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CLOSING WILDERNESS CAMPSITES: VISITOR USE PROBLEMS
AND ECOLOGICAL RECOVERY IN THE
SELWAY-BITTERROOT WILDERNESS,
MONTANA

by

Beth Ranz

B.A., Colgate University, 1975

Presented in partial fulfillment of the
requirements for the degree of

Master of Science

UNIVERSITY OF MONTANA

1979

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ABSTRACT

Ranz, Beth, M.S., March, 1979 Resource Conservation

Closing Wilderness Campsites: Visitor Use Problems and Ecological Recovery in the Selway-Bitterroot Wilderness, Montana (123 pp)

Director: Sidney S. Frissell SSF.

The purpose of this study was to describe the effects of closing Wilderness campsites to visitor use by 1) surveying Wilderness managers in the Northern Rocky Mountains, 2) studying visitor use, and 3) measuring the amount of ground cover recovery on closed campsites at Big Creek Lake in the Selway-Bitterroot Wilderness of Western Montana.

Questionnaires were sent to 41 Forest Service managers and nine National Park Service managers. Thirty percent of the managers reported having closed campsites, while an additional 10 percent reported planning to close campsites in the future.

Visitor use was observed around Big Creek Lake during the summer of 1977. Sixteen percent of the visitor groups camped in closed areas.

Twenty-two campsites were identified around Big Creek Lake, including seven campsites that developed as a result of closing the other campsites. Ground cover (i.e., percent cover of vegetation, natural litter, bare soil, and individual plant species) was sampled on the campsites and six natural areas. A comparison was made between ground cover on closed campsites, and open established campsites. The closed campsites had 14.7 percent more vegetation cover, and had a different plant composition than open campsites.

A trend study was done on the campsite vegetation using Forest Service vertical photographs taken in 1975 and 1977. Vegetation cover increased an average 8.8 percent on closed campsites, while vegetation cover on open campsites averaged a zero change.

Closing Wilderness campsites has the following problems, 1) all visitors do not comply with the closures, 2) ecological damage occurs elsewhere with the formation of new campsites, and 3) recovery is slow relative to the time it takes for damage to occur.

ACKNOWLEDGMENTS

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Karen Wilson helped by editing the thesis draft. Shirley Pettersen, University of Montana, typed the draft and final copies of this thesis. Cindy Romo, University of Montana, drew the figures.

Finally, I would like to thank my Minnesota family, Montana family, and fellow graduate students for all their support while I worked on this study. To mention all those friends who have contributed to this study would be impossible, but I hope they know their help was appreciated.

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INTRODUCTION

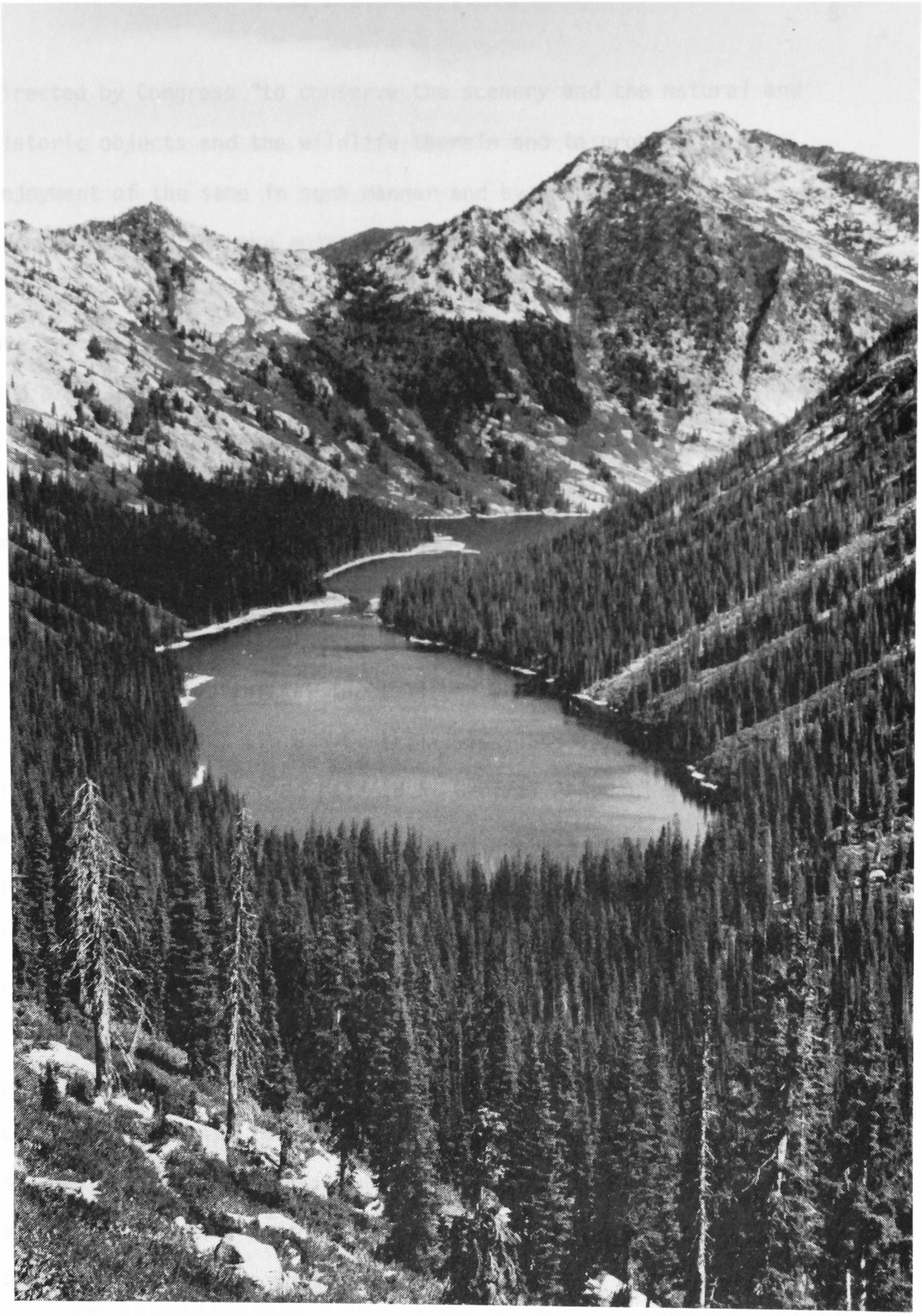
The Problem

When a wilderness area is to be managed for preservation of natural qualities and a supply of outdoor recreation opportunities, ecological changes will occur. If these changes exceed the "limits of acceptable change" (Frissell and Stankey 1972), a management action is called for. One of these potential actions is to close the site to recreational use. The purpose of this study is to examine the effects of closing wilderness campsites at Big Creek Lake in the Selway-Bitterroot Wilderness of Western Montana (Fig. 1).

The most serious problems facing wilderness and park managers today result from increasing numbers of visitors. Since 1969, visitation to Forest Service Wilderness Areas has grown at an average annual rate of 8 percent. Several National Parks report that back-country use has tripled or quadrupled in the last ten years. These increases have occurred on a land base which has remained essentially the same size (Stankey et al. 1976). As crowding increases, ecological and sociological problems occur.

The 1964 Wilderness Act established areas "administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness" (16 U.S.C. 1131-1136, 1964). In addition, the National Park Service is

Figure 1. Big Creek Lake in the Selway
Bitterroot Wilderness



directed by Congress "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" (16 U.S.C. 1, 1958). Managers of National Parks and National Wilderness Areas are therefore directed to protect the natural qualities of these areas and provide for use by the American people. Unfortunately, overcrowding is not compatible with these goals. Crowding has resulted in trampled vegetation, compacted soils, conflicts with wildlife, man-made litter, and deterioration of water quality. These changes threaten wilderness and their natural qualities. Crowding has impaired the use and enjoyment of these areas "as wilderness". It is becoming more difficult to find "outstanding opportunities for solitude and a primitive and unconfined type of recreation" (16 U.S.C. 1131-1136, 1965). Additional problems include a growth in crime rate (U.S. General Accounting Office 1977) and vandalism (U.S.F.S. 1976). Thus wilderness and park managers are faced with a predicament: How can these natural areas be preserved for future generations, as natural areas, and yet provide outdoor recreation for today's generation?

Many suggestions have been made as to how managers can approach this problem. Basic alternatives have included: 1) doing nothing, 2) concentrating use in a limited area, 3) dispersing use over a large area, 4) limiting use to a certain number of visitors, 5) modifying the visitors' behavior, and 6) combinations of the above. Combinations of these alternatives include zoning and campsite rest-rotation.

A necessary part of a campsite rest-rotation system is closure for a rest period. Campsite closures are made to allow a natural recovery from past recreational damage, displace use to another area, and create a "rest-rotation" system of campsite management. Usually the goal of a rest-rotation system of campsite management is to provide a sustained yield of high-quality recreation. Alternatively, site closures are permanent when necessary to protect especially fragile natural areas. Site closures are now administered by the National Park Service and the United States Forest Service. Inevitably, there are some questions associated with these recreational site closures. First, how well do visitors comply and stay out of closed areas? Secondly, to what degree have natural processes restored these sites to natural conditions? This paper attempts to answer these questions.

Objectives

The first objective of this research will be to describe the extent and general problems of wilderness campsite closures in the Northern Rocky Mountains. This situation has not been well documented, and the results obtained at Big Creek Lake should be placed in a broader perspective.

The second objective will be to describe visitor use of the Big Creek Lake area with a particular interest in those visitors who continue to select closed campsites. Total number of visitors to the Big Creek Lake area is estimated and visitor group characteristics (campsite choice, mode of travel, group size and use of fishing equipment) are described. The type of visitor who chooses to violate the closures is studied in relation to these visitor group characteristics. To determine if crowding would effect compliance with the closures, the number of visitors camping in closed areas is related to the total number of visitors per night.

The third objective of this research will be to determine if there is any natural recovery on the Big Creek Lake campsites, after five years of closure. A comparison is made between present conditions on the closed campsites and the campsites which have remained open to determine if there are substantial differences. Additionally, two-year trends in ground cover conditions are analyzed to see if there are any substantial differences between the closed and open campsites.

Past Research

Ecological Effects on Recreation

Ecological changes resulting from recreational use have been well documented. As early as 1929, Meinecke reported soil changes in recreational areas. In 1935, Bates reported vegetative changes along English foot paths, sidewalks, cart tracks, and gateways. The need for research into these ecological changes was formalized by Dana (1957) in a Forest Service problem analysis. Literature has been compiled and reviewed by Liddle (1975), Speight (1973), and Stankey and Lime (1973).

The majority of the studies have addressed the change in vegetative structure on campsites. Early research was forestry related and analyzed how tree growth, both height and diameter, was altered by recreational use. LaPage (1962) found tree diameter growth different between campsites and nearby control areas in Eastern white pine. Site index was not different and LaPage interpreted this to mean growth in tree height was less influenced by recreational use.

Merriam and Smith (1974), Beardsley and Wager (1971), Echelberger (1971), and Magill (1970) disagreed with LaPage's findings and report no effect on tree diameter growth between campsites and control sites. In some cases tree growth appeared to increase as a result of campsites reducing competition from other plants (Magill 1970). In the Adirondacks, Echelberger reported not only tree diameter growth, but tree height, average overstory density, and average number of stems per tent site were not related to use intensity. Dykema (1971) found tree canopy coverage was no different between campgrounds and control sites in the Southern Sierra Nevada.

A more serious problem than diameter growth seems to be physical damage to the trees. Dykema (1971), Merriam and Smith (1974), and Frissell and Duncan (1965) reported finding more physical damage on campsite trees than on control trees. Merriam and Smith (1974) described the physical abuse of campsite trees from vandalism, wood chopping, and exposed roots. Also in the Boundary Waters Canoe Area (BWCA), Frissell and Duncan (1965) reported 60 percent of the campsites they inventoried had trees with exposed roots. This would subject the trees to future mechanical damage, drought, and windfall. Hinds (1976) studied mechanical injuries and the incidence of fungal infections on aspen in Colorado. He concluded that desirable aspen-type campsites could be degraded to treeless sites within 10 to 60 years.

A still more serious problem may be the loss of tree regeneration. Dykema (1971), Frissell and Duncan (1965), and Magill (1963) reported fewer tree seedlings or saplings on campsites than nearby control sites. This raises the question of long-term use impact and how camping fits into the life cycle of a forest. If tree seedlings are continuously destroyed, and the existing trees grow old, decay, and die, a flat unshaded clearing will remain. The original forest will have disappeared.

Recreational use has been shown to effect the understory vegetation of forest stands. In terms of lateral screening, Magill (1970) found less on California campsites than on unused areas. Many shrub species were eliminated while some species showed a resistance to use impacts.

Probably the most widely used variable for measuring recreational impacts has been green plant coverage. In many cases the green plant coverage on recreational sites has been compared with the coverage on control sites, or on sites with differing amounts of recreational use. Frissell and Duncan (1965) reported that BWCA campsites had 57 to 99 percent (average of 85%) less ground cover than nearby control sites. Dykema (1971) found consistently less herbaceous ground cover on Sierra Nevada campsites than on control sites. Willard and Marr (1971) found plant cover was partially destroyed after one season, 26 seasons and 38 seasons of walking on Rocky Mountain National Park tundra. In the Big Horn Crags of Idaho, Coombs (1976) found significant differences in vegetative cover among heavily used, lightly used, and unused sites. Hartley (1976) and Dale (1973) have documented the loss of green plant cover from trails, using transects set perpendicular to the trail direction. Hartley (1976) observed the reduction of plant cover near Glacier Park trails. Ketchledge and Leonard (1970) described trail-side vegetation as being trampled and then washed out by running water in the Adirondacks. Cole (1977, 1978) used a cover reduction value to describe the sensitivity of different vegetation types to trails and campsites in the Eagle Cap Wilderness of Northwestern Oregon.

Two research studies have observed the effects of newly established campsites (Merriam and Smith 1974, Merriam et al. 1973, LaPage 1967). Both reported a severe loss of ground cover vegetation in the first season of use. LaPage (1967) measured percent plant coverage on newly established campsites in the Allegheny N.F., where campsites lost 45 percent of their plant cover in the first year. In the BWCA, Merriam and Smith reported severe ground cover reduction in the first two years of use and then a stabilizing of the effect over the next three years.

Another form of research has involved the use of artificial trampling on ground cover vegetation. Wagar (1964) studied the response of vegetative biomass to mechanical trampling, as a simulation of recreational use. He described the biomass of vegetation as decreasing and then leveling off with increasing tramples per week. Hartley (1976) applied controlled amounts of human trampling on Glacier National Park tundra, to calculate a mean loss of 3.2 percent vegetation per weekly trampling. Palmer (1972) applied human trampling to plots on Sierra Nevada meadows. He reported vegetation was able to withstand trampling up to five times before showing some visual damage. Experimental trampling of 200 times (equivalent to 20 people each walking over the same strip of meadow vegetation ten times) reduced total vegegation 6 percent.

Another measurement of environmental change, campsite size, is dependent upon the previously-mentioned variable of vegetation cover. Merriam and Smith (1974) measured the size of newly established campsites in the BWCA. They noted a rapid expansion in the first year and then a stabilizing of campsite size. Frissell (1973) used campsite size as an indicator of impact on wilderness campsites in the Spanish Peaks of Montana.

One consistent result of recreational use has been change in plant composition. In terms of numbers of species, Hartley (1976), Willard and Marr (1971), and LaPage (1967) counted fewer species after trampling. In a comparison of heavily used campsites, lightly used campsites, and unused control areas, there was a greater number of plant species on lightly used campsites than the other two areas (Coombs 1976).

One of the early recognized elements of this compositional change was the increase of graminoids. As early as 1935, Bates noted the predominance of the graminoids: Carex, Juncus, and Poa pratensis along trails. Later Cole (1978, 1977), Foin (1977), Dale (1973), Palmer (1972), Willard and Marr (1970), LaPage (1967), and Wagar (1964) confirmed these results. Grasses and sedges were more resistant to recreational use, while dicotyledonous herbs were more easily destroyed.

In addition to graminoids, some forbs proved to be more capable of surviving recreational use. Magill (1970), working in California, listed the following resistant forbs: western yarrow (Achillea lanulosa), aster (Aster spp.), deer vetch (Lotus nevadensis), California goldenrod (Solidago californica), and Phlox spp.

The differential responses of plant species to trampling suggested the classification of plant species by response, as range management has classified plant species into their different responses to grazing. Dale (1973) and then Dale and Weaver (1974) have classified plants as increasers or decreasers, according to their response to distance from trails in Northern Rocky Mountain forests. For example, Vaccinium scoparium decreased in frequency and coverage toward trails, so was classified as a "decreaser" (Dale and Weaver 1974). Their conclusions are included in Appendix 1, along with the results of other scientists. Hartley (1976) and Helgath (1975) also identified increaser and decreaser plant species next to trails. The increaser plants were characterized by more light tolerance, more drought resistance, thick fibrous roots, or introduction by horse use (Helgath 1975). Helgath's and Hartley's classifications are included in Appendix 1.

Cole (1977, 1978) compared the importance values of plants close to, and farther from trails in the Eagle Cap Wilderness of Northeastern Oregon. He summed the differences of importance values from several plants to calculate a "coefficient of floristic dissimilarity" for each vegetation type. These coefficients could be used to compare the relative susceptibility of different vegetation types to trails.

On campsites, Coombs (1976) classified increaser and decreaser plant species in the Big Horn Crags of Idaho. Her classification of plant species as increasers or decreasers is included in Appendix I. She suggested the use of this change in vegetative composition as a management tool. The presence, cover, or frequency of some of these increaser plants could be used as indicators of ecological damage. A good increaser plant, absent from the natural climax vegetation, but which becomes well distributed on lightly used areas, might be used. Coombs suggested the use of *Antennaria lanata* or *Erigeron peregrinus* in the Big Horn Crags of Idaho.

Limited research has been done on the physiological effects of recreation on plants. Hartley (1976) examined the effects of trampling on the physiology and reproductive capability (flowering) of alpine plants. He concluded that trampling reduced the amounts of non-structural carbohydrate reserves in the roots and corms of *Erythronium grandiflorum*, and reduced flowering in 7 plant species.

Another indicator of ecological change is the coverage of organic litter (duff) or exposed mineral soil on a campsite. Coombs (1976), Dykema (1971), Willard and Marr (1971), Magill (1970), and Frissell and Duncan (1965) found less organic litter (cover, depth, weight, or volume) on campsites than on natural areas. Dale and Weaver (1974) classified bare ground as an increaser toward trails.

Soil compaction and erosion are problems on campsites. Lutz (1945) and Meinecke (1929) first identified the relationship between recreational use and soil compaction. Meinecke observed soil compaction and the resulting decrease in water infiltration rates in the redwood parks. He also hypothesized the loss of gas exchange between the roots and atmosphere. Lutz observed bulk density increases, pore volume decreases, and air capacity decreases in Connecticut State Park soils. LaPage (1962) reported soil compaction increased with intensity and duration of recreational use. Dotzenko et al. (1967) likewise observed soil bulk density increases under campsites. They also measured decreases in the organic matter and moisture content of campsite soils. Dykema (1971) found significantly more soil compaction on campsites. On Rocky Mountain National Park tundra, Willard and Marr (1971) found soil loss was initiated by recreational use, and then was aggravated by snowmelt water, wind, and ice. In the BWCA, soil compaction increased the greatest amount during first year use, and then leveled off (Merriam and Smith 1974).

Soil compaction has also been studied on trails (Hartley 1976). Cross-sectional soil loss has been and is currently being used to measure trail impact on natural areas (Leonard and Whitney 1977, Lucas 1975, Helgath 1975, Dale and Weaver 1974, Ketchledge and Leonard 1970).

There have been fewer studies on the ecological effects of recreattion on water quality. Barton in 1969 listed recreational dangers to water quality in remote recreational areas as the introduction of solid wastes, human wastes and gasoline from outboard motors (the case in the BWCA). Four years later, Merriam et al. (1973) measured larger amounts of coliform bacteria, phosphate, and turbidity in water near BWCA campsites, compared to water farther away. The campsite coliform counts exceeded levels considered safe for drinking water, according to standards set by the U.S. Department of Health Education and Welfare.

Some recent studies have examined the distribution of wildlife populations around campsites and trails. Frissell (1973) listed the first probable effect of human use in a natural area as disruption of animal communities. Again, as in the case of vegetative response to recreation, bird and small mammal responses are highly variable by species (Foin 1977).

Bird distribution around campsites was studied by Garton (1977) in Yosemite National Park, and Dykema (1971) in the Sierra Nevada. They both concluded that campground development increased the diversity and density of bird communities. Both authors identify Brewer's Blackbird as having a higher density on campgrounds. Dykema also identified jays as being increasers because of campsite development. Garton identified the Brownheaded Cowbird and Robin as increasers in Yosemite National Park. Garton identified the Oregon Junco as a decreaser, because of its characteristics of ground nesting and ground foraging.

