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Changes on Trails in the Selway-Bitterroot Wilderness, Montana, 1978-89

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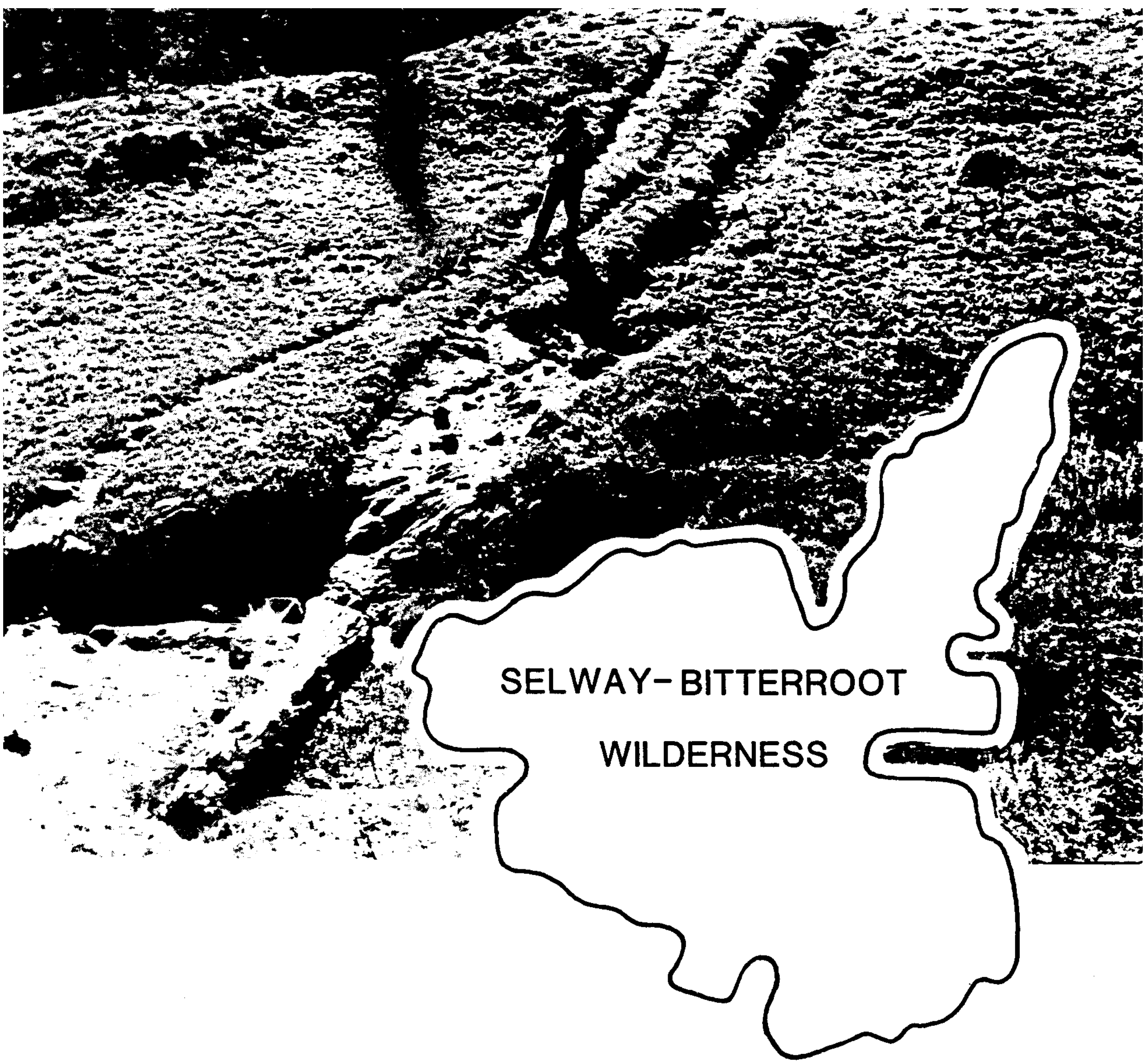

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RESEARCH SUMMARY

Over an 11 -year period there was no net erosion from three trails in the Selway-Bitterroot Wilderness, Montana. Most individual trail segments experienced change, but deposition was slightly more common than erosion. Mean cross-sectional area decreased from 1,187 cm^2 in 1978 to 1,155 cm^2. Trail widening was more pronounced than trail incision. The lightly used South Fork Trail experienced more change than the more heavily used Big Creek Trail. Although these trail systems, taken as a whole, are relatively stable, deterioration does occur in certain places. One purposively located trail segment's cross-sectional area increased from 7,991 cm^2 in 1979 to 10,230 cm^2 in 1989. Solutions to these localized problems generally involve either improving trail design and maintenance or relocating the trail in a more durable place.

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INTRODUCTION

Although wilderness areas are to be managed for "natural conditions," trails are built and maintained to improve access for recreationists. Over time, many trail segments deteriorate to the point where they must be rebuilt or closed to use. Deterioration can be caused both by natural processes, either consistent, gradual processes or cataclysmic events, and by wear from recreational traffic (Summer 1986; Tinsley and Fish 1985). Relatively large sums of money are spent every year to maintain, rebuild, and relocate wilderness trails.

