canyons that approach heights of one third mile: Santa Elena, Mariscal, and Boquillas. Seasonal flooding is common along the river, as this section is relatively unaffected by dams. The river provides a moist habitat for riparian vegetation and an important source of water for native animals and local residents, particularly Mexican nationals. Domesticated, free-ranging horses often cross the river from their owners in Mexico.

The Park is within the northernmost region of the Chihuahuan Desert. The region is noted for high summertime temperatures and cool winters (MacMahon 1985). Winter snows are not uncommon; yet, they are also infrequent and short-lived. The desert is known for its grasses, yuccas, and agaves, as well as its geologic formations. Rainfall is sparse over the year, but locally heavy rains can occur. Average annual precipitation varies from 9 to 16 inches, depending upon elevation, and 75% of the precipitation falls during the months from April through September (USDA 1985). After a rainfall, some of the water will drain into gullies that become short-lived streams. Much of the remaining water evaporates. Some, however, will collect into tinajas, natural depressions in rocks. Scattered, larger tinajas may contain water throughout the year and serve as small, although critical, reservoirs for desert animals.

Within the Park lies the Chisos Mountains, a small range notable for being the only mountain range completely encompassed by a U.S. National Park. These mountains form a relatively moist island of woodlands surrounded by desert. They are of volcanic origin. Average rainfall in the Chisos is twice the amount that falls along the Rio Grande in the Park.

Vegetation

The Park's Resource Management Plan lists six broad categories of vegetation found in the Park (USDI 1993). The *woodland* type occurs above the Sotol-Grass Formation and includes the Chisos Mountains. Most often associated with moderate to steep slopes of the Chisos and Green Gulch, but also extending down to the desert floor along small and medium size washes. The canopy need not be closed, as several scrub and meadow subtypes are associated. Common families include oak (*Quercus*), pine (*Pinus*), fir (*Pseudotsuga*), and even maple (*Acer*).

The *sotol grass* type is typically located between the woodland and shrub desert formations. This type is marked by fairly continuous grasses and an assortment of shrub species. Notable plants within this type include lechuguilla (*Agave lecheguilla*), sotol (*Dasylirion leiophyllum*), and several members of the *Yucca* family, although grasses, especially those of the Grama family, best define the type.

The *shrub desert* type encompasses most of the Park. It is dominated by creosote bush (*Larrea tridentata*), ocotillo (*Fouquieria splendens*), and lechuguilla, although large trees and shrubs may be found around springs. Grasses are often intermixed within this type, but tend to be more widely spaced than in the sotol grass formation.

The *river floodplain* is immediately associated with the Rio Grande and its larger tributaries. Common families include mesquite (*Prosopis*), reed grasses (*Phragmites*, *Arundo*), huisache (*Acacia*), cottonwood (*Populus*), and willow (*Salix*). Species from these families may appear mixed together (heterogeneously) or in distinct (homogeneous) growth areas.

Two remaining types are fairly uncommon. The *island* type is seen as a small area of one type surrounded by one or more types, as might be found around a spring. The *bare* type is an area lacking any vegetation regardless of recreation effects.

Soil

The Big Bend region is geologically diverse, marked by sedimentary rocks from the Cretaceous Age (65-140 million years ago) intruded by volcanic rocks of the Tertiary Age (20-45 million years ago), both heavily eroded (USDA 1985). Natural erosion occurs easily, although rainfall is sparse. This apparent paradox happens because rain that does fall is often intense, and vegetation commonly is lacking, unavailable to hold soil or absorb water. A shale dominated unit and a sandstone dominated unit comprise much of the Park. These areas are associated with the sotol grass and shrub desert vegetation types. Both soil units contain important amounts of

clay with a high shrink-swell potential. Swelling of soil following rain can contribute to a reduction in soil compaction where compaction has occurred.

Surface soil conditions vary greatly. In the woodlands of the Chisos, organic deposits can form an organic horizon of some depth. Much of the remaining areas of the Park have a shallow or absent organic horizon, especially in the shrub desert and bare vegetation types. In areas outside the Chisos, particularly in the shrub desert vegetation type, *desert pavement* may form. It is marked by extremely sparse local vegetation and a surface layer of cobbled gravel consisting of regularly spaced stones, often less than 3 inches in diameter, with darkened undersides and interspersed with fine textured soil. Elsewhere in the Park, the soil surface frequently consists of mineral soil, small and large stones, or exposed bedrock.

Cultural History

Human history in the Big Bend region extends 10,000 years (USDI 1993, Horgan 1984). Land that is now the Park has witnessed the mostly unwritten history of Native American cultures whose shadows remain as the occasional pictograph or petroglyph, arrowhead chip or flake, hearth, midden, or rock shelter. Until the last several centuries, most of those who visited the area were Native Americans attracted by chert and other materials they needed for arrowheads and similar implements. They frequently congregated near water sources, many of which remain active today (Alex 1993).

The land has seen the partially documented adventures of Spanish adventurers passing through in search of, first, shipmates, and, then, silver and other treasure. They found little reason to stay, calling the land 'the uninhabited place.' The land also has witnessed Mexican and European settlers who struggled with the rugged landscape, heat, and seasonal raids by Comanche and Kiowa bands of Native Americans seeking horses and supplies needed to continue their mostly nomadic life in the North American plains.

It was cattle, brought in large numbers by Anglo-American settlers in the late nineteenth and early twentieth centuries, that forever changed Big Bend. What was once described as thickly sodded grassland became desert (Maxwell 1949, Utley 1962). Grasses, once thought to be endless and indestructible, proved vulnerable to the forces of too many hooves attached to too many hungry cattle. Once grand grasslands are no more. What remains is a frail hint of their former selves. Today, the face of the Big Bend region is well-weathered.

RESEARCH METHODS

This project's objectives call for design and implementation of a system capable of monitoring changes in a backcountry campsite's resource conditions. More specifically, the system must apply to campsites found in Big Bend National Park. To monitor changes in resource conditions requires comparison between two locations with similar conditions (disturbed and undisturbed) or the same location assessed at two times (assessments of the same campsite completed several years apart). The literature review conducted during this project revealed that previous efforts in Big Bend National Park to assess backcountry campsites have limited comparability with this or other future efforts. A typical reason for this is that methods were imprecisely documented, as when a consistent definition of a campsite is unavailable. By implication, this effort is limited to assessing differences between the condition on the campsite and that on immediately adjacent, undisturbed, comparable areas. Although this project establishes a repeatable method, opportunities to compare results with previous work are few.

Monitoring Procedures

Monitoring procedures employed during this study emphasize a multiple indicator, measurement-based approach with condition class assessments and photographs. Specific methods are documented in a field manual provided with this report. The manual clearly describes measurement techniques for each indicator, and contains reassessment procedures, as well.

Each campsite assessment required a field crew of two persons approximately 15 minutes to complete. The survey's objective was *to conduct a census of all discernable backcountry campsites in frequently visited areas*, as opposed to throughout the Park. A map of areas and trails covered has been submitted with the final copy of this report and is on file in the Park's Resources Management and Science Division.

A census was viewed by investigators and Park staff as necessary to accurately characterize the distribution of campsites and aggregate change for each campsite condition indicator (e.g. the total area of disturbance affected by camping). The need to characterize the condition of campsites in more frequently visited areas of the Park is in addition to the need to characterize individual campsites in those areas. Both needs are met with a census. Comprehensive data

from frequently visited areas is also needed to support any future implementation of a new standards-based management framework. Such data are essential for both developing realistic standards for various opportunity classes and for identifying the number and location of campsites that exceed those standards.

Field work was conducted from September to December, 1993. Specific assessment dates are included for each campsite. Survey staff included two paid Virginia Tech staff, with occasional assistance from several Student Conservation Association (SCA) volunteers working with the Park. Approximately 7 total person-months (1 person working 160 hours/month) were required to complete all fieldwork. Field staff typically worked in pairs. When working with SCA volunteers, a pair consisted of one paid and one volunteer member. Virginia Tech field staff used the first three weeks of the project to adapt Marion's (1991a) manual to Big Bend National Park's specifics.

Defining a Backcountry Campsite

For the purposes of this project a backcountry campsite is defined as an area other than a trail that has been disturbed by people recreating, as might result from either overnight camping or daytime activities. The disturbed area is neither too steep nor too small for camping. The campsite is noticeable because its vegetation, surface litter, or ground surface have been changed compared to conditions on similar, undisturbed, and adjacent areas. A visible boundary must exist between the campsite and adjacent areas. Survey staff did not seek to distinguish between effects of camping activities and the effects of day-visit activities because the significance of the effects is identical. A key criteria is that the area reasonably could serve as a camping location.

Undisturbed areas separating sites might not exist in all areas with multiple sites, so a surveyor occasionally might make an arbitrary decision to define separate sites. The manual instructed surveyors to note on the associated campsite survey forms whenever any such case occurred.

Locating a Campsite

Three approaches assist in locating campsites: 1) discussions with experienced backcountry rangers to identify potential camping areas, 2) floating of each of the three major canyons, stopping at every potential camping location; hiking of all Park trails, however faint; and driving of all passable Park roads in the backcountry, and 3) searching areas identified on maps as likely camping locations (areas near water and formal Park trails with low slopes). Because of the Park's size, the small number of surveyors, and the relatively short amount of time available, there are areas of the Park where campsites were not assessed or where the assessment was more limited. Assessment on Mesa de Anguila, for example, was limited to areas around major tinajas and trails.

Assessing the Three Types of Campsites in Big Bend National Park

Once a surveyor recognizes that a campsite exists with a reasonably clear boundary between disturbed and undisturbed areas, the surveyor begins a site survey by selecting a form appropriate for the type of campsite (Figure 6). Each type of form allows surveyors to collect consistent information in three general categories: 1) identifying the campsite, 2) describing its location, and 3) indicating its condition. *Campsite condition indicators*, collected in the third category, are those elements of a campsite that are affected by camping or other recreation activities, that can be measured reliably by surveyors, and that will change as a result of actions to manage camping. Measurement of condition indicators may require a comparison between off-site and on-site conditions. Alternatively, surveyors may measure an indicator's areal extent within the campsite.

1. **BACKCOUNTRY CAMPSITE FORM:**
for either a designated or undesignated campsite that requires hiking for access.
2. **BACKCOUNTRY ROAD DESIGNATED SITE FORM:**
for a designated campsite to which one drives in the backcountry.
3. **RIO GRANDE RIVER USE AREA FORM:**
for all areas where the primary access is by river. Some Rio Grande sites are accessible by road, too. The primary access route for those who camp in these areas determines the appropriate form. If most campers access the location by river, then the river form applies. However, if most campers access the area by road, then either the DESIGNATED SITE FORM or the BACKCOUNTRY CAMPSITE FORM applies, depending on whether the site is designated or not. If in doubt, use your best judgement and note your reasoning.

Figure 6 Description from the Surveyor Manual of the three campsite assessment forms applied in Big Bend, 1993.

Rio Grande campsites present a special situation because the effects of river flooding and livestock presence greatly outweigh those of camping. Recreational effects at these campsites are substantially confounded with flooding effects. Severe flooding can completely rearrange the riparian zone and dramatically alter or even remove individual campsites. Additionally, the boundary between off-site and on-site conditions is often indistinct and can be affected greatly and easily by river conditions. For these reasons, techniques selected to assess Rio Grande campsites intentionally do not allow comparison between on-site and off-site conditions or measure the area of disturbance. Surveyors were instructed not to distinguish between on-site and off-site conditions at Rio Grande campsites except with general comments. Likewise, surveyors did not install permanently referenced campsite centerpoint pins because flooding is likely to either wash away the pins or deposit material that makes relocation impossible. Changes due to livestock also confound any assessment of camping effects even between flood events, although the degree of change due to livestock is likely also outweighed by flooding.

Special caution is necessary when considering Rio Grande campsites. Information collected during a monitoring effort must be relevant to the process of interest, in this case recreation, as shown in **Figure 4** (page 19). This is especially important should managers intend the information for a standards-based decision process. For Rio Grande campsites, comparisons between off-site and on-site conditions would require inappropriately subjective decisions. Results from such a comparison might lead one to conclude erroneously that recreation contributes more to condition than likely it does. The influence of the river and livestock is greater on those sites, especially if one were to compare conditions measured several years apart. In such a case, the river is certain to have altered the site at least once and livestock have an ongoing effect on the area, so any comparison for the purposes of assessing changes caused by camping during that period would be inappropriate. Instead of capturing data with uncertain value, information gathered during this survey emphasizes general site location, capacity, apparent activity level, and basic indicators of whether visitors are complying with Park regulations (e.g., litter, human waste, and fire sites). Several of these indicators are assessed based on the experience of National Park Service River Rangers who accompany survey staff and are familiar with river activities.

The conditions of all campsite indicators were assessed only within the established boundary of the campsite. Procedures also allowed for additional assessments within obvious "satellite" areas. Those additional procedures are found in the Monitoring Manual. Fixing the area of interest within campsite boundaries is necessary to increase the precision of assessments made by different surveyors, although this approach reduces measurement accuracy. For example, counts of damaged trees and stumps are conducted only within campsite boundaries to increase the efficiency and precision of these assessments. Theoretically, a more accurate approach would involve thorough off-site searches to assess these indicators. However, experimental trials have shown this approach to be exceptionally time-consuming and imprecise, as surveyors vary considerably in their thoroughness conducting off-site searches. Additionally, problems were encountered in assigning damaged trees or stumps that were mid-way between two or more campsites. Although off-site tree damage and stumps were not assessed, we expect that thorough on-site and off-site assessments for these indicators would be highly correlated, especially for data aggregated over larger numbers of campsites.

In summary, for monitoring purposes it is often necessary to partially compromise measurement accuracy (closeness of measurements to a true value that can never be known) in order to increase measurement precision (closeness of measurements to each other). This compromise, however, improves a monitoring method's utility because a standards-based management framework requires a high degree of precision for reliable comparisons of data to standards and to data from other monitoring cycles. Greater consistency between surveyors is most important for monitoring purposes because it allows the identification of actual changes, as opposed to

perceived changes that are really only a reflection of differences between surveyors. The discussion about measurement error helps clarify this point and follows shortly.

Condition Indicators

Campsite indicators were selected on the basis of earlier recreation ecology studies and discussions with Park staff. Consideration was also given to the criteria selecting monitoring indicators (shown in **Figure 4**) and knowledge about recreation effects on soil, vegetation, and aesthetics. For soil, the percentage of exposed soil was assessed according to a six-category cover-class scale. Where applicable, the number of trees with moderate to severe root exposure were counted within delineated campsite boundaries as an indication of soil compaction and erosion. The primary ground surface on-site and off-site also were categorized for comparison. Vegetation conditions were assessed according to the percentage of ground covered by either non-woody vegetation or grasses on-site and off-site. A six-category cover-class scale provided categorical estimates of cover. Where applicable, the number and degree of damaged trees and number of tree stumps were also assessed. Aesthetic and behavioral indicators included the number of trails extending from a campsite, distance from the campsite to water and formal Park trails, number of fire scars or fire rings, the presence of litter, and the presence of human waste. Number of satellite campsites also was assessed. Additional discussion on the selection of indicators and a thorough review of related literature is provided by Williams (1994).

Finally, some data was most efficiently collected following field work. In particular, assessments of campsite distance to roads and Park structures and campsite density were made using U.S. Geological Survey maps (1:24,000), upon which campsites had been precisely located during field work.

Data Analysis

A challenge associated with all resource inventory and monitoring programs is efficient storage and evaluation of collected data. Occasionally, because of the extensive time required for data input and analysis, monitoring data may not be interpreted or used in the planning and management process as originally intended. To alleviate this problem, a database and associated menu-driven programming were produced using DBASE IV, a personal-computer database management package. The database is saved in a standard format that most other database and statistical analysis computer programs will read. The programming simplifies statistical analysis of this and future data.

We have presented the study results in tables and show both the mean (arithmetic average) and median (value above and below which half of the measurements fall). The mean is not always

the best measure of central tendency due to the effect of outlier data (values that are far removed from the rest) and distributions which are highly skewed (not distributed in the form of a bell-shaped curve). In these instances the median provides a better estimate of central tendency and is emphasized in discussions for those indicators. We also report the standard deviation and the minimum and maximum values for each indicator because they serve as evidence of the range and variability within those data.

Assessing Measurement Error

Measurement error is part of the resulting data from any study of resource conditions. As with all measurements, every measurement of an indicator consists of two components: (1) a component reflecting an accurate assessment of true conditions and (2) a component reflecting measurement error. Measurement error does not mean that a measurement is wrong. It means only that variation occurs in data even when they come from multiple measurements of a single unchanged item. Measurement error associated with projects of this type primarily come from differences in the judgement of field staff who apply the assessment procedures. These differences in opinion are entangled and confounded with actual changes in resource conditions.

To identify the degree of error and to improve the interpretation of survey results, a field experiment is necessary to evaluate the precision of campsite measurements. Precision relates to measurement consistency and reflects the ability of field staff to obtain the same or similar results when independently evaluating a common set of campsites. Further discussion on measurement error and its implications for backcountry campsite assessments is provided by Williams (1994).

For this project, detailed measurement procedures and the hiring, training, and supervision of capable field staff helped to minimize measurement error. It remains, however, an element of the values reported. All measurements of campsite indicators are an approximation of the true value, made fuzzy by an unavoidable degree of measurement error and an element of subjectivity introduced by multiple raters or surveyors. Investigators must distinguish between the typical measurement error associated with their survey methods and the effect of multiple raters of multiple campsites. Only then can they hope to understand the range within which the true value is most likely to lie. Only with such information can investigators describe the likelihood that a difference between measurements taken by different raters or at separate times is an actual difference and not an artifact of either measurement error or rater subjectivity.

Because only one team of raters predominantly gathered the data for this project, assessment of precision is not possible. Future assessment applications, however, should seek to identify the

rater's consistency. Techniques for doing this are described in Williams and Marion (1995) and Williams (1994).

For statisticians: Williams and Marion (1995) apply techniques of generalizability theory (G-Theory) to assess their data. Extensive citation of literature from G-Theory applications is located in their (1995) report and in Williams's (1994) thesis. The statistical program SAS contains a procedure called VARCOMP that allows an investigator to complete a factorial ANOVA analysis of individual indicators when the data has been sorted by those indicators. The *facets of interest* become campsite and rater. Campsites are the *objects of measurement* and raters are *conditions* controlled by the method. G-theory allows an investigator to identify the variation attributable to changing raters and campsites, and to identify unexplainable variation. As a result, it is possible to identify those indicators that assessors measure most consistently and to describe the degree of measurement error and variability associated with measuring each indicator. Williams (1994) provides more detailed discussion of these analyses and describes specific procedures.

SURVEY RESULTS

These results represent the survey of 268 backcountry campsites found in Big Bend National Park. Survey results are presented to describe: (1) campsite distribution, (2) campsite attributes, and (3) campsite resource conditions.

An important footnote to the following presentation is that survey results apply only to a near census of "discernable" campsites within the areas searched. Survey staff may have missed some campsites, although thorough searches were conducted in all areas identified by Park staff as likely to have campsites (refer to Methods section for search procedures). Additionally, it is not clear how many backcountry visitors actually camp on otherwise pristine sites that are used so infrequently that no boundaries exist that would make them discernable as campsites. It is clear, however, that survey staff found no such sites within the areas they searched. This is notable because much of the ground surface in Big Bend National Park consists of gravel and is uncomfortable to sleep on unless a camper moves the rocks. In these areas, a single camper often leaves a site with a recognizable area where rocks have been moved for a sleeping spot. Thus, even a single camping event can leave a noticeable campsite, although soil compaction and vegetation disturbance may be negligible.

Campsite Distribution

The distribution of campsites by location and type is presented in Table I. The largest grouping of campsites are those outside the Chisos Mountains which are undesignated and accessed by trail (N=86, 32%). The Rio Grande, with 55 campsites (21%), and road accessed designated campsites (N=52, 19%) each account for approximately one-fifth of the Park's campsites. In the Chisos Mountains, survey

Table I Number and percent of campsites by campsite location and type.