The distribution of Mountain Voles (Microtus montanus) was not affected, but the density of Deer Mice (Peromyscus maniculatus) increased with recreational activities (Foin 1977). Bears (both grizzly and black) have been attracted to roads, car camps and park dumps, because of food availability (Dykema 1971).

Duffey (1975) and Chappell et al. (1971) studied soil fauna and their distribution around trails. Chappell recorded a reduction in population size of soil arthropods, earthworms, and land molluscs. Duffey noted different population responses from different species, although the total number of organisms declined under trampling.

Four studies (Frissell 1978, Merriam et al. 1973, Ketchledge 1970, Willard and Marr 1970) used a combination of ecological changes to create condition classes (or impact stages) of environmental damage. Ketchledge used degrees of vegetation and soil loss to create stages in trail erosion. Willard and Marr used the degree to which vegetation percent cover changed from the natural, soil exposure, and erosion for a scale of visitor impacts on Rocky Mountain National Park tundra. Merriam used quantitative measures of bare soil, ground vegetation, soil compaction, number of dead trees or trees with exposed roots, and the increase of campsite size to formulate campsite impact stages. Frissell (1973, 1978) suggested the use of condition classes based on easily observable qualitative changes, such as loss of vegetation, loss of the duff layer, soil erosion, tree root exposure, and tree vigor decline. These condition classes can then be used to prescribe management actions for different campsites.

Alternatives for Campsite Management

Congress establishes national park and wilderness management policies. Politically, these policies are often stated in general and vague terms. The responsibility then falls on the agency or individual employees to interpret these policies and apply them to ground-level decisions. The best review of wilderness management philosophies, objectives, and techniques is contained in Wilderness Management, by Hendee, Stankey, and Lucas (1978).

The classic conflict in wilderness and park management has been the dialectic between use and preservation. "Use" of the national parks and wilderness implies opening them up to recreational and other human uses. In the extreme, this approach would create more access, facilities, comforts, and entertainment for the visitors (Julber 1971). The emphasis is upon the experience of the visitor. This approach has been labeled the anthropocentric philosophy (Hendee and Stankey 1973). Alternatively, the "preservation" philosophy calls for the emphasis on the resource. This approach implies that recreation and other human uses can be sacrificed to protect the natural area. The emphasis is upon "the natural integrity of wilderness ecosystems." This approach has been labeled the biocentric philosophy (Hendee and Stankey 1973).

Frissell and Stankey (1972) believe the basic question facing Wilderness managers is the degree to which variation from the pristine will be permitted, or what are the "limits of acceptable change" intended in the Wilderness Act. In their judgment, too much emphasis has been placed on determining "a" carrying capacity for a Wilderness area and not enough on establishing what are acceptable changes in the natural environment or the experiences of visitors.

After considering the philosophies and objectives of wilderness management, it is appropriate to consider the techniques available to the manager. Gilbert (1972) divided up management techniques into regulatory or modification techniques. Stankey (1974) placed management techniques on a continuum, from direct (emphasis on regulation of behavior) to indirect (emphasis on influencing or modifying behavior). Examples of the direct, restrictive approach are rules and law enforcement. Examples of the indirect or modification approach are education and information systems. Both authors recommend the use of the more subtle, non-authoritarian, non-regulatory approach. They believe these techniques would be more acceptable to wilderness visitors, more consistent with the experiences intended in the Wilderness Act, and hence more effective in protecting wilderness values.

The decision of how use or environmental damage will be directed is contained in these management techniques. Visitor use can be directed in five ways.

1) Use can be concentrated or limited in space or time, so that the remaining space or time will be free of the imprint of man's recreation.

2) Use can be dispersed to less crowded areas or times, so that there is less contact among visitors, and ecological effects are dispersed. The assumption is made that larger areas are better able to absorb and recover from ecological effects than smaller areas.

3) Use can be modified, behaviorally.

4) Use can be reduced in terms of numbers.

5) A combination of these use directions can be applied to preserve wilderness values.

Use concentration is most obvious in developed automibile campsites. Techniques have evolved around how a particular site can be made more resistant or "hardened" to recreational use. Beardsley et al. (1974), Beardsley and Wagar (1971), Magill (1970), Ripley (1965), Densmore and Dhalstrand (1965), Tocher et al. (1965), and Wagar (1964) reported on different techniques for maintaining developed campsites. The techniques include planting hardy plant species, building structural barriers, tent pads, and fire grills, surfacing with asphalt or wood chips, fertilizing, and watering.

The concept of hardening and applying other treatments to wilderness areas is against the intent of the Wilderness Act in the view of some scientists (Frissell and Stankey 1972). Others suggest that hardening campsites will protect more of the wilderness. Lime and Stankey (1971) suggested that wilderness carrying capacity can be increased by providing surfaces that withstand tremendous use. Merriam and Smith (1974, 1975) recommended the use of pump-out latrines to protect water quality and recommended planting shrubery to prevent the expansion of campsites. On the most popular sites they suggested planting resistant ground cover, building tent pads, and mulching with wood chips to promote tree vigor, while minimizing soil compaction and bare soil.

Concentrating visitor use has been recommended for the National Park Wilderness areas. Willard and Marr (1971) reported asphalt paths in Rocky Mountain National Park were used by 95 percent to 100 percent of the visitors when the paths were placed in directions considered attractive by the visitors. Hartley (1976) concluded the best management for Glacier Park alpine and subalpine areas was to keep people on the trails.

Most wilderness campsites have been selected by visitors, probably for a variety of reasons including visible access, good views, distance to water, and partially open canopies (Brown and Shomaker 1974, Merriam and Smith 1974, Frissell and Duncan 1965). Managers could select campsites on the basis of resistance to recreation. Ripley (1965) and Wagar (1961) recommended the consideration of site resistance to recreation in selecting campsites. Wagar (1961) developed a prediction formula for selecting sites as to their suitability for recreation development, based on their vegetation, soil, and topography.

Some differences in ecosystem resistance to recreation have been attributed to amount of soil moisture. Marr (1970) reported that more soil moisture increased the susceptibility of alpine ecosystems to trampling in Rocky Mountain National Park. Conversely, Hartley (1976) observed that Glacier National Park wet meadows were more resistant to recreational use than were dry meadows.

Vegetation type has been shown to determine the amount of damage occurring from recreation (Helgath 1975, Merriam and Smith, 1974, Cole 1978, 1977, Dale 1973, Dykema 1971, Marr 1970). For example, grassy turf areas were more resistant to recreation than areas covered with forbs (Hartley 1976, Marr 1970). Aspen-birch campsites were more easily damaged than other BWCA campsites (Merriam and Smith 1973).

Some differences in ecosystem response have been attributed to elevation (Foin 1977, Dykema 1971). Usually high elevations are more sensitive to recreational impacts.

Helgath (1975) discovered that use is less important than site characteristics in trail deterioration. She recommended the development of biophysical units (combinations of landform and vegetation type) in trail or campsite management. Different biophysical units should have different prescriptions for siting and maintenance.

The second direction for visitor use management is the dispersal of use to less crowded areas or times. Some authors have suggested that visitors should be encouraged to use recreational opportunities outside of Wilderness Areas (Wagar 1974, Stankey 1973).

Dispersal of use can be attempted within a wilderness or park area. Techniques include modification of access, trails, facilities, and information systems (Shomaker 1975, Stankey 1973, Lime and Stankey 1971, Frissell and Duncan 1965, Wagar 1964). However, Stankey et al. (1976) cautioned that perfectly uniform distribution would be impossible and undesirable, because of the spread of ecological damage, loss of opportunities for solitude and the lack of techniques for achieving a uniform distribution.

A travel simulation computer model was developed by Lucas and Shechter (1977). By programing the computer for a certain wilderness or park, managers can experiment with different use direction actions. These actions can involve trail and campsite construction, access manipulation, and use rationing and restrictions. The simulation model can apply these different actions and predict how patterns of crowding and solitude will change. The real value of this model is the ability to predict results of management actions before going through the expense of implementing them.

Tocher et al. (1965) recommended a better distribution of users within a particular campground. Dykema (1971) proposed a dispersal of attractive locations (picnic tables, fire pits, restroom facilities, and natural attractions), which might disperse use throughout the camping area and thus avoid zones of severe ecological impact.

With research on wilderness recreation has come the realization that environmental damage is not only a function of the amount or placement of use, but also the character of use. Differences in the mode of travel and group size characteristics have been shown to cause different degrees of environmental damage.

Mode of travel is an important part of a wildland trip and appears to determine some of the environmental impact (Jubenville 1970). In a study of campsites in the Spanish Peaks Primitive Area, Frissell found that horse party campsites were ten times larger and averaged 36 percent more bare soil than the campsites of hikers. Tying horses to trees compacted soil around tree trunks and destroyed tree roots (Frissell 1973). On Sierra Nevada wet meadows (Strand 1972) and on Montana trails (Dale and Weaver 1974), horse travel created deeper trails than just hiker travel. Weaver and Dale (n.d.) have described the different effects of hikers, horseback riders, and motorcyclists on trails.

Beardsley and Wagar (1971) recognized that different uses would have different effects on campsite ground cover. They mentioned volleyball versus bird watching and trailers versus tents, as examples.

Use characteristics not only affect the environment, but also the wilderness experiences of other users. Lucas (1964) and Stankey (1973) identified motorboats as damaging the wilderness experience of canoe travelers. Stankey (1973) concluded mode of travel, group size, and littering caused more social impact than did encounters with other groups. Stankey recommended eliminating motorboats in the BWCA, limiting group size, and more of a management emphasis on control of littering.

To change the behavior of visitors, Lime and Stankey (1971), Tocher et al. (1965), Frissell and Duncan (1965), and Wagar (1964) have recommended the use of education and information. If this fails, Wagar, Tocher et al., and Lime and Stankey admitted the need for regulations and more law enforcement. Lime and Stankey also suggested the use of fees and eligibility requirements to modify visitor behaviors.

The fourth approach to use management is to limit the amount of use, or simply regulate the number of visitors. This approach has been labeled the carrying capacity concept. For an extensive bibliography see Stankey and Lime (1973). Tocher et al. (1965) mentioned rationing in his list of management strategies for campgrounds. Willard and Marr (1970) pleaded for the establishment of carrying capacities in all ecosystems, especially in the National Parks. Rationing by a permit system is now being used in three California Wilderness Areas, the backcountry in the larger National Parks, river trips through the Grand Canyon, and in the BWCA.

Wagar (1964) first wrestled with the definition of wildland carrying capacity as containing sociological as well as ecological considerations. The setting of carrying capacity figures is dependent upon the management objectives of an area. Depending on what recreational experiences are desired, the carrying capacities are different. Additionally, the setting of carrying capacities entails costs for managers and visitors. In the end, "carrying capacity ultimately depends on the value judgment of people" (Wagar 1964).

Stankey (1973) studied Wilderness visitor perceptions and how they shape recreational carrying capacity. The number of encounters with other groups did serve to define carrying capacity for Wilderness visitors. Stankey found most wilderness visitors consider low intensities of use, involving only a few encounters, as an important dimension of the wilderness experience.

As previously mentioned, Frissell and Stankey (1972) contended that wilderness carrying capacity should be defined by "limits of acceptable change" and not in terms of an absolute number. The limits of acceptable change can be in sociological or ecological terms.

Stankey and Baden (1977) reviewed methods, problems, and guidelines for rationing wilderness use. Alternative rationing methods include advance reservation, lottery, queuing, price, or merit. Stankey and Baden discussed the advantages and disadvantages of each method.

Accessibility can be used to control the numbers of people using a park or wilderness. Jubenville (1970) concluded that wilderness use is mostly limited to trails. Since travel is controlled by access points and trail placement, managers could limit the number of people using a wilderness area by decreasing the number of access points or making trails more difficult to travel. Dykema (1971) ranked Sierra Nevada campsites by their accessibility and found that soil compaction and littering was greatest on the most accessible campsites. She suggested the possibility of limiting access to minimize camping damage.

The fifth possibility for use management involves combinations of the four previous approaches. Two combinations which have received widespread review are zoning and campsite rotation. Zoning is a combination of concentrating use in one area or dispersing use, and modifying the type of use. Zoning is the separation of different recreational activities into different areas. Zoning is used to separate incompatible activities (such as swimming and motorboating), reduce user group conflicts, and provide for different management within different areas. Zoning has been used to separate motorized from non-motorized travel (BWCA) and horse travel from foot travel (Jewel Basin Hiking Area in Montana).

Stankey (1973), Lime and Stankey (1971), Tocher et al. (1965), and Wagar (1964) listed zoning as one of the management techniques to reduce user conflicts and provide opportunities for high quality recreation. Stankey (1973), in his survey of Wilderness users, found that the concept of spatial zoning was very acceptable to users, especially to those in the BWCA.

Campsite rest-rotation is a combination of concentrating use impacts and dispersing use impacts. The intent of a campsite rest-rotation system is to use an area for a period of time and then to rest it for another period of time, to allow recovery of the natural conditions. When there is more than one area available, it is possible to alternate use and rest among the areas, thus "rotating" use. Frissell (1973), Stankey (1973), Frissell and Duncan (1965) Densmore and Dhalstrand (1965), Tocher et al. (1965), and Lutz (1945) have recommended the closure of damaged campsites and creation of a rest-rotation system. Thorud and Frissell (1969), after studying soil recovery from artificial tamping, concluded "a rest-rotation scheme may be the simplest and least expensive corrective measure" for campsite maintenance in some areas.

Campsite Closures and Rehabilitation

Closing a campsite or trail and relying on natural ecological processes for rehabilitation has had some success. LaPage (1962) observed tree growth improvements after recreational use was removed in Eastern white pine stands. He theorized that this was caused by lessening of soil compaction with frost action and wind rocking of trees. Thorud and Frissell (1969) observed natural soil rejuvenation after artificial tamping in a Minnesota oak stand and predicted the regain of natural conditions after six years of rest.

Parsons and DeBenedetti (1976) studied the effects of closing campsites at Bullfrog Lake in the High Sierra. After 15 years of closure the Bullfrog Lake campsites showed a greater litter depth, less soil compaction, more woody fuels, more growth over tree multilations, and generally more vegetation cover than nearby continually disturbed sites. The amounts of litter depth and soil compaction on the closed sites were similar to the amounts measured on nearby control sites.

The problem with campsite closures relying solely on natural processes for restoration, is the short amount of time for damage to occur, relative to the large amount of time it takes for recovery.

Three research studies have shown that the impact of camping is rapid and severe with small amounts of use. Wagar (1964), using artificial tamping on ground cover, concluded only a little direct contact causes marked changes in plant composition and appearance. LaPage (1967), studying newly developed campsites, concluded that there was an initial and inevitable heavy loss of ground cover following the onset of camping use. Merriam et al. (1973) described environmental damage on newly developed campsites in the BWCA. The greatest amount of damage occurred in the first two years of use, especially soil compaction. During the next three years damage leveled off. This assumed that soil conditions and water quality problems did not continue to worsen and become critical.

Other studies have shown natural recovery is slow, sometimes impossibly so. Shantz in 1917 estimated recovery to be 50 years on abandoned roads in Eastern Colorado. In England, trampled heath required five years to regain moss (Westhoff 1967). Fay (1975) tried to revegetate worn areas around shelters in Tuckerman's Ravine in New Hampshire. Merely fencing out areas for one year did not substantially change ground cover conditions.

High-elevation tundra in North America appears to be particularly fragile to trampling. Willard and Marr (1971) made exclosures on damaged Rocky Mountain tundra. After three years of closure, recovery was poor. Recovery was greatest on an area that had received only three years of trampling. Average vegetation cover increased 18 percent but still was 27 percent less than the natural undisturbed tundra. The vegetation cover increase was composed mostly of invader species, which were not common in the natural climax. Mosses and lichens had not returned after three years of closure. Recovery was extremely poor after an area had received 38 years of trampling. After three years of closure there was only a lessening of soil compaction caused by frost action. Willard and Marr concluded that after one season of use, it is possible to get recovery with two years of rest, but with more seasons of use, recovery can require hundreds to maybe a thousand years.
Bell and Bliss (1973) agreed and estimated up to one thousand years for recovery of Olympic National Park alpine vegetation. Hartley (1976) measured recovery on experimentally trampled Glacier Park vegetation. After six years of recovery, vegetation cover was approaching normal, but still lacked some species that had been rapidly eliminated by trampling.

Some "natural" treatments have been tried with little or slow success. Ketchledge (1971) tried transplanting native grass, fertilizing, and closures on summits of the Adirondack Mountains. After only one year of protection there was extremely poor revegetation. McClelland was more successful studying an area with several years of protection (B. Riley McClelland, personal communication). He applied native reseeding to scarred alpine tundra in Glacier National Park. The most successful results were achieved with alpine timothy (Phleum alpinum) and mulching with fir litter.

The problem of slow recovery from rapidly caused-recreational damage made Merriam and Smith (1974) conclude "the idea of rotating and rehabilitating campsites becomes futile and self-defeating. This practice would continually open up more shoreline, making too many holes and many campsites, which are quickly impacted but slow to recover."

Campsite closures usually have been fortified with artificial rehabilitation treatments. Beardsley and Wagar (1971) LaPage (1967), and Lutz (1945) recommended artificial treatments on developed automobile campsites, including loosening of soil, seeding of exotic grasses, mulching, fertilizing, and weekly watering.

In the Adirondack high country, Ketchledge (1971) used fertilizing, mulching with nearby natural "muck", and seeding with hardy non-native plant species. After one year, a 70 to 80 percent grass cover was attained.

Not all rehabilitation with artificial treatments has been so successful. Visitor use has prevented recovery (Cordell and Talhelm 1969) and longer periods of time than expected are needed for recovery (Fay 1975).

Most of the campsite recovery studies have been on developed automobile campgrounds (where law enforcement is more available) or have consisted of limited exclosures. One of the conditions for successful campsite closures is compliance by visitors. There have been suggestions in the literature that this will be a problem for any campsite rehabilitation program. Merriam and Smith (1974) identified the problem; since the most attractive campsites receive the majority of use they are probably the most likely to need closure. Alternative campsites, chosen by the managing agency, are usually less attractive and often more difficult for the visitor to find. Visitors then will return to the closed campsites and prevent effective recovery. Strand (1972) reported poor recovery of closed Sierra Nevada meadows and, in one case, continuing deterioration because of trespass grazing.

Site characteristics are factors in determining the degree of environmental damage from recreation; they are also factors in the recovery of natural conditions. Specifically, it has been shown that soil moisture is an important determinant of campsite recovery. Hartley (1976) concluded that not only is wet meadow vegetation more resistant to recreation damage, but it recovers more rapidly than dry meadow vegetation. From a comparison of photographs, Strand (1972) concluded wetter and lower elevation campsites recovered more rapidly than drier and higher elevation campsites in the Sierra Nevada. Strand also identified vegetation type, slope, and soil characteristics as important influences on recovery. Beardsley and Wagar (1971) reported that campsites under aspen responded much better to rehabilitation treatments than other forest types.

