

Effectiveness of a Confinement Strategy in Reducing Pack Stock Impacts at Campsites in the Selway-Bitterroot Wilderness, Idaho

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Abstract—In 1993, a management program was initiated in the Seven Lakes Basin in the Selway-Bitterroot Wilderness to bring high levels of campsite impact into compliance with management standards. The core of the strategy involved confining use, particularly by stock groups, and restoring certain campsites and portions of campsites. In just five years, campsite impacts were reduced substantially. Disturbed and bare area decreased on campsites, as did tree scarring and mineral soil exposure. Vegetation cover increased. The only impact parameter that continued to get worse was tree root exposure. Continuation of this program would likely reduce the extent of disturbance to less than one-third of the disturbance that existed before implementation. Fiscal costs were substantial, but experiential costs were judged to be minimal. This program should provide a good model for other wildernesses with campsite problems in certain destination areas.

One of the goals of wilderness recreation management is to avoid ecological impacts and provide opportunities for high-quality wilderness experiences. Another goal—which often conflicts with the former—is to provide access for these experiences and to avoid restriction and regulation, which can make experiences seem “confined.” Conflict between these two goals usually results in some compromise of both.

Ecological impacts are most problematic in campsites in popular destination areas. Proliferation of new campsites, leading to unnecessarily high campsite densities, has been a common trend over the past few decades (Cole 1993). Specific impacts include damage to overstory trees, loss of vegetation, changes in species composition, soil compaction, loss of organic horizons and exposure of mineral soils (Cole 1983). The worst sites are almost as compacted as pavement, have been without groundcover vegetation for half a century or more and have numerous scarred trees with roots exposed in tree wells.

Ecological impacts are particularly severe where pack stock use is common because, everything else being equal, groups traveling with horses and mules create more intense

impacts than groups traveling on foot (Cole 1983, Weaver and Dale 1978, Whinam and Comfort 1996). The trampling impacts of stock are qualitatively similar to those of hikers, but more severe (Cole and Spildie 1998, Deluca and others 1998). Impacts associated with grazing and confinement of stock are qualitatively unique to stock use and can be the most severe impacts of all (McClaran and Cole 1993). However, empirical studies of pack stock impacts are rare. Particularly lacking is information on pack stock management strategies and stock use handling techniques.

Increasingly, wilderness management plans are based on a goal-achievement framework, such as Limits of Acceptable Change (LAC) (McCool and Cole 1997). Such plans establish standards for maximum acceptable impact levels. If monitoring indicates that these standards are not being met, management actions that can eventually meet standards are required. Standards are often written for campsite impacts, and many wilderness plans report that there are certain destination areas—often lake basins—where campsite impact standards, such as number of campsites per square mile, are exceeded. The prevalence of this situation suggests the need to identify effective programs for bringing campsite impacts up to standard.

The goal of this paper is to describe a case study conducted in the Seven Lakes Basin in the Selway-Bitterroot Wilderness, Idaho, a destination area in which standards for both campsite density and intensity of campsite impact were violated. The management actions, implemented in 1992, were designation of a small number of stock campsites, closure of some sites to all use and intensive restoration of many sites and trails. This is a version of a containment strategy, one of the most effective approaches to minimizing ecological impact in a heavily used destination (Marion 1995). Specifically, this paper presents data on how the number of campsites and intensity of impact changed between 1993 and 1998 as a result of the implemented management program. We also outline the costs of this management program and discuss the management implications of our findings.

Seven Lakes Basin and Its Management Program

The study area (Seven Lakes Basin) consisted of two adjacent subalpine lake basins (Seven Lakes itself and the Maude-Lottie Lake basin) in the southcentral part of the 540,000 ha Selway-Bitterroot Wilderness, Idaho. The total area of Seven Lakes Basin is about 500 ha. The basin

In: Cole, David N.; McCool, Stephen F.; Borrie, William T.; O'Loughlin, Jennifer, comps. 2000. Wilderness science in a time of change conference—Volume 5: Wilderness ecosystems, threats, and management; 1999 May 23–27; Missoula, MT. Proceedings RMRS-P-15-VOL-5. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

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contains 11 lakes and is located at an elevation of 1,860-2,000 m. It can be accessed within one day from the Wilderness Gateway trailhead but requires a climb of about 1,000 m in the last 10 km of the 19 km trail. We excluded the area around the two northeasternmost lakes (Rock Lake and Surprise Lake) and the two southwesternmost lakes (unnamed) from our study because few management actions have been taken at these lakes and because they are either physically separated from the others or seldom visited. Use levels in the basin are moderate. Records show that there are virtually never more than four other groups in the basin at one time. Most visitors are fishermen who camp near a lake for several days (many with pack stock). Many groups with pack stock camp at lower meadows, where there is more feed, and visit the basin on day rides.

The Selway-Bitterroot Wilderness Limits of Acceptable Change Plan established standards for the Wilderness that were not being met at Seven Lakes. In this class III area (on a scale with class IV accepting the most impact), campsite density should not exceed three campsites per square mile. There should be no extremely impacted campsites and no more than one moderately impacted campsite per square mile. Monitoring showed that previous recreation use, particularly by groups with pack stock, has left 26 substantially impacted campsites in the area (fig. 1). Campsite density was as high as 13 campsites per square mile, the number of extremely impacted campsites reached five per square mile, and the number of moderately impacted sites reached four per square mile. To reach standards, as many as 10 campsites per square mile needed to be closed and

restored, and up to five extremely impacted campsites and three moderately impacted sites needed either improvement or restoration.

To make progress toward the goals established in the Wilderness LAC plan, a restoration plan was developed for the Seven Lakes Basin in 1992. This plan established more realistic short-term (“interim”) standards, although ultimately the original LAC standards were to be met. These interim standards called for reducing density to no more than eight campsites per square mile and reducing the number of intensively impacted campsites, while leaving at least one campsite open for stock use at each of the major lakes. These objectives were to be met by implementing management actions. The most important of which were (1) the designation of three day-use stock containment areas and six overnight stock containment areas, where stock are to be tethered between designated trees with a high line, rope or electric corral, (2) the prohibition of stock containment on other campsites or other parts of designated campsites, and (3) the prohibition of all camping on four campsites. Tying stock directly to trees or in places where tree roots can be damaged was prohibited. Stock numbers were limited to a maximum of 10 animals.

