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Campsite Conditions in the Bob Marshall Wilderness, Montana

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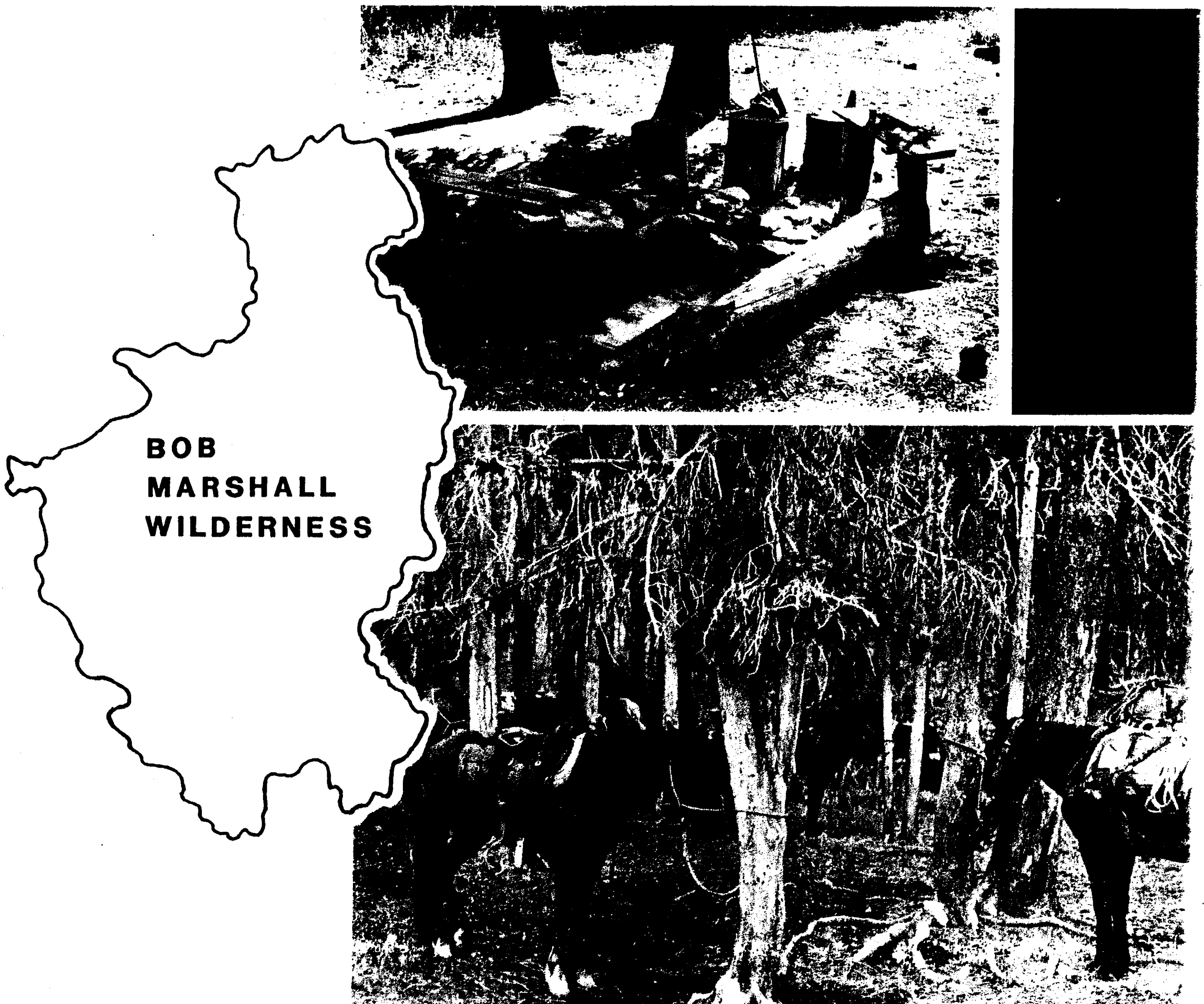

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RESEARCH SUMMARY

Conditions were examined on campsites in low-to-mid-elevation forests and grasslands in the Bob Marshall Wilderness, Mont. Camp area, bare area, and the extent of tree damage were evaluated. Other changes were assessed by comparing campsites to comparable control sites. The changes estimated in this way were loss of tree seedlings, ground vegetation, and duff, increase in mineral soil exposure and compaction, change in species composition, and reduction in infiltration rates.

Trampling disturbance of groundcover vegetation and soils was similar in magnitude to what has been reported elsewhere. The unique features of these campsites were the large area that had been disturbed and the great number of damaged trees. Such damage is primarily a result of the prevalence of large parties with stock and the persistence of practices such as felling trees for tent poles and tying stock to trees.

Campsites used primarily by backpackers, sites used primarily by private stock parties, and sites used by commercial outfitters in the fall were compared. Certain types of impact, such as percentage of vegetation lost, were comparable on all three types of campsite. The types of impact that are most extreme on Bob Marshall campsites, however, are most pronounced on those sites used primarily by private stock parties and commercial outfitters.

Several management actions can be taken to reduce campsite damage. Most importantly, users must be educated about the damage resulting from felling trees and tying stock to trees. It would also be helpful to encourage the use of existing campsites in popular areas. In less popular areas, people could be encouraged to use undisturbed, resistant sites, such as many of the grasslands, to avoid seriously damaging any single site. Finally, in places that are frequently used by novice stock parties the Forest Service should consider providing corrals or hitchrails to reduce tree damage.

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INTRODUCTION

Of the recreational impacts occurring in wilderness, those on campsites are the most troublesome and complex to manage. The potential solutions to such problems are numerous, and it is seldom obvious which solutions are most appropriate or likely to be effective. Use rationing, limitations on length of stay or group size, concentrating campers on designated sites, dispersing campers among numerous sites, campsite closures, prohibition of wood fires, and visitor education are some of the techniques that have been used in an attempt to solve campsite problems. Too often the effects of such actions cannot be accurately predicted. Even more regretable, after actions have been taken it is seldom possible to evaluate their effectiveness because systems for monitoring changes in campsite condition are not in place.

In the western United States, most studies of campsite condition have been conducted at high elevations; therefore, the conclusions drawn may not be applicable to campsites at lower elevations. Furthermore, previous studies have not compared the condition of campsites that have been subjected to very different types of use. Such informational gaps provided the impetus for long-term monitoring of campsites in the Bob Marshall Wilderness, Mont., an area frequented by parties of backpackers, private individuals with packstock, and commercial outfitters and their clients. Specific purposes of this study were: (1) to document campsite condition for future monitoring; (2) to compare the condition of sites subjected to the three major categories of user; and (3) to test the hypothesis that low-elevation campsites are less fragile than high-elevation campsites. This report describes the study area, how the study was conducted, results of the study, and management implications.

STUDY AREA AND STUDY METHODS

The Bob Marshall Wilderness is located south of Glacier National Park, along the Continental Divide in Montana. At just over 1 million acres (408 000 ha), the Bob Marshall is one of the largest wildernesses in the Nation. User densities are moderately low (0.15 visitor-day/acre in 1981), although certain travel corridors and destinations do receive concentrated use. The area is unique in the high proportion of stock users and the importance of fall hunting. In 1970, two-thirds of all parties had packstock; about one-half of these were with outfitters. Over one-third of the use was in the fall, and about one-third of all parties hunted (Lucas 1980).

We examined 35 campsites within the Bob Marshall Wilderness, selecting sites located in various parts of the wilderness (fig. 1). Both forest and grassland sites were examined, but all sites were at relatively low elevations for a mountainous wilderness in the West—between 4,100 and 5,500 ft (1 250 and 1 675 m) (fig. 2). Although only well-established sites were studied, use ranged from the most frequently used sites to sites used only a few times per year. We examined six camps that were used almost exclusively by backpackers. The most numerous sites were those used predominantly by private parties with stock (called horse camps hereafter). These sites, of which we selected 24 for study, are used less frequently by backpackers and by roving commercially outfitted groups. We also examined five camps assigned to commercial outfitters. Most of these sites are off the main trails, and are mainly used in the fall as hunting base camps.

Each sample site consisted of both a campsite and an undisturbed control site nearby. From a fixed point close to the center of the campsite, we measured the distance to the edge of the campsite, and to the first significant amount of vegetation along each of 16 transects. This defined the campsite area and the area of the barren central core (bare area). Tree seedlings between 6 and 55 inches (15 to 140 cm) tall were counted within the camp area, excluding any untrampled "islands"; larger trees were counted within the entire camp area, including the "islands." Any human damage to trees was noted.

On each campsite, 15 quadrats, 3.28 by 3.28 ft (1 m by 1 m) square, were located along four transects. The transects originated at the center point and were oriented perpendicular to each other. The distance between successive quadrats decreased with distance from the center point, so that the central part of the site was not oversampled. In each quadrat, the canopy coverages of total ground vegetation, exposed mineral soil, each vascular plant species, and mosses and lichens as a group were estimated. Coverages were estimated, always by the same investigators, to the nearest percent if under 10 percent or, in 10 percent coverage classes, between 10 and 100 percent. The midpoints of each class were used to calculate means for each variable. Plot layout and measurements are fully described and illustrated in Cole (1982).