CHAPTER II

THE STUDY AREA

Location and Natural Environment

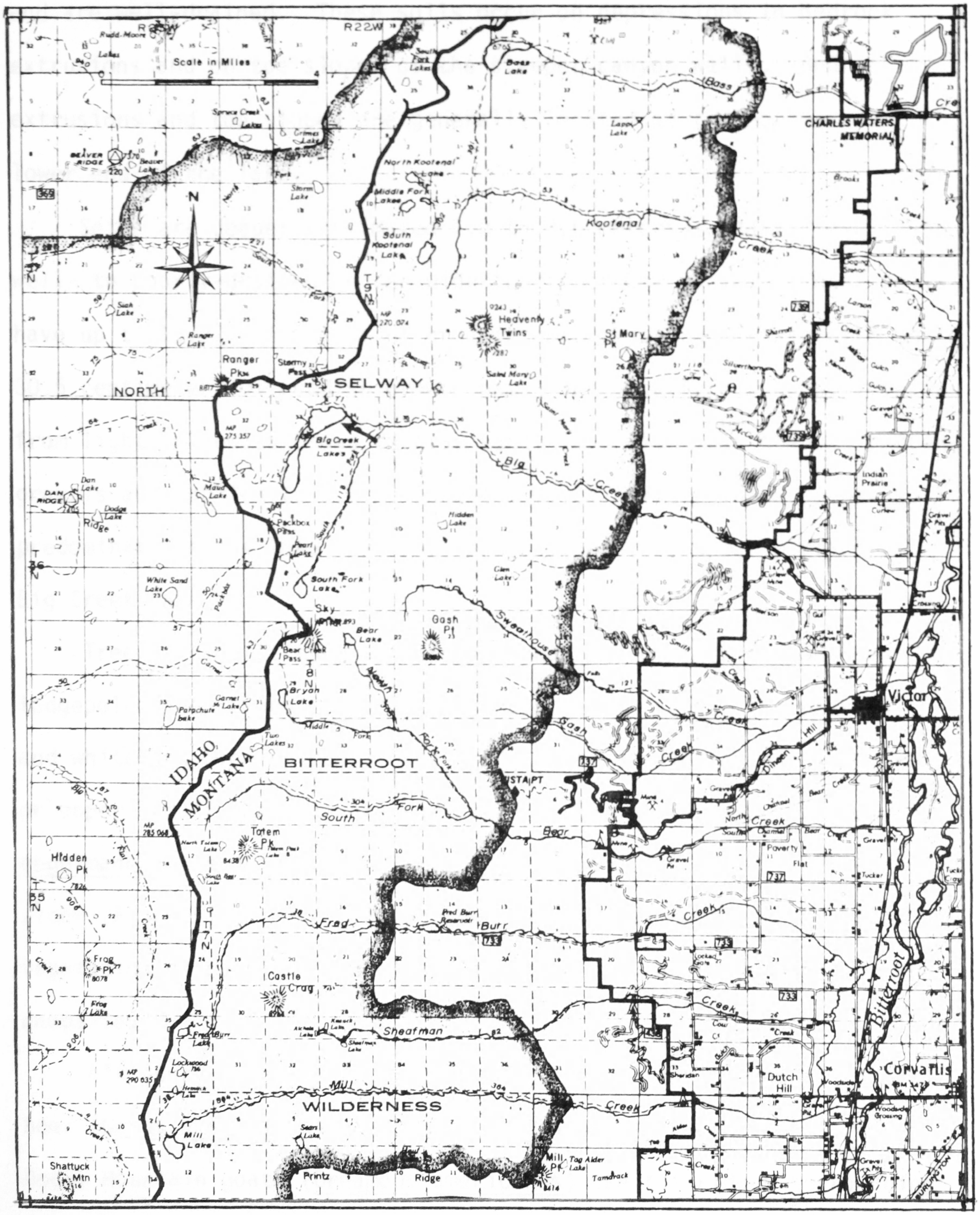
The Selway-Bitterroot Wilderness (497,464 hectares, 1,243,659 acres) is located on both sides of the Bitterroot Mountain Range, which forms the boundary between Idaho and Montana.

The Big Creek drainage is located in the northeastern part of the wilderness. The drainage lies west to east, and drains into the Bitterroot River. Big Creek Lake is located at the head of the main fork of Big Creek, in sections 33, 34 T.9N., R.22W. and section 5 T.8N., R.22W. (Fig. 2).

Big Creek Lake is a typical glacial cirque lake, originally impounded by bedrock and glacial moraines (Fig. 1). Topography is extremely variable. Ranger Peak, on the western side, is 2,685 meters (8,810 feet). Elevation at the lake level is 1,788 meters (5,865 feet). Slopes are generally steep, and include solid granite, talus fields, and avalanche paths. Some of the eastern slopes have portions as steep as 150 percent. The bedrock is quartz monzonite, a medium to coarse grained "granitic" rock of the Idaho batholith (U.S.D.A. Forest Service 1977).

Soils of the narrower portions of the valley are shallow with sandy textures, containing 40 to 60 percent by volume of gravels and boulders,

Figure 2. Big Creek Lake Location and Surrounding Trails.



and are well-drained. These soils occur on depressions in bedrock extrusions and on toe slopes of the steeper canyon walls. Bedrock extrusions and toe slopes are generally located at the northern or lower end of the lake.

Soils are deeper (estimated 1.8 to 3.6 meters), nearly level, and well- to poorly-drained in the wider parts of the valley. These soils have up to 15.2 centimeters of organic duff layer, underlain with up to 30.5 centimeters of reddish brown loam (loess) surface. Subsoil varies from light yellowish brown to gray sandy loam with less than 20 percent gravels and cobbles (U.S.D.A. Forest Service 1977). These deeper soils predominate at the lake "narrows" and southern, or upper portion of Big Creek Lake.

Tree species at the northern or lower end of the lake include lodgepole pine (Pinus contorta*), subalpine fir (Abies lasiocarpa), and whitebark pine (Pinus albicaulis). Tree species at the southern or upper end of the lake are dominated by Englemann spruce (Picea engelmannii), and subalpine fir (Abies lasiocarpa). There are extensive alder (Alnus sinuata) fields on the avalanche slide areas. Further vegetation discussion is included in Chapter V, on the ecology of the campsites.

Elk (Cervus canadensis), mule deer (Odocoileus hemionus), black bear (Ursus americanus), and moose (Alces alces) use the lake area. Rocky Mountain goats (Oreamous americanus) use the ridges surrounding the lake. Small mammals include shrews, snowshoe hares (Lepus americanus),

*Nomenclature for vascular plants follows C. L. Hitchcock and A. Cronquist's Flora of the Pacific Northwest, 1973, U. of Washington Press, Seattle, Washington.

porcupines (Erethizon dorsatum), squirrels, pine marten (Martens americana), mink (Mustela vison), pika (Ochotona princeps), and marmots (Marmota caligata). Birds reported in the area include the Common Raven, Belted Kingfisher, Steller's Jay, wrens, Golden Eagles, various water birds, and owls. Big Creek Lake is well populated with fish, especially rainbow and cutthroat trout (U.S.D.A. Forest Service, 1977).

Human History

Big Creek Lake has a long and varied history of human use. Early visitors were native Americans who hunted in the Bitterroot Mountains. They established a hunting camp at the northern end of the lake. The National Park Service excavated the camp during the summer of 1977. The Park Service archeologists discovered arrowheads and scrapers, made of quartz and chert. This stonework was characteristic of the Late Middle or Early Late Prehistoric periods, which date approximately 1,500 to 3,000 years ago. The artifacts suggest the site was used by a group of transient hunters, who used the site for several years (Fredlund 1977, U.S.D.A. Forest Service 1977).

Lake development by Americans of European origin, began in 1891, before the establishment of the Bitterroot National Forest. Between 1897 and 1906, an outlet was cut through the rock and a dam was constructed on the lake, for the purposes of regulating water to the Curlew Mine and fields in the Bitterroot Valley. In actuality, there were two lakes separated by a mud flat before dam construction. The dam raised the water level approximately 3 meters and created the present Big Creek Lake.

The lake became the responsibility of the newly-formed U.S. Forest Service in 1905. Based on recommendations of the Forest Service, the Secretary of Agriculture established the Selway-Bitterroot Primitive Area in 1936. In 1964, the Selway-Bitterroot Area became one of the first designations as a Wilderness Area, by congressional act. The Selway-Bitterroot Wilderness is now managed by the Forest Service, as wilderness, according to the Selway-Bitterroot Management Plan (U.S.D.A. Forest Service 1975). Big Creek Lake is managed by the Stevensville District of the Bitterroot National Forest.

The dam, and hence the water level of the lake, is still controlled by a group of irrigators, the Big Creek Lake Reservoir Association, under a special use permit issued in 1964. The dam was reconstructed in fall, 1977. The old dam had been deteriorating for many years, and the decision was made to continue supplying water to the irrigators, in order to preserve a rural way of life in the Bitterroot Valley (U.S.D.A. Forest Service 1977).

Today, the predominant use of the lake is for recreation. Both backpackers and horseback riders take one day and extended trips in the area. A major attraction is the fine fishing. Forest Service Trail number 11 starts at Big Creek campground, goes west 15.2 kilometers

(9.5 miles) to Big Creek Lake, continues along the western side of the lake and then rises over Packbox Pass. Several other trails intersect with Trail 11 (Fig. 2).

Big Creek Lake has always been a popular attraction for wilderness visitors. During the 1950s and 1960s two outfitters frequently horse-packed into the lake. Their clients included the American Forestry Association and the Wilderness Society. Occasionally groups would travel with up to 80 horses. This clearly left an impact on the lakeshore. Trees were cut for poles, girdled by tying stock, scarred by chopping, cut for wood, and weakened by exposed roots. Ground cover vegetation was trampled, and grazed. Soils were compacted, and began eroding into the lake. In 1973, the resource ranger on the Stevensville District initiated campsite closures. Five areas around the lake were closed to overnight camping, and the whole lakeshore was closed to livestock use. Signs were placed at the trailhead and on the campsite.

Trail registration data show visitor use on the Big Creek Trail has dropped 12 percent in the last 3 years, from 225 groups to 197 groups (Robert Lucas, personal communication). Over the same three-year period, wilderness registration on the Stevensville District increased 6 percent, from 1469 groups to 1552 groups. Further visitor use information is contained in Chapter IV.

CHAPTER III

WILDERNESS CAMPSITES IN THE NORTHERN ROCKY MOUNTAINS

Methods

A survey of public land agencies was conducted to determine the extent and associated problems of wilderness campsite closures. A questionnaire was designed to gather information on the existence of closed campsites, criteria for opening and closing, administration and enforcement problems, an estimate of compliance, an estimate of recovery, and future plans. One of the questionnaires with the explanatory cover letter is in Appendix 2.

Questionnaires were sent to 30 Forest Service district offices in Region 1 (Northern), 15 Forest Service district offices in Region 4 (Intermountain) and nine National Parks in the same geographic area.

Information from questionnaires was placed in a computer data file. Frequencies for each type of response and means for some responses were calculated using the Statistical Package for the Social Sciences (Nie et al. 1975).

Results

The Extent of Wilderness Campsite Closures

Of the 54 questionnaires sent out, 52 (96%) were returned. Two of the returned Forest Service questionnaires indicated their area of wilderness was actually managed by a nearby district. So, of the 52

Table 1

Numbers of Management Offices that have Closed Wilderness Campsites By Agency and Type of Closure in the Northern Rocky Mountains

	Forest Service Region 1	Forest Service Region 4	National Park Service	Totals
Offices with campsite closures	8 (30)	5 (36)	2 (22)	15 (30)
Offices with some permanent closures	4 (15)	2 (14)	1 (11)	7 (14)
Offices with some temporary closure	6 (22)	3 (21)	2 (22)	11 (22)
Offices with both types of closures	2 (7)	0 (0)	1 (11)	3 (6)
Total number of offices with wilderness management responsibilities	27 (100)	14 (100)	18 (100)	50 (100)

( ): Percentage based on total number of offices in particular agency or region with wilderness management responsibilities.

offices responding to the questionnaire, 50 actually have wilderness management responsibilities.

Of these 50 offices, 15 (30%) have campsites closed to recreational use for rehabilitation. Although the questionnaire did not contain a specific question on future plans, five (10%) mentioned they are considering site closures for the future. Seven of the 50 (15%) have made permanent closures to protect lake shorelines or reduce conflicts with wildlife. Eleven (22%) of the 5 have made temporary closures for rehabilitation. There are not substantial differences among the two Forest Service Regions or the National Parks in percentage of campsite closures. Table 1 summarizes the number of offices that have closed campsites by Forest Service Region and National Park Service.

Closing wilderness campsites is a recent management policy in the Northern Rocky Mountains. On the average, closures have been in effect for only four years, with a range from two to eight years.

The Criteria for Closing and Opening Campsites

The criteria for closing campsites are usually the more easily visible factors. All 15 offices with closures report that loss of vegetation caused them to close campsites. The next most often used criterion is "esthetic deterioration", reported by fourteen (93%) of the offices. The next two criteria, soil erosion and loss of an organic litter layer, are used by 10 (57%) of the agency offices.

The other two criteria mentioned on the questionnaire are not as visible. Two (13%) of the offices report conflicts with wildlife as a reason for closing campsites. Only one of the offices reports using the appearance of non-native plant species as an indicator of the need for campsite closure. A ranking was also made of criteria for reopening campsites. Vegetation cover was again checked by all 15 offices as being an indicator of recovery. Wildlife conflict was not mentioned as an indicator of recovery because the affected campsites were closed permanently.

The Types of Campsite Closures

There is some variety in types of closures. Five (33%) of the offices have closed campsites to all recreational use. Six (40%) have closed campsites to overnight camping but not to day use. Ten (67%) of the offices have closed campsites to livestock use. One office, managing a part of the Bob Marshall Wilderness, has a rest-rotation system where six campsites receive backpack use annually and livestock use every other year.

Visitor Information, Enforcement, and Compliance

Visitors are informed of the closures in many ways. A majority of 13 (87%) of the offices use signs to inform visitors. Twelve (89%) use visitor contacts at the district office or contacts with a wilderness ranger. Only three (20%) use portal assistants, employees who meet with visitors at the trailhead. Five (33%) use handout maps. Only one uses barriers around campsites to discourage visitor use. The National Parks use a backcountry permit system with designated campsites. This system allows managers to direct visitors away from closed areas.

Enforcement can be characterized in a variety of ways. Most of the management offices (14 or 93%) rely on a wilderness ranger patrolling the area. Seven (47%) have used warnings, and two (13%) have used citations as additional enforcement measures. The average length of time between inspection visits during the use season is 11 days, and ranges from one to 30 days. One Forest Service Office reports that they have no enforcement methods. Their closures are voluntary and "quite successful."

Management personnel were asked to estimate non-compliance by checking one of seven percentage categories. Only three of the seven possible categories were checked. The majority of the management personnel (12 or 80%) checked the 0 to 24 percent category. This means 0 to 24 percent of the visitors are estimated to camp in restricted areas out of the total number of visitors who have the opportunity to do so. Three (20%) of the offices estimated non-compliance to be higher, or in the category of 25 to 49 percent. One office, in addition to the 0 to 24 percent category, checked the 50 to 74 percent category, followed by the comment, "if they are not contacted prior to camping." There were not enough examples of closed campsites or a range of answers to the compliance question to relate compliance to other factors such as enforcement methods.

Use of Cultural Treatments

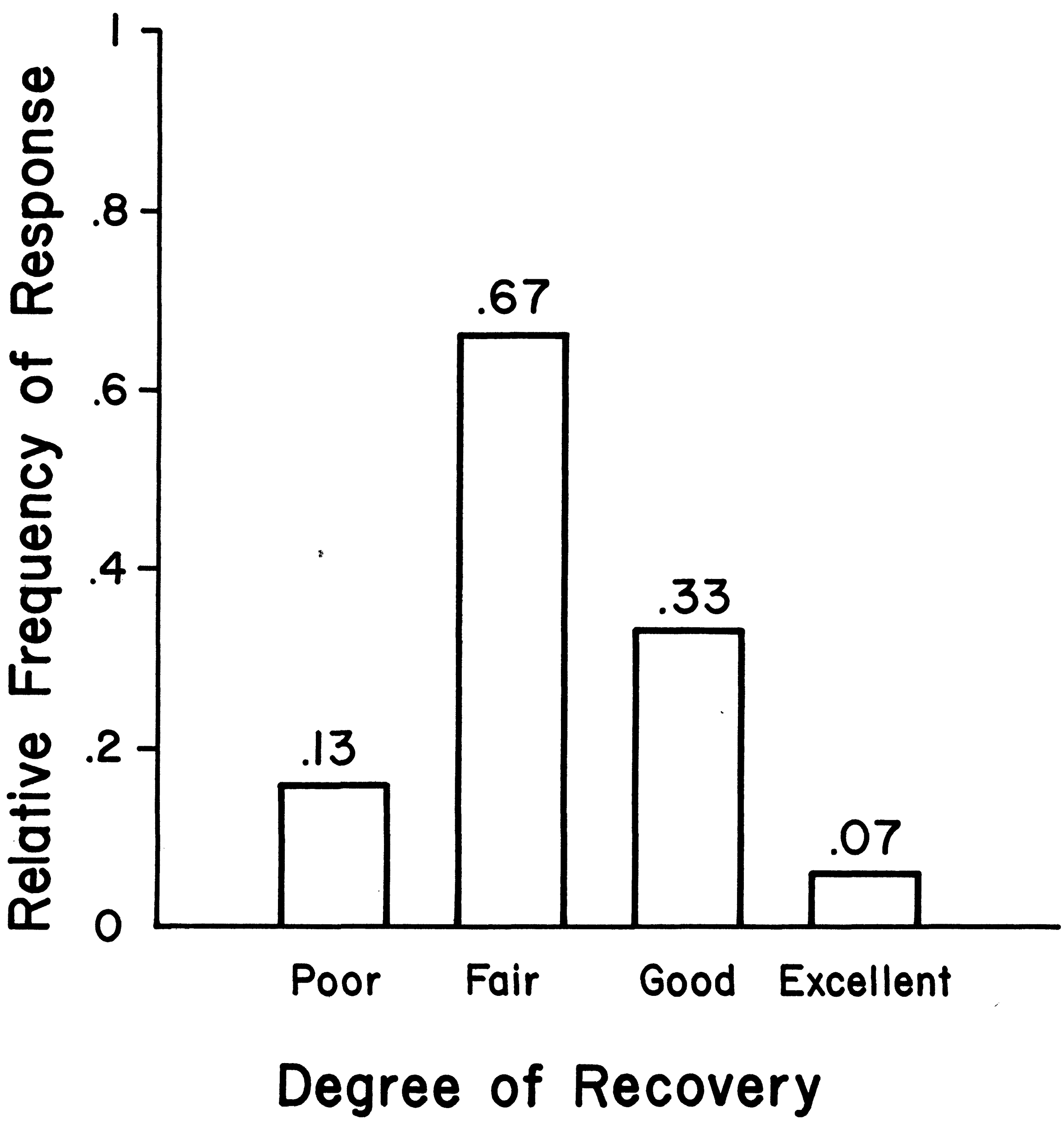
Few of the management offices use additional cultural treatments on their wilderness campsites. Twelve (80%) use no additional treatments. Two (13%) of the offices use scarification. Only one office, managing a part of the Sawtooth Recreation Area, uses seeding of native species and scarification. One Forest Service assistant district ranger reports the only cultural treatment they use is weeding of non-native plant species. Two offices are experimenting with vegetative "plugs" or sections of natural sod transplanted to the campsites.

Natural Recovery and Future Plans

Regarding campsites closed on a temporary basis, the questionnaire asked what was the expected average length of time for closure or rehabilitation. The average answer was approximately five years, with a range from two to eight years. Some offices replied that they did not know how long closures were necessary, and others replied it was dependent upon site characteristics.

Management offices were also asked to rate natural recovery into four categories: excellent, good, fair, or poor. The majority of 10 (67%) answered they were obtaining fair recovery. Answers were skewed to the poor end of recovery (see Fig. 3). There were not enough examples of campsite closures or enough of a distribution of responses on other questions to relate ratings of recovery to other factors, such as compliance and cultural treatments.

Figure 3. Responses to a Question Regarding Type of Recovery of the Vegetation and Soils on Closed Wilderness Campsites



The 11 managers who do have campsites closed on a rest-rotation system were asked what their future plans were for closed campsites. Nine (82%) of the 11 managers plan to reopen some of the campsites to original use. All 11 of the managers answered that they plan to reopen some of the campsites, but modify use from what it was prior to the closures. Six (54%) will limit number of visitors; nine (82%) will limit livestock use; only one will limit overnight use. Two Forest Service District Offices mentioned other limitations not suggested in the questionnaire. One office plans to prohibit wood fires in a well used area. Another office plans to require camping permits.

Additional Comments

Additional comments were requested on the questionnaire and many respondents added comments to individual questions. Some of these comments dealt with aspects of use restriction other than camping on a specific site. Most of the Forest Service districts now regulate group size, length of stay, number of stock per party, and commercial outfitters in Wilderness Areas, pursuant to the Code of Federal Regulations 36:261. Most Forests have a maximum group size of 20 persons, and a maximum length of stay of 14 consecutive days on one site. The number of stock allowed per party varies among different wilderness areas. In the Selway-Bitterroot the maximum number is 20, while in the Teton Wilderness it is 50. All Forest Service and Park Service Offices require a permit from commercial outfitters operating in Wilderness

Areas. Four (27%) of the management offices making closures commented that they had to close or severely regulate use of some outfitter campsites.

Discussion

Some of the results of this survey must be qualified. First, these are not the results of controlled experiments but the perceptions of management personnel. Management perceptions are often not the same as the physical reality or the perceptions of visitors (Lime and Stankey 1971, Lucas 1964). A second aspect of the problem is that a variety of management personnel responded to the questionnaire, including district rangers, assistant resource rangers, and wilderness rangers. They would each have different perceptions of visitor compliance and campsite recovery. Another aspect is that many wilderness management offices make area closures rather than single campsite closures. In these cases the questions were answered with the area in mind instead of individual campsites.

However, the purpose of this survey is not to describe the physical reality of the campsite closures, but to describe their extent in a region and their associated problems. The easiest and most reliable way to measure the extent is to survey the offices responsible for making the decision to close, and the offices responsible for actually closing the campsites. Management perceptions are also the best way of describing the attitudes toward the policy, both favorable and unfavorable. These attitudes serve to predict whether there will be more or fewer campsite closures in wilderness areas.