Campsite Location and Type	Campsites	
	Number	Percent
~~Rio Grande~~	~~55~~	~~20.5~~
~~Road Access, Designated~~	~~52~~	~~19.4~~
~~Road Access, Undesignated~~	~~6~~	~~2.2~~
Trail Access, Undesignated	86	32.1
Chisos, Designated	42	15.7
Chisos, Undesignated	27	10.1
Total Number of Campsites	268	100.0

Survey Results

staff located and assessed 42 designated campsites and 27 undesigned campsites, accounting for 26% of the total. Six undesigned road accessed campsites also were located.

The Park has divided the backcountry into several dozen Use Areas which serve as geographical units for visitor management (Big Bend NP 1993). Table II shows the distribution of campsites within each Use Area. It also shows the management designation and camping type of each Use Area. Each Use Area has a management designation as either Threshold, Primitive, or Wild, representing management objectives related to maintaining a range of visitor experience types based on levels of primitiveness and solitude. In part, prescribed levels of trail development and signing, overnight camper limits and camping type, and protection of sensitive resources are derived from these management designations. The largest number of campsites (N=69, 25.7%) are found in the High Chisos (CO2) Use Area. Although managed under a designated site camping policy, survey staff located 27 undesigned campsites. Additional discussion about these campsites is found under the campsite attributes section.

Just over one-fifth of the campsites (N=58, 21.6%) are located adjacent to backcountry roads,

Table II Number and percent of campsites by Park Use Area code.

Park Use Area Code	Management Designation	Camping Type	Campsites	
			Number	Percent
CO2, High Chisos	Threshold	Designated	69	25.7
CO3, Lower Juniper	Primitive	Open	6	2.2
CO4, Dodson	Primitive	Open	23	8.6
CO5, Blue Creek	Primitive	Open	2	0.7
EO5, Ore Terminal	Primitive	Open	2	0.7
EO6, Strawhouse	Primitive	Open	3	1.1
EO8, Marufo Vega	Primitive	Open	5	1.9
RO1, Rio Grande, Santa Elena	Unestablished	Open	21	7.8
RO3, Rio Grande, Mariscal	Unestablished	Open	8	3.0
RO5, Rio Grande, Boquillas	Unestablished	Open	26	9.7
SO1, Mule Ears	Threshold	Open	16	6.0
SO2, Upper Smoky	Primitive	Open	7	2.6
WO1, Canyon Flag	Primitive	Open	4	1.5
WO2, Bruja Canyon	Wild	Open	4	1.5
WO3, Mariposa	Primitive	Open	4	1.5
WO5, Terlingua Creek	Wild	Open	1	0.4
WO6, Chimneys	Threshold	Open	9	3.4
Backcountry Road Corridors	N.A.	N.A.	58	21.6
Total Number of Campsites			268	100.0

which are omitted from the Park Use Area zones. Along the Rio Grande, the Boquillas canyon has the largest number of campsites (N=26), followed by the Santa Elena canyon (N=21), with relatively few campsites in the Mariscal canyon (N=8). Other concentrations of campsites occur in the Dodson (CO4) and Mule Ears (SO1) Use Areas, with 23 and 16 campsites, respectively.

The vegetation community surrounding each campsite was determined according to six general vegetation communities described in the Park's Resource Management Plan (Big Bend NP 1993). Campsites are almost equally distributed among four vegetation types (Table III). Campsites in the River Floodplain vegetation type (N=65, 24.2%) are those along the Rio Grande, ten of which are primarily accessed by road or trail. Common species include mesquite, reed grasses, huisache, cottonwood, and desert willow. Campsites in the Shrub Desert (N=62, 23.1%) are typically located amongst creosote bush and lechuguilla, with some widely spaced grasses and cacti. Typically located between the Shrub Desert and Woodland formations, the Sotol Grass vegetation type accounts for 67 (25.0%) of the campsites. This type is characterized by nearly continuous cover of sotol and other grasses, with lechuguilla and yucca also commonly present. Campsites in the Woodland vegetation type (N=70, 26.1%) are predominantly those in the Chisos Mountains. Common tree species include piñon pine and several species of junipers and oaks, though many campsites occur under open or partially open tree canopies. Lastly, four campsites occur within the Island type, defined as a small area of one vegetation type surrounded by one or more other types.

Table III Number and percent of campsites by vegetation community.

Vegetation Community	Campsites	
	Number	Percent
River Floodplain		
River accessed	55	20.5
Road/trail accessed	10	3.7
Shrub Desert	62	23.1
Island	4	1.5
Sotol Grass	67	25.0
Woodland	70	26.1
Total Number of Campsites	268	100.0

Table IV Number and percent of campsites by primary mode of access.

Primary Mode of Access	Campsites	
	Number	Percent
2x4 Road	25	9.3
4x4 Road	33	12.3
Major Trail	76	28.4
Minor Trail	55	20.5
Primitive Trail	20	7.5
No Trail		
Hiking accessed	4	1.5
River accessed	55	20.5
Total Number of Campsites	268	100.0

Survey Results

Table IV (previous page) shows the number and percent of campsites by the primary mode of access. Over half of the campsites are primarily accessed by trail (N=151, 56.3%). However, some backcountry campsites are accessible by a standard two-wheel drive car (N=25) while others are most commonly accessed by four-wheel drive vehicles (N=33). Fifty-nine campsites have neither trail or road access, primarily the Rio Grande campsites (N=55) that are accessed directly from the river.

Campsite Attributes

Campsite attribute information was collected to further characterize campsite legality, campsite locations, environmental features, and facilities. This information is shown in Tables V and VI. According to current Park campsite legality criteria (Big Bend NP 1993), 121 out of 268 assessed backcountry campsites (45%) are illegal by one or more criteria (Table V). The majority of these illegal campsites occur in the undesignated trail category (N=84, 69.4%),

Table V Selected campsite legality criteria by campsite location and type¹ for 268 campsites assessed in Big Bend National Park, 1993.

LEGALITY CRITERIA	CAMPSITE LOCATION AND TYPE						Row Totals
	Rio Grande (N=55)	Road, Desig. (N=52)	Road, Undesig. (N=6)	Trail, Undesig. (N=86)	Chisos, Desig. (N=42)	Chisos, Undesig. (N=27)	
Illegal by 1 or more criteria:	4	<i>N.A.</i>	6	84	<i>N.A.</i>	27	121
Campsite < ½ Mile from a Road (#)	0	<i>N.A.</i>	6	3	0	0	9
Campsite < 100 yds from Archeological Site (#)	4	8	1	20	0	0	25
Campsite < 100 yds from Water (#)	<i>N.A.</i>	17	2	18	0	2	22
Campsite < 100 yds from Trail (#)	<i>N.A.</i>	<i>N.A.</i>	<i>N.A.</i>	80	24	26	106
Campsite not Designated but in a Restricted Camping Area (#)	0	0	6	0	0	27	33

¹ - Legality criteria are applied to all campsites; designated campsites that violate criteria, however, are indicated in italics and omitted from row and column totals.

although camping outside of designated sites in the Chisos Mountains accounts for an additional 27 illegal campsites. Several of the Chisos campsites, and perhaps all of them, likely existed prior to the 1985 policies that require visitors to camp in only designated sites. Prior to 1985, the sites likely would not have qualified as illegal. The campsites currently exhibit conditions that meet the criteria for active sites and, therefore, are illegal by current standards because they are undesignated campsites located in an area where camping is only allowed at designated sites. It is unclear whether this categorization is appropriate given the previous history. It is appropriate, however, to conclude that the sites have not recovered to a point where they no longer meet the criteria of a campsite. For this reason, we have assessed them as campsites and categorized them as illegal to draw attention to the question.

The most commonly violated campsite legality criteria is camping within 100 yards from a trail. There are 106 campsites (87.6%) that are in violation of this criteria. The large number and percentage of campsites in violation of this criteria suggests several possible interpretations. One is that backpackers frequently disregard this camping regulation. Another is that the regulation is poorly understood by or communicated to campers. And a third possible interpretation is that information about how to comply with the regulation is poorly understood or communicated to campers.

Less commonly violated campsite legality criteria include camping outside of a designated campsite in a restricted camping area (N=33), camping within 100 yards from an archeological site (N=25), and camping within 100 yards from water (N=22).

Table VI shows the location and attributes of Big Bend campsites. Campsites that are not designated tend to be located quite close to trails. The average (mean) campsite distance from trail is 78 feet for undesignated trail-accessed campsites, 115 feet for undesignated campsites in the Chisos, and 377 feet for the designated campsites in the Chisos. Nearly all of the undesignated trail-accessed campsites (80 out of 86, 93%) are less than 100 yards from a formal trail. Furthermore, 71 of these sites (83%) are within 50 yards of a trail and 65 (76%) are within 100 feet. Even in the Chisos, however, 24 of the 42 designated campsites (57%) are located within 100 yards of a formal trail and 8 sites (19%) are located within 50 yards.

Campsite elevation varies from an average (mean) of 1,964 feet for the Rio Grande sites to an average (mean) of 6,758 feet for the designated Chisos sites. This distribution mirrors the geographic diversity and range within the Park.

Table VI Selected campsite location and attribute indicators by campsite location and type.

INDICATOR ¹		CAMPSITE LOCATION AND TYPE					
		Rio Grande (N=55)	Road, Desig. (N=52)	Road, Undesig. (N=6)	Trail, Undesig. (N=86)	Chisos, Desig. (N=42)	Chisos, Undesig. (N=27)
Distance from Trail (ft)	Mean	N.A.	N.A.	47	78	377	115
	Median			8	46	277	68
	N			6	85	42	27
Elevation (ft)	Mean	1,964	2,556	2,513	3,524	6,758	6,538
	Median	1,920	2,411	2,493	3,200	6,745	6,915
	N	55	52	6	86	42	27
Distance to Water (yds)	<25	N.A.	7	1	13	0	2
	26-75		6	0	1	0	0
	76-100		4	1	4	0	0
	>100		35	4	68	42	25
Water Source	Spring	0	8	0	37	6	3
	Tinaja	0	2	0	9	0	0
	None ²	55	42	6	40	36	24
Canopy Cover over Campsite (%)	0-25	N.A.	46	6	84	10	16
	26-50		3	0	2	10	2
	51-75		0	0	0	8	4
	76-100		1	0	0	14	5
Other Campsites Visible (# of sites)	0	32	38	6	43	37	15
	1	20	9	0	22	5	7
	2	3	1	0	9	0	0
	3	0	2	0	5	0	0
	≥4	0	2	0	7	0	5
Toilet (nearby)	None	52	52	6	86	38	23
	Pit	0	0	0	0	4	4

1 - The median is the value above and below which half of the measurements fall and can be a better measure of central tendency than the arithmetic mean. Comparisons between areas may not be appropriate unless statistics are based on at least 5 and preferably more than 10 campsites (refer to "N" values in table above).

2 - No dependable water source within a 5 minute walk of campsite (some water sources are ephemeral). Rio Grande visitors carry all drinking water from developed sources.

Big Bend NP campsites are rarely located close to water. Most visitors carry water from the start of their backcountry trip because there are relatively few dependable water sources in the Park. In the Chisos Mountains, only 2 of 69 designated or undesignated campsites (3%) are located less than 100 yards from water. Eighteen of the 86 undesignated trail-accessed

campsites (21%) are less than 100 yards from water and 17 of 52 designated road-accessed campsites (33%) are less than 100 yards from water. Surveyors noted the type of water source within a five minute walk. Springs serve as a potential water source for 54 of the 268 campsites (20%), particularly for undesignated trail-accessed campsites where 37 of 86 campsites (43%) are located within a five minute walk of a spring. Campers at 11 assessed sites could obtain water from a tinaja within a five minute walk. The Rio Grande is within a five minute walk of 75 campsites, but its water is commonly considered too silty and polluted to be used as a water source except for bathing or dishwashing.

The majority of campsites are located in the open or under partial tree canopies. This is particularly true for the road-accessed campsites and the undesignated trail-accessed campsites. On the Rio Grand campsites tree cover is not reported because it was not assessed. Campsites in the Chisos Mountains are more typically located under partial to full tree cover. For example, just over half of the designated campsites in the Chisos have more than 50% tree cover, whereas only one other assessed campsite shares this characteristic.

Campsite inter-visibility refers to the number of other campsites visible from each campsite and is a measure of the potential for solitude while camping. Designated campsites in the Chisos Mountains offer the best opportunity for solitude, 37 of the 42 campsites (88%) have no other sites visible from their boundaries and only one other site was visible from the remaining five campsites. In contrast, only half of the 86 undesignated trail-accessed campsites have no other sites visible, 22 have no other sites visible, and 7 have more than 3 other sites visible.

Campsite facilities include pit toilets located near four of the designated campsites in the Chisos Mountains. These toilets are relatively close to two other designated and four undesignated campsites. In 1992, Park managers added steel food storage boxes to all the designated Chisos campsites because bears have returned to the area by migrating north from Mexico.

Two additional indicators were assessed only on Rio Grande river-accessed campsites. One is the site capacity and the other is level of site use. These two indicators were added to the survey after the Boquillas trip, so the results reflect only Mariscal and Santa Elena sections of the Rio Grande. Site capacity is a surrogate measure of site size that reflects the relationship between landing area capacity and camping area capacity. Some sites can land more people than their is room for camping and other sites have less space for landing boats and much room for camping.

In the estimation of survey staff with the assistance of accompanying NPS River Rangers, 21 of the river sites can only accommodate small groups (1 or 2 rafts), with respect to the size of either their boat landing area or area available for camping. Twenty of the river campsites can accommodate medium-sized groups (3-4 rafts) and 13 of the campsites can accommodate large

groups (≥ 5 rafts). Level of site use, determined with the help of experienced NPS River Rangers, ranged from inactive to high. Four sites were judged to be inactive, eight as low use, four as moderate use, and nine as high use. Surveyors assessed all sites, even those judged inactive, in each of the three river sections.

Campsite Conditions

Additional environmental measurements and assessments were made on all surveyed campsites to document their condition. Selected campsite condition indicators are presented in Table VII according to campsite location and type (the table begins on page 49 and spans three pages). Most of these assessments were omitted for the Rio Grande river-accessed campsites. The reason for omitting these sites is that, as previously noted, livestock grazing and annual flooding along the banks of the Rio Grande substantially affects the condition of river-accessed campsites. In particular, vegetation and soil disturbance from livestock grazing and trampling is similar to and difficult to distinguish from (i.e., are confounded with) the effects of human recreational activities. The effects of annual flooding are also pervasive, rearranging the riparian landscape by removing and creating the sandy river bars and shorelines upon which most campsites are situated.

Ground cover in Big Bend National Park typically consists of vegetation (herbs and cacti), grasses (including sedges), and exposed soil (gravel, larger rocks, mineral soil, organic litter, etc). Other, more woody vegetation also can occur, especially in the Chisos and in riparian areas. Because that growth form is quite un-resilient (very susceptible to damage and unlikely to recover), it makes a poor indicator and is not reflected in these surveys. Additionally, previous work elsewhere has shown that campers tend to select sites with the least amount of woody vegetation cover (Cole 1986b). During this survey work, grasses are distinguished from other vegetation because grass recovers more rapidly than other vegetation and is especially notable in a desert environment as compared to more forested areas.

Three groups of indicators are most helpful when trying to gauge the effect on ground cover that is attributable to camping. Those groups are vegetation cover, grass cover, and soil exposure. For each of these three groups of indicators, surveyors assessed the percentage of total ground cover comprised by the particular category (vegetation, grass, or soil) both within campsite boundaries and in immediately adjacent undisturbed off-site areas with similar environmental attributes. The off-site areas serve as a surrogate for how each campsite would have looked had no camping occurred. They then recorded the most appropriate coverage class from pre-defined categories (see Appendix I for specific procedures). These values represent categorical ranges. For analyses, the midpoint of each category is assigned. To estimate the change in the amount of

the original vegetation, grass, and exposed soil on the campsite, a separate percent value is calculated that reflects the ratio between the original percentage of coverage and the percentage seen on the campsite.

Condition Class

A descriptive condition class system was applied to each campsite and provides a general indication of site conditions. A description of each condition class appears in Figure 7. Undesignated campsites, regardless of location or access, are generally in the best condition. For example, 64 (74%) of the undesignated trail-accessed campsites outside the Chisos are rated as condition class 1 or 2. For undesignated campsites located in the High Chisos, 17 of the 27 campsites (63%) also fall into these two categories. These sites are generally small with minimal vegetative or soil disturbance. Campsites that are occupied more frequently, primarily the designated campsites, received condition class ratings indicative of greater environmental change. All of the designated Chisos campsites (100%; N=42) received ratings of 3 or 4 and all but two of the designated road-accessed campsites (96%; N=50) received such ratings. The effects of visitation are more obvious on these campsites, which have distinctive boundaries created by the disturbance of vegetation and substrates, particularly the removal of rocks and gravel. In contrast, only 10 of the 27 undesignated campsites in the High Chisos (37%) and 22

Class 1:	<i>CAMPSITE BARELY DISTINGUISHABLE</i> Soil surface only slightly disturbed. Vegetation cover barely altered. Organic litter barely disturbed compared to litter present outside of campsite boundaries in similar, adjacent areas.
Class 2:	<i>CAMPSITE APPARENT, EFFECTS CONFINED</i> Large stones absent from soil surface in areas where primary activities occur, and any previous vegetation cover or organic litter is either lost or pulverized. Obvious effects concentrated with effects tapering toward boundary.
Class 3:	<i>CAMPSITE OBVIOUS, EFFECTS THROUGHOUT SITE</i> Distinct boundary exists between the campsite and undisturbed adjacent areas. Vegetation cover or organic litter is lost or pulverized on much of the site. Few stones or gravel remain in areas where primary activities occur. Most gravel or stones present on the site are outside primary activity areas.
Class 4:	<i>CAMPSITE OBVIOUS, EFFECTS WIDESPREAD</i> Distinct boundary exists between campsite and undisturbed areas. Nearly complete or total loss of vegetation cover and organic litter. Bare soil widespread with little gravel or few stones present anywhere within boundaries.
Class 5:	<i>CAMPSITE OBVIOUS, EFFECTS WIDESPREAD AND CONDITION GREATLY DIFFERENT FROM ADJACENT AREAS</i> Soil compressed and may show small gullies. Vegetation absent within boundaries, roots are exposed, and little gravel or few stones present.

Figure 7. Condition class definitions.

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of the 86 undesignated campsites outside the High Chisos (26%) fall into either of these two categories. No campsite in Big Bend received a condition class 5 rating.

Campsite Size

The sizes of condition class 1-2 sites were assessed with the geometric figure method (Appendix 1). For condition class 3-5 sites, campsite size was assessed by measuring the lengths and azimuths of transects radiating from a center point to campsite boundaries (see Variable Radial Transect Method, Appendix 1). Campsite boundaries were defined as pronounced changes in either vegetation cover, vegetation height or disturbance, vegetation composition, substrate composition and appearance, or topography. Areas were computed from measurements using dBASE programs.

The designated road-accessed campsites have the largest median size, at 2,198 ft² or approximately 47 x 47 feet in size. Only six of these campsites are less than 1,000 ft² in size while eight exceed 5,000 ft², including the two largest campsites in the Park, at 10,680 ft² and 11,149 ft². The sum of campsite sizes for the designated road-accessed campsites, at 146,548 ft², is also substantially larger than any other campsite location and type of camping category. Undesignated trail-accessed campsites are generally the smallest. The typical undesignated (illegal) High Chisos campsite is 196 ft² in size (median) and the total area of disturbance associated with the 27 sites is 9,654 ft². More numerous are the undesignated non-Chisos trail-accessed campsites (N=86) with the smallest median size of 142 ft² and a total area of disturbance of 18,150 ft². The Chisos designated campsites range in size from 96 to 1,940 ft² with a median size of 650 ft². The total area of disturbance from camping (sum of all campsite areas) is 208,194 ft², equivalent to 4.78 acres.

discern betw. Chisos & other areas
discern in Chisos betw site capacities
1/4

Vegetation Loss

The amount of vegetation loss seen on each campsite is reported as a percentage. This indicator is not reported for Rio Grande accessed sites, for reasons described earlier. The typical site in the Park has lost more than 93% (median) of the original vegetation cover. Vegetation groundcover loss is greatest on the undesignated campsites in the High Chisos where a typical one of these sites has lost 100% (median) of the original vegetation. Undesignated, road accessed campsites typically have lost 97% (median) and all the other types of sites typically have lost 93% (median) of the original vegetation ground cover.