Soil compaction and depth of organic litter and fermentation (0) horizons (duff depth) were measured adjacent to each quadrat. Compaction was measured with a pocket soil penetrometer in the uppermost portion of the mineral soil after the organic horizons had been removed. Infiltration rates were measured with a double-ring infiltrometer, between 3 and 6 ft (1-2 m) from the center point along two of the transects. The rate that the first 0.39 inch (1 cm) entered the soil was called the instantaneous infiltration rate. After 2 inches (5 cm) had

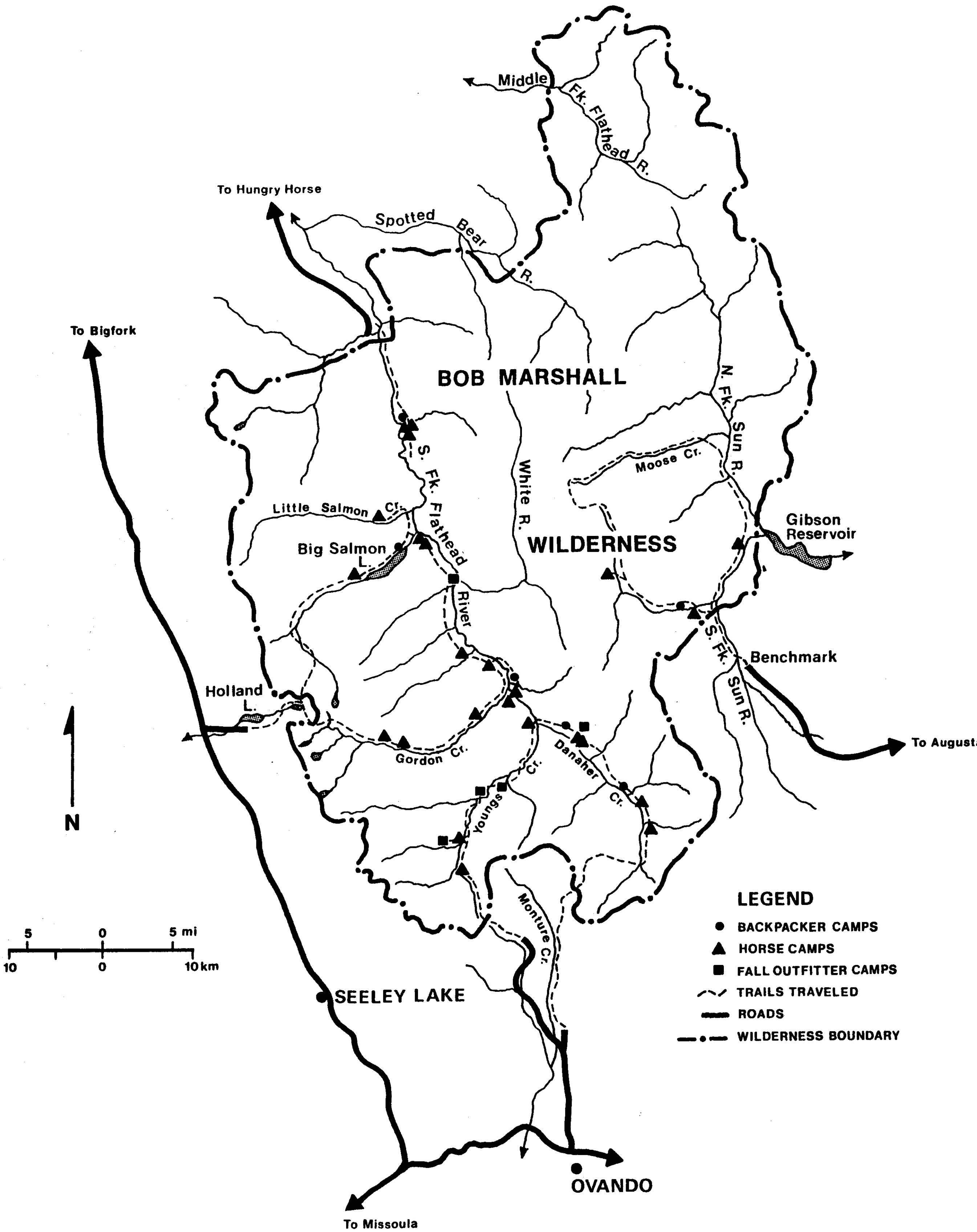

Figure 1.—Locations of sample campsites within the Bob Marshall Wilderness.

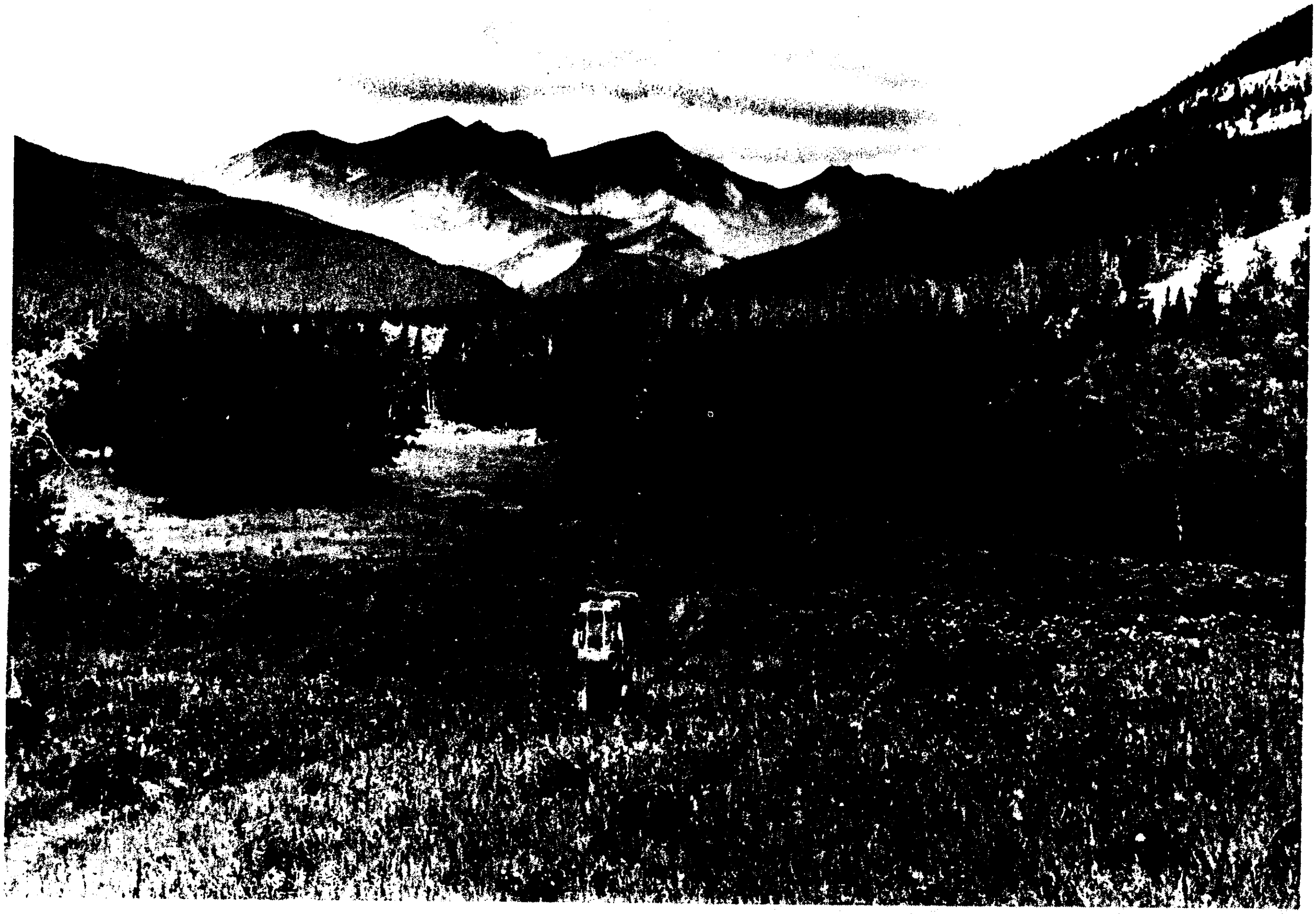

Figure 2.—The study campsites were located in forests and grasslands at relatively low elevations.

soaked into the soil, more water was added. The rate that the next 0.39 inch (1 cm) entered the soil was called the saturated rate. Both are expressed in centimeters per minute.

On the control plots, which usually varied in size between 165 and 330 ft^2 (50 and 100 m), we estimated the coverage of total vegetation, exposed mineral soil, each vascular plant species, mosses, and lichens for the entire plot. We counted numbers of seedlings and took 15 duff depth and penetration resistance measurements and two infiltration rate measurements.