Regulations on where to camp and contain stock were communicated to the public on a brochure, signs on bulletin boards at the trailhead and at the entry point to the lake basin in all trails, in local newspapers and by frequent visits of wilderness rangers to the area. Compliance was enforced through special orders and heavy ranger presence. Some trails in the basin were reconstructed; about 1 km of trail

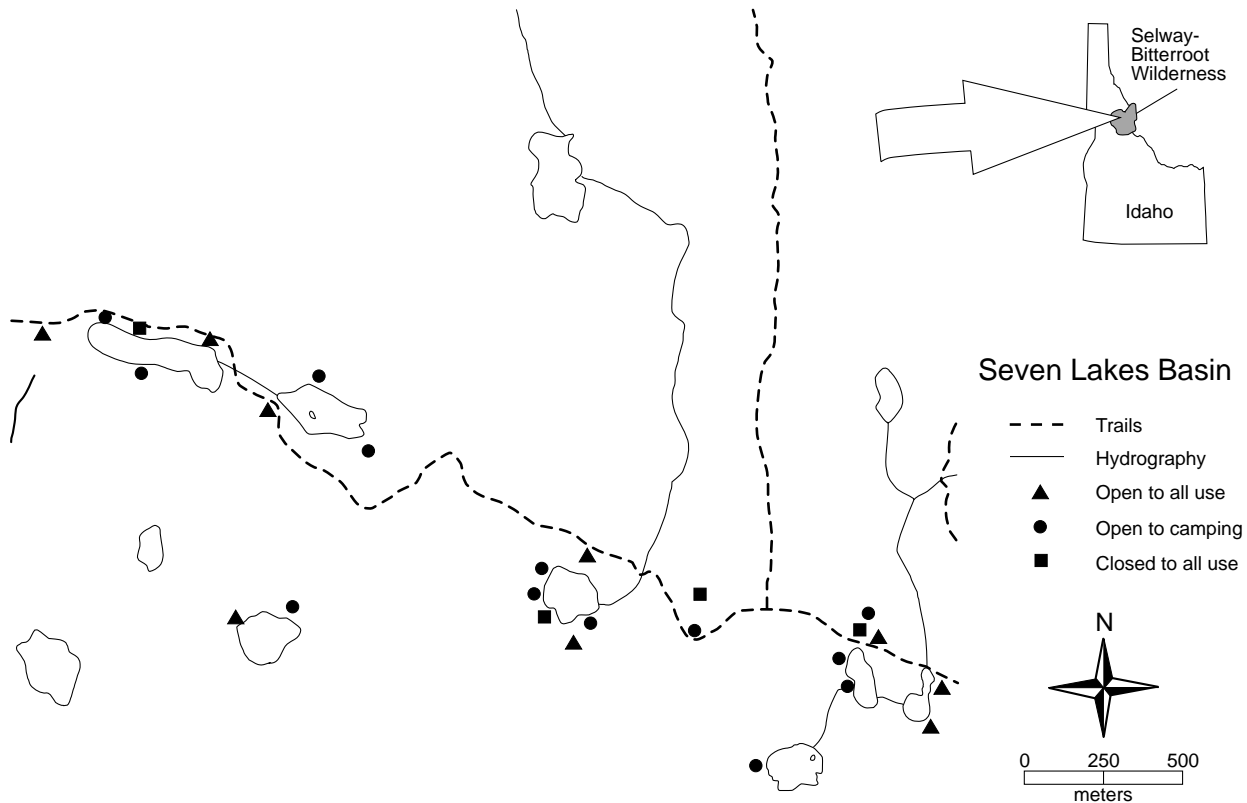


Figure 1—Location of campsites, differentiated by closure category, in the Seven Lakes Basin study area.

was rerouted, and another km of trail was closed and rehabilitated. Two bridges were built. Forty-seven former stock-holding areas were closed to stock containment. These areas were generally adjacent to clumps of trees with roots and mineral soil exposed by decades of tying horses to trees. These 47 areas were on 12 campsites that were closed to stock use, six campsites that remained open to stock use and one former campsite where day-use containment only of stock is allowed. Designated high line trees were signed at each of the six open stock campsites with a designated stock-holding area and the three day-use stock-holding areas. These campsites, where stock use is still allowed, were signed, as were four campsites that were closed to all use. Most closed areas were intensively restored. Seeds were collected, and about 2000 seedlings of three species, intermediate oatgrass (*Danthonia intermedia*), partridgefoot (*Luetkea pectinata*), and beargrass (*Xerophyllum tenax*), were propagated at the University of Idaho Forestry Nursery and packed up to the basin. Soils were scarified, organic matter was added to soils, and large rocks were used as "icebergs" (placed to protrude from the ground, making the site undesirable for camping). Stumps were flush-cut and tree wells were filled with soil. Pitch and charcoal were applied to trees to minimize evidence of tree scarring. Propagated seedlings, locally collected seed and local transplants were used to revegetate areas. Finally, some areas were covered with a mulching material. Campsite impact conditions were monitored over the period.

This work was largely accomplished by two people who shared one seasonal wilderness ranger position ranger, about four weeks of work per year. A six-person Student Conservation Association (SCA) crew assisted for two years (for a total of 2,400 person hours), and a seven-to-eight person Appalachian Mountain Club crew assisted for two years (total of 768 person hours). Other volunteers, including many from the IDAWA project, a partnership between the Forest Service and the Iowa Department of Education, contributed 720 person hours of work.

Field Methods

In this study, we assessed conditions on designated stock campsites (sites on which stock use continues), former stock campsites (sites on which stock use is no longer allowed), and backpacker campsites (sites on which stock use has seldom occurred). Designated stock campsites contained three different types of areas: (1) a camping area; (2) former stock-holding area(s); and (3) a designated stock-holding area. We assessed impacts, using different methods, on each of these three types of areas. In addition, we monitored change on an adjacent, undisturbed control site. Former stock campsites, on which either all camping or camping with stock is prohibited, had a camping area and former stock-holding area(s). Backpacker campsites had a camping area only.