Presently there are not many campsite closures in the Northern Rocky Mountain Wilderness Areas. Only 15 of the 50 wilderness management offices have closed campsites. However, there is potential for future campsite closures, since five of the 50 offices are considering future closures and two of these offices wrote that they would close campsites when they had adequate funds and personnel. Another indicator of the future is management in the BWCA and California Wilderness Areas, where people pressure is already great. In the BWCA managers have been using permanent and rest-rotation closures for the last 15 years on several hundred campsites (J. Higgins, personal communication). If predictions on the growth of wilderness use in the West become a reality, some of the western Wilderness Areas will be facing the same problems as the BWCA, hence further closures might become necessary.

Compliance of wilderness visitors was not perceived as a problem. Most of the offices estimated compliance with their closures as close to 100 percent. This was especially true when visitors were contacted personally by district office employees, portal assistants, or wilderness rangers.

Two offices commented that instead of using site closures they would indirectly limit the use of an area by personal contacts. The federal employee would discourage use of damaged areas by encouraging the use of less crowded and more natural areas. However, remember the cautions of Stankey et al. (1976) on dispersing use: ecological damage is caused elsewhere and opportunities for solitude may be lost.

Recovery is rated on the poor end of the scale. Managers attributed this to the short period of time the campsites have been closed, site factors (high elevation), degree of impact (only bare mineral soil remaining), and continuing visitor use. Few wilderness managers in the Northern Rocky Mountains are experimenting with cultural treatments for rehabilitation. The offices using vegetative "plug" transplanting report encouraging results.

Two Forest Service rangers responded with a rejection of campsite closures and made recommendations for other approaches. One ranger wrote that instead of using a formal closure program, they have posted sites as "Wilderness Restoration Sites" with a specific message asking the visitors' cooperation on selecting an unused site nearby. Enforcement is limited to contacts with management personnel who stress a minimal impact camping message. The ranger writes, "We feel that this approach is as effective, possibly more so, [than] a strictly regulatory approach." The other ranger rejecting a formal closure program, wrote of an aggressive approach to visitor contact and education, use redistribution, and transplanting of native vegetation "plugs." He reports they have "in three years severely reduced the damage occurring to the available campsites, have changed pattern of use, and the small parks and meadows are showing the effects."

These approaches do not all have optimistic results. Inherent in any of these campsite closures or use redistributions is the problem of ecological damage moving elsewhere. Two rangers mentioned this problem without providing a solution.

Basic to many of the comments on the questionnaires is a philosophical question of whether or not it is appropriate to designate campsites in a wilderness. The Wilderness Act sets aside areas to be preserved as wilderness, where evidence of man is substantially unnoticed. However, the Wilderness Act allows some deviations from the pristine, by using the words generally, primarily, and substantially to describe the natural characteristics of wilderness. Also the Act prohibits certain uses, such as roads, use of motorized equipment, structures, "<u>except</u> as necessary to meet minimum requirements for the administration of the area for the purpose of this Act" (emphasis added). To some managers the designation of campsites is "sacrificing of sites," followed by "hardening of sites." One manager observed, "The whole question is a philosophical one. My personal feelings are that designated campsites are a copout to Wilderness management, unless related to specific or unique situations, like a sand bar on a Wild River where other sites are not available." To other managers the designation of campsites is necessary to protect the surrounding area. "We feel that some sites are going to be scarifice campsites. If we continue to keep closing areas and move people around at lake areas the entire area will eventually be in an overused condition."

The question, "Have you designated alternative campsites to the closed ones?" seemed to draw out this conflict. Eight of the 15 offices (53%) said no, and one commented "We don't designate any campsites except for commercial outfitters."

Many of the offices now stress "minimal impact" camping, where fire rings are destroyed and campsites are "naturalized" by campers before they leave, to discourage future campers from using the same campsite.

On the other side of the question, the National Parks, the BWCA, some California Wilderness Areas, and some respondents to this questionnaire have designated campsites. Campers are required to camp in designated campsites, although enforcement of this policy varies from area to area.

In conclusion, there is a conflict whether or not to designate campsites in the Northern Rocky Mountain Wilderness Areas. As use has increased in other wilderness areas, managing agencies have gone to designating and maintaining campsites. Perhaps these levels of use will not be reached in some areas of the Northern Rocky Mountains, or other alternatives will be used to minimize environmental damage. As the literature review of this thesis points out there are other alternatives to concentrating use in one area. These alternatives are dispersing use, modifying use, limiting numbers of users, and combinations of alternatives. These issues are further discussed in Chapters IV, V, and VI.

CHAPTER IV

VISITOR USE OF BIG CREEK LAKE CAMPSITES

Field Methods

Big Creek Lake visitors were observed during the summer season of 1977. The author made observations on five consecutive evenings, followed by three nights without observation. The author hiked the length of the lake, in obvious view of visitors, while making observations. No attempt was made to speak with, or otherwise disturb the visitors. Signs were maintained on the campsites by the author, but no other effort was made to enforce the campsite closures. Campsite choice, group size, travel method, and visible fishing equipment were recorded for each visitor group observed (Appendix 3).

Analysis

Total visitor use during the season was estimated by first averaging both the number of new visitors and new visitor groups per night. These averages were stratified by Saturday night versus other week day night. The stratified averages for new visitors and new visitor groups per night were multiplied by the number of respective nights in the season, to arrive at a number for total use. The summer season was assumed to extend from mid-June, when snow usually melts in the Bitterroot Canyons, to the first week in September, or the Labor Day vacation.

The number of nights that visitors camped on the lake was determined in a length of stay analysis. Only those groups that were observed arriving and leaving during a sampling period were used in the analysis. Therefore this length of stay analysis contains a length of stay bias that emphasizes short stays, and misses longer stays. However, only two groups (2%) of all the groups observed stayed longer than two nights, within any sampling period, suggesting that these groups were a small part of the visitor population.

Number of visitor-days was estimated using length of stay proportions, average group size, total number of groups, 1.8 visitor-days for each individual camping one night on the lake, and 3.8 visitor-days for each individual camping two nights on the lake.

In an attempt to identify the causes of non-compliance with the closures, the variable of campsite choice was crosstabulated with the other visitor use characteristics (e.g., group size, travel method, length of stay, use of fishing equipment). Significance was tested using a corrected Chi square and the Crosstabs program in the Statistical Package for the Social Sciences (Nie et al. 1975).

Campsite choice was also related to the amount of crowding, by use of a simple regression analysis. The proportion of groups camping on closed campsites for each night sampled was regressed on number of groups camping around the lake. The hypothesis was that as crowding (i.e., the number of groups in the area) increased, the proportion of groups camping in closed areas would increase, assuming that as available open sites were filled, new visitor groups would be pushed into closed sites.

Results

Numbers of Visitors

Ninety-three groups were observed camping on the lake during 53 nights of observation. Saturday night was usually more crowded with 3.3 new groups on the lake or 8.7 new individuals. These averages were used to calculate an estimate of the total camper population of 158 visitor groups or 418 individuals, for the time period from mid-June to the first week in September.

The average number of visitors per night encountered on the lake is higher because of some visitors staying longer than one night. The average number of groups on a Saturday night was 3.9 groups and ranged from 1 to 8. During the other nights of the week the average number of groups was 1.8 and ranged 0 to 5. This information is summarized in Table 2.

Length of Stay and Number of Visitor Days

Forty-two groups were observed arriving and leaving during a sampling period. Thirty-six (86%) stayed only one night and left. Six (14%) of the groups stayed two nights. These average lengths of stay were used to calculate a seasonal amount of visitor-days in the canyon of 854.5. This is definitely an under-estimation because it misses day use and visitors to the South Fork of Big Creek.

Table 2.

Average Number of Visitors on Big Creek Lake Stratified by Saturday or Other-Day Night

		Number of Groups	Number of Individuals
Saturday:	Mean	3.89	10.33
	Range	1-8	2-21
	Standard Error	.44	1.30
Other Days of Week:	Mean	1.82	4.95
	Range	0-5	0-29
	Standard Error	.33	1.44

Based on 93 groups and 53 nights

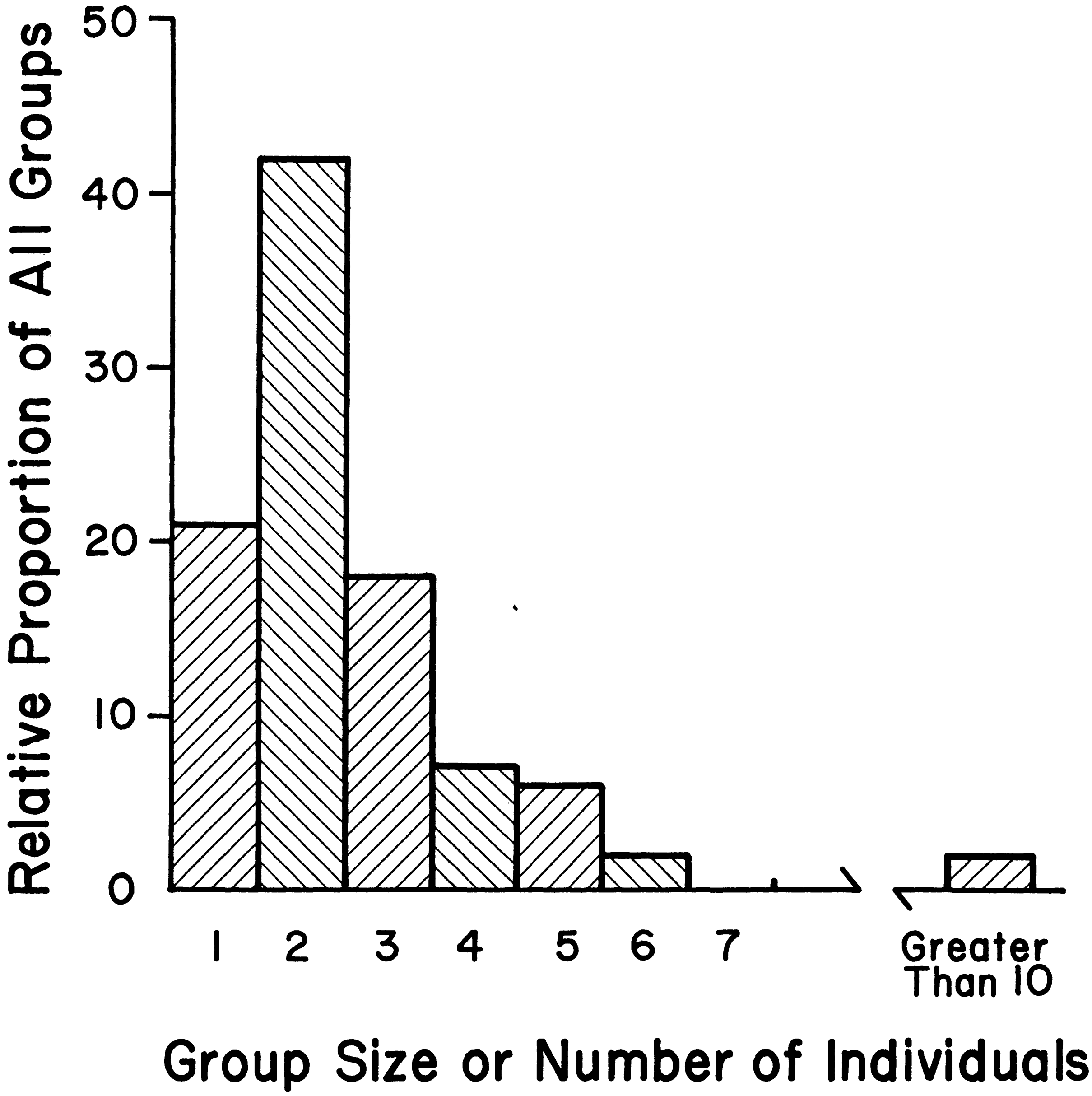
Visitor Use Characteristics

The average group size was 2.6 individuals and ranged 1 to 17. Sixty-two percent of the groups had one or two individuals in them. The distribution of groups to size is contained in Figure 4.

Eighty-five percent of the groups were hiking while backpacking all their gear. Three percent were hiking while leading horses packed with camping gear. Twelve percent were horseback riding and horsepacking. The average number of horses per group, of the groups traveling with horses, was 2.9, and ranged 1 to 5 horses.

Seventy-five percent of the visitor groups were fishing or had fishing equipment when observed.

Figure 4. The Size of Visitor Groups at Big Creek Lake



Based on 93 groups and 311 individuals.

Average Group Size = 2.6.

Three different types of areas were used for campsites around Big Creek Lake. These were closed campsites, open established campsites, and areas that appeared natural without any trace of camping evidence. Sixteen percent of the observed groups camped on closed campsites. Sixty-seven percent camped on open campsites. The remaining 17 percent camped on natural areas.

Noncompliance Visitor Groups

The visitors that chose to camp in closed areas are impossible to categorize. Through unsystematic observations and casual conversations with these visitors, it was learned that some are students, some are Bitterroot Valley land owners, some are railroad workers, and some are seasonal employees of the Forest Service. There was also no correlation between campsite choice and group size, use of fishing equipment, or length of stay (Appendix 4).

However, one relationship was discovered. Those groups travelling with horses are more likely to camp in closed areas than groups without horses. Although the majority of both backpackers and horsepackers comply with the closures, only 11 percent of the backpack groups camp in closed areas, while 40 percent of the horsepackers do so. This crosstabulation is shown in Figure 5 and was statistically significant at the 98 percent level.

Although the data on campsite choice and crowding did not fit a simple linear regression, a different relationship emerged. As crowding or the number of groups increased, the proportion of groups camping on

Campsite Choice		Method of Travel: Walking	Method of Travel: Horses	Campsite Choice Percentages
	Natural Areas	16 17.2 20.5	1 1.1 6.7	18.3
	Open Campsites	53 57.0 67.9	8 8.6 53.3	65.6
	Closed Campsites	9 9.7 11.5	6 6.5 40.0	16.1
	Method of Travel Percentages	83.9	16.1	

^{2} = 4.14 with 3 degrees of freedom

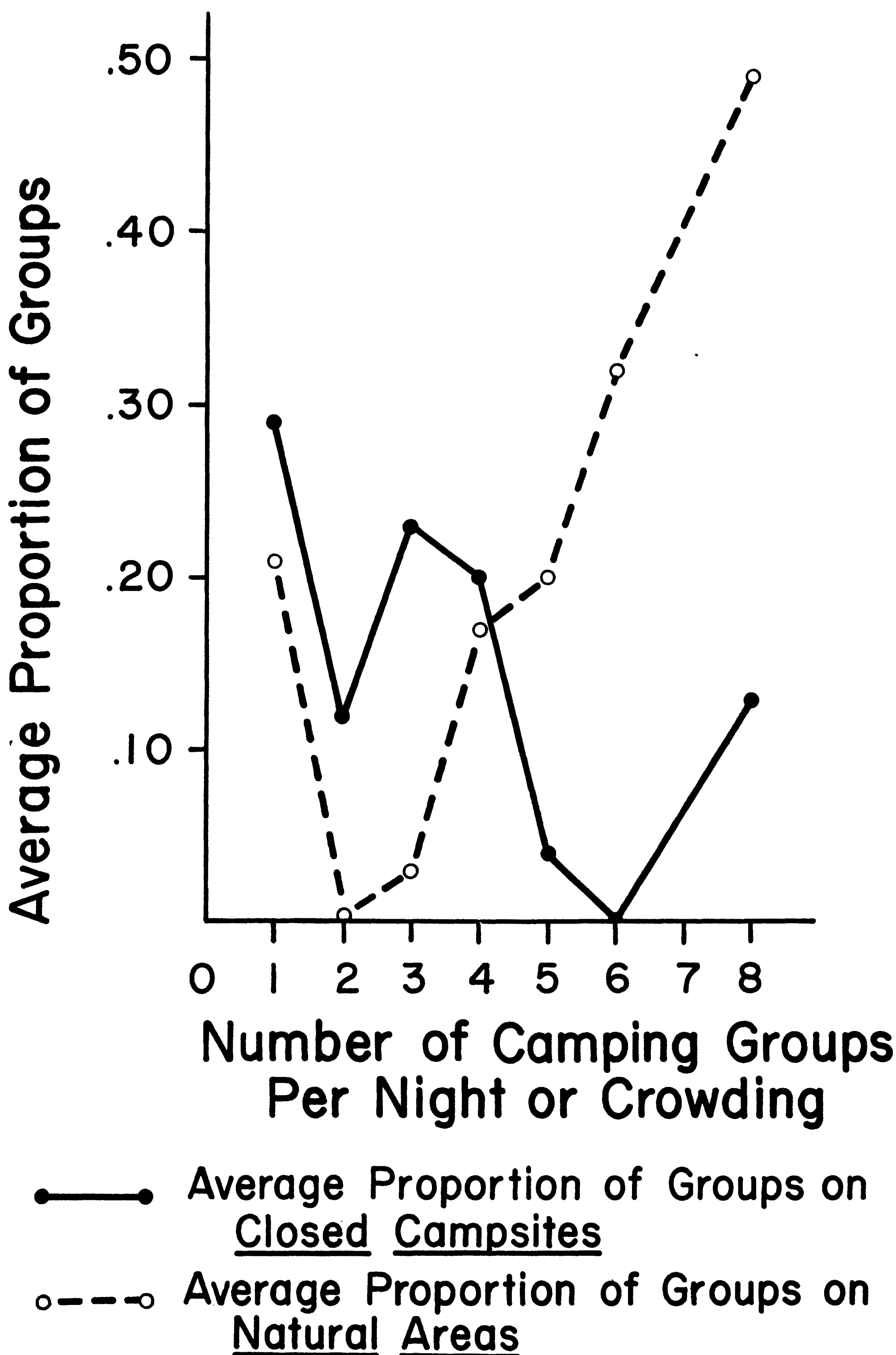
Based on 93 groups.
Explanation of cells:

Absolute frequency of cell
Cell percent of total
Column percentage

Figure 5. Crosstabulation of Campsite Choice with Travel Method

closed campsites decreased, while the proportion of groups camping on natural areas increased. This effect can be visualized in Figure 6. There is no statistical significance attached to these effects.

Figure 6. Campsite Choice and Crowding



Discussion

Campsite Preference

A variety of people travel to, and camp around Big Creek Lake. Probably the scenic and natural qualities of the Bitterroot Mountains, and the fisheries of the Big Creek Canyon are the major attractions. Associated with these attractions are the activities of camping, photographing, hunting, nature study, rock climbing, swimming, rafting, hiking, horseback riding, and socializing with a group.

Even though there is a variety of travellers to Big Creek Lake, they seem to prefer similar areas for campsites - flat areas, close to the Lake, with little brush, and with easy fishing. Frissell and Duncan (1965) found visitors to the BWCA preferred open, flat areas, islands, and pine stands. Brown and Shomaker (1974) found that most campsites in the Spanish Peaks had flat areas, were close to water, had a view of a lake, were dry, and close to a primary trail. They also suspected that fishing was an element in campsite selection.

The physical needs seem to be a flat usable area, a water supply, firewood, and grazing potential if traveling with stock. The other needs seem to be psychological - a view of a lake, and opportunities for fishing. Another important consideration of campsite use is location and accessibility. Many campsites center around major wilderness attractions, such as a lake, or one day's journey from the trailhead.

Noncompliance Visitor Groups

The reasons why visitors camp on closed campsites are probably many and complex. There are probably certain visitors who are more likely to camp on closed areas. Likewise there are probably environmental conditions that make it more likely for any visitors to camp on closed areas. The identification of these visitors and environmental conditions is beyond the scope of this research, but some speculation is possible.

The visitor characteristics observed and related to camping on closed areas were group size, travel method, use of fishing equipment, and length of stay. The only correlation discovered was between camping on closed areas and travel method. This could be attributed to the environmental conditions around Big Creek Lake. There is limited grazing, so horse campers concentrate on specific areas. If the Forest Service District personnel perceive these areas as damaged, they are most likely to close the areas to camping and stock use. Unfortunately, the areas would still be the most desirable, vegetatively, for grazing. Wilderness travellers with horses find they have no alternative grazing and may therefore camp in closed areas.

Alternatively, this noncompliance on the part of horse users could be attributed to the users themselves. Since they do have horses, they may be local landowners who have visited Big Creek Lake often in the past. They may have selected their favorite campsites and consider these sites their own "territory". They would not appreciate the Forest

Service intruding on what they consider their own "territory". Therefore, noncompliance could be a symptom of a conflict between the local landowners and the Forest Service. This fits the conflict theory, a theory developed by sociologists to explain deviant or depreciative behavior (McCaghy 1976).

The environmental condition of crowding was investigated to see if it affected the proportion of groups camping on closed areas. No conclusive statements can be made because there is a lack of data, especially for extremely crowded conditions. However, some speculation is again possible.