On very large sites, where there were several discontinuous disturbed areas, usually holding areas for stock, we took detailed measurements in the central area used for cooking. Then we estimated the size of the entire disturbed area and assessed tree damage in this larger area.

The amount of change that has occurred is inferred from comparisons of campsites and controls. I calculated both absolute change—the difference between measurements on the control site and measurements on the campsite—and relative change—the absolute change expressed as a percentage of the measurement on the control site. Where control conditions are variable, relative change provides a more valid basis for site-to-site comparisons than either absolute change or current campsite conditions. Change in species composition was measured with the following coefficient of floristic dissimilarity:

$$FD = 0.5 \Sigma |p_1 - p_2|$$

where p_1 is the relative cover of a given species on the control plot, and p_2 is the relative cover of the same species on the campsite (Cole 1978).

Two different analyses were used to determine the statistical significance of results. The first analysis involved testing whether campsites were significantly different from controls. The Wilcoxon matched-pairs, signed-ranks test ($\alpha = 0.05$) was used to test the null hypothesis that campsite conditions were not significantly different from controls (Siegel 1956).

The second set of tests examined the differences between backpacker camps, horse camps and outfitter camps. The null hypothesis that conditions on each of these types of camp were identical was tested using the randomization test for two independent samples ($\alpha = 0.05$) (Siegel 1956). Randomly selected samples of 5 of the 6 backpacker sites and 5 of the 24 horse sites were compared with each other and with the 5 outfitter sites examined.

RESULTS AND DISCUSSION

How Much Change Has Occurred?

Campsite area on the 35 sites varied between 624 and 6,512 feet² (58 and 605 m²) (table 1); the median site was 2,352 ft² (216 m²). Most of the campsite area was vegetated; the median bare area was only 150 ft² (14 m²). Some 23 of the 35 sites, however, had large areas away from the camping area that had also been disturbed, usually from holding packstock. About one-tenth acre (405 m²) was disturbed on the median campsite. The largest site had a disturbed area of more than 2.5 acres (10,600 m²).

On most campsites, all of the overstory trees have been damaged. Typically, about 15 percent of the on-site trees have been felled, another 55 percent are scarred with ax marks, nails, and so on, and the rest have had their lower branches broken off for firewood. Over one-half of these trees have also had their roots exposed, usually from the trampling of stock tied to their trunks.

The number of trees affected is sizeable, particularly when damage on the entire disturbed area—both campsite and stock-holding area—is considered. The median number of damaged trees was 63 per site, but on one site approximately 500 trees had been damaged. Particularly disturbing were the large number of trees that had been felled (median of 15 per site) and that had exposed roots (median of 28 per site). This is visually obtrusive, long-term damage (fig. 3). On many areas with no other evidence of use, tree damage identified the place as a former campsite. This damage is also cumulative—each year newly damaged trees are added.

Table 1.—Size of disturbance, tree damage, and change in species composition on all 35 campsites

Statistic	Camp area	Bare area	Disturbed area	Damaged trees	Scarred trees	Felled trees	Trees with exposed roots	Damaged trees	Scarred trees	Felled trees	Trees with exposed roots	Floristic dissimilarity
	Square meters			Percent on camp area				Number on disturbed area				Percent
Median	216	14	405	100	70	15	54	63	49	15	28	63
Range	58-605	0-291	58-10,600*	0-100	0-100	0-67	0-100	0-500*	0-300*	0-200*	0-100*	31-97

*The highest values are visual estimates rather than counts or measures.

Figure 3.—Cut trees provide evidence of human use long after trampled vegetation has recovered.

The long-term importance of tree damage is reinforced by the lack of tree reproduction on campsites. About three-fourths of the campsites have no tree reproduction at all, and reproduction is very low on the other sites (table 2). In the future we can expect reductions in tree density and the creation or expansion of nonforested areas used as campsites.

Although the barren central core of the campsite is typically small, trampling has affected groundcover over the entire site. The median campsite has only one-third the vegetation cover of its paired control. Several sites have lost over 90 percent of their original vegetation. The composition of the vegetation that does survive is very different from that on controls. The median floristic difference between campsites and controls (an index of change in species composition that can vary from no change—0 percent—to complete change—100 percent) is 63 percent (table 1).

To better understand the compositional changes resulting from trampling, I compared the relative cover of different growth forms on campsites and controls (table 3). The most pronounced change is the near elimination of shrubs and subshrubs (woody species other than trees) on campsites. Their median relative cover on controls was 21 percent, while their median relative cover on campsites was only 4 percent. Mosses and lichens have also been nearly eliminated on campsites. There has been a corresponding increase in the importance of graminoids (grasses and grasslike species) and forbs (herbaceous species other than graminoids) on campsites. Median relative cover values for graminoids were 29 percent on controls and 36 percent on campsites; for forbs values were 43 percent on controls and 51 percent on campsites.

To examine the response of individual species to trampling, I categorized the most common native species into those that are particularly resistant to trampling damage, those that are particularly susceptible, and those that are neither resistant nor susceptible. Less common native species are listed in the appendix. I also identified species that "invaded" campsites—species that are always found more frequently on campsites than controls and that often also provide more cover on campsites than controls (table 4). The invader list includes 27 introduced species (8 of which are annuals) and 12 natives (8 of which are annuals). Three of the four most abundant species on campsites are common domestic lawn species—*Poa pratensis* (Kentucky bluegrass), *Taraxacum officinale* (common dandelion), and *Trifolium repens* (white clover).

Table 2.—Soil and vegetation changes on all 35 campsites*

Statistic	Seedlings	Vegetation	Soil exposure	Duff depth	Penetration resistance	Infiltration rates Instantaneous	Infiltration rates Saturated
	Stems/ha	------*Percent*------		*cm*	*kg/cm²*	--------*cm/min*--------	
Campsite							
median	0	29	7.4	1.2	3.1	0.5	0.1
range	0-560	1-84	0.3-53.2	.05-4.4	1.7-4.5	0.06-6.0	0.03-0.7
Control							
median	600	85	0	2.1	2.2	1.8	0.6
range	0-7,342	65-100	0-5	0.2-11.0	0.8-4.5	0.2-10.0	0.04-4.0
Median absolute change	880	52	7.1	0.7	0.9	1.2	0.4
Median relative change (%)	100	66	∞	45	71	66	72
Significance level	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

*Absolute change is the difference between campsite and control values; relative change is the absolute change divided by the control value. Significance was tested with a one-tailed Wilcoxon matched-pairs, signed-ranks test.

Table 3.—Relative cover of growth forms on all 35 campsites and controls*

Growth form	Campsites Median	Campsites Range	Control sites Median	Control sites Range	Significance level
	---------------- *Percent* ----------------				
Graminoids	36	7-63	29	6-60	0.01
Forbs	51	15-91	43	9-57	.004
Shrubs and subshrubs	4	0-53	21	0-59	<.001
Mosses and lichens	1	0-27	3	0-38	.002

*Significance was tested with the Wilcoxon matched-pairs, signed-ranks test.

Table 4.—Cover and frequency of campsite "invaders"*

Species	Frequency of occurrence		Mean cover		Mean relative cover	
	Camps	Controls	Camps	Controls	Camps	Controls
	----- Number -----		----------------- Percent -----------------			
Agropyron repens[1]	7	3	2.9	3.0	3.3	1.6
Agrostis alba[1]	3	0	1.0	.0	2.3	.0
Arabis glabra[1]	3	2	.2	1.0	.2	.5
Bromus inermis[1]	3	2	1.7	6.3	2.8	2.8
Bromus tectorum[1,2]	1	0	.7	.0	.6	.0
Capsella bursa-pastoris[1,2]	11	0	.6	.0	1.6	.0
Cerastium arvense	8	1	1.2	.9	1.1	.3
Chenopodium album[1,2]	2	0	2.2	.0	2.9	.0
Collinsia parviflora[2]	5	1	.3	.4	.8	.2
Dactylis glomerata[1]	3	1	.7	.5	.8	.4
Descurainia richardsonii[2]	4	1	2.4	.5	6.9	.3
Epilobium paniculatum[2]	1	0	.2	.0	1.8	.0
Filago arvensis[1,2]	1	0	.2	.0	1.8	.0
Lappula redowskii[2]	2	0	.6	.0	1.6	.0
Lepidium densiflorum[2]	3	0	.1	.0	.4	.0
Linanthus septentrionalis[2]	2	1	.5	1.0	.6	.4
Lychnis alba[1]	2	0	1.4	.0	1.7	.0
Matricaria matricarioides[2]	4	0	1.3	.0	5.5	.0
Medicago lupulina[1,2]	3	1	2.7	2.0	4.0	1.2
Phleum pratense[1]	13	3	1.4	2.7	1.8	1.2
Plagiobothrys scouleri[2]	6	0	6.0	.0	10.3	.0
Plantago major[1]	12	0	.5	.0	1.0	.0
Poa annua[1,2]	4	0	3.6	.0	4.8	.0
Poa palustris[1]	1	0	3.0	.0	1.2	.0
Poa pratensis[1]	29	14	12.4	7.6	20.0	3.2
Polygonum aviculare[1,2]	5	0	2.4	.0	6.6	.0
Potentilla argentea[1]	1	0	.1	.0	.3	.0
Rumex acetosella[1]	2	1	1.6	2.0	1.5	.7
Rumex crispus[1]	3	1	1.7	.3	2.2	.1
Sagina saginoides	1	1	4.3	5.0	5.1	2.0
Stellaria calycantha	1	0	.7	.0	.9	.0
Stellaria longipes	2	0	1.2	.0	1.6	.0
Taraxacum officinale[1]	31	15	4.4	1.2	6.9	.6
Thlaspi arvense[1,2]	4	0	.3	.0	.5	.0
Tragapogon dubius[1]	1	0	1.0	.0	.6	.0
Trifolium pratense[1]	6	4	.6	.6	.6	.4
Trifolium repens[1]	20	14	4.0	2.9	5.9	1.4
Verbascum thapsus[1]	1	0	.2	.0	1.8	.0
Veronica serpyllifolia	3	2	.5	.8	.5	.3