Camping Areas

Although old campsite monitoring data were available, protocols had changed enough through the years that some could not be used for comparisons. Consequently, we reinventoried each camping area, the area around tents and

cooking areas in July 1993. We used a rapid inventory approach, referred to in Cole (1989) as the Bob Marshall method, where it was first developed. This procedure involves rapid estimates of vegetation cover, exposed soil cover, tree damage, root exposure, level of development, cleanliness, number of social trails, camp area and barren core area. In addition, radial transects were used to more precisely estimate the camp area (area evidently disturbed by use) and the barren core area (area completely devoid of vegetation in the most heavily used part of the camp). These procedures, with the exception of the radial transects, were repeated on each camping area in August 1998.

Former Stock-Holding Areas

Forty-seven distinct former stock-holding areas were found on 19 different campsites used by stock. Six of the 19 campsites remain open to stock use, one is now a day-use stock-holding area, and 12 have been closed to stock use. Where stock use continues, containment is confined to designated areas and is not allowed on the former stock-holding areas. In each of the former stock-holding areas, we established a permanent center point (marked with a buried nail). We measured the distance and direction from this point to (1) the first vegetation and (2) the edge of obvious disturbance along a variable number of radial transects. The number and location of transects are the minimum needed to capture the shape of the campsite (Marion 1991). The distances to the first vegetation define bare area, while distances to disturbance define the disturbed area of the former stock-holding area. Within the perimeter of the disturbed area—assuming straight lines between adjacent transect end points—we assessed impacts to trees. For each tree greater than 2.5 cm d.b.h., we noted whether the tree was alive, dead and standing, a cut stump or a stump of undefined origin; measured the areal extent of scarring to the bole (considering linear slices to have a width of 0.5 cm if they were narrower than this); and measured the linear extent of exposed roots at least 2.5 cm wide. Percent cover of live vegetation and exposed mineral soil was visually estimated in 1-m square quadrats, using 10% cover classes or to the nearest percent if cover was less than 10%. Quadrats were located along one to four transects running between the center point and end points (located at the edge of the disturbed area and permanently marked with buried nails) in cardinal directions. Number of transects, quadrats per transect and total quadrats varied with the size and configuration of the area. On the smallest area, only one quadrat was assessed. The maximum number of quadrats was 12. When aggregated to the campsite level, seven campsites had between one and four quadrats in their former stock-holding areas; seven had between 5 and 13 quadrats, and five had between 14 and 23 quadrats.

Designated Stock-Holding Areas

The nine designated stock-holding areas have two trees designated as high line trees. Stock should be confined in a rectangle between these two trees. We established a transect between the two trees, permanently marking the center point of this transect. Then we established four permanent

points at the corners of the rectangle, 4 m perpendicular from each of the endpoints of the initial transect (adjacent to the designated tree). Disturbed area and bare area were assessed by measuring the distance from the center point to first vegetation and edge of disturbance, along eight transects running in cardinal directions. Tree impacts were assessed, as done in former stock-holding areas within the rectangle. Sixteen 1-m square quadrats were located along four 8-m long transects, located equidistant and perpendicular to the initial transect between trees. Quadrats were located 1 m apart, on the same side of the transect. Vegetation and mineral soil cover were visually estimated in each quadrat.

To adjust for natural changes in vegetation and exposed soil cover due to climatic variation, we established control sites in undisturbed places in the vicinity of each designated area. Sites were selected on the basis of similarity to the designated area in terms of topography, rockiness, tree canopy cover and understory species. Controls were 8-m squares with permanent markers (buried nails) at each corner. Sixteen quadrats were located 1 m apart on the same side of four 8-m long transects located 2 m apart. Vegetation and mineral soil cover were visually estimated in each quadrat.

All measurements were repeated in August 1998. Buried nails were relocated using reference information, such as distances and azimuths from obvious landmarks such as large trees, unusual species, rocks and so on. A magnetic pin locator facilitated this process. In the results presented in this paper, we have combined the three designated day-use stock campsites with the six designated stock campsites.

Data Analysis

Data analysis was complicated by the fact that the number of impacted areas varied greatly between campsites. Some campsites had as many as five separate former stock-holding areas, a designated stock-holding area and a camping area. All former stock-holding areas on the same campsite were aggregated into a single set of measures per campsite. A single set of measures for the total campsite involved aggregating designated and former stock-holding areas, along with the camping areas. For disturbed area (area obviously disturbed by trampling), bare area (area of the central area completely devoid of vegetation), tree scarring (total area of tree scarring on all trees) and root exposure (total length of exposed root on all trees), aggregation involved simply adding all the values together. For vegetation and exposed mineral soil cover (expressed as percent of the campsite), however, it was necessary to weight the percent cover of each area by the proportion of total disturbed area in that area. This procedure was used when aggregating former stock-holding areas as well.

This provided data for camping areas, former stock-holding areas, designated stock-holding areas and the total campsite for each campsite for 1993 and 1998. Means and standard errors are presented for each of the six impact variables, along with an estimate of change, expressed as a percent of 1993 values. Change was the 1993 value minus the 1998. Minus change values represent deterioration in conditions, except in the case of vegetation cover. The number of campsites that improved, deteriorated or stayed the

same was assessed. If values did not change by more than 10% of their original condition, they were considered unchanged.

Since we censused all impacted sites in the basin, there was no need to use inferential statistics to assess confidence in our estimates of change between 1993 and 1998. Changes reported did occur, subject to measurement error. We did use t-tests and analysis of variance to assess the extent to which magnitude of change was significantly influenced by (1) whether the site had been restored and (2) whether it was open to all use, open to backpackers only or closed to all use. The latter two categories were sometimes difficult to distinguish. Originally, 10 campsites were slated for complete closure, and signs indicating site closure were established at seven closed campsites. By 1998, only two of these sites still had closure signs; another two sites were so intensively iceberged and revegetated that further camping was very unlikely. Consequently, we decided that only four campsites were still clearly closed to all camping (fig. 1).