Relate to

The area over which vegetation cover has been lost on campsites is perhaps the most environmentally and aesthetically significant measure of vegetation loss. According to this measure, the loss of vegetation is most severe on the designated road-accessed campsites, where vegetation has been lost over an area of 965 ft² on the typical or median campsite. Undesignated road accessed sites typically have lost 128 ft², designated sites in the Chisos have typically lost

57 ft², undesignated trail accessed campsites outside the High Chisos typically have lost 43 ft², and undesignated trail accessed campsites in the High Chisos typically have lost 17 ft². The larger sizes of the designated road-accessed campsites most likely account for the greater vegetation loss.

The sum of these square foot measures of vegetation loss for each campsite location and type provides a comparative measure of vegetation disturbance that takes into account campsite numbers. The total area of vegetation loss is greatest for the designated road-accessed campsites (67,896 ft², N=50), followed by the undesignated trail accessed campsites (5,617 ft², N=85). Designated Chisos sites have an aggregate loss of 2,582 ft² (N=42), undesignated road accessed sites have an aggregate loss of 1,030 ft² (N=5), and undesignated Chisos sites combine for a vegetation loss of 807 ft² (N=27). The total amount of vegetation lost is 77,932 ft² (N=208), an area not much smaller than the size of three football fields (a square 280 feet on each side). Converting this figure to acres, the combined loss of vegetation on the assessed sites is 1.8 acres.

Grass Cover Loss

The percent of grass cover loss is high (greater than 93% median) for all assessed campsites. On designated sites in the Chisos, 97% (median) of the former grass cover is gone as compared to adjacent off-site areas. For undesignated sites in the Chisos, 96% (median) has been lost. Designated road accessed campsites typically have lost 95% (median), and both undesignated road accessed and undesignated trail accessed campsites typically have lost 93% (median).

The amount of grass cover loss is greatest for designated Chisos sites. A typical one of these sites has lost 388 ft² (median). Designated road accessed campsites typically have lost 286 ft² (median); undesignated campsites in the High Chisos typically have lost 96 ft² (median); undesignated road accessed campsites typically have lost 91 ft² (median); and undesignated trail accessed campsites outside the High Chisos typically have lost 43 ft² (median).

The sum of these area measures of grass loss provides a comparison across the different types of campsites that takes into account the number of campsites within each type. For this measure, designated road accessed sites, as with vegetation cover, have lost the most grass cover compared with the other types of campsites in the Park. A total of 26,840 ft² of grass cover has been lost on these sites (N=50). Designated sites in the Chisos have a combined grass cover loss of 19,460 ft² (N=41); undesignated trail accessed sites outside the High Chisos have a combined loss of 5,985 ft² (N=86); undesignated sites in the High Chisos have a combined loss of 3,663 ft² (N=27); and undesignated road accessed sites have a combined loss of 1,186 ft² (N=5). The total amount of grass cover lost on the assessed campsites in the Park is 57,134 ft² (N=208), an area equivalent to a square 240 feet on a side, about two football fields. Converting this figure to acres, the amount of grass loss attributable to camping on the assessed sites is 1.3 acres.

Combined Vegetation and Grass Cover Loss

When vegetation and grass cover loss are combined, the percent of loss, again, is quite high. The typical site assessed in the Park has lost more than 90% (median) of the original cover. Sites with the highest values are the designated sites in the Chisos (95% median value); sites with the lowest are the undesignated road accessed ones (91% median value). For designated road accessed, undesignated trail accessed, and undesignated High Chisos sites, the typical site has lost 94% (median) of the original combined cover of vegetation and grass.

The amount of combined vegetation and grass cover loss is greatest for the typical designated road accessed campsite (1,402 ft² median) and least for the typical undesignated trail accessed site outside the High Chisos (90 ft² median). Designated sites in the High Chisos typically have lost 468 ft² (median); undesignated road accessed sites typically have lost 251 ft² (median); and undesignated sites in the High Chisos typically have lost 132 ft² (median).

The total amount of vegetation and grass cover loss, by site type, is greatest for designated road accessed campsites (94,736 ft², N=52) and least for undesignated road accessed sites (2,216 ft², N=5). Designated sites in the High Chisos have a combined loss of 22,025 ft² (N=42); undesignated trail accessed sites outside the High Chisos have a combined loss of 11,601 ft² (N=86), and undesignated trail accessed sites in the High Chisos have a combined loss of 4,470 ft² (N=27). The total combined loss of vegetation and grass cover is 135,048 ft² (N=208), an area 268 feet square. Converting this figure to acres, the combined loss of vegetation and grass cover for the assessed campsites is 3.1 acres.

Exposed Soil Increase

Exposed soil was assessed using the same predefined categories and mid-point transformations as for vegetation loss (see Appendix 1 for specific procedures). For this project, soil exposure is defined as areas with very little or no vegetation or grass cover. Such soil exposure naturally occurs to a greater degree in desert plant communities than in the higher elevation Chisos Mountains. The production of organic litter is also very low in desert environments with limited accumulation on the ground surface, in contrast to the Chisos where organic litter is considerably more common.

Data from this assessment show that soils are exposed over 98% of the typical (median) desert campsite, irrespective of campsite type or location, due to the loss of vegetation cover and the lack of organic materials. However, soil exposure occurs naturally in undisturbed areas surrounding these sites, with median values ranging from 22% to 47%. The typical designated road accessed and undesignated trail accessed campsite exhibited an estimated increase in soil exposure of 306% (median) equal to three times the amount that would have been present naturally. Undesignated road accessed campsites typically showed a 110% (median) increase.

In the Chisos Mountains median soil exposure is 86% on both designated and undesignated campsites. Offsite soil exposure is estimated at 1%. Designated campsites in the High Chisos show 84 times more exposed soil (8,450% median); undesignated sites in that area typically show 62 times more exposed soil (6,200% median).

The amount of exposed soil seen on the typical designated road accessed site is 1,411 ft² (median) and for both undesignated trail accessed sites outside and in the High Chisos the typical site has 93 ft² (median). Designated sites in the High Chisos typically have 468 ft² (median) exposed soil and undesignated road accessed sites typically have 243 ft² (median).

The increased area of soil exposure on campsites, over and above that which occurs naturally, is perhaps the most significant and meaningful measure. Median values indicate that camping contributes to the most substantial increase in soil exposure on the road-accessed designated campsites (N=47). This is true both for individual sites (median = 1,428 ft²) as well as for all sites cumulatively (median = 91,689 ft²). Soil exposure is also pronounced on the Chisos designated campsites where the median site has 468 ft² of exposed soil and the combined sum is 22,000 ft² (N=41). Undesignated trail accessed sites outside the High Chisos have a combined 11,202 ft² of exposed soil (N=84) and undesignated trail accessed sites in the High Chisos have a combined 3,398 ft² (N=24). Undesignated road accessed sites have a combined 2,347 ft² of exposed soil (N=5). The total amount of soil exposure increase found on the assessed campsites is 130,309 ft² (N=208), an area equal to that of a square 261 feet on a side. Converting this figure to acres, the assessed sites in the Park combine for 3.0 acres of exposed soil attributable to camping.

Tree Damage

Any living tree within campsite boundaries was assessed for human-caused damage using three discrete categories: none/slight, moderate, and severe (see Appendix 1 for definitions).

Moderate and severe damage categories are combined; the number and percent of damaged trees within campsite boundaries are presented. The number of damaged trees is emphasized. Damage to 20 of 40 trees present on one campsite should be viewed more critically than damage to 2 of 4 trees present on another campsite. The number of damaged trees, 20 vs. 2, conveys this difference, the percentage of damaged trees, 50% vs. 50%, does not.

Due to the absence of trees within campsite boundaries this parameter was assessed for only 47 (17.5%) of the campsites. In general, tree damage does not seem to be a significant type of impact, most likely because campfires are not permitted. For the road-accessed designated campsites the number of damaged trees ranges from one to four with a total of 11 damaged trees on four separate campsites. Tree damage is more common on the designated Chisos campsites. Of the 31 campsites with trees, 12 have no tree damage and 13 have 1 or 2 damaged trees. The

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median site has only one damaged tree and 48 damaged trees were tallied for the entire area. Only four of the undesignated Chisos sites have damaged trees for a total of five damaged trees.

Root Exposure

Root exposure was assessed in three categories as previously described for tree damage. All other procedures and comments are applicable to this indicator as well.

Only 16 trees, all in the Chisos Mountains, were assessed as having excessive root exposure. On designated campsites 10 sites each have one tree with exposed roots and 2 sites each have 2 trees with exposed roots. On undesignated campsites two campsites each have 1 tree with exposed roots. Such findings suggest that soil erosion is not a significant problem on those campsites where trees are present.

Access Trails

All trails leading away from the outer campsite boundary were counted to assess the general density of related off-site trails (see Appendix 1 for details of procedures). Although most of the campsites have discernable trails leading to them, survey staff did find and assess 25 hiking accessed campsites that did not. In particular, 20 of the 86 undesignated trail-accessed campsites (23%) lack discernable trails. The number of access trails is highest for the Chisos designated campsites with a median of 3 trails per site and a total of 156 trails. For this area, only 8 campsites have 1-2 trails, while 29 sites have 3-5 trails, and one site has 8 trails.

Fire Sites

All fire sites within campsite boundaries were counted (see Appendix 1 for details of procedures). Evidence of campfires exists on 94 campsites in spite of a Park ban on campfires in the backcountry. Along the Rio Grande, one or more fire sites are evident on 20 of the campsites. This figure is questionable because conflicting directions to the field staff led to a decision to not count small fire sites that, according to a knowledgeable Park staff member, are most likely attributable to local Mexican residents. The survey methods described in the manual (appendix 1) now instruct future surveyors to count all fire sites. A total of 77 fire sites were tallied on 35 of the designated road-accessed campsites. Though 11 of these sites have only 1 fire site, 8 have 3 fire sites and 11 fire sites were identified on 1 campsite. Fire sites are also not uncommon in the Chisos Mountains where they are found on 20 of the designated campsites and 7 of the undesignated sites.

Improperly Disposed Human Waste

A quick search of likely toilet areas was conducted in the vicinity of each campsite to evaluate the extent of improperly disposed human waste (Appendix 1). In general, human waste disposal problems were less evident on the undesignated campsites. Human waste is more obvious on

the designated road-accessed campsites (N=52) where 22 sites (42%) are assessed as having some, defined as few distinct examples (<5), and 7 sites (13%) are assessed as having much (>5 examples). Combining these categories, 29 sites (56%) had noticeable human waste. Similarly, on the designated Chisos campsites (N=42), field staff assessed improperly disposed human waste as “some” on 15 sites (36%) and as “much” on 5 sites (12%). Combining these categories, 20 sites (48%) had noticeable human waste.

Litter

Surveyors assessed the amount of litter visible from within campsite boundaries using four categories: none, little (less than a handful), some (less than a quart-sized bag), and much (more than a quart-sized bag). Hiker-accessed campsites (N=155) are generally quite clean. Only 1 campsite are assessed as having “much” litter and only 8 campsites as “some”. River accessed campsites along the Rio Grande (N=55) were either clean (43 sites) or have “some” litter (10 sites). The most littered sites were those that have road access (N=58), with 13 classified as having “much” litter and 11 as having “some” litter.

Table VII. Selected campsite condition indicators by campsite location and type.
Page 1 of 3. Table Footnotes appear at the end of the table.

INDICATOR ¹		CAMPSITE LOCATION AND TYPE					
		Rio Grande (N=55)	Road, Desig. (N=52)	Road, Undesig. (N=6)	Trail, Undesig. (N=86)	Chisos, Desig. (N=42)	Chisos, Undesig. (N=27)
Condition Class	1	N.A.	0	1	14	0	1
Rating	2		2	1	50	0	16
(# of sites)	3		12	4	16	13	8
	4		36	0	6	28	2
	5		0	0	0	0	0
Campsite Size	Mean	N.A.	2,991	1,006	211	686	358
(ft ²)	Median		2,198	361	142	650	196
	Sum		146,548	5,032	18,150	28,810	9,654
	N		49	5	86	42	27
Vegetation Cover	Mean	N.A.	2 / 46	4 / 31	3 / 36	4 / 16	1 / 11
Onsite / Offsite	Median		3 / 38	3 / 27	3 / 38	3 / 16	0 / 16
(% / %)	N		50 / 51	5 / 6	86 / 85	42 / 42	27 / 27
Vegetation Loss	Mean	N.A.	-92	-77	-90	-81	-90
(% of original %) ²	Median		-97	-93	-93	-93	-100
	N		50	5	85	42	27
Vegetation Loss	Mean	N.A.	-1,358	-206	-66	-61	-30
(ft ²)	Median		-965	-128	-43	-57	-17
	Sum		-67,896	-1,030	-5,617	-2,582	-807
	N		50	5	85	42	27
Grass Cover	Mean	N.A.	5 / 26	2 / 15	6 / 40	7 / 75	24 / 80
Onsite / Offsite	Median		3 / 16	3 / 16	3 / 38	3 / 86	3 / 86
(% / %)	N		50 / 51	5 / 6	86 / 85	41 / 42	27 / 27
Grass Loss	Mean	N.A.	-79	-92	-84	-91	-74
(% of original %) ²	Median		-95	-93	-93	-97	-96
	N		50	5	85	41	27
Grass Loss	Mean	N.A.	-537	-90	-70	-475	-136
(ft ²)	Median		-286	-91	-43	-388	-96
	Sum		-26,840	-1,186	-5,985	-19,460	-3,663
	N		50	5	85	41	27

Table VII (cont.) . Selected campsite condition indicators by campsite location and type.

INDICATOR ¹		CAMPSITE LOCATION AND TYPE					
		Rio Grande (N=55)	Road, Desig. (N=52)	Road, Undesig. (N=6)	Trail, Undesig. (N=86)	Chisos, Desig. (N=42)	Chisos, Undesig. (N=27)
Veg. & Grass Loss Onsite / Offsite (% / %)	Mean	N.A.	6 / 72	6 / 45	9 / 76	10 / 91	24 / 91
	Median		3 / 79	5 / 54	5 / 76	5 / 100	5 / 100
	N		50 / 51	5 / 6	86 / 85	41 / 42	27 / 27
Veg. & Grass Loss (% of original %) ²	Mean	N.A.	-90	-90	-89	-88	-75
	Median		-94	-91	-94	-95	-94
	N		50	5	85	41	27
Veg. & Grass Loss (ft ²)	Mean	N.A.	-1,895	-443	-136	-537	-166
	Median		-1,402	-251	-90	-468	-132
	Sum		-94,736	-2,216	-11,601	-22,025	-4,470
	N		50	5	85	41	27
Soil Exposure Onsite / Offsite (% / %)	Mean	N.A.	95 / 29	95 / 55	90 / 25	89 / 10	70 / 10
	Median		98 / 22	98 / 47	98 / 24	86 / 1	86 / 1
	N		47 / 51	5 / 6	85 / 85	41 / 42	27 / 24
Soil Exposure Increase (% of original %) ²	Mean	N.A.	3,141	135	3,066	5,489	5,659
	Median		306	110	306	8,450	6,200
	N		47	5	84	41	25
Soil Exposure Increase (ft ²)	Mean	N.A.	-1,944	-469	-133	-537	-141
	Median		-1,411	-243	-93	-468	-93
	Sum		-91,362	-2,347	-11,202	-22,000	-3,398
	N		47	5	84	41	24
Damaged Trees ³ (#)	Mean	N.A.	2.8	0	0	1.5	1.0
	Median		3.0	0	0	1.0	1.0
	Sum		11	0	0	48	5
	N		4	0	0	31	5
Trees with Exposed ³ Roots (#)	Mean	N.A.	0	0	0	0.4	0.4
	Median		0	0	0	0.0	0.0
	Sum		0	0	0	14	2
	N		4	0	0	31	5

Table VII (cont.) . Selected campsite condition indicators by campsite location and type.

INDICATOR ¹		CAMPSITE LOCATION AND TYPE					
		Rio Grande (N=55)	Road, Desig. (N=52)	Road, Undesig. (N=6)	Trail, Undesig. (N=86)	Chisos, Desig. (N=42)	Chisos, Undesig. (N=27)
Fire Sites (#)	Mean	0.6	1.5	0.7	0.1	0.6	0.3
	Median	0.0	1.0	1.0	0.0	0.0	0.0
	Sum	34	77	4	9	24	7
	N	55	52	6	86	42	27
Improperly Disposed Human Waste ⁴	None	49	23	3	78	22	22
	Some	5	22	3	7	15	3
	Much	1	7	0	1	5	2
Litter ⁴	None	43	20	3	75	27	19
	Little	0	9	2	8	11	6
	Some	10	11	0	3	4	1
	Much	0	12	1	0	0	1

1 - The median is the value above and below which half of the measurements fall and it can be a better measure of central tendency than the arithmetic mean. Comparisons between types of sites or different areas may not be appropriate unless statistics are based on at least 5 and preferably more than 10 campsites (refer to "N" values in table).

2 - This figure represents the ratio between the amount of grass, non-woody vegetation, or exposed soil that would have been present and the amount that is now present on the campsite. Because the amount are represented as percentages of total ground cover, this figure is a percentage of a percentage.

3 - Data pertain only to those campsites that have trees present within their boundaries (refer to "N" values in the table).

4 - Refer to the Manual (Appendix 1) for definitions of each category.

DISCUSSION AND RECOMMENDATIONS

This survey developed and applied state-of-the-knowledge methods for assessing the condition of backcountry campsites in Big Bend National Park. Survey results are discussed and recommendations offered for three primary topics: effectiveness of camping policies in minimizing resource degradation, new programs needed, and future application of survey methods to monitor campsite conditions over time.

Effectiveness of Camping Policies

Backcountry camping at Big Bend NP is currently managed under two separate strategies. In the Threshold Use Areas, including all areas adjacent to backcountry roads and highly visited areas of the Chisos Mountains, visitors are required to camp in designated campsites. A “containment” strategy is thus employed in these more intensively visited environments to focus camping activities and associated environmental changes on resistant locations developed and maintained to sustain such use. In the Primitive and Wild Use Areas visitors are permitted to select their own campsites under an “at-large” camping strategy designed to enhance visitor freedom. The effectiveness of these strategies are examined in more detail as applied to four types of backcountry areas within the Park: the Rio Grande River corridor, the backcountry road corridors, the remote backcountry, and the North and High Chisos Mountains.

Overview and Significant Finding

The majority of campsites are in good condition, although possibly excessive size is apparent at some sites. Visitor education and site design/site maintenance actions are recommended as means to contain or reduce campsite sizes if decided. Campsite size (median square footage) is greatest for designated campsites (road access and trail access). Vegetation and grass cover loss (median percent of original cover), however, is notably consistent across all types of campsites. Soil exposure (median percent of original cover) is greatest at all campsites located in the High Chisos, most likely because sites located in lower, desert areas begin with more exposed soil.

Combined, these findings suggest surprising conclusions regarding the ecological significance of designating campsites. Specifically, designated campsites in Big Bend National Park are larger than undesignated sites, have greater total amounts of disturbance (sums for entire survey), and may not concentrate camping effects to the degree expected, as shown by the consistent percentages of disturbance across the condition indicators of vegetation, grass, and vegetation and grass combined. On the other hand, the expected concentration of effects is shown by the

greater increases in vegetation and grass loss when measured in square feet. Also, designated campsites show greater increases in exposed soil whether measured in square feet or as an increase in the percentage. These findings may be quite related to the larger size of designated campsites more than the actual concentration of effects.

The social significance of these surprising findings, however, is perhaps most important and is outside this study's purposes, although some comments are fair. Designated campsites likely provide a camping opportunity that is highly sought by those who visit and stay at them. In addition, such sites provide a known destination for those visitors who are less familiar with the area. These are among the possible social advantages of designating campsites and requiring visitors to stay at those locations if they wish to camp in the area.

Designated campsites do offer visitors opportunities for more secluded backcountry camping experiences, even in area where the number of overnight visitors is relatively high. These opportunities could be enhanced by establishing minimum distances between campsites and roads, campsites and trails, and between campsites. Compliance with resource protection setback distances could also be improved. Management control over such site selection criteria is a principal advantage of the containment strategy. This strategy has concentrated the effects of visitation on a restricted number of campsites, thus minimizing the area of disturbance associated with camping activities.