There emerged a roughly inverse relationship between proportion of groups camping on closed areas and crowding. As crowding increased the proportion of visitor groups camping on closed areas decreased (Figure 6). This can be attributed to two possible causes. As crowding increases on the lake and trail, visitor groups are more visible to each others, they are not isolated from social norms. If the social norm, as perceived by most groups, is to comply with Forest Service signs, then the more groups in the area, the more likely they are to comply with the signs. The socially acceptable behavior is not to camp on closed areas. When visitors are alone and free from public review, they would be more apt to camp in a closed area.

Another cause of the inverse relationship between noncompliance and crowding could be the presence of a Forest Service Wilderness Ranger. When the Forest Service suspects that there will be crowding at Big Creek

Lake, for example on the Fourth of July weekend, the Wilderness Ranger is more apt to be there, enforcing the closures.

In casual conversations with visitors around Big Creek Lake, the author heard varying rationales for camping on closed areas. Some of these relationales might help identify the causes of noncompliance. One rationale was, "I can't see the sign from where I have my tent pitched, so this must be outside of the closed area." This is a real problem on a broader perspective, how to inform the visitors of the closures. The Stevensville District has placed signs at the trail head, trail junctions, both ends of the lake, and upon each closed camping area. However, problems arise when visitors flagrantly tear down signs. In previous summers, the responsibility of maintaining signs belonged to the Wilderness Ranger. Since he or she was able to visit the lake only once a month, signs were missing for a long time. As a result, many well-intentioned but uninformed visitors camped in closed areas. This problem did not occur during the field season, because the author maintained signs on a weekly basis. During late July and August, this meant replacing a sign about once a week. This may mean that in previous summers camping on closed areas was greater than 16 percent of the groups. The 16 percent is a number describing the amount of visitors who intentionally or flagrantly violate the closures.

Another rationale was "There aren't any other places to camp or graze horses, except these closed areas." In reality there were 15 available campsites around Big Creek Lake. These campsites were less visible from the main trail and in some cases more difficult to reach. To a certain extent, this rationale reflects laziness on the part of wilderness visitors to seek out available campsites. This also might be based on misinformation. Some visitors assumed that since five areas were closed around the lake, the whole lake was closed to camping. Trail registration data shows that there has been a decrease in use of the Big Creek Canyon, while at the same time, there has been an increase of use of the Wilderness Area managed by the Stevensville District. Therefore the campsite closures may have discouraged visitors from using the Big Creek Canyon.

Another rationale, which was often implied rather than expressed, was "We can get away with it; no one is going to stop us." In more cases than not, visitors were able to camp in closed areas and escape any consequences from the Forest Service. The Wilderness Ranger did catch four groups in the act of camping on closed areas. This is 27 percent of the groups that were observed camping on closed areas. One citation was written by the Wilderness Ranger. Because the Wilderness is defined as an area having opportunities for solitude and unconfined recreation, visitors in a wilderness setting are isolated from the view of other people, and therefore in an unfettered environment. This may contribute to deviant or depreciative actions.

The most commonly heard rationale was, "We won't cause any damage, just us for one night." This is the individual saying that his actions will not affect other people. The fundamental problem is that when many individuals take this point of view, the damage becomes multiplied several times. Then the effect of "just camping one night" will be substantial. This is a fundamental problem in any public land management, and has been described as the "tragedy of the commons" (Hardin 1968). Basically on the "commons" or publicly owned property, an individual has the opportunity to make a gain from a small loss to many others. Individuals can abuse the wilderness without clearly damaging other people because the wilderness is publicly owned and managed.

In summary, the preceding discussion has been speculation on the causes of noncompliance with camping regulations. There has not been any cause and effect relationship established by this study. The major information gained from this study is that 16 percent of the groups to Big Creek Lake camp in closed areas, and that there is a correlation between travelling with horses and camping in closed areas.

CHAPTER V

ECOLOGICAL RECOVERY ON THE BIG CREEK LAKE CAMPSITES

Methods

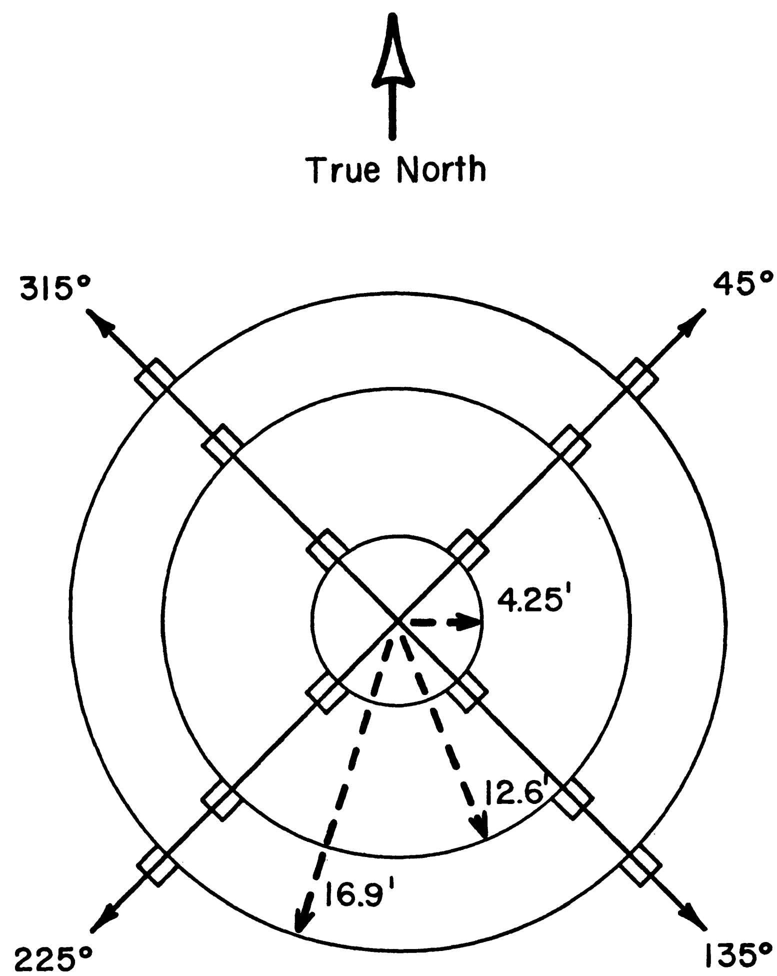
Field Methods

The campsite ground cover and the natural ground cover were studied around Big Creek Lake during the summer of 1977. Campsites were recognized by the presence of a fire ring and a flat area for a tent pad. Some of the campsites had been inventoried by a Forest Service use-impact study (Lucas 1975).

Six natural areas were selected as controls. These had a large enough flat area for a tent and fireplace but had not received use. Unfortunately, most of the areas suitable for camping had already been chosen and used as campsites. This meant that the controls often had a slightly steeper slope or more of a brush cover than the areas that were selected for camping. However, these controls provide the best comparison for investigating the effects of campsite development.

Ground cover on campsites and control areas was studied in one meter square plots laid out in a systematic pattern (see Figure 7). The pattern follows the Forest Service use-impact study (Lucas 1975), and a study by Frissell (1973). In this procedure, the campsite center was selected visually as the center of impact. Then plots were laid out on transects directed 45°, 135°, 225°, and 315° from true

Figure 7. Plot Placement for Ground Cover Sample



Transect lines on which plots are placed.

Plot.

Distance from campsite center.

north. Three plots were placed on each transect, 1.3, 3.8, and 5.1 meters (4.25, 12.6, and 16.9 feet) from the center. This systematic procedure was developed because it: a) sampled a gradient from the center of the campsite to the outside, b) provided camera angles, c) the four plots on each radius represent a 10 percent sample of the area enclosed by that radius, and d) the three plots on each transect represent a 10 percent sample of the quarter of the circle in which the transect is placed. Therefore, parts of the circular area could be eliminated from the analysis (if for example the part falls on the surface of a lake), and the remaining plots would still sample 10 percent of the remaining area.

Within each plot, the area covered by bare soil, organic litter, vegetation, and individual plant species was estimated by canopy coverage classes (Daubenmire 1959). The cover of different grass species was lumped into one category, Gramineae. Also the cover of different *Carex* and *Juncus* species was lumped into one category *Carex-Juncus*. On the campsites, these graminoids were often so damaged that identification was impossible. Individual graminoid species were identified outside the plots and are listed in Appendix 5.

Plants were collected and identifications verified by Peter Stickney of the U.S. Forest Service Forestry Sciences Lab in Missoula, and Klaus Lackschewitz of the Botany Department, University of Montana. A voucher collection is housed in the Botany Department Herbarium, University of Montana.

The different ground cover categories overlapped in the plots. Therefore the ground cover measurements were not mutually exclusive and the total measurement of ground cover per plot often exceeded 100 percent. For example, the canopy coverage of individual plant species overlapped and sometimes plant cover overlapped bare soil. This latter case was measured as both bare soil and plant cover. Bare soil was defined as soil without a surface cover of organic litter, rocks, logs or low growing plants, but it could be covered by shrub leaves.

Additionally bare rock and logs made up some of the ground cover of the campsites, so the total measurement of ground cover per plot did not always add up to 100 percent.

Trend Study from U.S. Forest Service Slides

Researchers working for the Wilderness Management Project of the U.S. Forest Service Forestry Science Lab have taken photographic slides of the ground cover of some of these campsites, as part of a larger use-impact study (Lucas 1975) (Fig. 8). The photographic slides were taken in 1975, 1976, and 1977 of 125 of the same plots used in the field work of this study (Fig. 7). However, since the slides could be viewed in the laboratory without constraints on time, a different form of measurement was used. The slides were projected on a 100 point grid, and the number of points that covered green vegetation were counted. This number represented the percent cover of vegetation within the plots. The other ground cover characteristics (eg. bare soil, organic litter layer, individual plant species) were not measured from the slides.

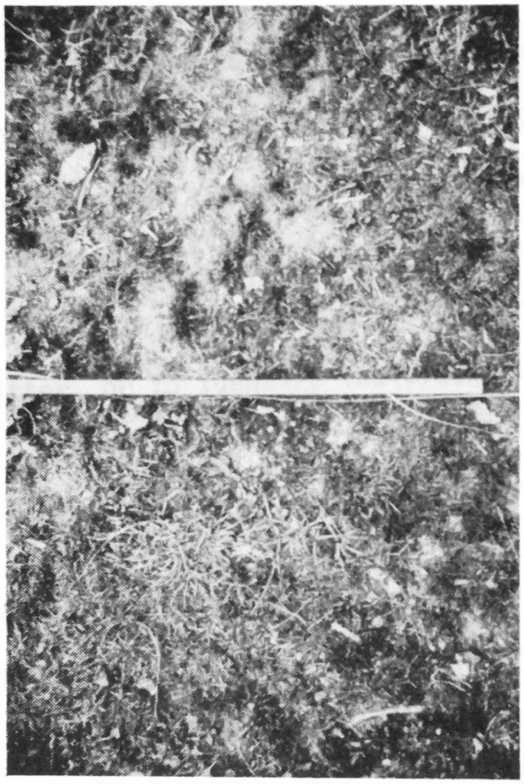
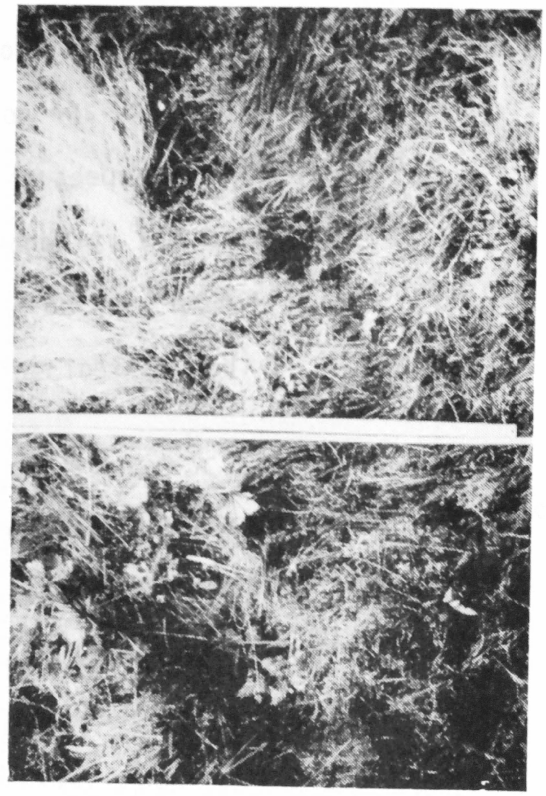
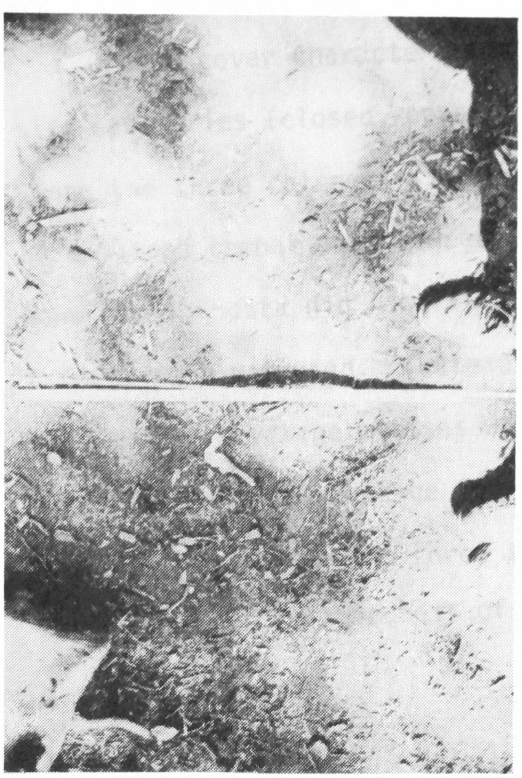
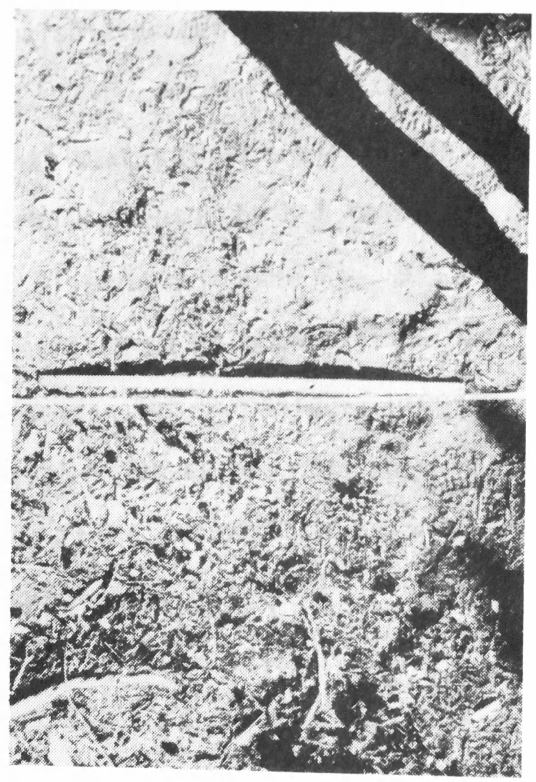
Plot on closed campsite number 3. Photograph taken in August, 1975.

Same plot on closed campsite number 3, two years later (August, 1977). Plants are *Rumex acetosella*.

Plot on closed campsite number 5. Photograph taken in August, 1975.

Same plot on closed campsite number 5, two years later (August, 1977). Plants are grasses, sedges, and *Boykinia major*.

Figure 8. Vertical photographs of ground cover taken by Forest Service research technicians. Reprinted from color transparencies.

This was because only the highest regime or level of cover could be measured from the slides. Since vegetation was usually the highest level of cover, vegetative cover could most adequately be measured, while the other covers were obscured. Secondly, the quality of the slides made it impossible to differentiate between bare soil and organic litter, or to identify individual plant species (Fig. 8).

Analysis

Ground cover characteristics were analyzed to describe the differences between the closed campsites, open campsites, and natural areas. Plant species with a grater than 1 percent average cover or a greater than .10 average frequency were used in the analysis. Percent ground cover was averaged for each site by using the mid-points of the coverage classes. The coverage classes, their percent ranges, and midpoints are listed in Table 3.

Ground cover characteristics were also averaged within the three site categories (closed, open, natural). Averages were then compared among the three categories. The original statistical analysis was to be a paired comparison between the averages, tested by a t test. However, the data did not fit a normal distribution (see Fig. 9), so t tests were not used. Instead the distribution of observations over the percent coverage classes were compared. The "Crosstabs" program of the Statistical Package for the Social Sciences was used to compare distributions among the three site categories and differences were tested using a χ^2 goodness of fit test (Nie et al. 1975).

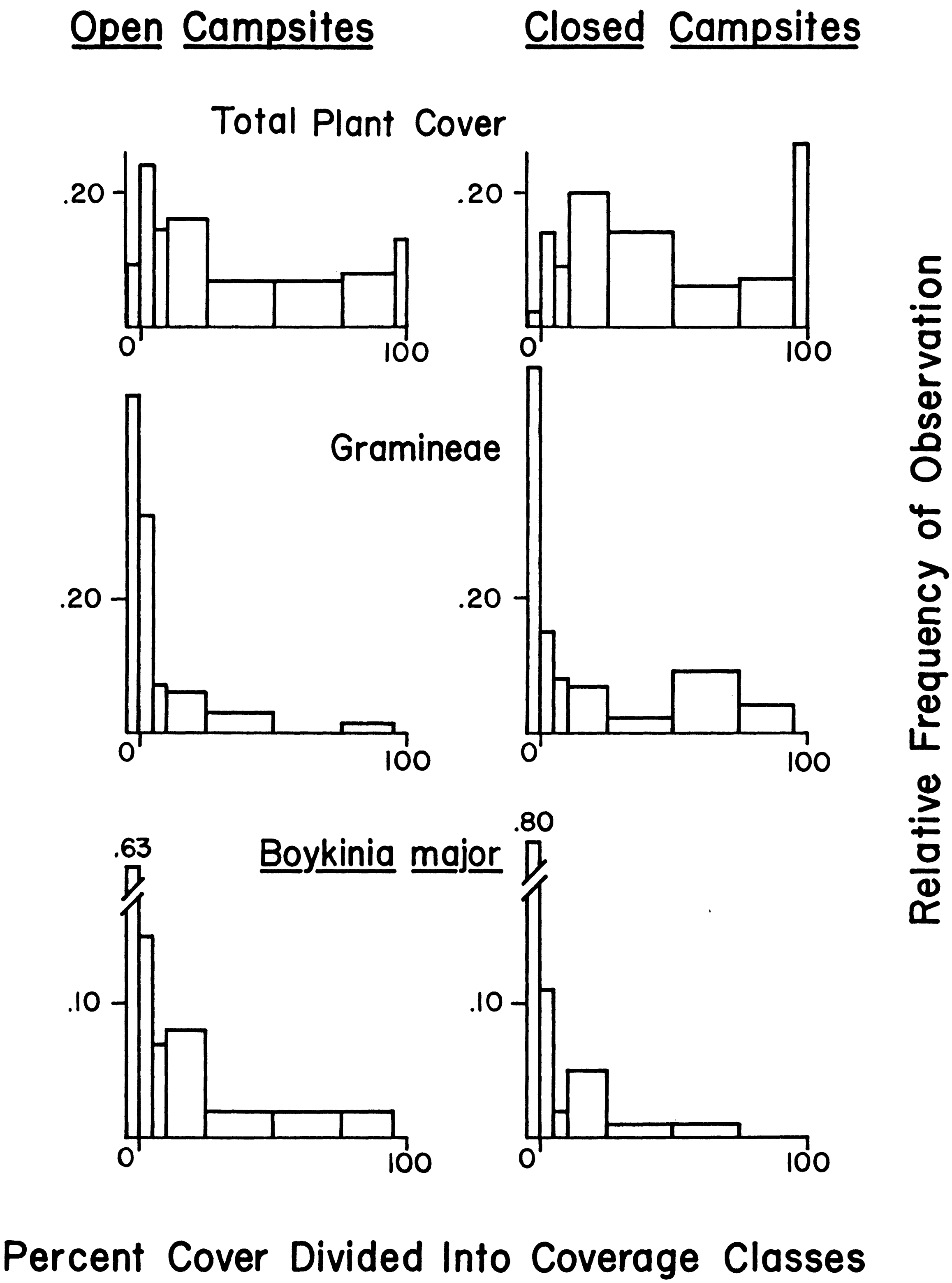
Table 3. Coverage classes used in the measurement of ground cover characteristics. Based on Daubenmire (1959) and Pfister et al. (1977)

Coverage Classes	Percent Range	Midpoint (%)
T	0-1	.5
1	1-5	3
2	5-25	15
3	25-50	37.5
4	50-75	62.5
5	75-95	85
6	95-100	97.5

Frequencies of individual plant species were averaged within the three site categories (i.e., closed, open, natural). Average frequencies were then compared between the natural and open campsites, and between the closed and open campsites. Differences in average frequencies were assigned 95 percent confidence intervals using the normal Z variable, since the sample sizes were 84 plots for closed campsites and 96 plots for open campsites.