Results

Described below are both the benefits and costs of the management program implemented at Seven Lakes Basin. Initially, we present data on changes between 1993 and 1998 in amount of impact. We have data on three types of areas within campsites—designated stock-holding areas, former stock-holding areas and camping areas—as well as for the campsite as a whole. For each of six different impact parameters, we present data for each of these types of area and the entire campsite. We describe what conditions were like in 1993 and how they changed between 1993 and 1998 (table 1). We present change as a percent of the condition in 1993, as well as the number of campsites that improved, deteriorated or stayed the same, within 10% of the original value. Then we compare changes on sites that were or were not restored (table 2), as well as on sites that were open to all users, open only to hikers or closed to all camping (table 3). Finally, we describe basin-wide changes in conditions.

Benefits of the Management Program

Changes in Disturbed Area on Campsites—The area obviously disturbed by visitors provides perhaps the best overall indication of the areal extent of recreation impact. Mean disturbed area for the entire campsite was 135 m² in 1993 (table 1). On the popular sites with designated stock-holding areas, the disturbed area was typically quite large. Both areas where stock-holding had been allowed and camping areas were typically smaller. For all campsites, disturbed area declined almost 40% by 1998—to a mean of 85 m². Sixteen campsites improved substantially, while only five deteriorated over this period. Moreover, the sites that improved most were those that were most disturbed in 1993 (fig. 2). Of the different types of area, only the disturbed area of designated stock-holding areas increased between 1993 and 1998 (4%). The disturbed area of former stock-holding areas and camping areas decreased between 40% and 50% in just five years.

For all campsites, the decline in disturbed area on sites that received assisted restoration (for example, iceberging,

Table 1—Means and standard errors for impact parameters in 1993 and 1998, percent change and number of areas that improved, deteriorated, or were unchanged.^a

	1993	1998	% change	Improved	Deteriorated	Unchanged
Disturbed Area (m²)						
Designated	79 (28)	82 (16)	-4	2	6	1
Former	87 (24)	46 (17)	47	16	1	2
Camp	48 (10)	25 (6)	48	12	3	9
Total	135 (34)	85 (21)	37	16	5	5
Bare Area (m²)						
Designated	14 (7)	29 (10)	-1	1	6	2
Former	26 (7)	14 (7)	46	12	1	6
Camp	25 (7)	7 (3)	71	15	0	9
Total	47 (10)	27 (9)	43	16	3	7
Tree Scarring (cm²)						
Designated	17 (12)	38 (21)	-121	0	3	6
Former	571 (238)	390 (196)	32	3	4	11
Camp	—	—	—	—	—	—
Total	497 (208)	351 (172)	29	3	5	13
Root Exposure (cm)						
Designated	400 (136)	1067 (329)	-166	0	7	2
Former	1674 (428)	1603 (433)	4	5	6	7
Camp	—	—	—	—	—	—
Total	1607 (404)	1831 (479)	-14	5	9	7
Vegetation (%)						
Designated	39 (7)	24 (4)	38 ^b	0	8	1
Former	28 (5)	47 (6)	-68 ^b	13	3	3
Camp	51 (7)	49 (7)	3 ^b	4	20	0
Total	39 (5)	46 (6)	-19 ^b	13	7	6
Soil Exposure (%)						
Designated	9 (4)	18 (7)	-100	1	8	0
Former	10 (3)	6 (2)	39	10	8	1
Camp	10 (3)	10 (4)	-9	6	16	2
Total	11 (3)	9 (3)	18	9	8	9

^aPercent change is the 1993 value minus the 1998 value divided by the 1993 value. Sites were considered changed if 1998 values were $\pm 10\%$ or less of 1993 values.

^bIn contrast to all other impact parameters, negative change in vegetation cover indicates improvement rather than deterioration.

scarifying and planting) was somewhat greater than on sites that were not restored (fig. 3), but the differences were not statistically significant (table 2). Note that figure 3 shows change as a percentage of original conditions, while table 2 shows change in the original units of measure, not adjusted for original conditions. The same was found on former stockholding areas. We do not show data for designated stockholding areas because they were never restored. In contrast, camping areas on sites that were not restored improved

significantly more than sites that were restored. This might be explained by the fact that many of the restored camping areas were popular sites that would take longer to recover than less impacted sites. As expected, on sites that were closed to all use, disturbed area declined more than on sites that remained open to camping (fig. 4, table 3). What was surprising was that sites open to all use—both horses and hikers—often recovered as much, if not more, than sites closed to all use. This probably reflects the within-site

Table 2—Change in impacts on restored (R) and non-restored (NR) campsites.^a

	Former stockholding areas			Camping areas			Total campsites		
	R	NR	p	R	NR	p	R	NR	p
Disturbed Area (m ²)	43(12)	36(25)	.39	14(7)	45(19)	.04	55(23)	45(31)	.40
Bare Area (m ²)	19(5)	-8(10)	.01	17(6)	21(9)	.35	27(9)	8(5)	.03
Tree Scarring (cm ²)	35(66)	56(56)	.44	—	—	—	23(58)	31(31)	.46
Root Exposure (cm)	387(291)	-1032(653)	.02	—	—	—	-25(358)	-621(398)	.16
Vegetation (%) ^b	-19(6)	-1(6)	.03	9(5)	5(7)	.33	-6(5)	0(7)	.24
Soil Exposure (%)	1(5)	8(3)	.09	-1(5)	-3(3)	.44	0(5)	6(7)	.22

^aTable reports mean (standard error) change between 1993 and 1998 (1993 values minus 1998 values) and results of t-tests.

^bIn contrast to other impact parameters, negative change in vegetation cover indicates improvement rather than deterioration.