It is important to note that designated campsites assessed as part of this survey often violated many of the Park's criteria for selecting an "open" campsite (Table 6) and raises the concern of inconsistency between designated sites and at-large, dispersed camping criteria. Park staff members may wish to address this inconsistency. One possible option is to relocate those sites that are inconsistent. Another is to review the camping criteria and consider whether any are unnecessary. A third option is to address the inconsistencies as part of an expanded information and education effort directed toward Park visitors and explaining the appropriateness of these apparent discrepancies.

Rio Grande River Corridor

Camping along the Rio Grande River is managed with an "at-large" or "open" camping strategy. Visitors may select and camp on any campsite they find or create new campsites. The survey located 55 campsites. The environmental effects of camping are small in comparison to substantial vegetative and soil disturbances associated with natural cycles of river flooding and by grazing and trampling disturbance from livestock owned by Mexican citizens. Quantitative measurements of camping disturbance and monitoring of these changes over time is not possible given these confounding influences.

Some issues of concern to management are apparent, however, from the current assessment. In particular, survey staff noted two extremely large sites at the mouth of Santa Elena Canyon. Site expansion is a common problem when group sizes are large and environmental factors such as uneven topography or dense vegetation are not present to limit the size of campsites. Sandbars and broad flat river embankments with open vegetation are common along the Rio Grande. In addition, Park policies currently permit group sizes up to 30 individuals (party size is limited to 15 elsewhere in the Park). Camping in the vicinity of archaeological sites is another issue; four campsites are located within 100 yards from an archaeological site. Less significant problems include the presence of fire sites on 20 campsites (in violation of a Park-wide backcountry campfire ban), and litter found on 10 sites.

In general, the effects of camping in the Rio Grande corridor are not substantial, particularly in comparison to the human-related trespass livestock impacts. Park staff members may wish to reconsider the current group size limit of 30 individuals. Such a level exceeds most social norms in backcountry and wilderness settings and most certainly contributes to problems with campsite expansion. Low impact or *Leave No Trace* (LNT) camping literature should emphasize selecting resistant camping locations that have disturbed or minimal vegetation ground cover. Camping activities should be concentrated in core campsite use areas to avoid site expansion. The avoidance of camping near archaeological sites should also be emphasized. Finally, LNT messages regarding the use of fire pans, proper disposal of fire ashes, and “pack-it-in, pack-it-out” litter policies need to be better communicated to river visitors, particularly those in private parties. A departure from the “at-large” or “open” camping strategy does not appear necessary at the current time. Problems with campsite proliferation, campsite clustering, and high intervisibility are likely to become problematic only under considerably higher visitation levels. Until such time, educational approaches will likely provide the most effective means to address camping-related resource degradation.

Backcountry Road Corridors

Camping along backcountry dirt roads is managed under a “containment” strategy where visitors must camp at one of 52 designated campsites. Except for one site that has a corral for horses, specific campsites can be reserved no earlier than the day prior to beginning their overnight visit on a first-come, first-served basis. The objective of designated site camping is to minimize the effects of camping activities by containing or concentrating the effects of visitation at a limited number of locations. Recreation ecology research supports the effectiveness of this approach, particularly in areas receiving intensive visitation or in areas with fragile environments (Hammit and Cole 1987; Cole 1987, 1992). This strategy allows managers to control the number and location of campsites, although at a cost to visitors because their freedom to travel and camp in the areas and on a schedule of their choosing is restricted.

Compliance with the designated site camping policy along the backcountry road corridors appears to be quite high. Only six undesignated or illegal campsites were found. Expanded distribution of camping brochures, onsite “No Camping” signing, and increased visitor contact and law enforcement are most likely to help address such illegal site use. The survey identified a number of problems associated with management of the designated campsites. Eight of the campsites are within 100 yards of archaeological sites and 17 are within 100 yards of a natural water feature. These attributes should render these designated campsites as illegal according to criteria established in the revised Backcountry Management Plan. Exceptions may be warranted, but Park staff may wish to remain consistent with campsite selection regulations imposed on backcountry visitors wherever possible because consistency reinforces visitor compliance.

Asking visitors to camp away from water sources and archeological sites and then requiring them to camp near them at some sites is a mixed message that detracts from the opportunity for visitors to learn about how they can help protect their public lands.

The rationale for such regulations is fairly critical. Visitors at campsites have more idle time to explore and disturb fragile riparian vegetation and soils or cultural structures and artifacts than those who are traveling through an area. The ecological and archaeological significance of these features is exceptionally high and resource protection objectives should be paramount. We recommend that Park staff reexamine the survey’s findings, grant specific exceptions where appropriate, carefully explain to visitors why those exceptions are appropriate, and relocate remaining designated campsites to resistant locations that exceed the minimum compliance criteria.

The physical arrangement of the road-accessed designated campsites is a second issue of concern. Most campsites are located directly off the backcountry roads such that visitors have limited privacy and are highly affected by the sight, sounds, and dust of vehicular traffic. The backcountry camping experience could be enhanced by relocating these campsites to some minimum setback distance, perhaps 50 yards. A number of the designated sites are intended to accommodate two separate groups, a situation that should be avoided to reduce visitor conflicts and enhance camping solitude. The road-accessed campsites are also excessively large in many instances. Within each campsite, parking areas need to be clearly identified and separate or distinct from the tent camping areas. Logs used for this purpose on many of these sites have been very effective in both defining and containing (concentrating) visitor activities and in minimizing the area of disturbance. Additional work of this type is needed to define the minimum areas required for parking and tent camping activities. Educational efforts can help to promote appropriate backcountry camping experiences by instructing visitors to camp in the designated areas away from their vehicles. The distance from the parking areas to the campsites could vary because some individuals may prefer hike-in campsites and more distance and privacy from roads and vehicles.

Campsite intervisibility is another issue: fourteen of the designated road-accessed campsites are located within view of one or more other campsites. Camping solitude could be enhanced by relocating those campsites with the highest intervisibility to alternate locations not visible from any existing campsites. Finally, the existence of fire sites, improperly disposed human waste, and litter on many of these campsites suggests a need for an enhanced program of visitor education. *Leave No Trace* information and personal messages to visitors at the time of their backcountry permit registration are perhaps the best approach for addressing these problems.

Remote Backcountry

Outside of the Chisos Mountains, backcountry visitors on foot may camp anywhere they please, subject to a number of general and specific exceptions. General exceptions specify as “closed” those locations within ½ mile of any developed area or road and within 100 yards of any trail, historical structure, archaeological site, water source, dry wash, or cliff edge. The exceptions seek to protect sensitive cultural sites and water sources, to disperse visitors away from developed areas and trails, and to promote visitor safety. This policy is classified as an “at-large” or “open” camping strategy and is designed to promote the ability of backcountry visitors to travel and camp freely.

The survey revealed that visitors are not complying with many of the camping regulations that specify various areas as “closed” to camping. While few campsites are located close to roads, nearly all (80 of the 84 campsites) are within 100 yards from a trail (Table 6). Median distance from trail for this category of campsites is only 46 feet (Table 7). Additionally, twenty campsites are within 100 yards of an archaeological site and 18 are within 100 yards of a water source. Park managers should seek to understand and address the causes for such noncompliance. The first issue is whether the camping regulations are being effectively communicated to visitors. Are all visitors made aware of the regulations and do they understand their rationale? A second issue is whether the regulations are realistic. Are the regulations easy or difficult to comply with? What are the barriers to improved compliance? For example, traveling cross-country through lechuguilla and cactus is often difficult and locating a comfortable camping site can be challenging in portions of the Park. The causes of noncompliance should be addressed through education and information efforts, or, where appropriate, through regulatory changes. Following these actions, managers could rehabilitate illegal campsites, install temporary “No Camping” signing where necessary, and enhance backcountry visitor contact and law enforcement activities to improve compliance over time.

Note: Field staff conducted intensive searches in more distant off-trail locations on occasion to verify that camping in such locations was rare or nonexistent. We believe the survey findings are relatively accurate in representing both campsite numbers and the close proximity of campsites to backcountry trails.

Higher campsite intervisibility is a second area of concern. Half of all remote backcountry campsites are within sight of at least one other campsite, although the frequency of occasions when other campers are within view is unknown. During busy periods, however, there are areas of the Park where the opportunity for camping solitude is likely diminished by the high density of campsites. Managers should promote low-density backcountry camping experiences through educational efforts that stress the selection of campsites that are out-of-sight of both other existing campsites and trails. In some areas, installation of designated campsites could increase the opportunity for solitude and reduce campsite intervisibility. Mule Ear Spring is one location where the installation of designated sites might markedly improve opportunities for solitude and reduce the environmental effects of camping near water and archeological sites.

On the plus side, the remote backcountry campsites tend to be quite small with a median size of only 142 ft². Aside from the loss of vegetation and grass cover and the increase in soil exposure, the most prominent form of alteration for these campsites is the removal of rocks to create flat tentsites. This is primarily a visual impact with little ecological consequence. It is quite easy, however, to “rehabilitate” such campsites by tossing rocks back until the surface is covered as much as and in a similar pattern to offsite areas. Additionally, Park brochures and staff members could instruct campers to toss rocks back on sites before they leave. Some sites where this occurs may remain inactive once the rocks are replaced, allowing vegetation and grasses to return.

A dispersal strategy is possible in this desert environment though poor compliance could lead to a considerable proliferation of campsites. Under this strategy visitors would be encouraged to seek out and camp on pristine sites that lack evidence of prior camping. Visitors could be instructed to learn and employ *Leave No Trace* camping practices, including careful naturalization of the site prior to departure. Unfortunately parks generally lack the personnel and funding to sustain the intensive visitor education programs necessary to achieve success with dispersal strategies. The result of failed dispersal policies is campsite proliferation that can substantially increase the total area of disturbance associated with camping. Our recommendation is thus to promote *Leave No Trace* camping practices with the exception that visitors be instructed to locate “existing” but legal campsites rather than pristine sites. Those visitors who have mastered such skills should not be prohibited from applying them, however.

North and High Chisos Mountains

A “containment” strategy is also employed in the High Chisos Mountains, where Park policy requires visitors to camp on one of 42 designated campsites. Compliance with this policy is difficult to gauge, yet survey staff located and assessed 27 undesignated campsites. Some or all of those sites may pre-date the designated campsite policy that began in 1985. Because no rehabilitation of undesignated sites occurred at that time, we only know that 27 sites exist in the

High Chisos that qualify as undesignated campsites according to criteria applied during this assessment work.

Designated campsites are located along short marked side trails that lead off of primary Park hiking trails. The median distance from Park trails is 277 feet (mean = 377 ft), but 24 campsites are less than 100 yards from Park trails. Park staff may want to reevaluate some of the closer sites for possible relocation. Eight are less than 150 feet from Park trails. Intersite spacing is fairly good. Only five campsites have other sites visible from their boundaries. In general, the designated camping policy appears to be quite successful in ensuring solitude both for hikers and campers in the Chisos Mountains.

Campsite conditions on the designated sites are remarkably good given their intensive visitation. The median campsite is only 25 by 25 feet in size. The borders of most campsites are outlined by logs that have been very effective in concentrating camping activities. Camping posts placed near the entrance of each campsite also serve as permanent markers for visitors, identifying the campsite and helping to focus visitor activity in core use areas. Illegal fire building, improperly disposed human waste, and litter are problems on these sites, however (Table 8). The latter two problems seem somewhat surprising given the relatively widespread adoption of “clean camping” ethics and practices widely discussed today. Improved educational messages are likely to be effective in reducing these kinds of problems. The problems with human waste do not appear to be substantial enough to warrant the installation of additional backcountry toilets.

Recommended New Programs

Visitor Education

Visitor information materials, educational programs, and communication efforts are often most appropriate and effective at addressing many of the backcountry camping management problems described in this report. These can include personal messages during contacts at visitor centers, the permit writing process, and during encounters in the backcountry. Expanded and improved literature and brochures about backcountry camping and travel also are an effective means.

Personal contacts are more effective than literature. All Park staff who commonly interact with backcountry visitors should become completely familiar with backcountry camping regulations, the rationale for those regulations, and associated *Leave No Trace* messages applicable to each backcountry area. Existing printed material related to backcountry visitors should be reevaluated and revised to include additional information on regulations, their rationale, and appropriate *Leave No Trace* travel and camping information for each backcountry area. A cooperative effort or reviews by individuals in the interagency *Leave No Trace* program office of the National

Outdoor Leadership School is recommended to ensure accuracy and consistency with other regional and national efforts. A similar effort recently completed for Great Smoky Mountains National Park might serve as a model.

Campsite Management: Site Selection, Maintenance, and Rehabilitation

Site management efforts can be as effective as regulatory and educational programs in reducing the area of disturbance associated with camping. Such efforts can effectively close and rehabilitate unnecessary campsites and direct and concentrate camping activities at individual sites. In areas where designated camping is in effect, the number and distribution of campsites should match visitor numbers and distribution patterns, where resource capabilities and protection concerns permit. Typically, public land managers seek to provide sufficient site numbers to meet needs on typical high use weekends or periods, not peak use periods. Accommodating peak use often requires a substantial increase in site numbers and area of disturbance. This is commonly viewed as an inappropriate compromise of resource protection objectives to support rare instances of extremely high visitation that should not be encouraged in backcountry settings.

Campsite selection criteria can be developed to provide a consistent approach to designating campsites that provide appropriate high quality backcountry camping experiences while minimizing associated resource degradation. Camping solitude can be promoted by locating backcountry campsites away from frontcountry developed areas, roads, trails, and each other. Resource protection concerns require that backcountry campsites be located away from fragile archaeological sites, cultural structures, rare plant or animal habitats, or critical wildlife habitat (nesting, feeding, or watering areas). Camping disturbances can be minimized by locating campsites in vegetation or soil types that are resistant to the effects of trampling and/or are located in areas that have high resiliency (areas that easily recover following disturbance). Finally, campsites must meet the needs of campers. Visitors must be able to easily find campsites that are attractive and have sufficient flat ground to permit tenting, cooking, and socializing activities. Criteria developed to guide the selection of designated campsites can also be communicated to visitors as either regulations or site selection recommendations.

Trail maintenance is a common and accepted backcountry management tool. Campsite maintenance, in contrast, is relatively uncommon, except for the cleaning or removal of fire pits. Numerous other actions are possible, however, including some practices already employed at Big Bend NP. Individual designated campsites should be clearly identified with either camping posts, signs, or some other permanent feature to distinguish legal from illegal sites and to promote activity concentration. Activity concentration can be enhanced by selecting sites with natural boundaries (flat areas surrounded by sloped terrain, dense or prickly vegetation) or by artificially creating boundaries with logs or rocks. The appropriateness of creating artificial

campsite boundaries in backcountry or particularly wilderness settings is an issue that Park staff should consider. Results from this work, however, suggest that the technique is highly effective in concentrating camping activities and minimizing campsite sizes on both road and trail accessed designated campsites.

Areas within intended site boundaries should be gently sloped for optimal drainage without soil erosion. A sufficient number of usable tenting areas should exist or be subtly improved or created within site boundaries. It is often the lack of adequate tenting areas onsite that prompt the expansion of campsite boundaries or use of offsite "satellite" use areas. Unneeded campsite areas or satellite use areas can be rendered unusable by burying large rocks with their tops protruding ("iceberging") or by digging shallow pits and mounding soil to create an uneven surface. Such areas should also be naturalized with organic material or rocks so that their appearance resembles adjacent undisturbed areas. Revegetation using cultivated nursery stock derived from the local area or with offsite plant material can also help speed the recovery of such areas and discourage further use. Vegetation should be planted only in protected locations during seasons of ample rainfall and/or little visitation.

Campsite closures are often necessary to eliminate unneeded sites or to shift camping away from sensitive areas. Yet, campsite closures do not allow highly altered sites to recover because, as recreation ecology research has demonstrated, newly established campsites deteriorate at far greater rates than closed sites can recover (Hammitt and Cole 1987; Cole 1987, 1992). The substantial difference in these two rates for all environments studied make clear that campsite rest-rotation schemes are an ineffective strategy for managing visitor impacts.

The recovery of closed campsites is largely dependent upon the ability of managers to prevent continued visitation. Even minimal visitation will prevent recovery of vegetation in many environments. Visitor contact, trailhead postings, onsite signs, and enforcement actions are the primary actions available to managers to ensure effective closures. Actions previously described for discouraging activities on "satellite" areas are also effective for enhancing natural recovery on closed campsites. Actions such as "iceberging" large rocks are still necessary to permanently reduce the attractiveness of the site, even following its recovery to natural conditions.

Prescriptive site recovery plans that describe specific actions outlined on site maps will help to guide restoration workers and document work. Site recovery should be monitored to provide an objective basis for evaluating the success of such efforts and to guide their improvement. This could be quite effective for undesignated campsites in the High Chisos.

Campsite Monitoring

Continuation of the monitoring effort is recommended so as to provide information regarding the success of previous management actions and the possible need for additional actions to address changes in visitor habits, environmental conditions, or Park management. Monitoring also offers

Discussion and Recommendations

the means to identify long-term trends in backcountry conditions or to confirm trends hypothesized at some earlier time. As part of a decision framework, monitoring can fulfill a regulatory role by establishing whether indicator standards are within tolerances, as opposed to exceeding acceptable limits established through an open, participatory planning effort.

To compensate for seasonal variation in either vegetation or visitation, future assessments should occur within one to two weeks on either side of the original assessment date. The original assessment date is noted in the computer database provided with this report.

✧ Future surveyors should complete a four-day training session immediately before beginning the field work. This training should teach good judgement in applying procedures and the importance of both accuracy and precision in all field assessments.

The campsite monitoring procedures included in Appendix I, with some modifications, are recommended for future monitoring surveys. To increase the precision of comparisons between surveys, site remeasurement procedures are noted for several indicators. However, these procedures lengthen assessment times from an average of 15 minutes to approximately 30 minutes. The majority of time needed to conduct campsite monitoring is spent in travel to the sites. Thus, the additional assessment time is likely to increase staffing needs only 20-30% over those of the initial survey, from seven to perhaps nine personnel-months (see Methods section).

Several options exist for conducting the campsite monitoring program. The most comprehensive option is to apply the monitoring procedures to all campsites (a census) at some specified interval of time. A monitoring cycle of five years is recommended unless visitor use levels are rapidly changing. Monitoring could be more frequent if visitation is increasing dramatically or at a longer interval otherwise. An advantage of this approach is that all campsites are assessed, permitting Park-wide evaluations of site-specific changes, aggregate change, and indicator standards (if developed). A disadvantage of this approach is cost.

A more cost-effective option is to sample some percentage of backcountry campsites. One possible approach is to assess either one-third or one-half of the campsites each monitoring cycle. The sample should be stratified by Park use area and camping strategy (at-large vs. designated site) to enable evaluations of campsite conditions in different areas and comparisons across areas managed under different strategies. All campsites within the sampled areas should be located and assessed in order to permit evaluations of changes in the number and distribution of campsites. A disadvantage of this approach is that complete information is not obtained from any single monitoring cycle. This limits and complicates any comparisons to earlier monitoring data or evaluation of campsite condition standards.

The accuracy and precision of the data collected from future monitoring cycles is critical to the validity of the campsite monitoring program and management decisions derived from its data. Managers must ensure that field staff have the necessary background and training to replicate all procedures with the same degree of professionalism applied to the initial survey. The core field staff should be individuals devoted full-time to the monitoring effort until it is completed. They may be assisted by part-time staff or staff involved in the assessments as a collateral duty but results will be most consistent by involving as few individuals as possible. As part of all future assessments, a separate one-day evaluation of surveyors should be conducted with field trials and repeated measures to gauge how consistent they are when collecting data. The need for this work is briefly described in the Research Methods section of this report. Williams (1994) provides the most detailed discussion of methods and analyses, as well as thorough justification of the need for this work.

CONCLUSIONS

National Park Service backcountry and wilderness areas are administered under a single mandate with dual objectives. Congress has directed managers to balance resource protection and recreation provision objectives. Some degree of environmental change is inevitable where recreational visitation occurs. Managers are challenged by this mandate and must select recreation resource management policies that can offer high-quality recreational experiences and sustainable environmental conditions and processes that are free from the effects of human disturbance. Surveys such as this one assist managers in their difficult task by providing objective information describing the types and severity of resource changes attributable to recreation visitation. Furthermore, knowledge of relationships between the extent of resource change and use-related, environmental, and managerial influences can suggest effective management strategies and actions for minimizing such changes. Such information, combined with managerial experience and judgement, provides a sound basis for management decision making, especially when made part of an open, participatory decision process where interested individuals and groups can share their insights and assist managers.