During the analysis, it became evident that the campsites were set on a variety of vegetative habitats, and some of the differences attributed to management action might be caused by site differences. To remedy this, five of the closed campsites, two of the natural areas, and two of the open campsites were selected as having similar site

Figure 9. Plant Cover on Campsites and a Comparison of Plant, Gramineae, and <u>Boykinia major</u> Cover Between Closed and Open Campsites.



characteristics such as tree canopy, soils, and amount of use. Cover percentages and plant frequencies were then averaged, and comparisons were made between the closed and open campsites within this subsample of campsites.

Trend Study

Two year changes in plant cover were calculated by pairing observations from 1977 slides with 1975 observations. A difference value (D) was calculated by subtracting the 1977 observation from the 1975 observation (Fig. 8). The D values were averaged within the categories of open campsites or closed campsites. The D values were tested by use of the Wilcoxon Signed Rank test (Conover 1971), to determine if there was a significant change in plant cover over the two-year period on either the closed or open campsites. The method essentially tested whether there tended to be more plant cover in 1977 than in 1975.

Results

Number of Campsites

Twenty-two campsites were discovered around Big Creek Lake (Fig. 10). Seven of these campsites are located within closed areas. Eight are located outside of the closed areas and appear to have been well established in 1973 when the closures were initiated.

The remaining seven campsites appear to have developed since 1973. This assumption is based on three factors. First, six of these seven

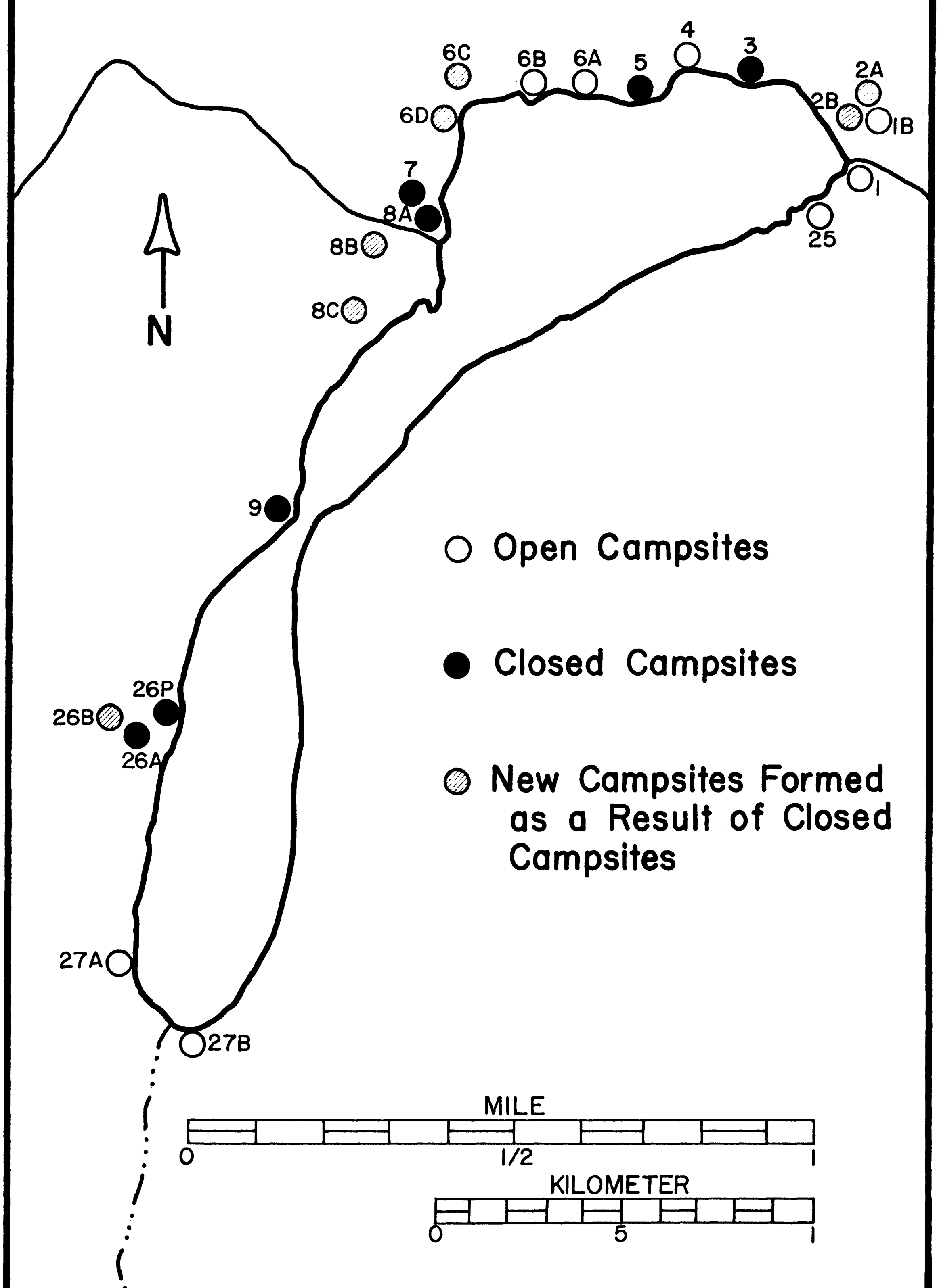


Figure 10. Big Creek Lake Campsites

campsites were not identified by the Forest Service Use Impact Study researchers in 1975, but were later identified (Lucas 1975). These campsites apparently developed after 1975, or at least became more visible as campsites. The second reason for making this assumption is the location of these campsites. Five are located in proximity to closed areas but are less preferred sites. They are either smaller, on steeper slopes, farther from water, or farther from a view of the lake. These campsites apparently developed as alternative sites to the closed, or most preferred campsites. The third reason for making this assumption is related to the trees surrounding the campsites. Five of the campsites are set in denser forest than the majority of the campsites, but have fewer cut and damaged trees. This could suggest differences in the users of the campsites, but it is more likely that these campsites are more recently formed and have not yet been used by campsers who cut and damage trees.

Comparison of Open Campsites with Natural Areas

Because of the predominance of steep slopes around Big Creek Lake, the campsites are associated with topographical features that provide a flat and open area for camping. Most campsites are on the lower slopes of avalanche slide areas or on flat bedrock extrusions. A few are set in small clearings in *Abies lasiocarpa-Picea engelmanii* forest. Most of the campsites have a southern or eastern aspect, are all on slopes less than 30 percent, and occur at elevations ranging from 5865 to 5960 feet.

The tree overstory of the campsites and natural control areas include Abies lasiocarpa, Picea engelmannii, Pseudotsuga menziesii, and Pinus contorta. The dominant species are Abies lasiocarpa and Picea engelmannii.

The lower plant layers on the natural sites averaged 87.5 percent cover. This consisted primarily of grasses, Xerophyllum tenax, Polygonum phytolaccaefolium, Vaccinium globulare, and Menziesia ferruginea. The ground cover on natural sites is listed by major species in Appendix 6. Average cover of organic litter was 92.2 percent and bare soil covered only 1.1 percent of the natural sites.

Average values from the campsites are misleading because they were rarely observed. Instead the plots tended to contain 0 or 100 percent plant covers. Vegetation on campsites is highly clustered or clumped. Campsite use causes vegetation to be removed from some parts, but "islands" of vegetation survive around trees and brush. Dykema (1971) and Coombs (1976) also observed these bimodal or skewed distributions. Figure 9 shows the skewed distributions of plant cover and major plant species on Big Creek Lake campsites. This skewness made it inappropriate to compare means. Instead the author compared the distributions of observations over the coverage classes.

In general, the older established campsites, open to use, had less plant cover, less organic litter cover, and more bare soil than the natural areas (Table 4). There was 57 percent less plant cover on campsites than on natural areas.

Table 4. Comparison of Open Campsites with Natural Areas

	On All Open Campsites and Natural Areas		On the Subsample of Selected Sites	
Decreasers	Cover Differences	Frequency Differ-ences	Cover Differences	Frequency Differ-ences
Vegetation	-57.2*		-65.2*	
Natural Litter	-29.1*		-32.0*	
Polygonum phytolaccaefolium	- 9.4*	-.42*	-19.9*	-.25
Gramineae	- 8.9*	.13	-27.0	-.13
Menziesia ferruginea	- 7.7*	-.13*		
Vaccinium globulare	- 7.3*	-.22*		.04
Xerophyllum tenax	- 6.1*	-.13*	1.3	.04
Epilobium angustifolium	- 4.8*	-.10	-15.0*	-.58
Athyrium filix-femina	- 4.5	-.08	- 3.0*	-.46
Aster foliaceus	- 3.7*	-.32*	-11.2*	-.88
Senecio triangularis	- 1.4*	-.11		-.08
Montia cordifolia	- 1.2*	-.41*	- 1.1*	-.87
Agastache urticifolia	- .7*	-.12*	- 2.2*	-.37
Polemonium pulcherrimum	- .1	-.10*	- .8	-.25
Stellaria crispa	- .1*	-.15*	- .4*	-.37
Smilacina stellata	- .1	-.05	- .4*	-.33
Increasers and Invaders				
Bare Soil	12.9*		13.9*	
Poa annua	1.7*	.20*	6.7*	.66
Boykinia major	.5*	.17*	4.9	.05
Spergularia rubra	.4*	.08*	.4*	.33
Trifolium repens	.2	.06*	.9	.16
Rumex acetosella	.1*	.10*	.3*	.41

* Denotes statistical significance at a 95% confidence level.

The plant composition of the campsites differed from the surrounding natural areas. The loss of some plants on the used areas, and the reduction in abundance of others were obvious. In this study, plants that had less cover and less frequency (with at least a 95 percent confidence level) on campsites were labeled decreasers. Fourteen plants were so identified (Table 4). The major decreasers were; the tall forbs; Aster foliaceus, Epilobium angustifolium, Polygonum phytolaccaefolium; and the woody shrub, Menziesia ferruginea.

Plant species that have a greater cover or a greater frequency on campsites than on control sites have been labeled increasers or invaders (Table 4). Invaders are plants which are not present in the natural plant community, but appear with recreational use. Increasers or invaders were determined in this study on a 95 percent confidence level. Only one plant species, Boykinia major, was identified as an increaser, present in the natural plant community and increasing in abundance with recreational use. Four invaders were identified: Poa annua, Rumex acetosella, Spergularia rubra, and Trifolium repens. Other plants, not abundant enough to be included in the analysis but generally recognized as introductions into the Selway-Bitterroot Wilderness, are Plantago major, Plantago lanceolata, and Taraxacum officinalis.

Comparison of Closed Campsites with Open Campsites

The closed campsites were more similar to the open campsites than to the natural areas. Closed campsites had 14.7 percent more plant cover than the open campsites, but did not have substantially different amounts of organic litter or bare soil (Table 5, Fig. 11). This 14.7 percent difference in green plant cover was determined by the total analysis that included all seven closed and all eight open campsites. In the subsample of campsites selected for similar site characteristics, there was only a difference of 1.9 percent, and this was significant at the 85 percent level. However, eight individual plant species showed more cover on closed sites while only two showed less.

The major increaasers on closed sites were the graminoid categories, Gramineae and Carex-Juncus species (Table 5). The grasses showed 7.9 percent more cover on the closed campsites, and the Carex-Juncus species showed 5.4 percent more cover. The Carex-Juncus difference of 5.4 percent was determined by the analysis of all closed and all open campsites. In the subsample of campsites, there was 1.6 percent more Carex and Juncus species on open campsites than on the closed campsites. This discrepancy is probably based on the exclusion of closed campsite #9, a site with an abundance of Carex and Juncus species, from the subsample (Appendix 6). The Carex and Juncus species were more frequent on closed campsites than on open campsites, so were identified as increasers. The other plants identified as increasers on closed campsites were; the exotic, Rumex acetosella; the smaller forbs, Montia cordifolia and Polemonium pulcherrimum; the tall forbs, Polygonum phytolaccaefolium and Senecio triangularis; and the shrub, Vaccinium globulare (Table 5).

Figure 11. Comparison of Plant Cover, Natural Litter Cover, and Exposed Soil on Natural Areas, Open Campsites, and Closed Campsites.

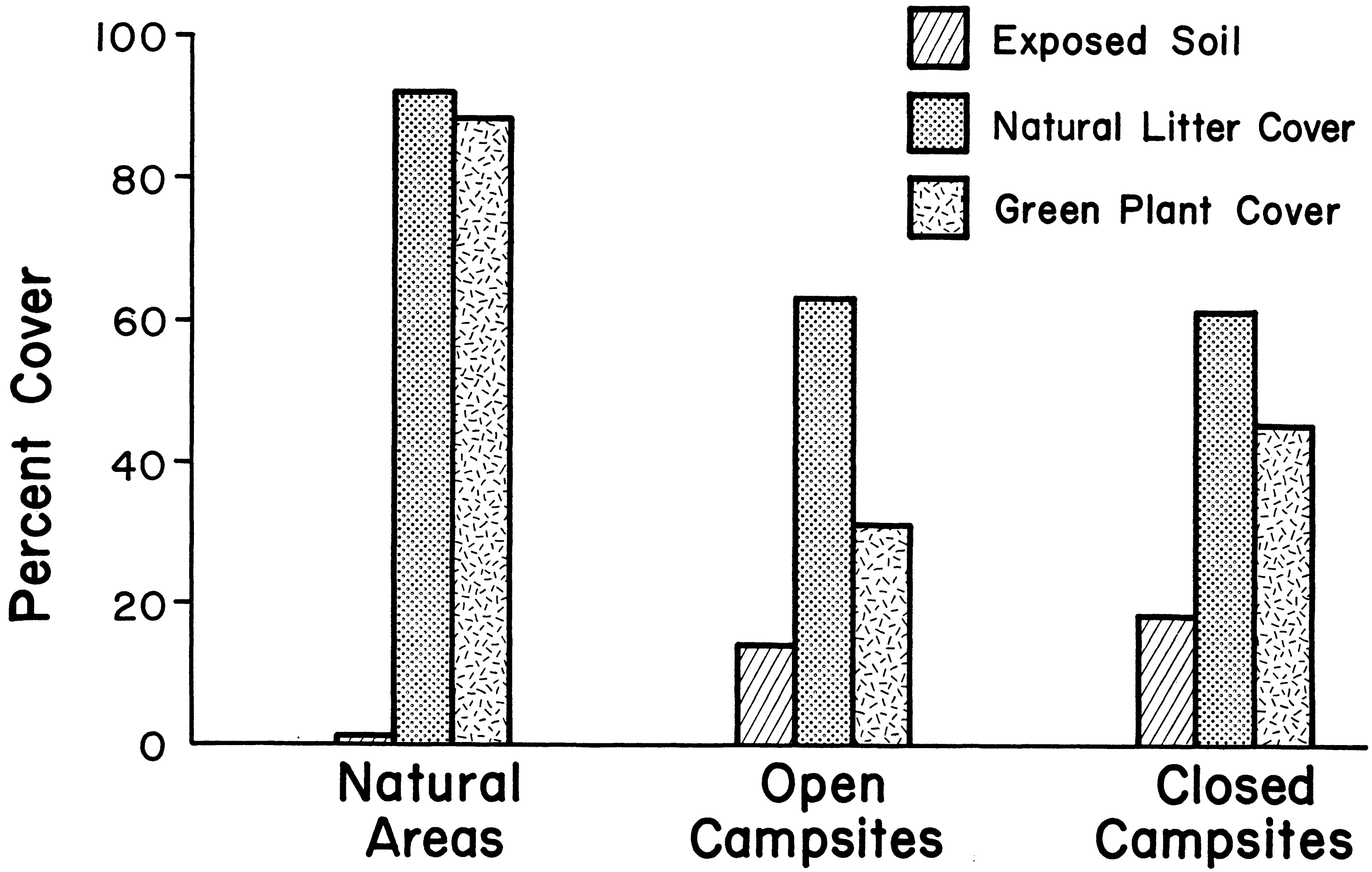


Table 5. Comparison of Closed Campsites with Open Campsites

Increasers on Closed Campsites	On All Closed and Open Campsites: Cover Differences	On All Closed and Open Campsites: Frequency Differences	On the Subsample of Selected Closed and Open Campsites: Cover Differences	On the Subsample of Selected Closed and Open Campsites: Frequency Differences
Vegetation	14.7*		1.9	
Gramineae	7.9*	.04	6.4*	-.24
Carex-Juncus species	5.4*	.70	-1.6*	.46
Menziesia ferruginea	3.8	.04	5.3	.08
Polygonum phytolaccaefolium	2.0*	.08*	2.9	.14
Vaccinium globulare	1.7*	.03	2.7	.09
Rumex acetosella	1.1*	.34*	.8	.11
Smilacina stellata	.6	0	.5	.01
Spergularia rubra	.5	.08	.4	-.15
Polemonium pulcherrimum	.3*	.19*	.5*	.27
Montia cordifolia	.3*	.15*	.7	.08
Mitella breweri	.2	.02	.1	.13
Trifolium repens	.1	.07	-.5	-.03
Senecio triangularis	-.1	.10	.9*	.30
Stellaria crispa		.06		.10
Decreasers on Closed Campsites				
Boykinia major	-3.1*	-.16*	-2.5	+.06
Xerophyllum tenax	-1.5	-.05	.8	-.05
Poa annua	-.8*	.07	-5.5*	-.38

*Denotes statistical significance at a 95% confidence level.

Trend Study

Difference values (D) were estimated by subtracting the plant cover observed in 1975 photographic slides from the plant cover observed on 1977 slides (Fig. 8). Fifty-nine plots on closed campsites were investigated to calculate closed D values, which ranged from -21 to +52 percent. The D values were averaged to calculate a difference of 8.8 percent on closed campsites, i.e., 1977 plots had an average of 8.8 percent more vegetation than the 1975 plots.

The D values were tested by use of a Wilcoxon Signed Rank Test. The test determines if there tended to be more plant cover in 1977 than in 1975. The average difference was 8.8 percent and it was significant at the 80 percent confidence level.

Sixty-six plots on open campsites were investigated to calculate open D values, which ranged -20 to +39 percent. The D values, when averaged indicated a zero percent change on open campsites; i.e., the 1977 plots tended to have the same percent plant cover, 38 percent, as the 1975 plots.

Discussion

Natural Plant Communities

The most difficult task of this study was to describe the original plant communities that occurred around Big Creek Lake, before human use affected them. What really are the "natural conditions" at Big Creek Lake? One complication in defining the natural conditions is that the

Lake has been used for perhaps thousands of years as a camping and hunting area by Native Americans and white settlers entered the area probably a hundred years ago. As a result it is impossible to determine the age of the campsites. Another complication is the lack of literature on natural communities of the Bitterroot Canyons. Pfister et al. (1977), Habeck (1972), Larsen (1930), and Leiberg (1900) have described the forest types in the Selway-Bitterroot Wilderness, but their information is not specific enough for a campsite study. Therefore, a description of the natural plant communities was developed from six control sites.

Natural areas, that have potential for campsite development, are in open forest stands dominated by Abies lasiocarpa and Picea engelmannii. Major understory plants include Tiarella trifoliata, Xerophyllum tenax, Vaccinium globulare, Smilacina stellata, Clintonia uniflora, and Menziesia ferruginea. The open areas have tall herbs and grasses. Polygonum phytolaccaefolium, Epilobium angustifolium, Valeriana stichensis, Aster species, Solidago species, Senecio triangularis, and some Umbelliferae are the major tall forbs and Elymus glaucus, Deschampsia cespitosa, and Trisetum cernuum are the dominant grasses (Appendix 6).

Effects of Campsite Development

The effects of camping are pronounced. The native vegetation is trampled and grazed, so that it is removed completely or only the most resistant part survives. Campers gather sticks and logs for firewood, and scrape away conifer needles, dried leaves, pine cones, and other organic materials for fire places and tent pads. The constant trampling of camper feet compacts the soil and eventually can lead to erosion. Human waste and horse manure are introduced in the area and may damage water quality. Trees are damaged by exposed roots, stock tying, axe hacking, and bough cutting. At Big Creek Lake, many of the native plants are reduced in cover (e.g., *Aster foliaceus*, *Epilobium angustifolium*, *Polygonum phytolaccaefolium*, *Menziesia ferruginea*, and Gramineae species). A few plants increase in cover because of campsite development (e.g., *Boykinia major*). Other plants invade the area because of campsite development, (*Poa annua*, *Rumex acetosella*, *Spergularia rubra*, and *Trifolium repens*).