Table 3—Change in impacts between campsites that are open to all use, open to camping, and closed to all use.^a

	Former stock-holding areas			Camping areas			Total campsite			Open to all use	Open to camping	Closed to all use	p
	Open to all use	Open to camping	Closed to all use	p	Open to all use	Open to camping	Closed to all use	p					
Disturbed Area (m ²)	62(18)	21(16)	45(22)	.24	36(21)	13(7)	34(21)	.40	76(46)	26(12)	79(43)	.39	
Bare Area (m ²)	11(10)	12(8)	15(14)	.97	21(9)	15(6)	26(18)	.70	10(7)	22(7)	40(31)	.31	
Tree Scarring (cm ²)	170(147)	-28(21)	-19(22)	.22	—	—	—	—	93(87)	-28(21)	-19(22)	.35	
Root Exposure (cm)	-239(806)	175(298)	331(345)	.77	—	—	—	—	-826(520)	175(298)	331(345)	.16	
Vegetation (%) ^b	9(8)	16(9)	20(7)	.72	-16(12)	-4(3)	-2(8)	.41	-7(5)	7(6)	19(6)	.08	
Soil Exposure (%)	-3(6)	7(6)	5(3)	.48	-10(11)	0(2)	8(6)	.21	-9(7)	4(3)	21(12)	.02	

^aTable reports mean (standard error) change between 1993 and 1998 (1993 values minus 1998 values) and results of analysis of variance. Sites open to camping are closed to stock.

^bIn contrast to other impact parameters, negative change in vegetation cover indicates improvement rather than deterioration.

recovery from confining stock to only one designated area on each campsite.

The total area of disturbance in the Seven Lakes Basin was 3518 m² in 1993. In 1998, total disturbance was just 2205 m². This represents a 37% decrease in the extent of impact in just five years. If the current management program continues, all closed campsites and former stock-holding areas should recover completely, probably within a decade or two. At that time, the total area of impact would be just 1262 m²—or only 36% of what it was before the management program was implemented.

Changes in Bare Area on Campsites—The bare area represents the size of the heavily used part of camp that is devoid of vegetation. Sites with large bare areas are highly problematic, since re-establishment of vegetation is often difficult. Mean bare area of the entire campsite declined from 47 m² in 1993 to 27 m² in 1998, a decrease of nearly 43% (table 1). Sixteen campsites improved, while only three deteriorated during this time period. Only on designated stock-holding areas did bare area increase between 1993 and 1998 (1%). Former stock-holding areas improved on 12 of the 19 sites. Camping areas improved most. Mean bare

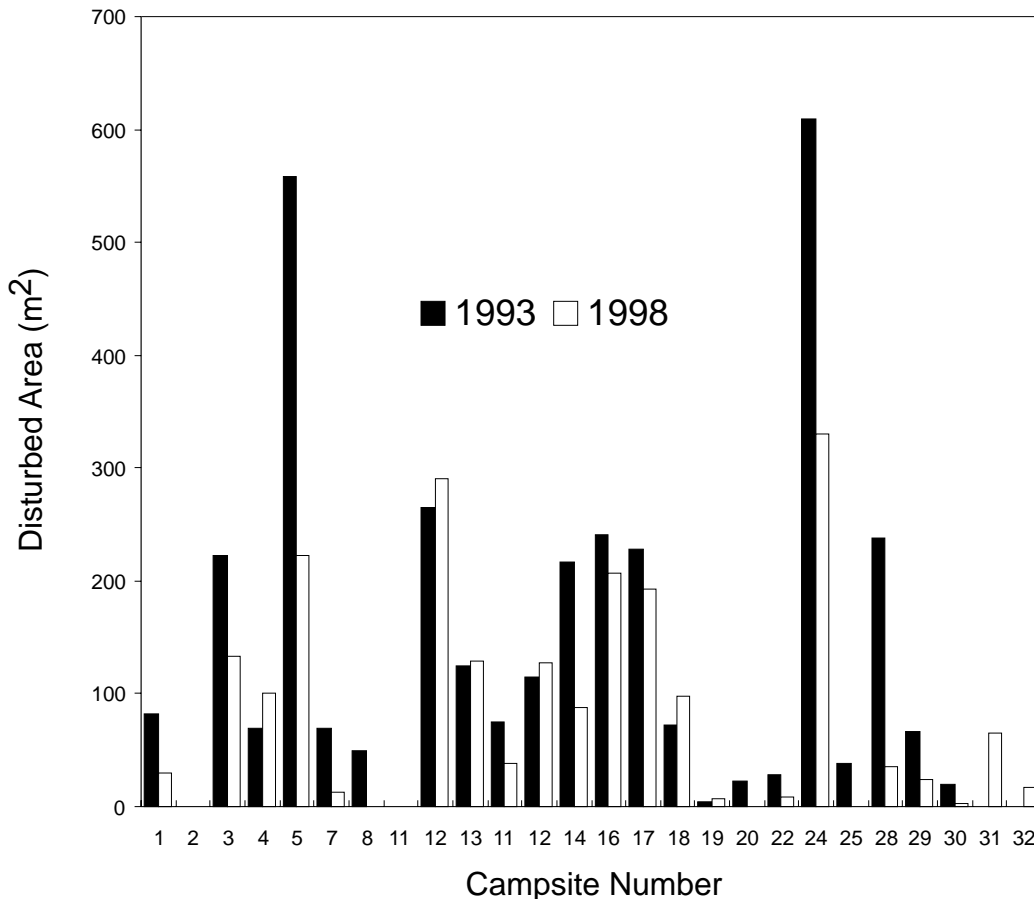


Figure 2—Change in the disturbed area of each of the 26 campsites between 1993 and 1998.