*Species that are more common on campsites than on controls. Means are for the sites on which the species was found—not all 35 sites. The [1] indicates a nonnative species; the [2] indicates an annual.

Only nine of the native species commonly found on controls are resistant to trampling (table 5). These species have less cover on campsites than on controls, but they survive more often than their associates. Consequently, their relative cover is higher on campsites than on controls. The list includes three species of graminoid and various forbs, most of which have basal leaves, a characteristic that reduces susceptibility to trampling damage. One of these resistant species, *Xerophyllum tenax* (beargrass) is one of the more common understory dominants in middle and higher elevation forests throughout much of the Pacific Northwest and Northern Rocky Mountains.

Twenty-four common species were categorized as highly susceptible; their relative cover on campsites was much lower than on controls (table 6). Many of these species are shrubs, subshrubs, or tall, leafy-stemmed forbs. Three of these—*Vaccinium caespitosum* (dwarf huckleberry), *Arctostaphylos uva-ursi* (kinnikinnick), and *Thalictrum occidentale* (western meadowrue) are among the most common species on control sites. Sites with these species in abundance should be considered highly susceptible to vegetation loss, if used for camping.

Table 5.—Cover and frequency of common native species that are particularly resistant to damage*

Species	Frequency of occurrence		Mean cover		Mean relative cover	
	Camps	Controls	Camps	Controls	Camps	Controls
	----- *Number* -----		----------------- *Percent*		-----------------	
Agoseris glauca	7	6	1.2	1.7	1.7	0.8
Agrostis scabra	7	6	4.3	4.4	4.9	2.3
Carex rossii	14	6	.5	1.1	1.7	.5
Penstemon confertus/procerus	20	21	2.4	4.4	6.0	2.0
Potentilla gracilis	11	7	2.8	2.9	2.7	1.3
Smilacina stellata	11	14	1.0	3.3	3.2	1.5
Solidago missouriensis	6	8	1.3	3.4	5.0	1.7
Stipa occidentalis	12	11	4.9	13.4	9.4	6.2
Xerophyllum tenax	3	8	.7	8.4	9.4	5.2

*Species that are less abundant on campsites than controls, but that have a much higher relative cover on campsites. Common species are those that are found on at least one-fourth of the sample sites. Means are for all sites on which the species was found—not all 35 sites. Some of the *Potentilla gracilis* may be *P. recta*, a nonnative species.

Table 6.—Cover and frequency of common native species that are particularly susceptible to trampling damage*

Species	Frequency of occurrence		Mean cover		Mean relative cover	
	Camps	Controls	Camps	Controls	Camps	Controls
	----- *Number* -----		----------------- *Percent*		-----------------	
Arctostaphylos uva-ursi	5	18	0.4	11.8	1.1	6.7
Aster conspicuus	11	19	.5	7.9	1.3	3.9
Campanula rotundifolia	4	14	.1	1.6	.1	.7
Danthonia intermedia	3	11	.2	6.6	.1	3.0
Elymus glaucus	4	9	.2	6.4	.3	3.2
Epilobium angustifolium	8	18	.2	1.8	.2	.9
Geum triflorum	4	7	.2	1.3	.2	.6
Juniperus communis	2	12	.1	3.3	.4	1.7
Koeleria cristata	5	10	.5	6.1	.9	3.1
Lichens	2	10	.1	4.2	.1	2.1
Linnaea borealis	1	11	.1	8.4	.1	4.4
Lithospermum ruderale	2	9	.4	2.2	.5	1.0
Lupinus sericeus	5	10	.1	4.0	.3	2.1
Osmorhiza chilensis	4	8	.1	1.5	.1	.6
Pachistima myrsinites	2	8	.1	2.9	.2	1.5
Potentilla arguta	4	9	.1	2.3	.2	1.1
Pyrola secunda	1	9	.1	3.1	.8	1.5
Rhamnus alnifolia	0	8	.0	2.6	.0	1.1
Senecio pseudaureus	10	17	.4	6.0	1.2	2.7
Shepherdia canadensis	0	11	.0	2.7	.0	1.4
Symphoricarpos albus	13	16	.6	8.7	2.1	4.8
Thalictrum occidentale	9	21	.4	9.9	1.2	4.4
Vaccinium caespitosum	8	9	.8	24.1	4.7	13.4
Viola adunca	5	8	.1	1.2	.3	.6

*Species with much lower relative cover values on campsites than on controls. Common species are those that occur on at least one-fourth of the sample sites. Means are for all sites on which the species was found—not all 35 sites.

Table 7 lists common species that are neither resistant nor fragile. These include the most common plants on controls, mosses, *Calamagrostis rubescens* (pinegrass), and *Fragaria virginiana* (strawberry), as well as the least susceptible of the common shrubby species, *Berberis repens* (creeping Oregon grape), *Rosa* sp. (rose), and *Spiraea betulifolia* (shiny-leaf spirea).

In addition to removing vegetative cover, trampling also disturbs organic horizons, exposing the mineral soil beneath. Most control sites had no exposed mineral soil, while the median exposure on campsites was over 7 percent (table 2). The depth of the organic horizons (duff) decreased 45 percent, from median values of 0.8 inches (2.1 cm) on controls to 0.5 inches (1.2 cm) on campsites.

Trampling also compacts the soil. Penetration resistance increased over 70 percent, from median values of 2.2 kg/cm² on controls to 3.1 kg/cm² on campsites. Infiltration rates were reduced as a result of this compaction. Median instantaneous infiltration rates on campsites were less than one-third of those on controls and median saturated rates are only one-sixth of those on controls.

Table 7.—Cover and frequency of common native species that are neither highly resistant nor highly fragile*

Species	Frequency of occurrence		Mean cover		Mean relative cover	
	Camps	Controls	Camps	Controls	Camps	Controls
	Number		Percent			
Achillea millefolium	26	25	1.0	2.9	1.5	1.4
Allium cernuum	10	17	.7	3.6	1.4	1.7
Anemone multifida	9	9	.2	2.6	.9	1.3
Antennaria microphylla/umbrinella	11	19	.7	3.4	1.0	1.6
Arnica cordifolia/latifolia	9	14	.7	7.8	4.4	4.2
Aster foliaceous	12	10	1.0	4.4	2.4	2.1
Berberis repens	19	21	.6	6.0	1.9	3.2
Calamagrostis rubescens	15	22	2.9	29.7	8.2	15.8
Carex geyeri	5	10	1.4	9.5	3.4	5.0
Cirsium hookeriana	5	12	.4	2.6	.7	1.2
Disporum trachycarpum	3	7	.1	2.0	1.0	1.0
Fragaria virginiana	31	33	3.1	14.2	6.5	7.1
Galium boreale	18	22	1.0	4.6	2.3	2.3
Gentiana amarella	7	6	.1	.9	.2	.4
Heuchera cylindrica	6	6	.3	2.0	.6	1.1
Mosses	21	23	3.0	23.5	6.2	10.4
Rosa sp.	15	18	1.2	6.5	3.1	3.5
Sedum lanceolatum	6	6	.7	2.1	.8	.9
Senecio serra	4	10	.3	1.6	.5	.7
Spiraea betulifolia	6	15	.6	8.1	4.3	4.6

*Common species are those that occur on at least one-fourth of the sample sites. Means are for all sites on which the species was found—not all 35 sites.

How Do These Changes Compare to Those Found Elsewhere?