The campsite inventory and condition assessment study described in this report was initiated in recognition of the managerial need for reliable information regarding the number, distribution, and condition of backcountry campsites within Big Bend National Park. This survey sought to locate and assess the condition of all backcountry campsites using state-of-the-knowledge procedures that could be replicated as part of a long-term monitoring program. An additional objective was to evaluate the designated site camping and open or at-large camping policies currently employed in different areas of the Park.

The survey evaluated 268 campsites, including 55 along the Rio Grande River, 58 along backcountry roads, 69 in the Chisos Mountains, and 86 along trails elsewhere in the Park. A substantial number of both designated and visitor-selected campsites are “illegal” according to current Park regulations. Improving compliance with Park regulations governing site location should begin with the designated campsites. A review of survey findings and site location regulations should be conducted to determine where campsite relocations are needed. Nearly all campsites in areas permitting open camping violate one or more of the site location regulations, principally the minimum setback distance from trails (100 yards). An improved understanding of the causes of these violations is needed in order to develop effective management responses. A combined program of visitor education, possible regulatory modifications, campsite closure and restoration, and expanded visitor contact and enforcement is recommended.

Limited problems with the construction of illegal fire sites, improperly disposed human waste, and litter are also evident from survey results. These problems are more common on designated campsites and on sites along the Rio Grande River. Increased visitor education efforts including the development of *Leave No Trace* camping literature are recommended.

Designated campsites also violated many of these criteria (Table 6) and raises the concern of inconsistency between designated sites and at-large, dispersed camping criteria. Park staff members may wish to address this inconsistency. One possible option is to relocate those sites that are inconsistent. Another is to review the camping criteria and consider whether any are unnecessary. A third option is to address the inconsistencies as part of an expanded information and education effort directed toward Park visitors and explaining the appropriateness of these apparent discrepancies.

The majority of campsites are in good condition, although possibly excessive size is apparent at some sites. Visitor education and site design/site maintenance actions are recommended as means to contain or reduce campsite sizes if decided. Campsite size (median square footage) is greatest for designated campsites (road access and trail access). Vegetation and grass cover loss (median percent of original cover), however, is notably consistent across all types of campsites. Soil exposure (median percent of original cover) is greatest at all campsites located in the High Chisos, most likely because sites located in lower, desert areas begin with more exposed soil.

Combined, these findings suggest surprising conclusions regarding the ecological significance of designating campsites. Specifically, designated campsites in Big Bend National Park are larger than undesignated sites, have greater total amounts of disturbance (sums for entire survey), and may not concentrate camping effects to the degree expected, as shown by the consistent percentages of disturbance across the condition indicators of vegetation, grass, and vegetation and grass combined. On the other hand, the expected concentration of effects is shown by the greater increases in vegetation and grass loss when measured in square feet. Also, designated campsites show greater increases in exposed soil whether measured in square feet or as an increase in the percentage. The social significance of these surprising findings is unknown. Designated campsites likely provide a camping opportunity that is highly sought by those who visit and stay at them. In addition, such sites provide a known destination for those visitors who are less familiar with the area.

Designated campsites do offer visitors opportunities for more secluded backcountry camping experiences, even in area where the number of overnight visitors is relatively high. These opportunities could be enhanced by establishing minimum distances between campsites and roads, campsites and trails, and between campsites. Compliance with resource protection setback distances could also be improved. Management control over such site selection criteria

Conclusions

is a principal advantage of the containment strategy. This strategy has concentrated the effects of visitation on a restricted number of campsites, thus minimizing the area of disturbance associated with camping activities.

Many of the Park's campsite management problems are most appropriately addressed through an expanded program of visitor education and communication. Development and widespread distribution of improved *Leave No Trace* literature is recommended. Improved information for desert, riparian, and montane environments now exists and could be easily adapted to Big Bend NP. Improved campsite selection criteria could also be developed and employed to protect sensitive habitats and cultural sites and to promote camping solitude. Campsite maintenance and rehabilitation programs can also help to restore natural conditions and concentrate visitor activities to minimize the area of disturbance. Finally, managers should consider the adoption of a decision framework, such as LAC, to guide decisions about backcountry management. Campsite assessment procedures developed for this survey are recommended as part of an ongoing program of campsite condition monitoring. Such information provides an objective basis for decisions, either within or separate from a formal decision framework like LAC.

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Appendix 1

Big Bend National Park Backcountry Campsite Assessment Manual

Note:

**Pagination for this Appendix is distinct from the Report entitled
“Assessment of Backcountry Campsite Conditions in Big Bend National
Park” so that it can go into the field as a separate document
during future assessment efforts.**

**Big Bend National Park
Backcountry Campsite Monitoring Manual**

Cooperative Park Studies Unit
Virginia Tech Department of Forestry
March 1995

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DEFINITION OF CAMPSITE AND DESCRIPTION OF MONITORING FORMS

For the purposes of this manual...

A BACKCOUNTRY CAMPSITE IS DEFINED AS AN AREA OTHER THAN A TRAIL THAT HAS BEEN DISTURBED BY PEOPLE RECREATING, AS MIGHT RESULT FROM EITHER OVERNIGHT CAMPING OR DAYTIME ACTIVITIES. THE DISTURBED AREA IS NEITHER TOO STEEP NOR TOO SMALL FOR CAMPING. THE CAMPSITE IS NOTICEABLE BECAUSE ITS VEGETATION, SURFACE LITTER, OR SOILS HAVE BEEN CHANGED COMPARED TO CONDITIONS ON SIMILAR, UNDISTURBED, AND ADJACENT AREAS. A VISIBLE BOUNDARY MUST EXIST BETWEEN THE CAMPSITE AND ADJACENT AREAS.

Undisturbed areas separating sites might not exist in all areas with multiple sites, so a surveyor occasionally might have to make an arbitrary decision to define separate sites. Surveyors are to note on the associated campsite survey forms whenever any such case occurs.

Three approaches assist in locating campsites: 1) discussions with experienced backcountry rangers to identify potential camping areas, 2) floating of each of the three major canyons, stopping at every potential camping location; hiking of all park trails, however faint; and driving of all passable park roads in the backcountry, and 3) searching areas identified on maps as likely camping locations (areas near water and formal park trails with low slopes).

Once a surveyor recognizes that 1) a campsite exists and 2) it has a boundary between disturbed and undisturbed areas, the surveyor begins a site survey by selecting a form appropriate for the type of campsite (see Table 1).

Table 1 Description of the three campsite assessment forms applied in Big Bend, 1993.

1. BACKCOUNTRY CAMPSITE FORM:
for either a designated or undesignated campsite that requires hiking for access.
2. BACKCOUNTRY ROAD DESIGNATED SITE FORM:
for a designated campsite to which one drives in the backcountry.
3. RIO GRANDE RIVER USE AREA FORM:
for all areas where the primary access is by river. Some Rio Grande sites are accessible by road, too. The primary access route for those who camp in these areas determines the appropriate form. If most campers access the location by river, then the river form applies. However, if most campers access the area by road, then either the DESIGNATED SITE FORM or the BACKCOUNTRY CAMPSITE FORM applies, depending on whether the site is designated or not. If in doubt, use your best judgement and note your reasoning.

Each type of form allows surveyors to collect consistent information that 1) identifies the campsite, 2) describes its location, and 3) indicates its condition. *Campsite condition indicators*, collected in this third category, are elements of a campsite that are affected by camping or other recreation activities, that can be measured reliably by surveyors, and that will change as a result of actions to manage camping. Appropriate measurement of condition indicators often requires a comparison between off-site and on-site conditions, and of each indicator's area within the campsite.

Assessment of Rio Grande Campsites should not allow comparison between on-site and off-site conditions or measure the area of disturbance because flooding and other river conditions, more than recreation, influence the physical and biological condition of those campsites. Additionally, because the boundary between off-site and on-site conditions can be affected greatly and easily by river conditions, surveyors are not to distinguish between on-site and off-site conditions except with general comments. It is inappropriate to collect information that may be misleading. A comparison between off-site and on-site conditions might lead one to conclude erroneously that recreation contributes more to the Rio Grande campsite conditions than likely it does. The influence of the river is greater. This is especially true were one to compare conditions measured several years apart. In such a case, the river is certain to have altered the site at least once, so any comparison for the purposes of assessing changes caused by camping during that period would be inappropriate. Appropriate indicators of campsite condition must be relevant to the process of interest, namely recreation activities.

ASSESSMENT MATERIALS

COMPASS, peephole type (not corrected for declination)
USGS TOPOGRAPHIC MAPS, (1/24,000)
TRAIL GUIDE MAP (annotated with comments from NPS staff members)
RIVER GUIDE MAP (if appropriate. Be sure to bring one with the locations of previously surveyed campsites clearly marked on it)
TAPE MEASURE, 50 foot (marked in tenths)
FLAGGED WIRE PINS, (25 minimum)
CENTERPOINT STAKE, larger steel nail (12 inch)
CAMERA (35 mm SLR capable of indicating photograph number accurately, 35 mm lens, ASA 100 or 200 color print film [store in freezer])
ALUMINUM NUMBERED TAGS
4 INCH GALVANIZED STEEL NAILS, 15 per day minimum
CLIPBOARD
ASSESSMENT MANUAL
ASSESSMENT FORMS (an assortment of types, including some on waterproof paper),
PENCILS (3-4 or extra leads for mechanical pencil)
LEATHER GLOVES (thorn-proof)

either:

WIPE-BOARD WITH ERASABLE MARKER
or FLIPCHART WITH CAMPSITE TAG NUMBERS (photo documentation)

(remeasurement only)

MAGNETIC PIN LOCATOR (and trained ear)

From most recent assessment:

SITE IDENTIFICATION INFORMATION FOR EACH CAMPSITE (from most recent assessment)
CENTERPOINT PHOTOGRAPHS AND PHOTO DESCRIPTION OF EACH CAMPSITE (to relocate centerpoint and to repeat the photograph)
CENTERPOINT REFERENCES FOR EACH CAMPSITE (to relocate the centerpoint if the nail and tag are missing or hard to find)
VARIABLE RADIAL TRANSECT COORDINATES FOR EACH CAMPSITE (from most recent assessment)

[DO NOT BRING]

ANY INFORMATION ABOUT LOCATION CHARACTERISTICS OR CONDITION INDICATORS FROM PREVIOUS ASSESSMENT (Previous assessment results must not influence current assessment)

Recommended personal gear

SUNSCREEN (SPF 8-15)
SUNSCREEN FOR LIPS, NOSE, ETC. (SPF 15-25)
HAT WITH BRIM
SUN GLASSES (100% UV & 100% IR protection)
LIGHTWEIGHT, LONG SLEEVED SHIRT
LIGHTWEIGHT, LONG-LEGGED PANTS
LEATHER BOOTS (with good ankle support)
GAITERS (Cordura, to withstand cactus & lechuguilla spines)
2-3 QUARTS OF DRINKING WATER PER PERSON PER DAY (this does not include water for cooking while on an overnight trip; anticipate consuming 1-2 gallons of water daily)
FIRST-AID KIT (basic: tape, antibiotic ointment, ibuprofen, etc.)

PROCEDURES

Each of the three forms contain a similar set of indicators. Some indicators identify the campsite, some characterize its location, some describe its condition, and some document either its size or the photographs taken. Each indicator is assigned a unique number that is consistent on each form. For this reason, indicators appearing on some forms are not numbered sequentially.

BACKCOUNTRY TRAIL ACCESSED CAMPSITE FORM¹

Site Information

- 1) **Site Tag Number:** Each site is to be numbered with a unique aluminum tags buried within campsite boundaries. When sites are reassessed, examine the mapped locations and field forms to determine if a site was present during the previous survey. Locate campsite centerpoints with centerpoint references, centerpoint photograph, and the pin locator. Verify campsite numbers by digging up the campsite number tags. Rebury the tag and nail, following instructions seen in Table 2. REPLACE ANY LOST TAGS AND CENTERPOINT NAILS ONLY IF YOU ARE ABSOLUTELY CERTAIN OF THE CAMPSITE NUMBER AND CENTERPOINT LOCATION. NEW SITES MUST RECEIVE A UNIQUE NUMBER.
- 2) **BIBE Site Code (if applicable):** Record the designated campsite code if applicable. Attach the most recent coding sheet to the appendix of this manual.
- 3) **Use Area:** Record the Big Bend Use Area code. Attach the most recent coding sheet to this manual.
- 4) **Trail Name:** Record the name of the trail closest to the campsite.
- 5) **USGS Quad:** Record the code for the quad sheet showing where the site is located (see Table 2).

Table 2 Codes for USGS Quadrangles applicable to Big Bend National Park, 1993.

1 Persimmon Gap	11 Lajitas	21 Cerro Castolon
2 Bone Spring NE	12 Amarilla Mtn.	22 Emory Peak
3 Bone Spring	13 Terlingua	23 Glenn Spring
4 Dagger Flat	14 Tule Mtn.	24 San Vincente
5 Christmas Mts.	15 The Basin	25 Boquillas
6 Sombrero Peak	16 Panther Jct.	26 Smoky Creek
7 Grapevine Hills	17 Roys Peak	27 Reed Camp
8 McKinney Spring	18 Ernst Valley	28 Mariscal Mtn.
9 Sue Peaks	19 Mesa De Anguila	29 Solis
10 Stillwell Crossing	20 Castolon	

NOTE: The numbering sequence might be changed to reflect the addition of areas depicted with Butter Bowl and Twin Peaks quads.

Locate/Label on Map-- Mark the quad sheet with a dot precisely where the campsite is located. Label the dot with the campsite number. Draw a short line to the label in areas with a high density of campsites. Be as accurate as possible and, when necessary, supplement the quad map with either copier enlargements of the quad (for high density areas) or informal maps quickly sketched in the space provided on the rear of the survey form. Place a scale on the original prior to any copier enlargements.

¹ Actual form located in appendix 1.

UTM COORDINATES Universal Transverse Mercator (UTM) coordinates allow one to collect relatively exact surface location information. An assessor may obtain the UTM coordinates from either a USGS map or from a Geographic Positioning System (GPS) machine. In either case, proper training by experienced personnel is essential. Find someone in the Science and Resources Management Division who will teach you if you are not already familiar with the techniques.

6) **E:** Record the UTM Easting.

7) **N:** Record the UTM Northing.

8) **UTM Source (Map or GPS):** Record the source for the UTM coordinates (If a map is the source, do not gather the UTM coordinates in the field. It is more efficient to gather the coordinates for many campsites at once during a few hours in the office).

9) **Describe Site Location:** Describe the campsite location with brief references to local features (trail intersections, stream crossings, water sources, archeological sites, large boulders or trees) and paced distances. (See ? for pacing procedures). Use sufficiently descriptive detail and additional local area maps as necessary so that someone else five years from now could find the site (see examples at end of manual).

10) **Date Assessed:** Record the date of the Assessment.

11) **Assessed By:** Record the initials of the person responsible for completing the form.

Site remeasurement: Due to phenological and visitation patterns occurring during a year, it is critical that campsites be remeasured as close to the initial assessment month and day as possible, preferably within 1 to 2 weeks. Explaining results from comparisons between conditions assessed at different times of the year is exceptionally difficult.

Location Characteristics

Campsite is (Y or N):

12) **< ½ mile from road?** - Examine map, ½ mile is equal to 1 and 5/16 inches on the map.

13) **< 100 yards from obvious archeological site?** - An obvious archeological site is one that is clearly an historic or prehistoric site, not one that would be overlooked by someone with no training. If necessary, pace this distance (see "Feet per Pace" [#24], and Table 5 for definition of pace and its measurement).

14) **Otherwise closed area?** - Check "yes" if the campsite is in an area closed for a reason other than the two previous reasons. Note the reason for the closure in the Comment/Recommendation section found on the back of the form.

15) **Elevation:** From the map, determine the campsite's elevation to the nearest 40 feet (one contour line).

16) **Aspect:** With your back facing upslope, sight your compass in the direction of downslope and record the compass bearing in degrees.

17) **Site Position:** Depending on the campsite's topographic location, record one of the following codes.

"F" for "Flood plain"	if the campsite is within a Flood plain of a permanent or intermittent stream or river.
"D" for "Drywash"	if the campsite is within the corridor of a drywash (a Flood plain would be outside the corridor).
"P" for "Plain"	if the campsite is outside a drywash or Flood plain, yet not on a slope.
"M" for "Midslope"	if the campsite is above a plain, drywash, or Flood plain, yet not on a ridge.
"R" for "Ridgetop"	if the campsite is on a ridge or summit.

18) **Distance to Water:** With the following categories, indicate the distance between the campsite boundary and the closest water source along the most direct route:

1=<25 yds 2=26-75 yds 3=76-100 yds 4=>100 yds

19) **Water Source:** Using the following codes, indicate the type of water source.

S=Spring or spring outflow T=Tinaja R=River N=Ephemeral course or None within a 5 minute walk

20) **Canopy Cover:** With the following codes, indicate the percentage of tree canopy cover.

0=<1% 1=1-5% 2=6-25% 3=26-50% 4=51-75% 5=76-95% 6=96-100%²

21) **Vegetation Community:** Based on definitions described in Table 3, record the type of vegetation community surrounding the campsite.

Table 3 Vegetation Community Descriptions for Big Bend National Park.

Woodland	This type occurs above the Sotol-Grass Formation and includes the Chisos Mountains. Most often associated with moderate to steep slopes of the Chisos and Green Gulch, but also extending down to the desert floor along small and medium size washes. Canopy need not be closed, as several scrub and meadow subtypes are associated.
Sotol Grass	Typically located between the woodland and shrub desert formations, this type is marked by fairly continuous grasses and an assortment of shrub species. Notable species within this type include lechuguilla, sotol, and yucca, although grasses best define the type.
River Flood plain	Immediately associated with the Rio Grande and its larger tributaries. Common species include mesquite, reed grasses, cottonwood, and desert willow. These species may appear as mixed together or in distinct growth areas.
Shrub Desert	Most of the park falls into this category. It is dominated by creosote bush and lechuguilla, although large trees and shrubs may be found around springs. Grasses are often intermixed within this type, but tend to be more widely spaced than in the sotol grass formation.
Island	A small area of one type surrounded by one or more types, as might be found around a spring.
Bare	An area lacking any vegetation regardless of camping effects.

From: Big Bend National Park Resource Management Plan, 1993

22) **Trail Type:** Record the category that best describes the trail closest to the campsite, not considering access trails.

² These percentage categories are consistent for all similar indicators throughout this manual.

Table 4 Types of trails in Big Bend.

1) Major	Well marked and well traveled. Constructed to the highest standard and maintained to the highest level. Signs are sufficient for inexperienced visitors. Some signs may be interpretive, as well.
2) Minor	Constructed to a more minimal standard and maintained less intensively than Major trails. Compared with Major trails, sections of Minor trails are often narrower, steeper, and with fewer constructed items such as steps or walls. Basic navigation signs, but not interpretive displays, may be present.
3) Primitive	Virtually no constructed sections exist. These trails may be difficult to follow at times. Often located in remote, seldom visited areas. Steep, rugged conditions are common, often requiring map reading to find and negotiate these routes.
4) None	No trail exists, as when a route to a destination simply follows a drainage or traverses cross-country with no formal recognition of the route as a trail.

From: Big Bend National Park Backcountry Management Plan, 1993.

23) **Distance to Formal Trail:** Pace the distance, along a footpath if present, to the nearest formal park trail and record the number of paces. If over a 5 minute walk record a "-1".

24) **Feet per Pace:** Record the number of feet per pace of the person measuring paced distances.

Table 5 Pace defined and measured.

A walking pace is...

...the distance from where a foot leaves the ground to where it next strikes the ground.

To measure this distance, lay ten feet of the tape measure out on the ground, marking a starting line at the beginning of the tape. Start walking one or more paces behind the start line, walk toward the line, step so that your toe hits the line, and then complete a pace. Record the distance from the starting line to where the same toe that stepped on the line strikes the ground a second time. Do this several times and calculate an average value. It is important to walk naturally, not with an overextended or under-extended gait.