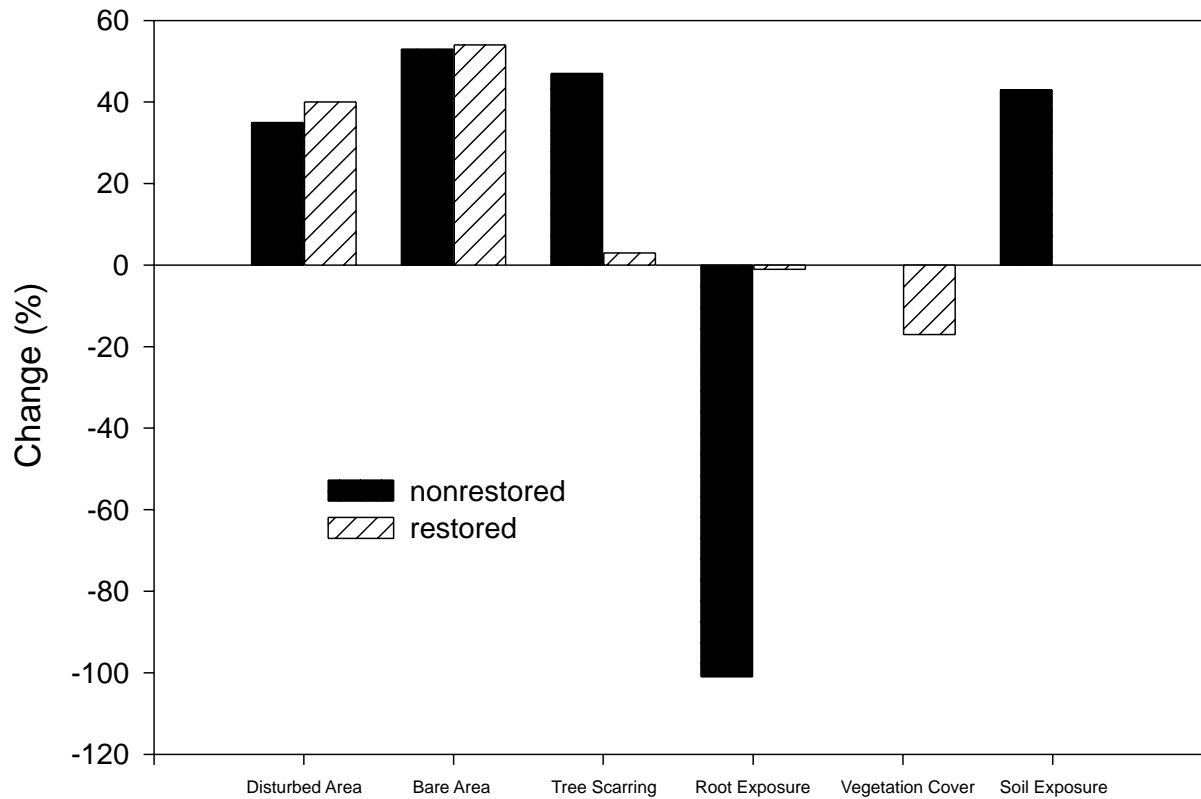


Figure 3—Percent change (1993 value minus 1998 value, divided by 1993 value) in impact parameters for non-restored and restored campsites. Negative values indicate deterioration, except in vegetation cover.

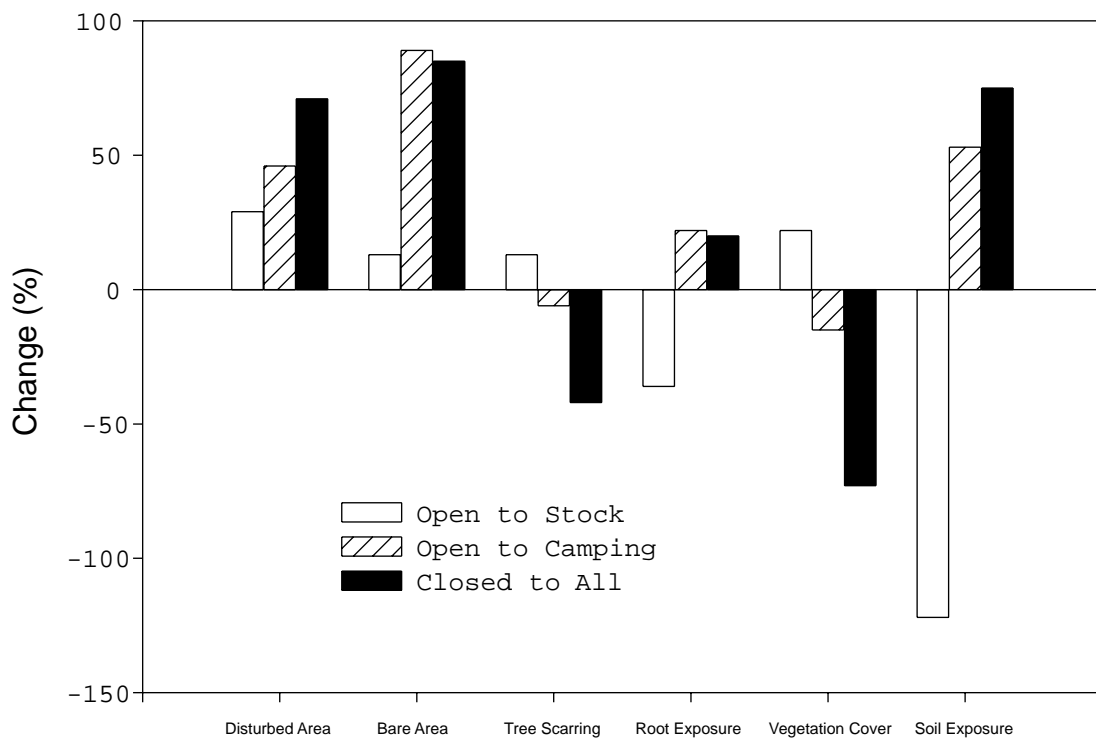


Figure 4—Percent change (1993 value minus 1998 value, divided by 1993 value) in impact parameters for campsites that are open to all use, open to camping, or closed to all use. Negative values indicate deterioration, except in vegetation cover.

area declined 71%, and 15 of 24 sites improved, while none deteriorated.

For all campsites, the decline in bare area on sites that received restoration (27 m²) was significantly greater than the decline on nonrestored sites (8 m²), (fig. 3, table 2). This was also true of the former stock-holding areas, which improved significantly due to restoration efforts. This was expected since these areas were closed to all use and targeted for restoration efforts. Restoration efforts were not significantly more effective in reducing the bare area of camping areas. At the campsite level of analysis, bare area declined more on sites that were closed to all use than on those that were open to camping or open to all use. The same was true for the former stock-holding areas and camping areas; however, none of the differences were significant (table 3). This demonstrates the positive effect of complete closure of a site on the recovery of bare ground impacts.

The total bare area in the Seven Lakes Basin declined from 1222 m² in 1993 to 699 m² in 1998, a considerable decrease of 43% in five years. If current management continues and closed sites and former stock-holding areas recover completely, the total bare area should decrease to approximately 289 m², or just 24% of the impact prior to implementation.