Changes on these lower elevation sites—4,100 to 5,500 ft (1 250 to 1 675 m)—can be readily compared with changes on sites in subalpine forests—7,050 to 7,800 ft (2 150 to 2 400 m) in the Eagle Cap Wilderness in Oregon because similar methods were used (Cole 1982). To a lesser extent they can also be compared with backcountry sites studied in detail in subalpine forests in the River of No Return Wilderness, Idaho (Coombs 1976), and the Mission Mountains Tribal Wilderness and Rattlesnake Wilderness, Mont. (Fichtler 1980), and with low-elevation forested sites in the Boundary Waters Canoe Area, Minn. (Frissell and Duncan 1965; McCool and others 1969). In none of these other study areas is horse use as predominant as it is in the Bob Marshall.

Disturbance of groundcover on the Bob Marshall sites is generally toward the lower bounds of the range found in other studies. The median area devoid of vegetation (14 m²) is much less than the bare area on Eagle Cap sites (87 m²), and the 66 percent loss of vegetation is considerably less than was found on Eagle Cap (87 percent) or Boundary Waters sites (85 percent). However, vegetation loss was slightly higher than was found on sites in the River of No Return and Rattlesnake Wildernesses. Thus the hypothesis that lower elevation sites in the Bob Marshall, with longer growing seasons, might be notably more resistant to vegetation damage than subalpine forests is incorrect. Instead there was more variation in resistance between plant communities within an elevational zone than between elevation zones. Subalpine forests with understories dominated by *Xerophyllum tenax*, as in the Rattlesnake Wilderness, are much more resistant than those with understories dominated by *Vaccinium scoparium*, as in the Eagle Cap Wilderness. In the Bob Marshall, several grassland sites lost less than 20 percent of their cover, while many of the forested sites with fragile understories lost more than 80 percent of their cover.

Despite the moderately low loss of vegetation cover, the change in species composition on Bob Marshall sites has been more dramatic than has been documented elsewhere. The invasion of introduced species has been particularly pronounced. Exotics constitute almost 15 percent of the campsite flora and are the most abundant species on most campsites. This invasion of exotics is promoted by heavy use of packstock (manure and feed are important seed sources) and is generally lacking on subalpine forest sites.

The elimination of essentially all tree seedlings on campsites is a finding common to all studies and attests to the extreme vulnerability of tree seedlings to trampling damage.

The increase in exposed mineral soil on Bob Marshall campsites is similar to that found on Mission Mountains sites (6 percent), but is considerably less than that found elsewhere (15 percent in the Boundary Waters to 25 percent in the Eagle Cap). The percentage of reduction in duff depth (relative change) is also somewhat less—45 percent in comparison to 51 percent on Eagle Cap sites and 60 to 65 percent on Boundary Waters sites. More duff has been removed (absolute change) from the Bob Marshall sites, however, than from the Eagle Cap sites—0.28 inches (0.7 cm) compared to 0.12 inches (0.3 cm). Apparently, more organic matter is lost from the Bob Marshall sites, but because the organic horizons are so thick to start out with, exposure of mineral soil is much less.

In the Bob Marshall wilderness, penetration resistance typically increased 71 percent, which is less than has been found elsewhere: Rattlesnake, 89 percent; Mission Mountains, 139 percent; and Boundary Waters, 220 percent. This may reflect the cushioning effect of thicker organic horizons or, more likely, it merely reflects inherent differences in soil characteristics. For example, undisturbed sites in the Bob Marshall have a higher penetration resistance than the campsites in the Mission Mountains.

Reductions in infiltration rates, perhaps the most meaningful measure of the effects of soil compaction, are more pronounced on Bob Marshall sites than on Eagle Cap sites. Both instantaneous and saturated rates on Eagle Cap campsites were still more than one-half of the rates on controls. In contrast, instantaneous rates on the Bob Marshall campsites were less than one-third of controls and saturated rates on campsites were one-sixth of controls.

Although disturbance of ground vegetation and soil is neither unusually high nor unusually low, the large size of the Bob Marshall sites and the amount of tree damage is unique. The size of the disturbed area on the median Bob Marshall site (4,360 ft^2; 405 m^2) is about twice the size of sites in the Eagle Cap (2,077 ft^2; 193 m^2) and Boundary Waters (2,830 ft^2; 263 m^2). The size of the area used for cooking and camping is similar in all three areas; the difference is the addition, in the Bob Marshall, of a large area disturbed by stock.

Given the character of use in the area—two-thirds of the parties have stock—this may be unavoidable. But the high level of tree damage on these sites is avoidable. The **percentage** of damaged trees on the campsites is comparable to other situations. In fact, the percentage of trees that have been felled is less than on Eagle Cap sites. It is the **number** of damaged trees that is so high on Bob Marshall sites. Compared to a median of 12 damaged trees per site in the Eagle Cap, the median Bob Marshall site had 63 damaged trees and one site had about 500. The median Eagle Cap site had 4 felled trees and 3 trees with exposed roots. Median values for the Bob Marshall sites were 15 felled trees and 28 trees with exposed roots (fig. 4 and 5). This high level of damage is a result of tying horses to trees and felling trees for tent poles—practices that are unusually prevalent in the Bob Marshall—as well as collecting firewood from standing trees and malicious or thoughtless chopping of trees—practices that are also common in other areas.

Figure 4.—The large number of trees felled on this campsite is typical of Bob Marshall sites.

Figure 5.—Exposure of tree roots is unusually pronounced on most Bob Marshall campsites and persists even when ground vegetation has recovered.

How Do Impacts on Backpacker, Horse, and Outfitter Camps Compare?

Elsewhere I have suggested that the type of use a site receives and the behavior of the campers that use it will usually have more effect on amount of damage than how many people use the site (Cole 1981a). To some extent this is illustrated by certain types of impact being unusually pronounced on Bob Marshall sites despite relatively low levels of use compared to Eagle Cap and Boundary Waters sites. The importance of type of use is also suggested by a comparison of the condition of the backpacker, horse, and outfitter sites that were examined.

Before reporting the data, it is important to stress their limitations. Differences in campsite condition cannot be attributed entirely to differences in type of use. Amount of use differed greatly, with many horse camps receiving more use than outfitter camps, which received more use than the backpacker camps. The inherent ability of the sites to resist damage also varied. Generally, outfitter camps were located on most resistant sites and backpacker camps were located on least resistant sites. Finally, some backpackers and outfitters use private horse camps, and some backpackers and private horse parties use outfitter camps. Nevertheless, the nature of the differences between these types of sites suggests that the predominant type of use each site receives is the major determinant of amount of impact.

Campsite area is smallest on backpacker sites (fig. 6), being generally less than one-third the size of other sites (table 8). This difference is primarily a result of fewer large backpacking parties. The lack of a significant difference in the camp area of horse and outfitter camps is misleading because outfitter camps consisted of many dispersed tent sites that were generally not included in the camp area measure. Differences in bare area are not significantly different, but none of the backpacker sites had the large bare area that a few of the horse and outfitter sites did.

Figure 6.—A relatively small campsite mainly used by backpackers.

Table 8.—Size of disturbance in relation to type of use*

	Camp area			Bare area			Disturbed area		
Type of use	**Median**	**Range**		**Median**	**Range**		**Median**	**Range**	
	Square meters								
Backpacker	76	58–175	a	3	2–34	a	76	58–175	a
Horse	251	200–404	b	13	5–291	a	456	200–1,204	b
Outfitter	233	145–443	b	14	0–100	a	3,143	408–10,600	c

*Any two sets of median and range values followed by the same letter are not significantly different at the 95 percent confidence level, using the randomization test for two independent samples.

The most pronounced differences are in the size of the disturbed area—the camp area plus other discontinuous disturbed areas. The median horse camp is 6 times larger than the median backpacker site. The median outfitter camp is 7 times larger than the horse camps and 41 times larger than the backpacker camps. These differences result from differences in party size (outfitter groups are generally larger than private horse groups, which are larger than backpacker groups), the addition of an area damaged by stock on the horse and outfitter camps, and a Forest Service policy of spreading out facilities on outfitter sites (fig.7).

Tree seedling loss is generally 100 percent regardless of the type of use (table 9). Damage to mature trees, however, is considerably more extensive on horse and outfitter sites. Essentially all trees on the campsites are damaged, but the number of such trees increases from a median of 5 on backpacker sites to 56 on horse sites and 100 on outfitter sites. A similar pattern applies to numbers of felled trees and trees with exposed roots, except that for these parameters the percentage of trees damaged is also lower on backpacker sites. Differences between horse and outfitter sites are not consistent enough to be statistically significant. The differences between backpacker sites and other sites are a function of size of the campsite, the need to hold stock on or adjacent to horse and outfitter camps, and the damaging practices of tying horses to trees and felling trees for tent poles (generally not done by backpackers because they carry their own tent poles) or forfirewood.