Effects of Closing Campsites

The effects of closing campsites are less pronounced than the effects of campsite development. At Big Creek Lake, there have been some changes after five years of closure. There appeared to be no change in the amount of organic litter cover or bare soil, but a pronounced increase in the amount of plant cover; closed campsites showing an average 14.7 percent more vegetation cover than open sites. Over two years, there was an increase of 8.8 percent in the amount of plant cover. These two increase values can be averaged for a rate of increase of 3.6 percent more plant cover per year. If this is assumed to be a constant average rate over long periods of time, then predictions can be made on the length of time required to restore specific amounts of plant cover to the campsites. For example, approximately twelve years may be required to restore a natural amount of plant cover to the presently closed campsites. Another illustration is if presently open campsites were closed, it would require sixteen years to restore a natural amount of vegetation. The reader should keep in mind that these predictions are based on averages: which conceal a great deal of variation; assume a constant rate of revegetation, and make no consideration of the composition of this vegetation cover.

To take into account one of these factors, weather conditions were investigated, using the records of three local weather stations. Temperature and amount of precipitation were averaged within the growing season (June to September), and then compared with conditions over a ten year period (1966 to 1976). The average growing season temperatures during the study period were not substantially different from the normal, generally cooler. Precipitation varied greatly from year to year, from 42 percent less than the ten year average in 1973 to 25 percent more than the ten year average in 1976. If the annual differences from the ten year average are added they tend to even out, showing that the study period was slightly drier than usual.

The composition of the vegetation increase on Big Creek Lake campsites was analyzed by comparing the plants on closed campsites with those on continuously disturbed campsites. The greatest difference in cover was discovered to be in the graminoid cover, the Gramineae and Carex-Juncus species. Closed campsites had 13.3 percent more cover of graminoids than the open campsites.

Polygonum phytolaccaefolium, a tall forb, also had more cover on closed campsites than on open campsites. It grows on steep rocky slopes in the Selway-Bitterroot. This forb had a cover of 2 percent more on closed campsites than on open sites. Another tall forb, Senecio triangularis was a significant increaser on closed campsites in the subsample of campsites selected for similar site characteristics.

On closed campsites, the shrub, Vaccinium globulare showed increases of 2 percent over all and 3 percent in the subsample. This appeared not to be the result of new plants, but the recovery of old plants from trampling and perhaps stock browsing. Menziesia ferruginea showed increases too, but not at a significant level.

The European weed, Rumex acetosella was doing well on dry open expanses where past horse use was evident. It was probably introduced in horse manure and horse feed and is increasing in abundance as a result of the closures. There was 1 percent more Rumex acetosella cover on closed sites. Another European weed, Spergularia rubra, showed increases in frequency and cover, but not at a significant level.

The small native forbs, Montia cordifolia and Polemonium pulcherrimum showed slightly more cover on closed campsites, .3 percent and .2 percent respectively. Although small, these differences were statistically significant. other small forbs that showed increases but not at a significant level were Stellaria crispa and Mitella breweri.

Boykinia major and *Poa annua* showed decreases in abundance within the closures and increases on open campsites. Therefore, it appears these plants are favored by recreational use. *Poa annua* is probably introduced by horse manure and horse feed and is resistant to trampling damage. *Boykinia major* is a rhizomatous herb that is native to the wet areas around Big Creek Lake. Rhizomatous plants have been shown to be more resistant to trampling (Helgath 1975). In addition, recreational use may damage other plants and reduce competition for the *Poa annua* and *Boykinia major*.

In summary, the ecological effects of closing wilderness campsites are first characterized by an increase of plant cover. The reestablishment of a soil covering of natural litter may take longer. The increase in plant cover was dominated by graminoids, but many other types of plants showed increases. Plant response to closures appears to be highly variable to species, as is plant response to recreational trampling. Finally, the ecological effects of closing wilderness campsites probably are dependent on many factors, including the success of keeping campers off the sites, the ecological characteristics of the sites, annual weather conditions of temperature and precipitation, and the length of time the campsites are closed.

CHAPTER VI

SUMMARY AND CONCLUSIONS

The Problem and Objectives

Wilderness and park managers are faced with a problem. With increasing numbers of visitors, it is becoming more difficult to preserve wilderness and park areas as natural areas. One of the tools available to wilderness and park managers is the closure of damaged sites.

The purpose of this study was to examine the effects of closing wilderness campsites on Big Creek Lake in the Selway-Bitterroot Wilderness. Visitor reaction and plant response were measured. Additionally, Forest Service Districts and Park Service offices were surveyed in the Northern Rockies to describe the extent of this management tool.

Summary

Survey of Wilderness Management Offices in the Northern Rocky Mountains

There are not many current campsite closure programs in the Northern Rocky Mountain Wilderness Areas. Only 15 (30%) of the 50 wilderness management units have closed campsites. However, there is potential for future campsite closures since 10 percent of the 50 offices are considering future closures.

Compliance of wilderness visitors was not perceived as a problem by wilderness managers in the Northern Rocky Mountains. Most of the managers estimated compliance as close to 100 percent. This was especially true when visitors were contacted personally by district office employees, portal assistants, or wilderness rangers.

Natural recovery on closed campsites was most often rated "fair", and tended to the poor end of a recovery scale. The majority of the closed campsites receive no cultural treatments, such as scarification, seeding, or fertilizing.

Visitor Use of the Big Creek Lake Campsites

Sixteen percent of the visitor groups camped on closed sites, 67 percent in open established campsites, and 17 percent in previously unused natural areas. The visitor groups who chose to camp in closed areas can not be placed in a single category. However, groups that travelled with horses were more likely to camp in closed areas. Although the majority of backpackers and horseback riders complied with the closures, only 11 percent of the backpackers camped in closed areas, while 40 percent of the horse users did so.

Ecological Recovery of the Big Creek Lake Campsites

Closed campsites had about the same amount of bare soil and natural litter cover as the open campsites, but had 14.7 percent more green plant cover than the open campsites. The plant cover on closed campsites had more grasses and sedges than the open campsites. Six other plant species showed more cover on closed campsites than on open campsites, and two plant species showed less cover on closed campsites. Plant response to the closures was highly variable by species.

After two growing seasons, green plant cover increased 8.8 percent on the closed campsites. Assuming that this is a constant rate, it will take approximately nine more years to regain a natural amount of green plant cover on the presently closed campsites.

As green plant cover increased on the closed campsites, seven new campsites developed in addition to the original 15.

Management Implications

This study has produced some encouraging results; there is a recovery of ground cover vegetation on closed campsites (Fig. 12). However, this recovery must be qualified by 1) a conflict situation with some visitors who camp on the closed areas, 2) ecological damage occurs elsewhere with the formation of new campsites, and 3) recovery is slow relative to the time it takes for damage to occur.

Any attempt to preserve absolutely pristine plant communities is unreasonable, since any level of use will alter the composition of original plant communities. Instead, managing agencies should define the desired conditions on campsites. Frissell and Stankey (1972) proposed a management framework defining "limits of acceptable change (LAC)". When a change occurs that exceeds a limit of acceptable change, then a management action is called for, perhaps a closure. However, managers should remember that there are other actions, besides closures that may be more efficient in accomplishing stated objectives. In the literature review of this paper, the author set forth five approaches for visitor

Closed campsite number 5. Photograph taken in July, 1973 by Claude Coffin, then with the Stevensville District of the U.S. Forest Service.

↓

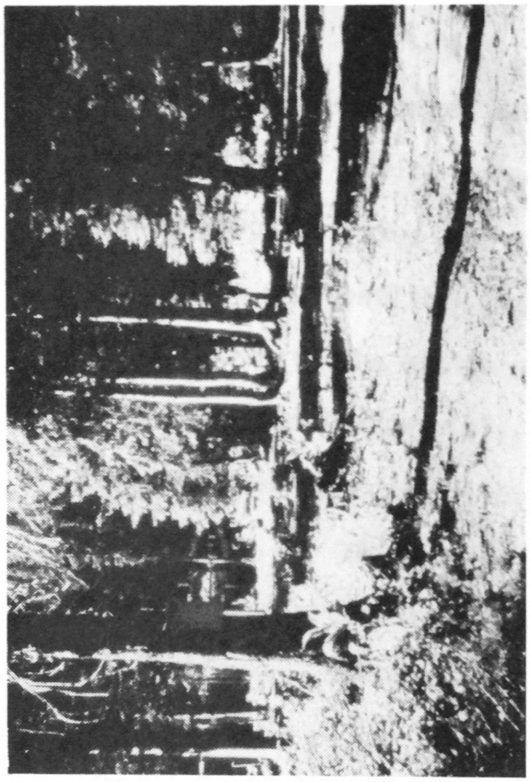
Same campsite, four years later (August 1977). Photograph taken by Beth Ranz. Plants are *Veratrum viride*, *Senecio triangularis*, *Boykinia major*, *Spiraea densiflora*, *Sambucus racemosa*, *Amelanchier alnifolia*, *Agrostis alba*, and *Poa pratensis*.

Closed campsite number 9. Photograph taken in July, 1973 by Claude Coffin, then with the Stevensville District of the U.S. Forest Service.

↓

Same campsite, four years later (August 1977). Photograph taken by Beth Ranz. Plants are *Polygonum phytolaccaefolium*, *Veratrum viride*, *Trisetum cernuum*, *Deschampsia cespitosa*, *Carex microptera*, *Juncus mertensianus*, and *J. ensifolius*.

Figure 12. Photographs taken in 1973 and 1977 of the same campsites. Reprinted from color transparencies.



management. These were: dispersal of use; concentration of use; modification of use by information, education or regulation; limitation on the amount of use; and combinations of these approaches.

There are conflicts between some of these approaches now. A good illustration is the option of whether or not to designate wilderness campsites (see Chapter III). Another illustration is managers who are faced with an uneven distribution of use and ecological impacts in some areas. On the Stevensville District, wilderness managers are attempting to redistribute visitor use by providing information to the public of where heavily used areas are located. At the same time, closures restrict the public from problem areas, thus dispersing them to other areas. These two illustrations point out the conflict between dispersing use over a large area or attempting to concentrate it in a smaller area. Some managers might assume if use was light enough and spread over a large enough area, the environment would be resilient enough to "absorb" this use. However, past studies have shown that only a slight amount of camping pressure is needed to cause ecological change. This problem is compounded by slow recovery rates. If visitor use is merely dispersed from problem areas, ecological impacts are spread over a larger area. Visitor use can be dispersed from problem areas when use is controlled to prevent unacceptable levels of ecological change in other areas.

Campsite closures are appropriate when past damage has exceeded the "limits of acceptable change." On Big Creek Lake, large groups travelled with large numbers of horses, and caused a great deal of damage, exceeding the "limits of acceptable change". This past unique damage should never occur again, given current restrictions on group size and numbers of stock per party. Secondly, campsite closures may be appropriate on truly fragile sites.

When a campsite closure is necessary, there are some factors that must be considered.

1) If visitor use is restricted from some areas, it necessarily goes somewhere else. Big Creek Lake visitors are being restricted from the closed areas, so are creating new campsites. When an area is closed to camping use, alternative camping areas should be designated or total use should be limtied. Perhaps only half of the damaged campsites on a lake should be closed, allowing continued use on the already established, but open campsites. The problems with designating alternative campsites are these campsites are usually not preferred by the visitors, or are more difficult for the visitors to find. There is always the difficult problem of preserving, as much as possible, an unregulated and unrestricted wilderness experience.

2) Visitors should be well informed of the closures. Signs are a time worn technique used by the Forest Service and the Park Service. This is probably the best way of informing the visitor of what specific site is closed. However, problems arise when vandals tear down the signs on the closed areas. If closed sites are only checked once a month by management personnel, many well-intentioned, but uninformed

visitors will camp in the closed areas until new signs are installed. The survey of wilderness managers suggests that visitors are much more likely to comply with a restriction if they are personally contacted by a management employee. Therefore, agencies should have more employees making visitor contacts, enforcing campsite closures, and checking conditions on the closed campsites.

3) Changes on the closed campsites and on the surrounding area must be monitored. The management agency should follow a campsite closure with checks for new campsite development, recovery on the closed areas, and visitor conflict situations. These actions are necessary to insure that the site closures do not cause more problems than they are designed to solve.

4) There might be treatments that will speed up recovery on closed areas. Additionally, if visitor use is allowed to concentrate on certain camping areas, then the managing agency will have to know more about maintaining acceptable conditions on these camping areas. Most scientists concerned with wilderness issues would argue that certain cultural treatments are not appropriate in Wilderness Areas. For example, hardening, non-native plant seeding, fertilizing, and watering are not appropriate, and some are prohibitively expensive in wilderness areas. However, seeding with native plants, vegetative "plug" transplanting, and scarification could be appropriate and deserve further study.

Future Research

Sociological Research

This research was a case study of closing campsites on Big Creek Lake in the Selway-Bitterroot Wilderness and opens up new possibilities for research. Future research should determine if visitor response to campsite closures is the same in other parts of the country. Compliance with other outdoor recreation regulations deserves study too.

Sociological research should examine how best to improve visitor compliance with regulations, while still allowing visitors a chance to have an unconfined and wilderness experience. There is a basic lack of knowledge of how best to provide visitors with necessary information. How effective are signs, maps, brochures, management personnel, television advertisements, meetings with school groups, etc. in reaching potential visitors to the wilderness?

Sociological research should also seek to identify the causes of noncompliance with camping regulations. If these causes were understood, perhaps the management agencies could alter the causes and prevent the problem. For example, if the cause of noncompliance is a conflict situation between the management agency and local landowners, then the solution may be to try and improve relationships within the community.

Ecological Research

The rate of recovery on the Big Creek Lake campsites is dependent on ecological factors such as type of plant community, elevation, temperature, precipitation, the degree of damage, the success of keeping visitors off the sites, and soil properties. Future research should identify those factors that are most important for determining the rate of recovery. Then predictions can be made on the recovery rates at specific locations, based on the ecological factors of that area. This information would vastly improve the effectiveness of closing campsites. When the amount of time required for recovery is known, then better decisions can be made about the trade offs of closing campsites.

Future research should investigate ways of accelerating recovery on closed campsites. Otherwise, managers will have to accept the long time period needed for natural recovery. Reseeding with native plants, scarification, and vegetative "plug" transplanting could be ways of accelerating ecological recovery. The recovery of individual grass and sedge species needs further research because these plants could be valuable for reseeding of campsites.

In conclusion, the use of site closures does involve problems. More research is needed on how best to deal with environmental damage caused by recreational visitors, how to gain better compliance from wilderness visitors, and how to accelerate ecological recovery on wilderness campsites. With this information, the closure of damaged sites can be a more effective tool to preserve and provide for the recreational use of wildlands.

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Appendix 1

Compilation of Literature on Plant Response to Recreation

Source	Place	Technique	Increaser Plants	Decreaser Plants
Dale 1973	Madison Range Montana	Distance from trails	*Arnica latifolia* *Carex podocarpa* *Epilobium alpinum* *Erythronium grandiflorum* *Erigeron peregrinus* *Hieracium gracile* *Lupinus sericeus* *Poa pratensis* *Sibbaldia procumbens* *Trifolium parryi*	*Abies lasiocarpa* *Aquilegia flavescens* *Arnica cordifolia* *Epilobium agustifolium* *Phyllodoce empetriform* *Pyrola secunda* *Thalictrum venulosum* *Vaccinium membranaceum* *Vaccinium scorparium*
Dale and Weaver 1974	Northern Rocky Mountains	Distance from trails	*Carex podocarpa* *Geranium viscosissimum* *Lupinus sericeus* *Poa pratensis* *Pseudotsuga menziesii* *Sibbaldia procumbens* *Taraxacum officinale* *Trifolium repens*	*Abies lasiocarpa* *Aster conspicuous* *Clematis columbiana* *Physocarpus malvaceus* *Pyrola secunda* *Symphoricarpos alba* *Thalictrum venulosum*
Helgath 1975	Selway-Bitter-root Wilder-ness	Distance from trails	*Achillea millefolium* *Arnica latifolia* *Claytonia* spp. *Coptis occidentalis* *Dactylis glomerata* *Lupinus* spp. *Menziesia ferruginea* *Pedicularis* spp. *Phyllodoce empetriformis* *Plantago* spp. *Pterospora andromedeae* *Pyrola* spp. *Rhododendron albiflorum* *Ribes* spp. *Rosa* spp. *Trifolium repens* *Valeriana sitchensis* *Xerophyllum tenax*	*Anemone piperi* *Carex geyeri* *Dodecatheon* spp. *Fragaria* spp. *Galium triflorum* *Linnaea borealis* *Lomatium sandbergii* *Phlox* spp. *Trillium ovatum* *Vaccinium scorparium* *Viola* spp.

Source	Place	Technique	Plant Increasers	Plant Decreasers
Hartley 1976	Glacier Park, Montana	Distance from trails	*Carex nigricans* *Phleum alpinum* *Senecio resedifolius*	*Abies lasiocarpa* *Agrostis thurberiana* *Anemone occidentalis* *Antennaria alpina* *Arnica alpina* *Arnica latifolia* *Castilleja miniata* *Claytonia lanceolata* *Erigeron peregrinus* *Erythronium alpinum* *Erythronium grandiflorum* *Hieracium gracile* *Hypericum formosum* *Luzula wahlenbergii* *Mitella breweri* *Oxyria digyna* *Parnassia fimbriata* *Pedicularis bracteosa* *Pedicularis groenlandica* *Phyllodoce empetriformis* *Phyllodoce glanduliflora* *Polystichum* spp. *Senecio triangularis* *Trisetum spicatum* *Valeriana sitchensis*
Coombs 1976	Big Horn Crags, Idaho	Campsite Comparisons	*Antennaria lanata* *Castilleja rhexifolia* *Chionophilia tweedyi* *Erigeron peregrinus* *Juncus parryi* *Lewisia pygmaea* *Pedicularis contorta* *Phyllodoce empetriformis*	*Arnica latifolia* *Carex rossii* Mosses *Luzula hitchcockii* *Vaccinium scorparium*

Source	Place	Technique	Plant Increasers	Plant Decreasers
Ranz 1979	Selway-Bitterroot Wilderness Montana	Campsite Comparison	*Boykinia major*	*Agastache urticifolia*
			Epilobium alpinum	*Aster foliaceus*
			Plantago spp.	*Athyrium filix-femina*
			Poa annua	*Epilobium angustifolium*
			Rumex acetosella	Gramineae
			Saxifraga ferruginea	*Menziesia ferruginea*
			Spergularia rubra	*Polemonium pulcherrimum*
			Taraxacum officinale	*Polygonum phytolaccaefolium*
			Trifolium repens	*Senecio triangularis*
				Smilacina stellata
				Stellaria crispa
				Vaccinium globulare
				Xerophyllum tenax
				Montia cordifolia

Appendix 2. Cover Letter and Questionnaire.

Beth Ranz
School of Forestry
University of Montana
Missoula, Montana 59801

August 25, 1977

I am a graduate student at the University of Montana, concerned with wilderness management. I am working in cooperation with the Forest Service Forestry Sciences Lab in Missoula, the Stevensville District of the Bitterroot National Forest, the Wilderness Institute at the University of Montana and the Montana Forest and Conservation Experiment Station.

My research is an evaluation of the policy of closing wilderness campsites, when overuse has resulted in damage to vegetation and soils. The intent of the closures is to restore the campsites to more natural conditions. My study area is the portion of the Selway Bitterroot Wilderness administered by the Stevensville District, Bitterroot National Forest, where a number of campsites have been closed to overnight camping and livestock use for five years.

To place my research in a broader perspective, I would like to survey wilderness managers concerning their campsite closure policies and identify common problems. Enclosed is a questionnaire, which should take only a short time to complete. Please return it to the above address as soon as possible. Responses received after October 30, 1977 may not be included in the analysis.

If you would like to know the results of this survey, please so indicate on the bottom of the questionnaire. Thank-you for your cooperation.

Sincerely,

Beth Ranz

I.

From: Beth Ranz
School of Forestry
University of Montana
Missoula, Montana 59812

Questionnaire Concerning Wilderness Campsite Closures

1. Do you administer any area which is classified or being considered as wilderness according to the Wilderness Act of 1964?

yes ___ no ___

If yes, what is the name of the area?

____

2. On these wilderness areas have you closed any campsites to recreational use, for the reasons of vegetation recovery or soil stabilization?

yes ___ no ___

If you answered no to the previous question, you may disregard the rest of this questionnaire.

3. How many campsites do you currently have closed? ______________

4. How many years have these campsites been closed? ______________

5. What is the type of these closures?

___ complete (closed to all recreational use)

___ overnight use excluded

___ livestock use excluded

___ other (describe):

6. How many of these closed campsites are located on lakes?

____

7. What site conditions prompted you to close these sites?

___ loss of vegetation cover

___ disappearance of an organic litter or duff cover

___ appearance of non-native plant species

___ soil erosion

___ esthetic deterioration

___ other (describe):

8. What is the expected average length of time these campsites will be closed?

____

9. How are the visitors informed of these closures?

___ signs (___ at trailhead, ___ trail junctions, ___ campsites)

___ information available at district or park office

___ wilderness ranger or guard

___ portal assistant

___ hand-out maps

___ barriers such as fences or ropes around the closed sites

___ other (describe):

10. How is the closure policy enforced?

___ wilderness ranger or guard patrolling area

___ warnings from management personnel

___ citations from management personnel

___ other (describe):

11. How often are these closed sites patroled or inspected by management personnel?

____

12. Have you designated alternative campsites to the closed ones?

yes ___ no ___

13. What percentage of the visitors to the immediate area would you estimate do not comply with the restrictions and camp on closed campsites?