Changes in Tree Scarring on Campsites—Tree scarring can affect the vigor and is a long-lasting visual impact. Although these wounds will slowly heal, there is no known restoration procedure to mitigate these impacts. Consequently, trees that are scarred do not recover from this impact, even if campsites are closed. The designated stock-holding areas showed a substantial increase in tree scarring (over 120%) between 1993 and 1998 (table 1). Most of the increased damage occurred on three of the nine designated campsites. Conditions improved on three of 18 campsites with former stock-holding areas; but 11 of these campsites were stable. Improvement of tree damage was most likely due to the removal of scarred and severely damaged trees during the restoration process. A different metric was used for determination of tree damage on camping areas, and these were not included in the final analysis. For the entire campsite, mean tree scarring declined and conditions were unchanged on most campsites. However, more campsites deteriorated than improved. This suggests that the rate of increase in tree damage has declined as a result of the confinement strategy, although further damage continues to be a problem on a few of the campsites.

Restoration efforts had little effect on the amount of change in tree scarring on the designated areas, former stock-holding areas, or the campsites (fig. 3, table 2). Degree of campsite closure also did not have a statistically significant effect on tree scarring (table 3). Ironically, there was more improvement on the sites still open to stock because several scarred trees were cut down on these sites (fig. 4). The long-lasting nature of tree impacts means they are unlikely to improve substantially in the time-frame of this study.

Change in Root Exposure on Campsites—The exposure of roots in tree wells and other areas of stock confinement is an impact that is visually obtrusive and ultimately associated with tree mortality. This impact is unnecessary because stock need not be tied to trees. Moreover, rapid

improvement is possible because exposed roots can be easily eliminated by filling in tree wells with soil and organic matter. As expected, given the concentration of pack stock use in designated stock-holding areas, these areas showed marked deterioration. Root exposure increased from 400 cm to 1067 cm, or 166% in five years (table 1). Seven of the nine designated areas deteriorated. Mean root exposure on former stock-holding areas improved slightly between 1993 and 1998, but only five of the 18 improved. For all campsites, root exposure increased slightly. Five campsites improved and nine deteriorated.

On former stock-holding areas, restoration efforts resulted in a reduction in root exposure, while root exposure increased on non-restored former stock-holding areas (table 2). Root exposure, at the scale of the entire campsite, increased less dramatically on restored sites (fig. 3) but differences were not statistically significant. Campsites open to all use deteriorated, while closed sites and sites open only to backpackers improved (fig. 4). This difference was particularly pronounced on former stock-holding areas. However, there was so much site-to-site variability that differences were not statistically significant (table 3).

Changes in Vegetation Cover on Campsites—Mean campsite vegetation cover increased 19%—from 39% in 1993 to 46% in 1998 (table 1). Vegetation increased on 13 of the campsites and decreased on six campsites. Despite this general improvement, vegetation cover decreased on designated stock-holding areas from 39% in 1993 to 24% in 1998. Vegetation cover also decreased slightly (3%) on camping areas. The improvement in conditions occurred on former stock-holding areas where vegetation cover increased 68%, from 28% in 1993 to 47% in 1998. The improvement more than compensated for deterioration of current stock-holding and camping areas.

On former stock-holding areas, restoration efforts resulted in significantly more improvement in vegetation cover (table 2). Since these areas are now closed to all use, the re-establishment of vegetation through seeding and transplanting was quite effective. Restoration efforts were not very effective within camping areas. At the scale of the entire campsite, vegetation cover increased more on restored sites (fig. 3), but differences were not statistically significant. Vegetation cover declined on campsites open to stock and increased on campsites not open to stock. Improvement was greatest on sites closed to all use (fig. 4)($p = 0.08$, table 3). These results suggest that closure to all use, in combination with active restoration, is the most effective prescription for vegetation recovery. However, recovery can occur simply by eliminating use by stock.

Changes in Soil Exposure on Campsites—Designated stock-holding areas received concentrated pack stock use, so it was not surprising that mineral soil exposure increased 100%, from 9% in 1993 to 18% in 1998 (table 1). With the cessation of pack stock use in the former stock-holding areas, mean soil exposure percentages decreased by 39% during the study period, with ten of the 19 areas improving. Since most camping areas continued to receive use, soil exposure increased 9%. For all campsites, soil exposure values decreased 18%, with nine campsites improving, eight deteriorating and nine unchanged. Again, improvement of the former stock-holding areas more than compensated for the deterioration in other parts of the campsite.

Soil exposure declined on campsites closed to stock use, while it increased on campsites open to stock use (table 3). However, restored campsites actually recovered less than those campsites that were not restored (table 2). This unexpected result reflects the fact that, (1) restoration of a duff layer was not among the techniques employed at Seven Lakes and (2) the campsites that were restored were the most severely impacted.

Costs of the Management Program

Despite the decided ecological benefits of the management program, there were also more limited experiential costs and substantial financial costs.

Experiential Costs—The need for more signage within the Selway-Bitterroot Wilderness (as you enter the basin and at designated sites and the two remaining signed closed sites) degrades the aura of wildness in this place. However, so do the extensive trail systems and heavy impacts. The management programs reduced freedom of recreation use, but not substantially. Camping is now restricted to about 17 campsites in the basin, and people with stock can now use only six sites to camp at in the basin. Moreover, the number of stock allowed and the number of people allowed per group, when camping, is only 10. All stock users—day and overnight—must not tie stock to trees; they must tie up at one of the nine designated stock-holding areas. Stock users and backpackers who want to travel in groups larger than 10 or who do not want to contain their stock between designated trees can simply camp outside the basin and make day visits. Since there are no limits on amount of use, no lakes where camping is not allowed, and no groups excluded from visiting the basin (other than those who do not meet entrance criteria for the entire Selway-Bitterroot Wilderness), we conclude that experiential costs are minor.

Financial Costs—Cost estimates were kept, although many hidden costs were undoubtedly missed, and certain costs were ballpark estimates. When both Forest Service and contributed costs are combined, we estimate conservatively that total costs for the first five years of the program exceeded \$135,000 (table 4).