NOTE THE FEET-PER-PACE WHENEVER A PACED MEASUREMENT APPEARS.

25) **Inter-site visibility:** Record the number of other campsites visible from the current one, an indication of how crowded an area can be and of how likely it is that campers might feel a sense of solitude. Do not include satellites associated with the current campsite (see Table 6 for a definition).

Table 6 Definitions of "Satellite" and "Island."

Satellite	Small areas of disturbance likely created by campers dispersing tents outside the main campsite or another similar reason. Access trails between the satellite and main site are often obvious. A satellite much smaller than a tent "footprint" should not be counted (minimum size of approximately 5 ft by 4 ft [20 ft ²]). Satellites are treated as part of the campsite.
Island	Small undisturbed areas within the main campsite boundaries, as might occur when a cluster of shrubs or cactus are not removed. Do not measure areas less than 3 ft. across or single large plants. Islands are not treated as part of the campsite.

26) Toilet: Record the type of toilet available to those camping at the site.

P=Pit toilet C=Containment Toilet N=None (no constructed toilet available)

27-30) Animal effects: Record the appropriate code describing the visibility of apparent effects for livestock, packstock, javelina, and other. The "other" category is intended to capture the amount of effects caused by unknown animals, but not attributable to people camping at the site. The purpose of this indicator is to distinguish between the effects of camping and those of animals. The codes are:

N=None No visible effects

S=Some Some noticeable effects

M=Much The campsite condition has been greatly affected by animals

31) Bear box distance from C.P. (-1=not present): Measure and record the distance in feet from the centerpoint of the campsite to the closest part of the bear box if the box is present. The centerpoint is where the aluminum tag bearing the unique campsite number is buried. It is not necessarily the center of the campsite. This figure indicates how close the bear box is to the more busy area of the campsite. In areas with aggressive bears, it is best to separate the bear box from the campsite.

Condition Indicators

Assessment of campsite condition begins by applying the Variable Radial Transect methods described in Appendix 2. Those procedural steps allow surveyors to:

- 1) install temporary flags that delineate the boundary between on-site and off-site areas,
- 2) establish permanent campsite centerpoint where a nail and tag eventually are buried,
- 3) record the bearing (azimuth) and distance from the center to each flag along the boundary,
- and 4) measure the "islands" and "satellites" associated with each campsite.

Prior to continuing, the temporary flags must be installed. Whether one completely applies the other steps before continuing is less important. Surveyors are encouraged to develop their own rhythm, as long as efficiency and consistency are retained.

32) Condition Class: Select the Condition Class that most closely describes the campsite (see Table 7).

Table 7 Campsite Condition Class Definitions, Big Bend, 1993.

Class 1:	CAMPSITE BARELY DISTINGUISHABLE: Soil surface only slightly disturbed. Vegetation cover barely altered. Organic litter barely disturbed, compared to litter present outside of campsite boundaries in similar, adjacent areas.
Class 2:	CAMPSITE APPARENT, EFFECTS CONFINED: Large stones absent from soil surface in areas where primary activities occur, and any previous vegetation cover or organic litter is either lost or pulverized. Obvious effects concentrated with effects tapering toward boundary.
Class 3:	CAMPSITE OBVIOUS, EFFECTS THROUGHOUT SITE: Distinct boundary exists between the campsite and undisturbed adjacent areas. Vegetation cover or organic litter is lost or pulverized on much of the site. Few stones or gravel remain in areas where primary activities occur. Most gravel or stones present on the site are outside primary activity areas.
Class 4:	CAMPSITE OBVIOUS, EFFECTS WIDESPREAD: Distinct boundary exists between campsite and undisturbed areas. Nearly complete or total loss of vegetation cover and organic litter. Bare soil widespread with little gravel or few stones present anywhere within boundaries.
Class 5:	CAMPSITE OBVIOUS, EFFECTS WIDESPREAD AND CONDITION GREATLY DIFFERENT FROM ADJACENT AREAS: Soil compressed and may show small gullies. Vegetation absent within boundaries, roots are exposed, and little gravel or few stones present.
NOTE:	Condition class is NOT affected by size, trash, or tree damage other than exposed roots. Condition class IS determined by soil exposure and vegetation coverage.

33) **Vegetative ground cover Offsite:** Estimate the percentage of live non-woody vegetative ground cover (including herbs and mosses; excluding grasses, sedges, tree seedlings, saplings, and shrubs) in an adjacent but largely undisturbed "control" area. The control site should be similar to the campsite in most ways, including slope and other environmental conditions. The intent is to locate an area closely resembling the campsite area if camping never occurred there. In instances where you cannot decide between two categories, select the category with less vegetative cover. The rationale for this is that, all else being equal, the first campers would have selected a site with the least amount of vegetation cover. For this and similar indicators, it is often helpful to narrow your decision to two categories and consider their difference. For example, if the vegetation cover is either category 2 (6-25%) or category 3 (26-50%), you can simplify your decision by focusing on whether vegetative cover is greater than 25%.

0=<1% 1=1-5% 2=6-25% 3=26-50% 4=51-75% 5=76-95% 6=96-100%³

34) **Grass/sedge cover Offsite:** Following the procedures and categories for "Vegetative ground cover Offsite" (#33), assess the combined percentage of grasses and sedges seen in adjacent, similar areas outside the campsite.

35) **Vegetative Ground Cover Onsite:** Estimate the percentage of live non-woody vegetative ground cover (including herbs and mosses; excluding grasses, sedges, tree seedlings, saplings, and shrubs) within the flagged campsite boundaries. Use the categories listed with #33 (refer to photographs following these procedures). Include any disturbed "satellite" use areas and exclude undisturbed "islands" of vegetation (see Table 6).

36) **Grass/sedge cover Onsite:** Following the procedures and categories for "Vegetative ground cover Onsite" (#33), assess the combined percentage of grasses and sedges seen in adjacent, similar areas outside the campsite. Include any disturbed "satellite" use areas and exclude undisturbed "islands" of vegetation (see Table 6).

³ These percentage categories are consistent for all similar indicators throughout this manual.

- 37) **Primary ground surface Offsite:** Select the category from Table 8 that best describes the ground in similar undisturbed areas adjacent to the campsite.

Table 8 Soil description categories applicable to Big Bend, 1993.

"B" for Bedrock	if the surrounding soil is exposed bedrock with few examples of other soil types.
"L" for Large stones & soil	if the surrounding soil is marked by large stones (>4" dia.).
"C" for river or wash Cobble	if the surrounding soil is mostly rocks and stones worn smooth by water.
"G" for Gravel	if the surrounding soil is more rocky than sandy (<4" dia. rocks but not all sand).
"M" for Mineral soil	if the surrounding soil is mostly sand or other fine minerals, but not packed hard.
"H" for Hardpan	if the surrounding soil is packed hard outside the campsite.
"O" for Organic	if the surrounding soil is mostly organic deposits such as old leaves, dead grasses, etc., usually noted by the "dirt" texture. Mostly found in Chisos.
"Y" for crYptogamic	if the surrounding soil has extensive growth of cryptogamic crusts or pedestals. These are very rare cases, especially in Big Bend.

From: Soil Survey of Big Bend National Park, Part of Brewster County, Texas (USDA, SCS 1985).

- 38) **Primary ground surface Onsite:** Select the category from Table 8 that best describes the ground within the campsite boundaries.

39) **Soil exposure Onsite:** Estimate the percentage of soil exposure, defined as ground with very little or no organic litter (partially decomposed leaf, needle, or twig litter) or vegetation cover, within the campsite boundaries and within satellite use areas (refer to the photographs following these procedures, also see Table 6). Dark organic soil, the decomposed product of organic litter, should be assessed as bare soil when its consistency resembles peat moss. Assessments of soil exposure may be difficult when organic litter forms a patchwork with areas of bare soil. If patches of organic material are relatively thin and few in number, the entire area should be assessed as bare soil. Otherwise, the patches of organic litter should be mentally combined and excluded from assessments. Code with categories from "vegetative ground cover Offsite" (#33).

40-42) **Tree damage:** Assign and tally each live tree (>1 in. diameter at 4.5 ft.) within or on campsite boundaries to one of the tree damage rating classes described below (refer to the photographs following these procedures). Include trees within undisturbed "islands" and exclude trees in disturbed "satellite" areas (see Table 6). Assessments are restricted to all trees within the flagged campsite boundaries in order to ensure consistency with future measurements. Multiple tree stems from the same species which are joined at or above ground level should be counted as one tree when assessing damage to any of its stems. Assess a cut stem on a multiple-stemmed tree as tree damage, not as a stump. Do not count tree stumps as tree damage. Take into account tree size. For example, damage for a small tree would be considerably less in size than damage for a large tree. Where obvious, assess trees with scars from natural causes (e.g., lightning strikes) as None/Slight.

NONE/SLIGHT . NO OR SLIGHT DAMAGE SUCH AS BROKEN OR CUT SMALLER BRANCHES, ONE NAIL, OR A FEW SUPERFICIAL TRUNK SCARS.

MODERATE . . . NUMEROUS SMALL TRUNK SCARS AND/OR NAILS OR ONE MODERATE-SIZED SCAR.

SEVERE TRUNK SCARS NUMEROUS WITH MANY THAT ARE LARGE AND HAVE PENETRATED TO THE INNER WOOD; ANY COMPLETE GIRDLING OF TREE (CUTTING THROUGH TREE BARK ALL THE WAY AROUND TREE).

N/A NOT APPLICABLE BECAUSE THERE ARE NO TREES WITHIN CAMPSITE BOUNDARIES. CHECK IF APPROPRIATE.

Site remeasurement: Begin by assessing tree damage on all trees within the site boundaries identified in the last measurement period. Place boxes around each tally for trees in areas where boundaries have moved closer to the centerpoint, i.e., former site areas which are not currently judged to be part of the site. Next, assess tree damage in areas where boundaries have moved further from the centerpoint, i.e., expanded site areas

which are newly impacted since the last measurement period. Circle these tallies. These additional procedures are necessary in order to accurately analyze changes in tree damage over time.

- 43-45) **Root Exposure:** Assign and tally each live tree (>1 in. diameter at 4.5 ft.) within or on campsite boundaries to one of the root exposure rating classes that follow. Include trees within undisturbed "islands" and exclude trees in disturbed "satellite" areas (see Table 6). Assessments are restricted to all trees within the flagged campsite boundaries in order to ensure consistency with future measurements. Where obvious, assess trees with roots exposed by natural causes (e.g., flooding) as None/Slight.

None/Slight . . . NO OR SLIGHT ROOT EXPOSURE SUCH AS IS TYPICAL IN ADJACENT OFFSITE AREAS.
Moderate TOP HALF OF MANY MAJOR ROOTS EXPOSED MORE THAN ONE FOOT FROM BASE OF TREE.
Severe THREE-QUARTERS OR MORE OF MAJOR ROOTS EXPOSED MORE THAN ONE FOOT FROM BASE OF TREE; SOIL EROSION OBVIOUS.
N/A NOT APPLICABLE BECAUSE THERE ARE NO TREES WITHIN CAMPSITE BOUNDARIES. CHECK IF APPROPRIATE.

Site remeasurement: Begin by assessing root exposure on all trees within the site boundaries identified in the last measurement period. Place boxes around each tally for trees in areas where boundaries have moved closer to the centerpoint, i.e., former site areas which are not currently judged to be part of the site. Next, assess root exposure in areas where boundaries have moved further from the centerpoint, i.e., expanded site areas which are newly impacted since the last measurement period. Circle these tallies. These additional procedures are necessary in order to accurately analyze changes in root exposure over time.

- 46) **Fire Sites within boundary or satellite areas (#):** Count each fire site within campsite boundaries, including satellite areas (see Table 6). Include old inactive fire sites as exhibited by blackened rocks, charcoal, or ashes. Do not include locations where charcoal or ashes have been dumped. However, if it is not clear whether or not a fire was built on the site, always count questionable sites that are within site boundaries and exclude those that are outside site boundaries.

- 47) **Trails exiting boundary (#):** Count all trails leading away from the outer campsite boundaries. Do not count extremely faint trails which have untrampled tall herbs present in their tread. Count only trails exiting the main campsite, not those exiting a satellite (see Table 6). Include trails to satellites.

- 48) **Human waste in likely areas:** Assess the amount of human waste visible with only a slight search of the immediately surrounding areas. Look at only those areas that are likely to fulfill this need.

None=No waste visible in likely areas Some=few distinct examples (<5)
Much=Many distinct examples (>5)

- 49) **Litter visible from boundary:** Categorize the amount of litter visible without searching beyond the campsite boundary.

None=No litter visible Little=less than a handful Some=less than a quart sized bagful
Much=More than a small bagful

- 50) **Number of satellite sites:** Count and record the number of satellite sites associated with this campsite (see Table 6).

- 51) **Total Campsite Area (calculated from measurements on reverse):** Using the dBASE computer program, compute the campsite size using the transect data. A similar program calculates the area of each island and satellite site (see the Geometric Figure Method sheet for procedures. Formulas are calculated by dBASE). Record these values in the spaces provided on the back of the form and calculate the Total Campsite Area. Record this value on the front of the form to facilitate computer data entry.

[BACK OF FORM]

- 52) **Comments/Recommendations:** An informal list of comments concerning the site. Note any assessments that you felt were particularly complex or subjective, difficulties with monitoring procedures or their application to this particular campsite, suggestions for clarifying monitoring procedures,

descriptions of particularly significant problems beyond campsite boundaries (quantify if possible), excessive litter, human waste, or horse impacts, or any other comments you feel may be useful.

Site Centerpoint Photograph: The primary reason for taking a campsite photograph is to allow someone other than you to relocate the centerpoint as easily as possible. Secondly, the photograph records the general campsite condition. You must make every effort to take a picture that provides this information.

Select a vantage point that shows: 1) a good view of the campsite, 2) the centerpoint location, and 3) one or more of the centerpoint references. Select a location clearly showing the centerpoint location in relation to nearby trees or boulders. It may be necessary to take a separate centerpoint photograph in some instances. Place the tape measure against the centerpoint stake so that it is clearly visible in the camera viewfinder. This will provide a consistent reference for scale in each photo.

Each photograph must contain an indicator with the campsite number clearly shown. Place either a numerical flip-chart or a write-erase board next to the centerpoint. Whether you use the flip-chart or board, you must show the campsite number clearly. Write large and be aware of sunlight glaring off the surface and washing out the number. Take a picture, pointing the camera slightly downward to include as much of the campsite groundcover as possible.

53) **Roll #:** Write the unique number of the film roll. Establish your numbering system at the beginning of the project. For example, "BIBE 1" might work, as might "BIBE 93,1" to record the Park, year, and roll number. Stick a piece of waterproof first-aid tape on the rear of your camera. When beginning a roll of film, you should use a waterproof marker to record the roll number on the piece of tape and on the film roll. **When preparing to send the film for developing, you should record the roll number on the receipt so that you can identify the rolls quickly when they return.**

54) **Photo #:** Record the unique roll-sequence number. You should have a camera that accurately displays this number.

55) **Bearing:** Use the peephole compass to measure the bearing from the point where photograph was taken to the centerpoint. Record this bearing in degrees.

56) **Distance (ft):** Measure the distance between the centerpoint and the photopoint. Record it to the nearest foot.

57) **Photo Description:** Write something unique about the photo that will allow you to recognize it and to recognize the centerpoint references. For example, record the frame location of all references appearing in the photograph. The frame location is where the object appears in the photo.

Example: "CP ref. #2, L of frame." (see "Centerpoint References" example).

58-60) **Centerpoint References:** Describe three objects in or near the campsite that one might refer to when relocating the centerpoint. Select objects that are likely to be permanent (e.g. will not move in the next few years). Each description should include the object, something recognizable about it, and its distance and bearing from the centerpoint.

Example: "2) 15' Ocotillo (largest near site)-- 25' @ 45°" (this example is cross-referenced with the "Photo Description" example).

61) **Satellite Site Dimensions:** Draw a replica of the geometric figure applicable to each satellite site associated with the campsite. Record the lengths of two sides if a square or rectangle. Record the length of all three sides if a triangle. Record the radius length if a circle. Next to the small drawing with the lengths labeled, record the bearing and distance from the Centerpoint to each satellite. In some cases it may be necessary to record the bearing and distance from one satellite to another. If this is necessary, note the two points you refer to with the bearing. See Table 6 for the definition of Satellite.

62) **Island Site Dimensions:** Following the general sequence for "Satellite Site Dimensions," record the location and size of any islands of undisturbed vegetation found within the campsite boundaries. See Table 6 for the definition of Island.

63-82) **Transect Data (for condition classes 3,4,5 only):** Follow the procedures described in Appendix 2.

Sketch of Site . . . [SITE DIMENSIONS IF CONDITION CLASS 1 OR 2] **BRIEFLY** draw a thumbnail sketch of the site with its key items noted. The centerpoint, photopoint, and all reference points should be labeled. Trails exiting the boundary should appear. Bearings to other sites should appear along with the tag-number (e.g. #234: 50' @ 45° with an arrow). Satellite sites and islands should appear, too. Do not spend more than 1-2 minutes. A rough drawing will do fine. The purpose for this sketch is to orient someone relocating the campsite.

Table 9 Instructions for burying the centerpoint tag and nail.

- | |
|--|
| <ul style="list-style-type: none">● Bury centerpoint nail and tag between 2-3 inches deep.● With your foot, compact soil over the tag location.● With your hand, scuff up the area around the centerpoint so that it does not look like something is buried there. |
|--|

- Collect all campsite boundary pins, the centerpoint stake, and all other equipment.

BACKCOUNTRY ROAD ACCESSED CAMPSITE FORM⁴

Most of the information collected for road-access backcountry campsites is identical to that collected for trail-access sites. Note the differences and refer consistently to the complete instructions, regardless of whether they appear in this section or the previous. Complete a "Backcountry Campsite Form" for any site that is not associated with a designated site. Any site accessed through parking at a designated site should be considered a satellite of the designated site.

Site Information

- 1) **Site Tag Number:** The same instructions apply as for Backcountry Campsites. Bury the tag toward the perimeter of the campsite and away from the access road. This will reduce the likelihood that the soil becomes excessively compacted around the tag. It also may reduce the possibility that metal objects, such as bolts or other pieces of trash, produce multiple echoes in the pin locator (metal detector) used to relocate the centerpoint.
- 2) **BIBE Site Code (if applicable):** Park managers have assigned a unique code to each designated backcountry road-access campsite. Record that designated campsite code. Attach the most recent coding sheet to the appendix of this manual.
- 3) **Use Area:** Apply the same instructions as for the Backcountry Campsite form.
- 4) **Road Name:** Record the name of the road closest to the campsite.
- 5) **USGS Quad:** Apply the same instructions as for the Backcountry Campsite form (see Table 2).

Locate/Label on Map-- Apply the same instructions as for the Backcountry Campsite form.

UTM COORDINATES Apply the same instructions as for the Backcountry Campsite form.

- 6) **E:** Record the UTM Easting.
- 7) **N:** Record the UTM Northing.
- 8) **UTM Source (Map or GPS):** Apply the same instructions as for the Backcountry Campsite form.
- 9) **Describe Site Location:** Apply the same instructions as for the Backcountry Campsite form. (See ? for pacing procedures).
- 10) **Date Assessed:** Record the date of the Assessment.
- 11) **Assessed By:** Record the initials of the person responsible for completing the form.

Site remeasurement: Due to phenological and visitation patterns occurring during a year, it is critical that campsites be remeasured as close to the initial assessment month and day as possible, preferably within 1 to 2 weeks. Explaining results from comparisons between conditions assessed at different times of the year is exceptionally difficult.

Location Characteristics

Campsite is (Y or N):

- 13) **< 100 yards from obvious archeological site?** - Apply the same instructions as for the Backcountry Campsite form.
- 14) **Otherwise closed area?** - Apply the same instructions as for the Backcountry Campsite form.
- 15) **Elevation:** Apply the same instructions as for the Backcountry Campsite form.

⁴ Actual form located in appendix 1.