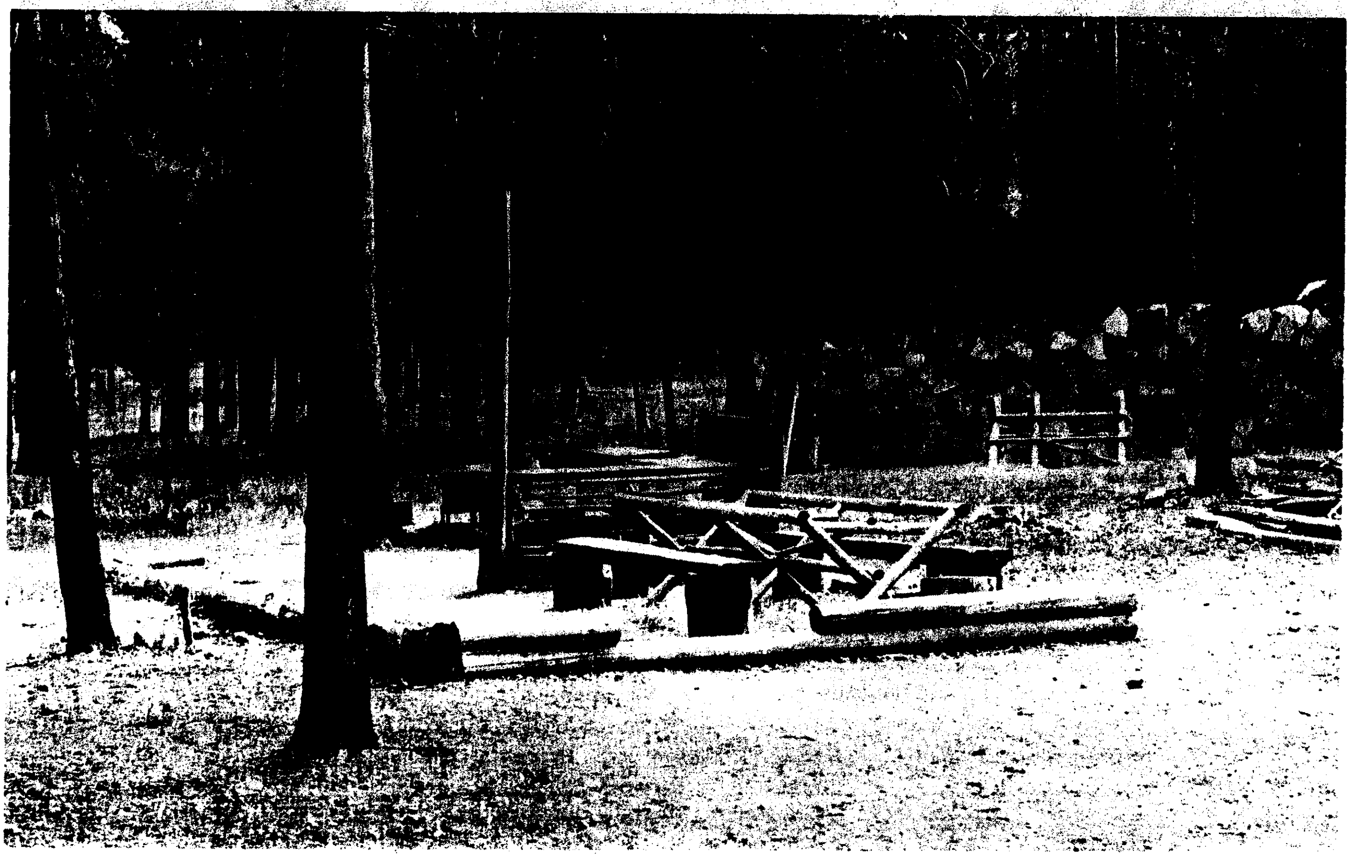

Figure 7.—Semipermanent tent frames, woodpile, and kitchen facilities typical of outfitters' camp.

Table 9.—Tree damage on campsites in relation to type of use*

Type of use	Seedling loss Median	Seedling loss Range		Damaged trees Median	Damaged trees Range		Felled trees Median	Felled trees Range		Trees with exposed roots Median	Trees with exposed roots Range	
	Percent			Number of trees in disturbed area								
Backpacker	100	100	a	5	3-29	a	0	0-8	a	1	0-4	a
Horse	100	92-100	a	56	21-180	b	8	0-33	b	25	10-38	b
Outfitter	100	100	a	100	23-500	b	15	3-250	b	37	13-100	b

*Any two sets of median and range values followed by the same letter are not significantly different at the 95 percent confidence level, using the randomization test for two independent samples. Seedling loss is relative change.

As was the case with bare area and seedling loss, there are no significant differences between backpacker, horse, and outfitter camps in the amount of surviving vegetation cover (table 10). There are also no differences in absolute or relative vegetation change. There are, however, some small, but statistically significant, differences in the amount of change in species composition. Backpacker sites have experienced less change than horse sites. Outfitter sites have the highest floristic dissimilarity value (76 percent), but they cannot be distinguished statistically from either backpacker or horse sites.

The most pronounced vegetational difference is in the degree to which these sites have been colonized by introduced and annual species (table 11). Introduced species account for only 5 percent of the cover on backpacker sites compared with 43 percent on horse sites and 61 percent on outfitter sites. Annuals, which are very rare in undisturbed places, are absent on most backpacker and horse sites but comprise 17 percent of the cover on outfitter sites.

Soil exposure generally increases from backpacker sites (5 percent) to horse (9 percent) and outfitter sites (33 percent). This corresponds with a gradient in duff depth from backpacker sites (0.9 in, 2.2 cm) to horse (0.5 in, 1.2 cm) and outfitter sites (0.1 in; 0.2 cm) (table 12). On Eagle Cap campsites, these are the types of change that were most aggravated by increases in amount of use. Thus these differences may reflect heavier use of horse and outfitter sites as well as differences in type of use.

Differences in penetration resistance on the three types of sites were not statistically significant. Penetration resistance values were highest on horse sites, and this difference is reflected in significantly slower infiltration rates on horse sites than on either backpacker or outfitter sites. All of these differences between types of sites are less pronounced than differences between any of these sites and controls, however.

Table 10.—Groundcover conditions on campsites in relation to type of use*

	Vegetation cover		Floristic dissimilarity		Soil exposure	
Type of use	Median	Range	Median	Range	Median	Range
	Percent					
Backpacker	26	10-59 a	62	31-72 a	4.6	0.7-13.3 a
Horse	33	6-45 a	69	63-89 b	9.3	.7-39.1 b
Outfitter	30	13-80 a	76	48-97 a,b	32.9	11.9-44.5 c

*Any two sets of median and range values followed by the same letter are not significantly different at the 95 percent confidence level, using the randomization test for two independent samples.

Table 11.—Relative cover of introduced and annual species in relation to type of use*

	Introduced species		Annual species	
Type of use	Median	Range	Median	Range
	Percent			
Backpacker	5	1-14 a	0	0-4 a
Horse	43	0-58 b	1	0-9 a
Outfitter	61	15-82 c	17	1-60 b

*Any two sets of median and range values followed by the same letter are not significantly different at the 95 percent confidence level, using the randomization test for two independent samples.

Table 12.—Soil condition on campsites in relation to type of use*

	Duff Depth		Penetration resistance		Infiltration rates: Instantaneous		Infiltration rates: Saturated	
Type of use	Median	Range	Median	Range	Median	Range	Median	Range
	cm		*kg/cm²*		*cm/min*			
Backpacker	2.2	1.1-4.4 a	2.6	2.3-4.3 a	1.0	0.5-3.3 a	0.3	0.2-0.7 a
Horse	1.2	.1-2.1 b	4.0	2.1->4.5 a	.1	.1-.5 b	.07	.04-.1 b
Outfitter	.2	.1-.5 c	3.6	3.1-4.2 a	.8	.1-1.5 a	.2	.03-.6 a

*Any two sets of median and range values followed by the same letter are not significantly different at the 95 percent confidence level, using the randomization test for two independent samples.

MANAGEMENT IMPLICATIONS

My initial hypothesis that impacts on these relatively low-elevation campsites might be much less severe than those found elsewhere proved to be false. Impacts resulting from trampling—loss of vegetation cover and organic horizons, and compaction of soil—were not very different from what has been found elsewhere. Vegetation loss is moderately low, but this is a result of the dramatic colonization of these sites by nonnative species. The situation is similar to many auto camp and picnic areas, where loss of vegetation cover is reduced by an invasion of introduced species (LaPage 1967; Brown and others 1977). Exposure of mineral soil is also low, but this reflects unusually thick organic horizons to start with. The amount of organic material lost as a result of trampling is as great here as elsewhere.

Instead these sites proved in some ways to be damaged to an unusually high degree, primarily as a result of the high proportion of large parties with stock and the prevalence of certain camping practices. For individual campsites, as opposed to campgrounds composed of numerous clustered sites, these camping areas are unusually large, and they have experienced exceptionally widespread tree damage.