Clearly, the financial costs of this program have been considerable, and they will be ongoing, but to a lesser degree. Nevertheless, through innovative use of volunteers and removing the fixed costs of seasonal employees, the “new” costs to the Forest Service were only about \$8,500 per year for the first five years and probably will be no more than \$1,000 per year into the future. This cost, while very high for measly wilderness budgets, is very reasonable when one considers the magnitude of remediation that was necessary after decades of unrestricted, high-impact use on the basin. If there were about 20 similar problem destination areas in the entire Selway-Bitterroot Wilderness, additional remediation costs to the Forest Service would be about \$87,000 per year for the first ten years of work. In the greater scheme of things, this is not a large amount of money, especially if it can bring most conditions into compliance with LAC standards in the fourth largest Wilderness in the continental United States. However, avoiding creation of excessively impacted places in the first place would be much less costly.

Table 4—Financial costs of the Seven Lakes restoration program, 1992-1998, broken out by costs to the Forest Service and costs contributed by volunteers.

	Forest Service	Contributed ^a	Totals
Planning	16,375	—	16,375
Restoration			
Seed collecting/cleaning	250	—	250
Seed propagation	500	2,000	2,500
Restoration work			
SCA crew	20,000	24,000	44,000
AMC crew	2,000	7,680	9,680
IDAWA crew	—	15,000	15,000
Volunteers	10,500	20,000	30,500
Wilderness rangers	8,000	—	8,000
Pack support	6,500	—	6,500
Materials	1,000	—	1,000
Monitoring	750	—	750
Signage	500	—	500
Forest Service cost	66,375	—	—
Contributed cost ^a	—	68,680	—
Total cost	—	—	135,055

^a The cost of work contributed by volunteers estimated at \$10/hour.

Discussion

Campsite impacts in the Seven Lakes Basin are comparable to those of many other moderately used wilderness destinations, where many visitors travel with pack stock. In many such destinations, existing conditions are not in compliance with management standards, and these places need to be more intensively managed. There are often many more campsites than necessary, and campsites are often heavily impacted. Pack stock impacts are particularly pronounced. For example, on Seven Lakes campsites in 1993, about 50% of the bare area and disturbed area were on sites used exclusively for confining stock. In addition, virtually all root exposure is a result of tying horses to trees. This suggests that camping with pack stock at least doubles the amount of disturbance that would be caused by camping without pack stock. Many wildernesses with these problems have had difficulty devising effective management programs to deal with them, particularly where horseback groups have been highly vocal and wield considerable political power. The Seven Lakes Plan provides a case study for evaluating the benefits and costs of a management plan that attempts to deal effectively with these problems, without curtailing use or significantly reducing freedoms.

Our results clearly show that the Seven Lakes Basin restoration program has been highly successful in reducing impacts associated with camping. Considerable progress has been made in the five years since the plan was initiated. Campsite densities have decreased slightly, and magnitude of impact has decreased on virtually all campsites and has decreased greatly on many sites. In just five years, disturbed area has decreased 37%, and bare area has decreased 43%. Disturbed area and bare area have declined at least 10% on 16 of the 26 campsites. Tree scarring has declined, although primarily from masking scars with pitch and charcoal. Vegetation cover has increased and mineral soil exposure

has decreased. Only root exposure has gotten worse. Moreover, if the management program is continued, the greatest positive changes are still to come. Disturbed area and bare area are likely to decline in a few decades to just 36% and 24%, respectively, of what they were in 1993.

Most of these positive changes come from confining where camping can occur, particularly by groups with pack stock. Improving conditions on former stock-holding areas have more than compensated for the increased impact on newly designated stock-holding areas. The closure of some campsites to all use and efforts to reduce the size of open campsites, through both closure and restoration of portions of large sites, have also been highly effective. Reductions in maximum group size have undoubtedly contributed to success. For these benefits to continue or increase in the future, the programs need to remain in effect.

The fiscal costs of this program are significant. As detailed in the results section, the five-year costs exceeded \$135,000, although the Forest Service was able to reduce out-of-pocket costs by more than 50% by using volunteer groups extensively. Experiential costs appear meager. They were borne primarily by stock groups because these groups were the primary source of impact problems. Stock groups had some of their freedom of site selection removed, although each lake still had one legal stock site. They were also not allowed to graze in the basin; they had to bring in feed. Finally, their ability to travel in large groups—more than 10 head of stock—was curtailed. However, they were still allowed near-complete freedom virtually everywhere else in the 500,000 ha Selway-Bitterroot Wilderness. They could graze and camp wherever they wanted, even in large groups, immediately outside the basin and visit it during the day. In other words, stock groups were still allowed access, and their behavior remained largely unrestricted.

In conclusion, the Seven Lakes Basin management program has been more successful than expected in its first five years. Because recovery always takes more time than impact, we expected little positive change in the first five years. In the moderately resilient environments of the northern Rocky Mountains, positive benefits occurred in the first five years. In a few decades, the program will probably reduce campsite impacts by at least two-thirds. This illustrates that the confinement strategy can be highly effective, particularly with types of use that have more potential to cause impact, such as stock groups. The Seven Lakes Basin restoration program provides a good model for the vast majority of wildernesses that have problem areas in which campsite impact is unacceptably high.

Our study also shows that it is possible to take management actions to bring conditions back into compliance with LAC standards, even without limiting use or seriously restricting user behavior. The concern is that it is very costly—from the perspective of extremely limited funds for wilderness management. Costs can be kept to reasonable levels by using volunteers extensively and by not tackling too many different destinations at one time. This problem also illustrates the need to prevent problems in the first place, rather than attempt to correct them after they have

already occurred, particularly with the types of use that can to cause substantial disturbance. This is one reason for rethinking the common principle of not taking restrictive actions until it is clear that nonrestrictive actions have failed (Cole 1995). It is important to anticipate where impact is likely to occur and to take effective, preventive actions, even if they need to be restrictive.

Finally, in addition to being costly, restoring recreation impact will be a slow and never-ending process. At Seven Lakes, the management program can now shift into more of a maintenance mode, perhaps selecting another problem area to restore. However, in the maintenance mode, restrictions must be kept in force, and frequent ranger presence is still needed to obtain reasonable compliance. Given the minimal budgets for on-the-ground wilderness management, even the maintenance mode will stretch available resources.

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