- 16) **Aspect:** Apply the same instructions as for the Backcountry Campsite form.
- 17) **Site Position:** Apply the same instructions as for the Backcountry Campsite form.
- 18) **Distance to Water:** Apply the same instructions as for the Backcountry Campsite form.
- 19) **Water Source:** Apply the same instructions as for the Backcountry Campsite form.
- 20) **Canopy Cover:** Apply the same instructions as for the Backcountry Campsite form.
- 21) **Vegetation Community:** Based on definitions described in Table 3, apply the same instructions as for the Backcountry Campsite form.
- 22) **Road Type:** Record the category that best describes the road closest to the campsite, not considering access roads.

Table 10 Types of backcountry roads in Big Bend.

5) 2x4 Road	Maintained so that vehicles with high-clearance and two-wheel drives can travel the road unless weather has caused recent, significant damage.
6) 4x4 Road	Not maintained. Black Gap road is the only road in 1993 that fit this description. Travel on these roads using park vehicles for the purpose of assessing backcountry campsites is not recommended.

From: Big Bend National Park Backcountry Management Plan, 1993.

- 25) **Inter-site visibility:** Apply the same instructions as for the Backcountry Campsite form. Do not include satellite campsites associated with the current site (see Table 6 for definition).
- 26) **Toilet:** Apply the same instructions as for the Backcountry Campsite form.
- 27-30) **Animal effects:** Apply the same instructions as for the Backcountry Campsite form.

Condition Indicators

As with backcountry campsites, assessment of road-access campsite condition begins by applying the **Variable Radial Transect** methods described in Appendix 2. Those procedural steps allow surveyors to:

- 1) install temporary flags that delineate the boundary between on-site and off-site areas,
- 2) establish permanent campsite centerpoint where a nail and tag eventually are buried,
- 3) record the bearing (azimuth) and distance from the center to each flag along the boundary,
- and 4) measure the "islands" and "satellites" associated with each campsite.

Prior to continuing, the temporary flags must be installed. Whether one completely applies the other steps before continuing is less important. Surveyors are encouraged to develop their own rhythm, as long as efficiency and consistency are retained.

- 32) **Condition Class:** Apply the same instructions as for the Backcountry Campsite form.
- 33) **Vegetative ground cover Offsite:** Apply the same instructions as for the Backcountry Campsite form.
- 34) **Grass/sedge cover Offsite:** Apply the same instructions as for the Backcountry Campsite form.
- 35) **Vegetative Ground Cover Onsite:** Apply the same instructions as for the Backcountry Campsite form.
- 36) **Grass/sedge cover Onsite:** Apply the same instructions as for the Backcountry Campsite form.
- 37) **Primary ground surface Offsite:** Apply the same instructions as for the Backcountry Campsite form.

- 38) **Primary ground surface Onsite:** Apply the same instructions as for the Backcountry Campsite form.
- 39) **Soil exposure Onsite:** Apply the same instructions as for the Backcountry Campsite form.
- 40-42) **Tree damage:** Apply the same instructions as for the Backcountry Campsite form.
- 43-45) **Root Exposure:** Apply the same instructions as for the Backcountry Campsite form.
- 46) **Fire Sites within boundary or satellite areas (#):** Apply the same instructions as for the Backcountry Campsite form.
- 47) **Trails exiting boundary (#):** Apply the same instructions as for the Backcountry Campsite form.
- 48) **Human waste in likely areas:** Apply the same instructions as for the Backcountry Campsite form.
- 49) **Litter visible from boundary:** Apply the same instructions as for the Backcountry Campsite form.
- 50) **Number of satellite sites:** Apply the same instructions as for the Backcountry Campsite form.
- 51) **Total Campsite Area (calculated from measurements on reverse):** Apply the same instructions as for the Backcountry Campsite form.

[BACK OF FORM]

- 52) **Comments/Recommendations:** Apply the same instructions as for the Backcountry Campsite form.

Site Centerpoint Photograph: Apply the same instructions as for the Backcountry Campsite form. Do not worry about capturing the entire campsite by taking several photographs. Make sure that the picture provides obvious clues about the centerpoint's location.

- 53) **Roll #:** Apply the same instructions as for the Backcountry Campsite form.
 - 54) **Photo #:** Apply the same instructions as for the Backcountry Campsite form.
 - 55) **Bearing:** Apply the same instructions as for the Backcountry Campsite form.
 - 56) **Distance (ft):** Apply the same instructions as for the Backcountry Campsite form.
 - 57) **Photo Description:** Apply the same instructions as for the Backcountry Campsite form.
 - 58-60) **Centerpoint References:** Apply the same instructions as for the Backcountry Campsite form.
 - 61) **Satellite Site Dimensions:** Apply the same instructions as for the Backcountry Campsite form.
 - 62) **Island Site Dimensions:** Apply the same instructions as for the Backcountry Campsite form.
 - 63-82) **Transect Data (for condition classes 3,4,5 only):** Follow the procedures described in Appendix 2.
- Sketch of Site . . . [SITE DIMENSIONS IF CONDITION CLASS 1 OR 2]** Apply the same instructions as for the Backcountry Campsite form.

- **Collect all campsite boundary pins, the centerpoint stake, and all other equipment.**

RIO GRANDE RIVER ACCESSED CAMPSITE FORM⁵

Some of the information collected for river-access backcountry campsites is identical to that collected for trail-access sites. Major differences appear because the effect of the Rio Grande outweighs that of backcountry camping. Several exceptions, however, occur and are incorporated into these procedures. For example, although the river may flood and remove most fire sites, human waste, and litter, the very presence of these indicators remains important. They allow one to assess compliance with regulations, and they reflect conditions that many backcountry visitors find objectionable regardless of how long any single example has been present. Here, we assume that few boaters care whether litter has been present for a day or for several months. In any event, the argument continues, boaters find the litter's presence undesirable.

Site Information

- 1) **Site Letter:** Tags are not buried on river-access campsites because of the likelihood that a flood will either wash the tag away or deposit material that makes relocating the tag impossible. Instead of tags, a alphanumeric code (letter and number) is assigned to each site. This code is placed carefully on the river guide maps. Bring and review maps with the location of previously surveyed campsites clearly shown. Confirm that you are on the same campsite and not a campsite that has formed in the interim between surveys.
- 2) **River mile:** Record to the nearest tenth of a mile the "river mile" location of the campsite.
- 3) **Use Area:** Apply the same instructions as for the Backcountry Campsite form.
- 4) **River Section:** Record the name of the canyon in which this campsite is located.
- 5) **USGS Quad:** Apply the same instructions as for the Backcountry Campsite form (see Table 2).

Locate/Label on Map-- Apply the same instructions as for the Backcountry Campsite form.

UTM COORDINATES Apply the same instructions as for the Backcountry Campsite form. In most cases, a GPS unit will not function within a canyon. Bringing a GPS unit on a river trip may be worthless, especially if it is damaged or lost.

- 6) **E:** Record the UTM Easting.
- 7) **N:** Record the UTM Northing.
- 8) **UTM Source (Map or GPS):** Apply the same instructions as for the Backcountry Campsite form.
- 9) **Describe Site Location:** Apply the same instructions as for the Backcountry Campsite form. Be certain to note whether the site is on the Texas or Mexican side of the river. Also, note the closest significant feature (e.g. side canyon, river bend, etc.).
- 10) **Date Assessed:** Record the date of the Assessment.
- 11) **Assessed By:** Record the initials of the person responsible for completing the form.

Site remeasurement: Due to phenological and visitation patterns occurring during a year, it is critical that campsites be remeasured as close to the initial assessment month and day as possible, preferably within 1 to 2 weeks. Explaining results from comparisons between conditions assessed at different times of the year is exceptionally difficult.

Location Characteristics

Campsite is (Y or N):

- 13) **< 100 yards from obvious archeological site?** - Apply the same instructions as for the Backcountry Campsite form.

⁵ Actual form located in appendix 1.

14) **Otherwise closed area?** - Apply the same instructions as for the Backcountry Campsite form.

15) **Elevation:** Apply the same instructions as for the Backcountry Campsite form.

Note: Aspect is not assessed for Rio Grande access sites because most are shadowed by canyon walls enough that any possible influence of this variable becomes too difficult to explain.

17) **Site Position:** Apply the same instructions as for the Backcountry Campsite form.

Note: Distance to Water is not assessed for Rio Grande access sites because it can vary significantly. It is assumed that water is accessible at every site on the river.

Note: Water Source is not assessed for Rio Grande access sites because it is assumed that the river is accessible for washing needs and that people bring their own drinking water in their boats.

Note: Canopy Cover is not assessed for Rio Grande access sites because it is assumed that canopy cover is less important than "canyon shade" and that even this variable is an unimportant component of campsite conditions when compared to more direct effects of the river itself.

Note: Vegetation Community is not assessed for Rio Grande access sites because only the *river Flood plain* community applies, although subtypes of this community do exist.

25) **Inter-site visibility:** Apply the same instructions as for the Backcountry Campsite form. Do not include satellite campsites associated with the current site.

27-30) **Animal effects:** Apply the same instructions as for the Backcountry Campsite form.

Condition Indicators

Unlike backcountry campsites, assessment of river-access campsite condition does not require the **Variable Radial Transect** methods. Surveyors do not assess the area of river-access campsites by measuring it because the area of the site is less important than the landing capacity (how many boats can beach).

83) **Capacity:** Instead of measuring the size of the campsite, surveyors are to assign one of three possible categories describing the capacity of the site. Capacity reflects both the number of boats that could beach and the general size of the campsite. For example, a capacity of "1" might reflect either a small camping area, regardless of the number of boats that might be beached, or a small beaching area, regardless of the area available for camping.

1=small group (1-2 boats) 2=medium group (3-4 boats)

3=large group or multiple groups (5 boats or more, or multiple landings associated with a large site)

84) **Activity Level:** With the help of experienced National Park Service River Rangers, record the amount of activity they believe occurs on this campsite. It is important to assess inactive sites as well as active sites because changes in their status as a group may be more immediately indicative of changes in river-access camping. For example, a significant change in the number of inactive sites may tell more than changes among the various categories of active sites, especially if one compares both possible changes in active and inactive sites.

I=Inactive Activity is very uncommon.

L=Low Activity occurs, but the site is not desirable enough to attract people often.

M=Moderate Activity is common during the busier seasons.

H=High Activity is frequent throughout the year.

Note: Vegetative ground cover **Offsite** is not assessed for Rio Grande access sites because it is assumed that most of the difference between offsite and onsite conditions is caused by flooding or other natural events.

Note: Grass/sedge cover **Offsite** is not assessed for Rio Grande access sites because it is assumed that most of the difference between offsite and onsite conditions is caused by flooding or other natural events.

35) **Vegetative Ground Cover Onsite:** Apply the same instructions as for the Backcountry Campsite form.

36) **Grass/sedge cover Onsite:** Apply the same instructions as for the Backcountry Campsite form.

Note: Primary ground surface **Offsite** is not assessed for Rio Grande access sites because it is assumed that most of the difference between offsite and onsite conditions is caused by flooding or other natural events.

38) **Primary ground surface Onsite:** Apply the same instructions as for the Backcountry Campsite form. This indicator is assumed to reflect the type of ground surface preferred by boaters.

46) **Fire Sites within boundary or satellite areas (#):** Apply the same instructions as for the Backcountry Campsite form.

48) **Human waste in likely areas:** Apply the same instructions as for the Backcountry Campsite form.

49) **Litter visible in area:** Apply the same instructions as for the Backcountry Campsite form except that surveyors must walk around the general area of the campsite. Do not include items that could not have been transported by raft, kayak, or canoe. This indicator should reflect only problems associated with river recreation, not the deposition of trash by flooding, as with old tires or other items.

52) **Comments/Recommendations:** Apply the same instructions as for the Backcountry Campsite form.

General Site Photograph: Apply the same instructions as for the Backcountry Campsite form. Do not worry about capturing the entire campsite by taking several photographs. Make sure that anything distinctive about the site appears in the picture. Place an object, like the tape measure, in the center of all photographs as an indicator of scale. Note that bearing and distance do not apply because there is no centerpoint.

53) **Roll #:** Apply the same instructions as for the Backcountry Campsite form.

54) **Photo #:** Apply the same instructions as for the Backcountry Campsite form.

57) **Photo Description:** Apply the same instructions as for the Backcountry Campsite form.

- **Collect all campsite boundary pins, the centerpoint stake, and all other equipment.**

Appendix 1a: Campsite Survey Forms

Table 11 Instructions for editing campsite assessment forms. Instructions appear in WordPerfect 5.1 document "allforms.sub" and should be followed explicitly. Note: these instructions are supposed to print here in the manual.

NOTE: THIS COMMENT WILL NOT PRINT OR OTHERWISE AFFECT THE DOCUMENT

1. If you make any changes, replace the date found at the lower corner of each page by using the MACRO "version" (Alt-F10, version,<Enter>) or (Macro, version, <Enter>).
 2. Save the SUBDOCUMENTS (Alt-F5, G, O, Y, R) or (Mark Text, Generate, cOndense MASTER DOCUMENT, Yes, Replace all remaining).
 3. After saving SUBDOCUMENTS, EXPAND this MASTER DOCUMENT (Alt-F5, G, E) or (Mark Text, Generate, Expand MASTER DOCUMENT)
 4. DO NOT edit documents individually. Use this MASTER DOCUMENT system to ensure all versions are current.
 5. When PRINTING, print the individual updated files as necessary.
-

BIG BEND NATIONAL PARK
RECREATION SITE CONDITION MONITORING FORM
BACKCOUNTRY TRAIL ACCESSED CAMPSITE FORM
(designated and undesignated)

SITE IDENTIFICATION

1) Site Tag Number _____ 2) BIBE Site code (if applic.) _____ 3) Use Area _____
4) Trailname _____ 5) USGS quad _____ Locate/Label on Map _____
*Note: If 6) and 7) are to be taken from a Map, it should be done in the office.
UTM coordinates: 6) E _ _ _ _ 7) N _ _ _ _ 8) UTM Source (Map or GPS) _____
9) Describe Site Location: _____

_____ 10) Date Assessed: ____/____/____ 11) Assessment By: _____

LOCATION CHARACTERISTICS

Campsite is (Y or N): _____

12) <1/2 mi. from road? _____ 13) <100 yds. from obvious arch. site? _____
14) Otherwise closed area? _____ [Note closure reasons in Comment/Recommendation]

15) Elevation _____ ft

16) Aspect _____ °

17) Site position (Flood plain, Drywash, Plain, Midslope, Ridgeline) _____

18) Dist. to water (1=<25 yd; 2=26-75 yd; 3=76-100 yd; 4=>100 yds/calculate from GIS or maps) _____

19) Water source (Spring/spring outflow, Tinaja, River, None/ephemeral) _____

20) Canopy Cover (0=<1% 1=1-5% 2=6-25% 3=26-50% 4=51-75% 5=76-95% 6=96-100%) _____ %

21) Veg. community (Woodland, sotol Grass, River Flood plain, shrub Desert, Island, Bare) _____

22) Trail type (1=Major, 2=Minor, 3=Primitive, 4=None) _____

23) Dist. to formal trail or parking area (-1=>5 min. walk) 24) (1 pace = _____ ft) _____ paces

25) Inter-site visibility _____

26) Toilet: (P=Pit Toilet C=Containment Toilet N=None) _____

27-30) Animal effects: (None, Some, Much) Livestock _____; Packstock _____; Javelina _____; Other _____

31) Bear box distance from C.P. (-1=not present) _____ ft

CONDITION INDICATORS

--Establish Boundary First--

32) Condition Class (1,2,3,4, or 5) _____

33) Vegetative ground cover Offsite (Use % categories from #20 above) _____

34) Grass/sedge cover Offsite (Use % categories from #20 above) _____

35) Vegetative ground cover Onsite (Use % categories from #20 above) _____

36) Grass/sedge cover Onsite (Use % categories from #20 above) _____

37) Primary ground surface Offsite (Use categories below) _____

< Bedrock, Large stones/soil, river/wash Cobble, Gravelly soil, Mineral soil, Hardpan, Organic, crYptog. >

38) Primary ground surface Onsite (Use categories above) _____

39) Soil exposure Onsite (Use % categories from #20 above) _____

40-42) Tree damage None/Slight _____ Moderate _____ Severe _____ N/A _____

43-45) Tree root exposure None/Slight _____ Moderate _____ Severe _____ N/A _____

46) Fire sites within boundary or satellite areas (#) _____

47) Trails exiting boundary (#) _____

48) Human Waste visible in likely areas (None, Some, Much) _____

49) Litter visible from boundary (None, Little, Some, Much) _____

50) Number of satellite sites _____

51) Total campsite area (calculated from measurements on reverse) _____ (ft²)

52) Comments/ Recommendations _____

Site Centerpoint photo: 53) Roll # _____ 54) Photo # _____ 55) Bearing _____ 56) Distance _____ ft

57) Photo Description _____

58-60) Centerpoint References

1. _____

2. _____

3. _____

61) Satellite Site Dimensions Bearing Distance (ft)

62) Island Site Dimensions Bearing Distance (ft)

63-82) **TRANSECT DATA**

for condition classes 3,4,5 only

Bearing Distance (ft)

1)

2)

3)

4)

5)

6)

7)

8)

9)

10)

11)

12)

13)

14)

15)

16)

17)

18)

19)

20)

BURY NAIL AND TAG _____

Campsite Area from dBASE Program	_____
+ Satellite Area	_____
- Island Area	_____
Total Campsite Area	_____ (sq ft)

SKETCH OF SITE, C.P., P.P., TRAILS, OTHER SITES, ETC
[SITE DIMENSIONS IF COND. CLASS 1 OR 2]
Spend no more than 1-2 minutes

**BIG BEND NATIONAL PARK
RECREATION SITE CONDITION MONITORING FORM
BACKCOUNTRY ROAD ACCESSED CAMPSITE FORM**

SITE IDENTIFICATION

1) Site Tag Number _____ 2) BIBE Site code (if applic.) _____ 3) Use Area _____
4) Road name _____ 5) USGS quad _____ Locate/Label on Map _____

*Note: If 6) and 7) are to be taken from a Map, it should be done in the office.

UTM coordinates: 6) E _ _ _ _ _ 7) N _ _ _ _ _ 8) UTM Source (Map or GPS) _

9) Describe Site Location: _____

10) Date Assessed: _ / _ / _ 11) Assessment By: _____

LOCATION CHARACTERISTICS

Campsite is (Y or N): _____

13) <100 yds. from obvious arch. site? _____
[Note closure reasons in Comment/Recommendation]

14) Otherwise closed area? _____

15) Elevation _____ ft

16) Aspect _____ o

17) Site position (Flood plain, Drywash, Plain, Midslope, Ridgetop) _____

18) Dist. to water (1=<25 yd; 2=26-75 yd; 3=76-100 yd; 4=>100 yds/calculate from GIS) _____

19) Water source (Spring/spring outflow, Tinaja, River, None/ephemeral) _____

20) Canopy Cover (0=<1% 1=1-5% 2=6-25% 3=26-50% 4=51-75% 5=76-95% 6=96-100%) _____ %

21) Veg. community (Woodland, sotol Grass, River Flood plain, shrub Desert, Island, Bare) _____

22) Road type (5= 2x4 rd.; 6= 4x4 rd.) _____

25) Inter-site visibility _____

26) Toilet: (P=Pit Toilet C=Containment Toilet N=None) _____

27-30) Animal effects: (None, Some, Much) Livestock _____; Packstock _____; Javelina _____; Other _____

CONDITION INDICATORS

--Establish Boundary First--

32) Condition Class (1,2,3,4, or 5) _____

33) Vegetative ground cover Offsite (Use % categories from #20 above) _____

34) Grass/sedge cover Offsite (Use % categories from #20 above) _____

35) Vegetative ground cover Onsite (Use % categories from #20 above) _____

36) Grass/sedge cover Onsite (Use % categories from #20 above) _____

37) Primary ground surface Offsite (Use categories below) _____

< Bedrock, Large stones/soil, river/wash Cobble, Gravelly soil, Mineral soil, Hardpan, Organic, crYptog. >

38) Primary ground surface Onsite (Use categories above) _____

39) Soil exposure Onsite (Use % categories from #20 above) _____

40-42) Tree damage None/Slight _____ Moderate _____ Severe _____ N/A _____

43-45) Tree root exposure None/Slight _____ Moderate _____ Severe _____ N/A _____

46) Fire sites within boundary or satellite areas (#) _____

47) Trails exiting boundary (#) _____

48) Human Waste visible in likely areas (None, Some, Much) _____

49) Litter visible from boundary (None, Little, Some, Much) _____

50) Number of satellite sites _____

51) Total campsite area (calculated from measurements on reverse) _____ (ft²)

52) Comments/ Recommendations _____

Site Centerpoint photo: 53) Roll # ____ 54) Photo # ____ 55) Bearing ____ 56) Distance ____ ft
 57) Photo Description _____

58-60) Centerpoint References

- 1.
- 2.
- 3.