A certain amount of this damage must be accepted. In fact, the largest campsites are the outfitter camps and a major reason for their large size is a Forest Service policy that encourages outfitters to spread their facilities. Aside from reevaluating this policy, the only ways to reduce the size of these areas are to cut back on party size (current party size limits are 15 hikers or riders and 35 head of stock) and to provide smaller holding areas for stock—hitchrails or corrals. This latter suggestion is likely to be most effective, particularly in areas that are frequently used. It would have the added positive effect of reducing the need to tie stock to trees, thereby cutting back on the exposure of tree roots. More visitors to the Bob Marshall considered pole corrals to be desirable than undesirable (Lucas 1980), and they have already been built in certain areas. On the other hand, they should be built only where absolutely necessary because over one-third of the visitors surveyed considered them to be undesirable.

Much of the trampling damage must also be accepted. Damage to vegetation and soil is only moderate and is the inevitable result of use. Vegetation loss, in particular, is as pronounced on backpacker sites as on horse camps. Because backpacker sites are less frequently used than horse sites, this suggests that neither reducing amount of use nor changing type of use is likely to substantially reduce trampling damage. The most effective means of minimizing these impacts is to influence where people camp.

Of the campsites examined, trampling damage was least pronounced on the grassland sites. The median vegetation loss on seven campsites located either in grasslands or open forests with a grassy understory was only 20 percent; the greatest loss on a grassy site was only 48 percent. In contrast, the median loss on six sites located on the *Abies lasiocarpa/Linnaea borealis* (subalpine fir/twinflower) habitat type (Pfister and others 1977) was 62 percent, and on seven sites located on the *Pseudotsuga menziesii/Symphoricarpos albus* (Douglas-fir/snowberry) habitat type was 66 percent. Vegetation loss was particularly pronounced on the *Abies lasiocarpa/Vaccinium caespitosum* (subalpine fir/dwarf huckleberry) habitat type; the median loss on 7 sites was 84 percent. Thus grassland sites here, as elsewhere (Weaver and Dale 1978; Cole 1981b), are the most resistant to damage (fig. 8). The lists of resistant and sensitive species (tables 5-7) can be used to judge site resistance.

In areas that are frequently used, impacts might be minimized by encouraging camping on already well-worn sites. It is particularly important for parties with a high potential for causing damage—parties that are large, have packstock, and build campfires—to use well-worn sites rather than create new campsites. As mentioned before, in some popular areas building hitchrails or a corral would concentrate stock damage within a campsite. In such areas, choosing a campsite in a resistant location is less important than using existing campsites and choosing sites that are out of the way of other parties. Campers should still avoid particularly sensitive sites, however.

In less frequently used areas, impacts might be minimized by encouraging parties to spread out among a large number of resistant campsites so that no site is used often enough to show evidence of use. This is particularly effective in grasslands or on areas without vegetation—sites that are resistant to damage. Visitors should be able to select sites that show no evidence of previous use and to leave little trace of their having used the site. Parties that are not prepared to do this should use well-worn sites. Obviously used but lightly impacted sites should be avoided because they will deteriorate quickly with increased use.

In the Bob Marshall, damage to trees is more serious than trampling damage. This damage is avoidable and unnecessary. Visitors should be educated so that they will not (1) hack and carve trees, hammer nails into trees, or break off branches for firewood; (2) cut down standing trees—dead or alive; or (3) tie stock to trees. These are the actions that have damaged Bob Marshall sites to an unusual extent.

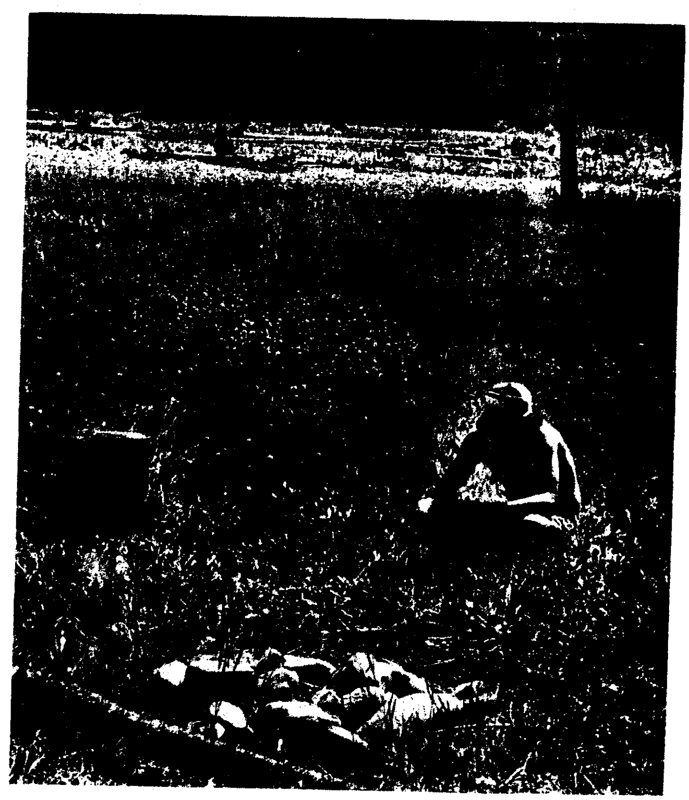

Figure 8.—Early-season photograph illustrating yearly vegetation recovery on resistant grassland campsites.

The purpose of not doing these things is to leave as little evidence of human use as possible. The ecological effects of tree damage are not highly significant. Very few trees are mortally wounded and the number of trees damaged, when compared to all the other trees, is of little significance. The problem is that at almost every campsite there is abundant evidence of use and what many consider to be abuse. Given the intent and spirit of the Wilderness Act, to preserve natural conditions, "with the imprint of man's work substantially unnoticeable," every visitor should strive to avoid leaving evidence of his presence.

Hacking or felling trees is prohibited in many wildernesses. Hacking trees, like littering and other thoughtless behavior, can be reduced by telling people why they should not do it. Nails are hammered into trees to provide campsite conveniences, such as clotheslines and places to hang things. It will probably be difficult to convince visitors that such conveniences are not appropriate in wilderness. The same is true of breaking branches off trees or felling standing trees for firewood. Visitors will need to accept the inconvenience of walking a bit farther to find downed wood rather than deface standing trees.

It will be even more difficult to change the time-honored practices of felling trees for tent poles and tying horses to trees. Such practices did not create serious problems when few parties ventured into the woods. In recent years, the need to minimize the impacts resulting from these practices has been well recognized, but managing agencies have had little success in controlling them.

Several wildernesses prohibit both of these practices. In the Bob Marshall, where this camping style is traditional, education is probably a more appropriate vehicle for change. Many parties could probably be convinced to use the standard lightweight tents that are used by backpackers and are prevalent in most wildernesses. Although they provide fewer of the comforts of home, they are lighter and more compact than canvas tents. Where condoned by the Forest Service, poles should be stored in plain sight, so others will not cut new ones. For this to work, other users need to be taught that cutting and storing poles is appropriate in the area, so they should not be thrown away or burned for firewood. This may be difficult since in most other areas visitors have been taught that this is not appropriate. People felling trees for poles should cut them away from camps and trails where the stumps that remain are not visually obtrusive.

I have suggested that providing corrals or hitchrails at the most popular campsites would partly solve problems resulting from tying stock to trees (fig. 9). These have already been built in a few places in the Bob Marshall. While such facilities do provide a visitor convenience, they are primarily there for resource protection and can be justified on those grounds.

If such facilities are provided, it might also be desirable to inform visitors, both at trailheads and on maps, of where these facilities are located. This information will allow people that are bothered by such facilities to go elsewhere or at least to know what to expect. It will also direct novices to these sites. This is particularly important because novices, especially those with stock that have had little experience with wilderness travel, have the greatest potential to inflict damage. Although total use of the site is likely to increase, per capita impact on the site should be reduced by the protective facilities provided and unprotected sites elsewhere will be used less frequently. Protective measures may need to be taken, however, to mitigate other effects of increased use, such as increased litter or human waste problems.

Figure 9.—Hitchrails confine packstock trampling to a small area and avoid damage resulting from tying stock to trees.

In most places, such facilities cannot be provided. Stock parties visiting such areas should be prepared to use restraining techniques other than tying horses to trees. Miller (1974) and the USDA Forest Service (1981) provide excellent suggestions on effective stock-holding techniques that have less impact on the land. Hobbling is the best technique if stock are properly trained. Stock can also be tied with halter ropes to a hitchline tied, above the horse's head, between two trees. If a cut pole is available, a hitchrail can be made by tying the pole between two trees. Picketing and staking are potentially damaging; these practices should be avoided unless great care is taken to avoid trampling damage and overgrazing.

The keys to improved management of campsite impacts in the Bob Marshall are in decreasing order of importance, educating visitors on minimum impact camping techniques, influencing where people camp, and providing stock-holding facilities in selected locations. Limiting use would contribute little to improvement in conditions, although a reduction in party size, particularly in the allowable number of stock, could lead, in time, to a significant reduction in the size of these large campsites. With such programs in place, it should be possible to avoid further tree damage and to confine serious trampling damage to the few frequently used places where such damage cannot be avoided. Nevertheless, the effectiveness of any program implemented should be evaluated by making periodic inventories of the number of campsites and their condition.