___ 100%

___ 99-75%

___ 74-50%

___ 49-25%

___ 24-0%

___ 0%

___ no idea

14. Have you applied any other treatments besides closure to speed up the recovery process?

___ seeding

___ mulching

14. Continued:

___ weeding of non-native plant species

___ fertilizing

___ watering

___ scarification

___ other (describe):

15. What type of recovery of the vegetation and soils have you observed on these closed campsites?

___ excellent

___ good

___ fair

___ poor

16. What indicators do you use to show recovery of natural conditions, on these campsites?

___ vegetation cover

___ organic litter or duff cover

___ disappearance of non-native plant species

___ soil stability

___ esthetic appearance

___ other (describe):

17. Do you plan to eventually reopen some of these campsites to original uses?

yes ___ no ___

18. Do you plan to eventually reopen some of these campsites, but modify use from what it was prior to the closures?

yes ___ no ___

19. If you plan to reopen the campsites but modify use, what do you plan to change from previous conditions?

___ number of visitors

___ livestock use

___ overnight use

___ other (describe):

___ unsure

20. Additional comments may be added to the back of this page.

Thank you very much.

Appendix 3.

Visitor Use Data

Date: _____

Day of week (1-Mon, 2-Tues etc.): _____

Holiday (0-no, 1-yes): _____

Weather (0-clear, 1-partly cloudy, 2-cloudy, 3-rain, 4-snow): _____

Temperature (C^{o}): _____

Site Number	Type of Site 1-natural 2-open 3-closed	Number of Groups	Number of Indivi.	Mode of Travel 0-foot 1-stock	Number of Stock	Fish Equipe. 0-no 1-yes	Length of Stay 1-first night etc.

Totals:

Appendix 4. Crosstabulations of Campsite Choice with Group Size, Use of Fishing Equipment, and Length of Stay.

Campsite Choice with Group Size

Group Size

ite ice		1	2	3	4	5	6	>10	Campsite Choice Percentages
	Natural Areas	6	6	3	1	1	0	0	
		6.5	6.5	3.2	1.1	1.1	0	0	18.3
		33.3	14.6	17.6	14.3	16.7	0	0	
	Open Campsites	11	29	8	5	5	1	2	
		11.8	31.2	8.6	5.4	5.4	1.1	2.2	65.6
		61.1	70.7	47.1	71.4	83.3	50.0	100.0	
	Closed Campsites	1	6	6	1	0	1	0	
		1.1	6.5	6.5	1.1	0	1.1	0	16.1
		5.6	14.6	35.3	14.3	0	50.0	0	
	Group Size Percentages	19.4	44.1	18.3	7.5	6.5	2.2	2.2	

X^2 = 13.11 with 12 degrees of freedom
Based on 93 groups
Explanation of cells: Absolute frequency of cell
Cell percent of total
Column percentage

Appendix 4 Continued

Campsite Choice with Use of Fishing Equipment

Use of Fishing Equipment

		No	Yes	Campsite Choice Percentages
	Natural Areas	5 6.0 25.0	10 11.9 15.6	17.9
ite ce	Open Campsites	13 15.5 65.0	41 48.8 64.1	64.3
	Closed Campsites	2 2.4 10.0	13 15.5 20.3	17.9
	Use of Fishing Equipment Percentages	23.8	76.2	

X^2 = 1.66 with 2 degrees of freedom.
Based on 93 groups
Explanation of cells: Absolute frequency of cell
Cell percent of total
Column percentage

Appendix 4 Continued

Campsite Choice with Length of Stay

Length of Stay

	1 Night	2 Nights	Campsite Choice Percentages
Natural	7	1	
Areas	16.7	2.4	19.0
	19.4	16.7	
Open	22	4	
Campsites	52.4	9.5	61.9
	61.1	66.7	
Closed	7	1	
Campsites	16.7	2.4	19.0
	19.4	16.7	
Length of Stay Percentages	85.7	14.3	

e

X^2 = .07 with 2 degrees of freedom.
Based on 42 groups.
Explanation of cells: Absolute frequency of cell
Cell percent of total
Column percentage

Appendix 5

Plant Species Found at Big Creek Lake in the Selway-Bitterroot Wilderness

Nomenclature and sequence of families follow C. Leo Hitchcock and Arthur Conquist's Flora of the Pacific Northwest, 1973, University of Washington Press, Seattle, Washington.

A voucher collection is housed in the Botany Herbarium, University of Montana, Missoula, Montana.

Polypodiaceae
- *Athyrium filix-femina*
- *Polystichum lonchitis*

Pinaceae
- *Abies lasiocarpa
- *Pinus contorta
- *Picea engelmannii
- *Pseudotsuga menziesii

Salicaceae
- *Populus tremuloides*

Betulaceae
- *Alnus sinuata*

Polygonaceae
- *Eriogonum umbellatum*
- *Polygonum douglasii*
- *Polygonum phytolaccaefolium*
- *Rumex acetosella*

Portulacaceae
- *Montia cordifolia*

Caryophyllaceae
- *Cerastium vulgatum*
- *Spergularia rubra*
- *Stellaria crispa*

Ranunculaceae
- *Aquilegia flavescens
- *Thalictrum occidentale*

Cruciferae
- *Sisymbrium loeselii

Crassulaceae
- *Sedum stenopetalum*

Saxifragaceae
- *Boykinia major*
- *Heuchera grossulariifolia*
- *Mitella breweri*
- *Saxifraga ferruginea*
- *Tiarella trifoliata (unifoliata)*

Grossulariaceae
Ribes lacustre
Rosaceae
Amelanchier alnifolia
**Fragaria sp.*
Geum macrophyllum
Potentilla glandulosa
Rubus parviflorus
Sorbus scopulina
Spiraea densiflora
Leguminosae
Trifolium repens
Hypericaceae
Hypericum formosum
Violaceae
Viola glabella
Viola orbiculata
Onagraceae
Epilobium alpinum
Epilobium angustifolium
Epilobium glandulosum
Umbelliferae
Angelica arguta
Heracleum lanatum
Ligusticum canbyi
Osmorhiza occidentalis
Ericaceae
Menziesia ferruginea
Pyrola secunda
Vaccinium globulare
Vaccinium scorparium
Apocynaceae
Apocynum androsaemifolium
Polemoniaceae
Phlox diffusa
Polemonium pulcherrimum
Labiatae
Agastache urticifolia
Galeopsis tetrahit
Scrophulariaceae
Castilleja miniata
Pedicularis racemosa
Penstemon ellipticus
Penstemon montanus
Veronica serpyllifolia
Plantaginaceae
**Plantago lanceolata*
Plantago major

Rubiaceae
- *Galium triflorum*

Caprifoliaceae
- *Lonicera utahensis*
- *Sambucus racemosa*

Valerianaceae
- *Valeriana sitchensis*

Campanulaceae
- *Campanula rotundifolia*

Compositae
- *Achillea millefolium*
- *Anaphalis margaritacea*
- **Antennaria racemosa*
- *Arnica latifolia*
- *Artemisia ludoviciana*
- *Aster foliaceus*
- *Hieracium albiflorum*
- *Rudbeckia occidentalis*
- *Saussurea americana*
- *Senecio triangularis*
- *Solidago canadensis*
- *Solidago gigantea*
- **Taraxacum sp.*

Juncaceae
- *Juncus bufonius*
- *Juncus ensifolius*
- *Juncus mertensianus*
- **Juncus tenuis*
- *Luzula piperi*

Cyperaceae
- *Carex mertensii*
- *Carex microptera*

Gramineae
- *Agrostis alba*
- *Agrostis scabra*
- *Calamagrostis canadensis*
- *Deschampsia cespitosa*
- *Elymus glaucus*
- *Poa annua*
- *Poa pratensis*
- *Trisetum cernuum*

Liliaceae
- *Clintonia uniflora*
- **Disporum sp.*
- **Erythronium sp.*
- *Smilacina stellata*
- **Streptopus sp.*
- *Trillium ovatum*

Veratrum viride
Xerophyllum tenax
Orchidaceae
Goodyera oblongifolia
Listera caurina

*Example of this plant is not contained in voucher collection

Appendix 6. Ground Cover on the Different Sites
Natural Sites: Average Percent Cover

Natural Sites	Vegetation	Natural Litter	Bare Soil	Agastache urticifolia	Aster foliaceus	Aytherium filix-femina	Boykinia major	Carex and Juncus species	Epilobium angustifolium	Gramineae	Menziesia ferruginea	Mitella breweri	Montia cordifolia	Polemonium pulcherrimum	Polygonum phytolaccaefolium	Saxifraga ferruginea	Senecio triangularis	Smilacina stellata	Stellaria crispa	Trillium ovatum	Vaccinium globulare	Xerophyllum tenax
1*	97.5	93.5	.1	4.4	17.4	0	.7	T	29.4	17.5	0	1.8	3.5	1.7	15.8	0	.1	0	.8	T	0	.1
2	86.7	88.5	.2	0	.6	0	0	.1	.2	.1	0	0	0	.2	9.2	.3	0	0	0	0	3.4	1.3
3	86.7	97.5	0	0	0	0	0	0	0	0	9.4	0	0	0	0	0	0	0	0	.1	37.5	52.4
4	64.4	82.3	6.3	0	0	0	0	1.6	0	0	37.2	.1	0	T	0	0	.7	0	0	0	6.7	1.3
5*	93.5	94.6	.1	0	5.5	36.1	0	1.6	.5	55.9	0	0	1.6	0	24.0	0	0	1.0	0	0	0	.1
6	96.5	96.5	0	0	0	1.5	28.2	0	0	0	0	.8	3.3	0	0	0	12.9	0	0	.8	0	0
Average for All Natural Sites	87.5	92.2	1.1	.7	3.9	6.3	4.9	.3	5.0	12.2	7.8	.5	1.4	.3	9.5	.1	2.3	.2	.1	.1	7.9	9.2

*Sites placed in the subsample because of similar site characteristics (i.e., soils and tree canopy).
T Average less than .05 percent.

Appendix 6. (Continued) Ground Cover on Sites
Natural Sites: Average Frequency

Natural Sites	*Agastache urticifolia*	*Aster foliaceus*	*Athyrium filix-femina*	*Boykinia major*	*Carex & Juncus* species	*Epilobium anqustifolium*	Gramineae	*Menziesia ferruginea*	*Mitella breweri*	*Montia cordifolia*	*Polemonium pulcherrimum*	*Polygonum phytolaccaefolium*	*Saxifraga ferruginea*	*Senecio triangularis*	*Smilacina stellata*	*Stellaria crispa*	*Trillium ovatam*	*Vaccinium globulare*	*Xerophyllum tenax*
1*	.75	1.00	0	.25	.08	1.00	.83	0	.42	.92	.50	1.00	0	.17	0	.75	.08	0	.08
2	0	.33	0	0	.17	.08	.42	0	0	0	.33	.75	.25	0	0	0	0	.25	.08
3	0	0	0	0	0	0	0	.17	0	0	0	0	0	0	0	0	.17	1.00	.92
4	0	0	0	0	0	0	0	.75	.25	0	.08	0	0	.25	0	0	0	.67	.25
5*	0	.92	.92	0	.42	.17	1.00	0	0	.83	0	.92	0	0	.75	0	0	0	.08
6	0	0	.17	.92	0	0	0	0	.42	.92	0	0	0	1.00	0	0	.33	0	0
Average for all natural sites	.12	.37	.18	.19	.11	.21	.37	.15	.18	.44	.15	.44	.04	.24	.06	.06	.10	.32	.23

*Sites placed in subsample because of similar site characteristics (i.e., soils and tree canopy).

Appendix 6 (Continued). Ground Cover on the Sites
Open Campsites: Average Percent Cover

Open Campsites: This Study	Lucas 1975	Vegetation	Natural Litter	Bare Soil	Aster foliaceus	Athyrium filix-femina	Boykinia major	Carex & Juncus species	Epilobium alpinum	Epilobium angustifolium	Gramineae	Menziesia ferruginea	Mitella breweri	Montia cordifolia	Poa annua	Polemonium pulcherrimum	Polygonum phytolaccaefolium	Rumex acetosella	Senecio triangularis	Smilacina stellata	Spergularia rubra	Stellaria crispa	Trifolium repens	Trillium ovatum	Vaccinium globulare	Xerophyllum tenax
25	25	29.4	65.6	19.3	0	0	0	0	0	0	.5	0	0	0	0	0	0	0	0	0	0	0	0	0	4.6	18.8
1	1	19.1	26.0	28.2	0	.2	0	0	0	0	T	.1	0	0	.1	0	0	0	0	0	0	0	0	.2	.1	0
1B*	-	29.7	35.8	21.2	0	0	0	0	0	0	3.7	0	0	0	3.3	0	0	.5	0	T	.7	0	0	T	0	2.5
4	4	60.8	92.5	0	.7	14.1	23.4	0	0	1.8	4.9	0	0	T	0	1.4	0	0	6.2	.3	0	T	.1	1.0	0	3.4
6A*	6A	64.8	59.0	10.1	.5	0	10.5	17.7	T	0	17.2	0	0	0	10.1	0	T	.2	0	0	0	0	1.8	0	T	.2
6B	6B	8.6	55.3	18.2	0	0	.7	0	0	.1	0	0	0	0	0	0	0	0	0	T	0	0	0	0	0	0
27A	27A	10.3	85.4	4.8	0	0	4.0	0	0	0	0	0	.3	0	0	0	0	0	.4	.3	0	0	0	.1	0	0
27B	27B	20.0	84.6	10.1	0	0	4.5	.7	.1	0	.6	0	.5	1.3	0	0	1.2	0	.2	0	0	T	0	0	0	0
Average for all open campsites		30.3	63.0	14.0	.2	1.8	5.4	2.3	T	.2	3.4	T	.1	.2	1.7	.2	.2	.1	.8	.1	.1	T	.2	.2	.6	3.1

*Campsites placed in subsample because of similar site characteristics (i.e., soils, tree canopy, and amount of use).
T Average cover less than .05 percent.

Appendix 6 (Continued). Ground Cover on the Sites
Open Campsites: Average Frequency

Open Campsites: This Study	Lucas 1975	Aster foliaceus	Athyrium filix-femina	Boykinia major	Carex & Juncus species	Epilobium alpinum	Epilobium angustifolium	Gramineae	Menziesia ferruginea	Mitella breweri	Montia cordifolia	Poa annua	Polemonium pulcherrimum	Polygonum phytolaccaefolium	Rumex acetosella	Senecio triangularis	Smilacina stellata	Spergularia rubra	Stellaria crispa	Trifolium repens	Trillium ovatum	Vaccinium globulare	Xerophyllum tenax
25	25	0	0	0	0	0	0	.67	0	0	0	0	0	0	0	0	0	0	0	0	0	.58	.50
1	1	0	.08	0	0	0	0	.08	.17	0	0	.25	0	0	0	0	0	0	0	0	.33	.17	0
1B*	-	0	0	0	0	0	0	.75	0	0	0	.50	0	0	.50	0	.08	.67	0	0	.08	0	.17
4	4	.25	.75	.58	0	0	.42	.83	0	0	.08	0	.42	0	0	.75	.25	0	.08	.17	.83	0	.17
6A*	6A	.17	0	.33	.75	.08	0	.83	0	0	0	.83	0	.08	.33	0	0	0	0	.33	0	.08	.08
6B	6B	0	0	.67	0	0	.25	0	0	0	0	0	0	0	0	0	.08	0	0	0	0	0	0
27A	27A	0	0	.75	0	0	0	0	0	.25	0	0	0	0	0	.33	.17	0	0	0	.25	0	0
27B	27B	0	0	.58	.92	.25	0	.75	0	.58	.17	0	0	.08	0	.42	0	0	.08	0	0	0	0
Average for all open campsites		.05	.11	.36	.21	.04	.08	.49	.02	.11	.03	.20	.05	.02	.10	.19	.07	.08	.02	.06	.19	.10	.11

*Campsites placed in the subsample because of similar site characteristics (i.e., soils, tree canopy, and amount of use).

Appendix 6 (Continued). Ground Cover on the Sites
Closed Campsites: Average Percent Cover

Closed Campsites: This Study	Lucas 1975	Vegetation	Natural Litter	Bare Soil	Aster foliaceus	Boykinia major	Carex & Juncus species	Epilobium alpinum	Epilobium angustifolium	Gramineae	Menziesia ferruginea	Mitella breweri	Montia cordifolia	Poa annua	Polemonium pulcherrimum	Polygonum phytolaccaefolium	Rumex acetosella	Saxifraga ferruginea	Senecio triangularis	Smilacina stellata	Spergularia rubra	Stellaria crispa	Taraxacum species	Trifolium repens	Trillium ovatum	Vaccinium globulare	Xerophyllum tenax
3	3	20.9	50.1	40.1	0	0	.7	0	0	0	0	0	0	.5	.4	0	0	0	0	1.5	.1	0	0	.1	T	2.7	.2
5*	5	73.7	68.8	14.3	.3	12.5	7.0	0	.2	39.0	0	0	0	1.5	.1	.2	1.4	0	3.7	3.2	.1	0	0	0	T	0	0
7*	7	26.1	44.0	27.6	.4	0	.4	.2	.5	.1	8.1	.3	0	T	1.5	T	.3	0	.1	0	.1	0	1.0	.1	.5	4.7	1.2
8A*	8A	34.9	64.8	8.7	0	0	2.0	T	0	0	18.5	0	0	.7	0	0	.4	0	0	0	3.6	T	0	1.8	0	8.7	6.5
9	9	48.4	61.7	11.5	0	.3	17.1	T	0	1.2	0	1.3	.2	0	0	.5	2.3	1.6	T	0	0	T	0	T	.1	0	0
26P*	-	93.5	96.5	1.2	0	1.3	22.9	0	T	38.4	0	0	3.2	3.5	0	14.3	.7	.5	0	0	0	.2	0	0	0	0	3.1
26A*	26A	17.8	39.9	30.0	0	0	3.9	.3	0	.2	0	.4	.2	0	1.2	T	2.9	0	.8	0	0	T	0	T	.4	0	0
Average for all closed campsites		45.1	60.8	18.9	.1	2.3	7.7	.1	.1	11.3	3.8	.3	.5	.9	.4	2.2	1.1	.3	.7	.7	.5	T	.1	.3	.1	2.3	1.6

*Campsites placed in subsample because of similar site characteristics (i.e., soils, tree canopy, and amount of use).
T Average cover less than .05 percent.

Appendix 6 (Continued). Ground Cover on the Sites
Closed Campsites: Average Frequency

Closed Campsites: This Study	Closed Campsites: Lucas 1975	Aster foliaceus	Boykinia major	Carex & Juncus species	Epilobium alpinum	Epilobium angustifolium	Gramineae	Menziesia ferruginea	Mitella breweri	Montia cordifolia	Poa annua	Polemonium pulcherrimum	Polygonum phytolaccaefolium	Rumex acetosella	Saxifraga ferruginea	Senecio triangularis	Smilacina stellata	Spergularia rubra	Stellaria crispa	Taraxacum species	Trifolium repens	Trillium ovatum	Vaccinium globulare	Xerophyllum tenax
3	3	0	0	.50	0	0	0	0	0	0	.50	.33	0	0	0	0	.25	.25	0	0	.08	.08	.25	.08
5*	5	.17	.92	.17	0	.08	.08	0	0	0	.25	.17	.08	.42	.08	.50	.25	.17	0	0	0	.08	0	0
7*	7	.33	0	.83	.42	.17	.17	.08	.25	0	.08	.50	.08	.58	0	.17	0	.17	0	.75	.17	.25	.33	.08
8A*	8A	0	0	.67	.08	0	0	.33	0	0	.58	0	0	.33	0	0	0	.58	.08	0	.42	0	.33	.17
9	9	0	.25	1.00	.08	0	.75	0	.17	.33	0	0	.25	.50	.42	.08	0	0	.08	0	.08	.17	0	0
26P*	-	0	.25	1.00	0	.08	1.00	0	0	.42	.50	0	.67	.67	.25	0	0	0	.33	0	0	0	0	.08
26A*	26A	0	0	.83	.67	0	.75	0	.42	.42	0	.67	.67	.58	0	.83	0	0	.08	0	.08	.33	0	0
Average for all closed campsites		.07	.20	.71	.18	.04	.39	.06	.12	.17	.27	.24	.25	.44	.11	.23	.07	.17	.08	.06	.12	.13	.13	.06

*Campsites placed in subsample because of similar site characteristics (i.e., soils, tree canopy, and amount of use).