61) Satellite Site Dimensions Bearing Distance (ft)

62) Island Site Dimensions Bearing Distance (ft)

63-82) **TRANSECT DATA**
 for condition classes 3,4,5 only
Bearing Distance (ft)

- 1)
- 2)
- 3)
- 4)
- 5)
- 6)
- 7)
- 8)
- 9)
- 10)
- 11)
- 12)
- 13)
- 14)
- 15)
- 16)
- 17)
- 18)
- 19)
- 20)

BURY NAIL AND TAG ____

Campsite Area from dBASE Program	_____
+ Satellite Area	_____
- Island Area	_____
Total Campsite Area	_____ (sq ft)

SKETCH OF SITE, C.P., P.P., TRAILS, OTHER SITES, ETC
 (SITE DIMENSIONS IF COND. CLASS 1 OR 2)
 Spend no more than 1-2 minutes

BIG BEND NATIONAL PARK
RECREATION SITE CONDITION MONITORING FORM
RIO GRANDE RIVER ACCESSED CAMPSITE FORM
Waterproof Paper Only

SITE IDENTIFICATION

1) Site Letter _____ 2) River mile _____ 3) Use Area _____
4) River section _____ 5) USGS quad _____ Locate/Label on Map _____

*Note: If 6) and 7) are to be taken from a Map, it should be done in the office.

UTM coordinates: 6) E _ _ _ _ _ 7) N _ _ _ _ _ 8) UTM Source (Map or GPS) _____

9) Describe Site Location: _____

10) Date Coded: _ / _ / _ 11) Assessment By: _____

LOCATION CHARACTERISTICS

Campsite is (Y or N): _____

14) Otherwise closed area? _____ 13) <100 yds. from obvious arch. site? _____
[Note closure reasons in Comment/Recommendation]

15) Elevation _____ ft

17) Site position (Flood plain, Other _____)

25) Inter-site visibility _____

27-30) Animal effects: (None, Some, Much) Livestock _____; Packstock _____; Javelina _____; Other _____

CONDITION INDICATORS

83) Capacity (1=sm. group; 2=med. group; 3=lg. group/mult. groups) _____

84) Activity Level (Inactive, Low, Moderate, High) _____

(0=<1% 1=1-5% 2=6-25% 3=26-50% 4=51-75% 5=76-95% 6=96-100%)

35) Vegetative ground cover Onsite (Use % categories above) _____

36) Grass/sedge cover Onsite (Use % categories above) _____

< Bedrock, Large stones/soil, river/wash Cobble, Gravelly soil, Mineral soil, Hardpan, Organic, crYptog. >

38) Primary ground surface Onsite [i.e., in area] _____

(Select as many categories as necessary & order proportionately)

46) Fire sites within area (#) _____

48) Human Waste visible in likely areas _____

(None, Some, Much)

49) Litter visible in area _____

(None, Little, Some, Much)

52) Comments/ Recommendations _____

General Site photo: 53) Roll # _____ 54) Photo # _____

57) Photo Description _____



United States Department of the Interior

NATIONAL BIOLOGICAL SERVICE
Cooperative Park Studies Unit
Virginia Tech / Department of Forestry
Blacksburg, VA 24061-0324

Memorandum

To:

From: Jeffrey L. Marion, Research Scientist/Unit Leader

Subject: Campsite area program

Enclosed is a disk with dBASE III and two campsite area programs. Transfer all files to a hard disk directory and type "dbase camparea" to start dbase and the program simultaneously. Enter the number of transects and on the next screen use the arrow keys to move around and enter the transect lengths and compass bearings. When done press "ctrl end" and it will calculate the area. I also included a program that computes the area of triangles (right or non-right angled triangles) based on the lengths of their 3 sides. You can access this program by typing "dbase triarea", enter lengths of 3 sides, and press "ctrl end" for the area. When you say "no" to stop, the programs exit you to the dBASE dot prompt. Type "quit" to exit dBASE. (Alternately, you can start dBASE by typing "dbase", press "esc" to get to the dot prompt, and type "do camparea" or "do triarea" to run the programs.)

Give me a call if you encounter any problems.

Appendix 1b: Variable Radial Transect Methods

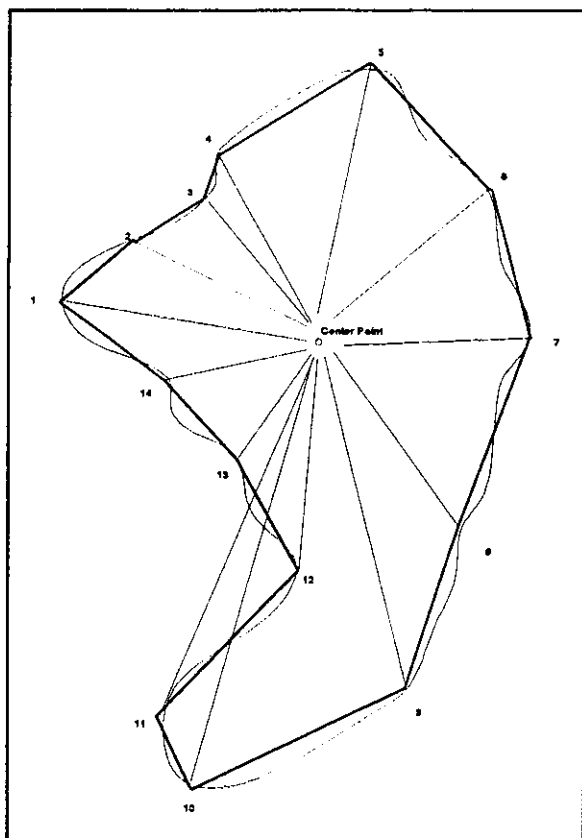


Figure 1 Variable radial transect method applied to campsite.

Step 1. Identify Campsite Boundaries and Flag Transect Endpoints. Walk the site boundary and place flagged wire pins at locations which, when connected with straight lines, will define a polygon whose area approximates the site area. Use as few pins as necessary, typical sites can be adequately flagged with 10-15 pins. Look both directions along site boundaries as you place the flags and try to balance areas of the site which fall outside the lines with offsite (undisturbed) areas which fall inside the lines. Pins do not have to be placed on site boundaries, as demonstrated in the diagram at left. Project site boundaries straight across areas where trails enter the site.

Step 2. Select and Reference Centerpoint. Select a campsite centerpoint which is: a) visible from all the boundary pins, b) close to and easily referenced by distinctive permanent features such as larger trees or boulders, and c) in a spot permitting the burial of the centerpoint nail and campsite tag. Embed a steel stake at the centerpoint and reference it to at least three features. Try to select reference features in three opposing directions as this will enable future surveyors to triangulate the centerpoint location. For each feature, take and record a compass bearing (nearest degree) and measure the distance (nearest 1/10 foot) from the centerpoint to the center of trees or the highest point of boulders. Also measure the approximate diameter of reference trees at 4.5 feet above ground (d.b.h.). Be extremely careful in taking these bearings and measurements as they are critical to relocating the centerpoint in the future.

Examples:

- 1) Boulder, 17.9 ft at 312°, (distance and bearing to highest point)
- 2) 15' Ocotillo (largest near site)-- 25' @ 45°⁶
- 3) Large creosote bush, closest to site, 14 ft. at 137° (shown in photograph).

Options: Some sites may lack the necessary permanent reference features enabling the centerpoint to be accurately relocated. If only one or two permanent reference features are available, use these and take the photograph from an angle that shows one or more reference points. If permanent features are unavailable, proceed with the remaining steps without permanently referencing the centerpoint. This option will introduce more error in comparisons with future measurements, particularly if the campsite boundaries are not pronounced. Note when you apply one of these options.

Step 3. Record Transect Azimuths and Lengths. Standing directly over the centerpoint, identify and record the compass bearing (azimuth) of each site boundary pin working in a clockwise fashion (in the exact order you would encounter them if you were walking the site boundary). Be careful not to miss any pins hidden behind vegetation or trees. Be extremely careful in identifying the correct compass bearings to these pins as error in these bearings will bias current and future measurements of site size. Next, anchor the end of your tape to the centerpoint stake, measure and record the length of each transect (nearest 1/10 foot), starting with the same boundary pin and in the same clockwise order as before. Be

⁶ This example is cross-referenced with the "Photo Description" example. See the "Backcountry Campsite Form" section.

absolutely certain that the appropriate pin distances are recorded adjacent to their respective compass bearings. Leave boundary pins in place until you finish all other site measurements.

Table 12 Using a Peep Hole Compass

Hold the compass level with the viewfinder close to your eye. The top of the white floating scale should be centered in the viewfinder. While standing over the centerpoint, align the vertical black line of the viewfinder with the object you are measuring. Allow the compass scale to come to rest. Read the bearing to the nearest degree. Be careful in reading the bearing from the scale, note that scale values decrease from left to right. The large scale interval is 5 degrees and the smallest interval is 1 degree. Practice and periodically compare compass readings with your partner to verify consistency.

Step 4. Measure Island and Satellite Areas. Identify any undisturbed "islands" of vegetation inside site boundaries (often due to clumps of trees or shrubs) and disturbed "satellite" use areas outside site boundaries (often due to tent sites or cooking sites). Use site boundary definitions for determining the boundaries of these areas. Use the Geographic Figure Method to determine the areas of these islands and satellites. Remove the centerpoint stake. Place a 4 inch long galvanized steel nail through the hole in the campsite number tag and bury at the centerpoint so that the tag is 2-3 inches underground.

Site Remeasurement - Relocate the centerpoint using centerpoint references, photos, and a magnetic pin locator. Reestablish campsite boundary pins using the transect data compass bearings and distances. Reassess boundary pin locations based on the following procedures:

- 1) Keep the same transect length if that length still seems appropriate, i.e. there is no compelling reason to alter the initial boundary determination.
- 2) Record a new transect length if the prior length is inappropriate, i.e. there is compelling evidence that the present boundary does not coincide with the pin and the pin should be relocated either closer to or further from the centerpoint along the prescribed compass bearing.
- 3) Repeat Steps 1 and 3 from above to establish additional transects where necessary to accommodate any changes in the shape of campsite boundaries (diagram below). Also repeat Step 4.

These additional procedures are designed to eliminate much of the measurement error associated with different individuals making subjective judgements on those sites or portions of sites where boundaries are not pronounced. These procedures may only be used for sites whose centerpoints can be relocated.

Appendix 1c: Protocol for Handling Campsite Monitoring Documents

To ensure all materials are stored properly, the following protocol must be followed carefully when handling campsite monitoring documents.

1. File each set of trail surveys separately in a manila folder labeled with the trail number, trail name, and any district information. These folders should be indexed according to trail number.

2. Each folder will contain:

Field maps Every map made of an area must be retained in the folder. This includes the original field maps, the clean field maps, and any extra field maps.

Area maps When several sites are found in a small area, a hand-drawn map should be made no more than two weeks after the area was surveyed. These area maps must have a key with the following information: 1) **trail number**, 2) **trail name**, 3) **sequence of campsite numbers on the map**, and 4) **the complete date that the area was surveyed**. Each campsite should be referenced to those sites closest to it. When several sites are close together, surveyors should reference the distance and bearing to **every campsite in the immediate area** (i.e., to the closest campsites that do not have another site between it and the site being surveyed).

Trail Summary Forms When a trail has been completely hiked, a summary form will be compiled and will contain a list of the number and condition class of each individual campsite. Surveyors will tally the total number of sites, and the total number of sites within each condition class.

Campsite Survey Forms Every campsite survey form will be filed in the appropriate folder. Except where impractical, the forms will be filed in ascending order according to the campsite number. Each form completed for a designated camping area will be filed with the sites found in that area. **No form damaged in the field will be destroyed.** If a form is damaged, a hand-copy should be made and stapled to the front of the original form.

3. **Campsite Centerpoint photographs:** At the earliest possible time, label the backs of 3x5 prints with the campsite number, date, film roll number, photograph number, bearing, and distance. Also, label and store the negatives. Labels should include the sequence of campsite tag-numbers. Store the photographs separately from the survey forms. Do not staple them together. A non-photoreactive box should be used to preserve the pictures. Organize the photographs according to campsite tag-number. The outside of the box should have an envelope attached. This envelope should contain a printed listing with the following information:

<u>Photograph number</u>	<u>Campsite tag numbers</u>	<u>BIBE Site Code</u>	<u>Use Area</u>	<u>Trail/Road/Canyon Name</u>
--------------------------	-----------------------------	-----------------------	-----------------	-------------------------------

Appendix 1d: Method for Assessing Rater Precision

To understand data from an survey of backcountry campsites, an investigator must assess the precision of raters. This precision reflects the consistency of the raters. The more consistent the raters are with each other, the greater their precision. The objective of these methods is to accurately reproduce the procedures of the larger survey except that multiple assessment of a single campsite occurs.

These methods assume the larger survey is designed to complete a single assessment of each individual campsite in a protected area. Such a census design allows no other method to assess rater precision other than the methods here. A multiple rater assessment design, however, would not necessitate a separate study of rater precision.

MATERIALS

- All raters involved in the larger campsite assessment effort. This assessment of rater precision does not apply when only one rater or one team of raters works on this project.
- Complete sets of campsite assessment materials for each rater or team of raters.
- 5-10 campsites representative of all campsites in the entire protected area, but all the sites selected for this assessment should be in a local area to eliminate travel time and increase efficiency.
- A full day.

METHODS

Step 1. Each rater or team of raters is assigned a number that they place at the top of each survey form they complete. They then *independently* assess each campsite with the same techniques of the larger survey. Communication between raters other than team members **must not** occur if the methods of the larger survey are to be accurately reproduced. Each rater or team of raters establishes independent boundaries for the campsite following the procedures of the larger survey. If the larger survey is the first iteration of a monitoring program, then boundaries and campsite areas should reflect the typical agreement among raters. If, on the other hand, the larger survey is reassessing campsites and boundary flag locations from that previous assessment exist, then raters should reestablish boundaries as they would during the larger survey.

Step 2. Results from the independent surveys should be collected immediately and compiled into a database for analysis. The database structure should include four fields:

- (1) the rater number
- (2) the campsite number (1 through n , not the campsite tag number!)
- (3) the indicator number
- (4) the value reported by each rater or team of raters for each indicator at each campsite.

Step 3. Sort the database by (1) indicator, (2) campsite, and (3) rater. Analyze the sorted database with the procedure VARCOMP in the SAS statistical program. This procedure applied to the database structure produces a factorial ANOVA.

Example of SAS VARCOMP procedure for analyzing results from a rater precision study:

```
proc DBF db4=shensas;
run;
title1 'shen: y= r c';
title2 'RB-55: block by rater';
proc varcomp method=type1;
class r c;
model y=r c;
by v;
run;
```

Step 4. Import the factorial ANOVA results from VARCOMP into a computer spreadsheet program and apply the mathematical formulas found in Shavelson and Webb (1991) to produce the G-study and D-study results.

APPENDIX 2

Big Bend National Park Backcountry Campsite Database Codebook

Big Bend National Park Backcountry Campsite Database

The following codes apply to each variable as listed.
Specific value labels and variable codes are described
in the Assessment Manual (Appendix 1 of this report).

SPSS File Information:

Variable names, Variable contents, and Variable codes (Value Labels)

File Name: 93sites.sys (the same codes apply to the database file accompanying this report).

List of variables on the working file. The list largely follows the sequence seen on the survey forms.

Variable Code Format:

Name	Content	Comment (if any)
------	---------	------------------

The number refers to the position of each variable within each database record.

Print format and *Write format* refer to whether the variable is a letter, number, or logical format.

Missing Values refers to the code applied if the data is missing for some reason and tells computer programs to ignore records with that value.

D_R		[Blank field used by some database programs to track the database record number for each record]
-----	--	--

1

Print Format: A1

Write Format: A1

TAGNUM	BIBE Tag Number
--------	-----------------

2

Print Format: F6

Write Format: F6

Missing Values: -9

BIBECODE	BIBE site code
----------	----------------

3

Print Format: A6

Write Format: A6

Missing Values: ' -9'

RVRMILE	River mile
---------	------------

4

Print Format: F6.2

Write Format: F6.2

Missing Values: -9.00

SITETYPE Type of site

5

Print Format: F3

Write Format: F3

Missing Values: -9

Value Label

- | | |
|---|-------------------------------------|
| 1 | Rio Grande, Santa Elena |
| 2 | Rio Grande, Mariscal |
| 3 | Rio Grande, Boquillas |
| 4 | Designated road site |
| 5 | Undesignated road site |
| 6 | Designated B.C. site |
| 7 | Undesig. B.C. site, not High Chisos |
| 8 | Undesig. B.C. site, High Chisos |

USEAREA Big Bend Use Area Code

6

Print Format: A3

Write Format: A3

Missing Values: '-9'

TRLRDNM Trail, Road, or River Section

7

Print Format: A12

Write Format: A12

QUAD USGS Quad

9

Print Format: A2

Write Format: A2

Missing Values: '-9'

UTME UTM Easting

10

Print Format: F6

Write Format: F6

Missing Values: -9

UTMN UTM Northing

11

Print Format: F7

Write Format: F7

Missing Values: -9

UTMSOURC How was UTM derived?

12

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

- | | |
|---|-----|
| G | GPS |
| M | Map |

ASSESSED

13

Print Format: A8

Write Format: A8

ASSESSBY

14

Print Format: A8

Write Format: A8

ROADLEGA <1/2 mi from road?

15

Print Format: A2

Write Format: A2

ARCHLEGA <100yds from obvious arch site?

16

Print Format: A2

Write Format: A2

Missing Values: '-9'

OTHERLEG Illegal for reason other than arch site?

17

Print Format: A2

Write Format: A2

Missing Values: '-9'

ELEV Elevation (feet)

18

Print Format: F4

Write Format: F4

Missing Values: -9

ASPECT aspect of site

19

Print Format: F3

Write Format: F3

Missing Values: -9

POSITION Slope Position

20

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

D Drywash
F Floodplain
M Midslope
O Other
P Plain
R Ridgetop

DISTH2O Distance to water

21

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

1 <25yds
2 26-75yds
3 76-100yds
4 >100yds

H2OSOURC Water source

22

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

N None/Emphemeral
R River
S Spring
T Tinaja

CANCOV Canopy cover

23

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

1 0-5%
2 6-25%
3 26-50%
4 51-75%
5 76-95%
6 96-100%

CANCOV2 Percentage of canopy cover
scale]

24

Print Format: F3

Write Format: F3

VEGCOMM Vegetation community

25

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

B Bare
D Shrub desert
G Sotol Grass
I Island
R River floodplain
W Woodland

TRLRDTYP Trail or road type

26

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

1 Major trail
2 Minor trail
3 Primitive trail
4 No trail
5 2x4 road
6 4x4 road

PACE Pace length

27

Print Format: F3.1

Write Format: F3.1

Missing Values: -9

TRLPRKDI Paces from trail or parking area

28

Print Format: F3

Write Format: F3

Missing Values: -9

FTFR Feet from Trail or Parking area

29

Print Format: F4

Write Format: F4

Missing Values: -9

INTERVIS How many other sites are visible?

30

Print Format: F2

Write Format: F2

Missing Values: -9

TOILET Presence and type of toilet

31

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

C Containment

N None

P Pit

LIVESTOC Apparent Livestock effects

32

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

L Little

M Much

N None

S Some

PACKSTOC Apparent Packstock effects

33

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

L Little

M Much

N None

S Some

JAVELINA Apparent Javelina effects

34

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

L Little

M Much

N None

S Some

OTHERANI Effects apparent from other animals

35

Print Format: A2

Write Format: A2

Missing Values: '-9'

Value Label

L Little

M Much

N None

S Some

BOXDIST Distance of bearbox from centerpoint

36

Print Format: F2

Write Format: F2

Missing Values: -9

CONCLASS Condition class

37

Print Format: A2

Write Format: A2