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APPENDIX

Cover and frequency of uncommon species on campsites and controls.

Species	Frequency of occurrence		Mean cover		Mean relative cover	
	Camps	Controls	Camps	Controls	Camps	Controls
	----- *Number* -----		----------------- *Percent* -----------------			
Acer glabrum	0	1	0.0	1.0	0.0	0.7
Actaea rubra	0	2	.0	1.0	.0	.5
Agastache urticifolia	0	1	.0	10.0	.0	5.3
Agropyron caninum	5	5	1.5	3.1	1.9	1.5
Agropyron spicatum	1	1	.3	5.0	.9	2.9
Agrostis exarata	0	1	.0	3.0	.0	1.1
Amelanchier alnifolia	1	6	.3	2.3	2.9	1.6
Angelica arguta	1	4	.1	2.3	.2	1.0
Antennaria racemosa	3	5	.3	2.7	.8	1.3
Apocynum androsaemifolium	0	2	.0	7.0	.0	4.0
Arabis holboellii	2	1	.1	.3	.2	.2
Arenaria congesta	1	1	1.2	4.0	1.3	2.1
Arenaria macrophylla	2	5	.3	3.0	2.2	1.4
Artemisia ludoviciana	0	1	.0	5.0	.0	1.9
Artemisia tridentata	0	1	.0	1.0	.0	.4
Aster chilensis	2	4	.4	4.3	1.0	2.2
Aster laevis	1	2	.7	4.5	1.7	2.3
Aster modestus	0	1	.0	5.0	.0	2.2
Astragalus alpinus	4	2	.2	2.4	.6	1.1
Astragalus robbinsii	0	4	.0	2.0	.0	1.1
Bromus carinatus	0	4	.0	11.5	.0	7.5
Bromus vulgaris	4	7	1.0	8.9	3.8	4.0
Calamagrostis canadensis	0	2	.0	6.5	.0	2.7
Calochortus apiculatus	3	6	.5	2.0	.6	1.0
Carex concinnoides	3	9	.1	2.3	.3	1.2
Carex filifolia	1	0	5.3	.0	4.2	.0
Carex hoodii	5	2	3.9	6.0	3.9	3.4
Carex limnophila	1	0	1.1	.0	1.4	.0
Carex microptera	3	1	1.8	3.3	2.4	1.3
Carex xerantica	1	0	1.3	.0	1.8	.0
Castilleja miniata	1	1	.1	1.0	.2	.6
Ceanothus velutinus	0	1	.0	1.0	.0	.8
Chimaphila umbellata	0	3	.0	1.0	.0	.7
Clematis ligusticifolia	3	4	.7	2.6	1.9	1.1
Clintonia uniflora	0	1	.0	25.0	.0	14.4
Collomia linearis	2	2	.7	1.0	.8	.5
Corydalis aurea	1	0	.1	.0	1.1	.0
Crepis atrabarba	2	2	5.6	8.0	5.9	4.9
Deschampsia elongata	2	2	0.7	2.7	1.7	1.0
Epilobium watsonii	2	2	.1	.5	.3	.3
Equisetum arvense	3	4	.6	14.0	4.1	5.5
Equisetum hyemale	0	1	.0	2.0	.0	1.1
Equisetum laevigatum	1	1	.3	10.0	.5	4.3
Erigeron compositus	1	0	1.0	.0	.8	.0
Erigeron glabellus	2	1	.7	1.5	1.0	1.0
Erigeron speciosus	6	6	.6	2.1	1.0	1.1
Eriogonum umbellatum	2	4	.4	2.0	.4	.9
Erythronium grandiflorum	4	3	.5	2.0	4.6	1.0
Festuca idahoensis	2	4	1.6	5.4	1.3	2.2
Festuca occidentalis	0	1	.0	25.0	.0	13.4
Festuca scabrella	1	6	.1	11.2	.1	5.9
Gaillardia aristata	0	2	.0	1.0	.0	.5
Galium triflorum	1	5	.1	2.8	.3	1.2
Gentiana calycosa	0	2	.0	1.0	.0	.5
Geranium viscosissimum	4	4	.2	2.2	.5	.9
Geum macrophyllum	4	3	.5	2.4	1.1	1.1
Goodyera oblongifolia	0	3	.0	1.3	.2	.6
Habenaria unalascensis	0	1	.0	2.0	.0	.7

Appendix.—(con.)

Species	Frequency of occurrence		Mean cover		Mean relative cover	
	Camps	Controls	Camps	Controls	Camps	Controls
	----- Number -----		---------------- Percent	----------------		
Hedysarum boreale	1	1	.1	7.0	.2	3.0
Hedysarum occidentale	0	1	.0	3.0	.0	1.7
Heracleum lanatum	0	5	.0	4.0	.0	2.1
Hieracium albertinum	2	4	.3	1.4	.4	.7
Hieracium albiflorum	4	3	.8	1.0	1.4	.7
Juncus balticus	1	0	.1	.0	1.1	.0
Juncus confusus	1	2	.1	1.0	.1	.4
Lomatium triternatum	2	1	.2	1.0	.2	.4
Lonicera involucrata	0	3	.0	6.3	.0	3.3
Lonicera utahensis	0	5	.0	3.2	.0	1.5
Luzula campestris	1	0	3.7	.0	2.9	.0
Luzula hitchcockii	0	1	.0	4.0	.0	2.8
Melampyrum lineare	0	1	.0	1.0	.0	.8
Melica subulata	1	3	.1	3.0	.1	1.4
Menziesia ferruginea	0	4	.0	7.8	.0	5.0
Mitella breweri	0	2	.0	3.0	.0	1.6
Mitella nuda	0	1	.0	10.0	.0	3.9
Muhlenbergia filiformis	1	1	1.5	5.0	1.9	2.0
Osmorhiza occidentalis	2	2	1.7	1.0	2.2	.4
Oxytropis campestris	1	1	7.1	1.0	5.8	.3
Oxytropis splendens	1	0	.2	.0	.3	.0
Pedicularis contorta	0	2	0.0	3.5	0.0	1.7
Phleum alpinum	1	0	.9	.0	.7	.0
Poa juncifolia	1	0	8.3	.0	11.3	.0
Poa nervosa	1	1	.5	15.0	1.8	8.7
Poa sandbergii	0	1	.0	8.0	.0	3.0
Polemonium pulcherrimum	2	1	1.7	1.0	11.4	.6
Potentilla fruticosa	1	7	.3	4.0	.4	2.0
Prunus virginiana	0	1	.0	3.0	.0	1.2
Pyrola chlorantha	1	2	.1	4.5	.3	2.5
Pyrola picta	0	1	.0	1.0	.0	.6
Pyrola uniflora	0	1	.0	1.0	.0	.4
Ranunculus uncinatus	2	1	1.0	1.5	1.2	.6
Ribes lacustre	1	5	.1	1.8	.1	.9
Rubus idaeus	0	1	.0	1.0	.0	.6
Rubus parviflorus	0	2	.0	2.5	.0	1.5
Salix scouleriana	0	1	.0	15.0	.0	8.8
Senecio canus	3	3	.1	1.4	.2	.7
Senecio integerrimus	5	2	.2	2.8	.6	1.3
Senecio triangularis	0	4	.0	10.3	.0	5.4
Sitanion hystrix	0	1	.0	2.0	.0	1.2
Smilacina racemosa	1	3	.1	.8	.1	.4
Sorbus sitchensis	0	2	.0	2.0	.0	.9
Stipa richardsonii	2	4	2.4	9.0	4.2	4.4
Tiarella trifoliata	1	2	.1	1.7	.2	1.1
Trisetum spicatum	0	1	.0	2.0	.0	1.2
Urtica dioica	1	1	.3	2.5	.4	1.4
Valeriana sitchensis	0	2	.0	1.0	.0	.7
Vaccinium globulare	3	4	.3	14.3	2.9	9.7
Vaccinium scoparium	5	4	.5	7.8	1.7	4.4
Veratrum viride	1	1	.1	2.0	7.7	1.4
Viola glabella	0	2	.0	2.5	.0	1.1
Viola orbiculata	2	6	.1	4.5	1.5	2.2

Cole, David N. Campsite Conditions in the Bob Marshall Wilderness, Montana. Res. Pap. INT-312. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station; 1983. 18 p.

The condition of campsites was examined in the Bob Marshall Wilderness, Montana. The amount of change that has occurred on these sites was inferred by comparing campsites with comparable control sites. Trampling disturbance—loss of vegetation, exposure of mineral soil, and compaction of the soil—was generally comparable to that found in other backcountry areas. Campsites were unusually large, however, and tree damage was severe. Such impacts were particularly pronounced on sites used by outfitters and large parties with stock. Actions for reducing damage are suggested.

KEYWORDS: ecological impact, campsites, wilderness, backcountry management, outfitters, packstock, Montana, Bob Marshall Wilderness

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