Although a number of studies of trail impact have been conducted (Cole 1987), most studies have assessed conditions at only one point in time. They provide a "snapshot" of trail conditions, but little perspective on how conditions are changing over time. We can assume from the amount of trail maintenance and reconstruction done every year that trail deterioration is occurring; however, we have little quantitative information about trends in trail condition in wilderness.

Four studies of change over time on trail systems have been conducted in situations that approximate wilderness. Studies by Bayfield (1985,1986) and by Lance and others (1989) have been conducted in wild areas in Scotland. Data on changes in trail width are available for periods of as much as 12 years. They found that many trails increased in width, but some trails were relatively stable. Generally, newly developed trails and those experiencing increased use were most subject to change. In Rocky Mountain National Park, CO, Summer (1980, 1986) also found considerable variation in response between trails. Over 7 years, four of nine trail segments widened substantially, while the others were generally stable. Two of five segments deepened substantially. Summer (1980) found that new trails were particularly prone to deterioration and that extent of deterioration was often related to terrain characteristics.

Fish and others (1981) and Tinsley and Fish (1985) studied trail erosion in Guadalupe Mountains National Park, TX. Over a 3.5-year period, little net erosion occurred. Some trail segments experienced erosion, while others experienced deposition. The net effect was not significantly different from what was occurring off-trail. A similar result was reported by Cole (1983) in a study of 2 years of change on a trail in the Selway-Bitterroot Wilderness, MT. The study reported here is an extension of this earlier one. Changes in trail condition over an 11-year period are reported for three trails in the Selway-Bitterroot Wilderness.

STUDY AREA AND METHODS

The three trail systems that were surveyed are located in drainages on the east side of the Bitterroot Range in Montana (fig. 1). I surveyed 27 km of the Big Creek trail, 21 km of the Bear Creek trail, and 11 km of the Sweeney Creek trail. The Big Creek and Bear Creek trails have gentle grades, slowly ascending close to the creeks. Most of the trail system occurs at elevations between 1,200 and 1,750 m, although the Big Creek trail ascends steeply to a pass at 2,200 m. The Sweeney Creek trailhead starts at an elevation of 1,750 m. The trail climbs to 2,300 m and then descends gradually to lakes at the head of the drainage. Most of these trail systems are located in closed coniferous forests; soils vary from highly rocky and well drained, on slopes, to deep and open poorly drained in valley bottoms.

Accurate data on visitor use are not available for these trails. Even by wilderness standards, none of these trails is very heavily used. Except close to the trailheads, no more than a few parties are likely to travel along these trails on any given day. Most of the use is by foot travelers, although some use of pack and saddle stock does occur.

On all three of these trail systems, permanent trail transects were located systematically every 1.6 km along the trail; the initial transect was randomly selected. For each transect, permanent stakes were located on each side of the trail. A tape was placed flush with the permanent stakes at ground level; it was not elevated above the trailside microtopography and, therefore, some precision was lost. Vertical measurements were taken every 6 cm. The cross-sectional area below the tape was then calculated using the formula in figure 2. Initial measurements

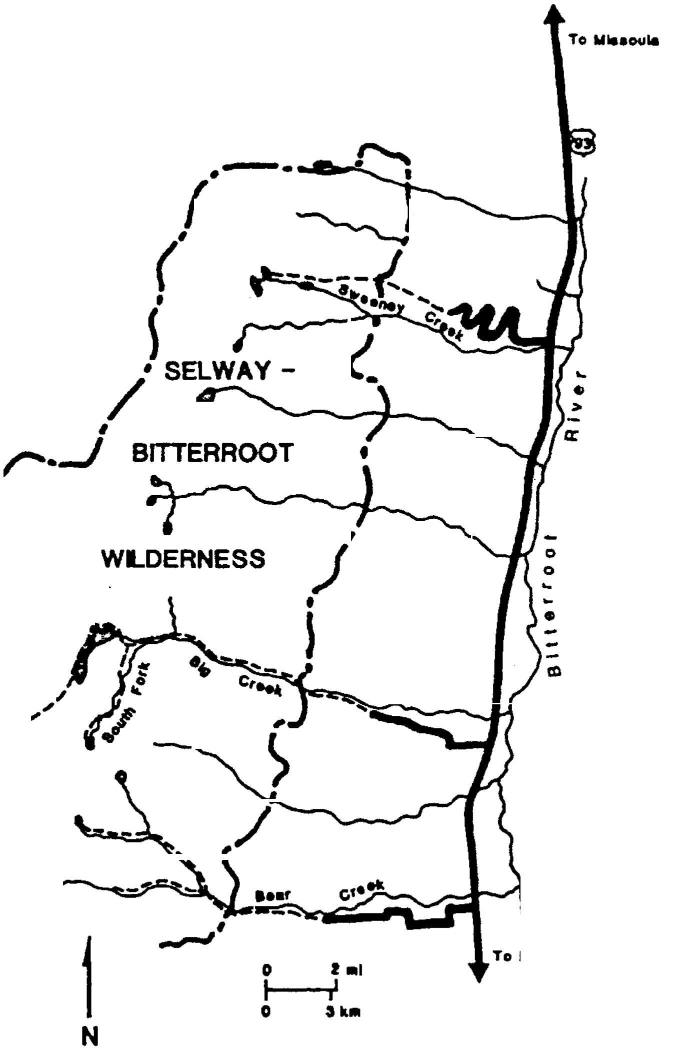
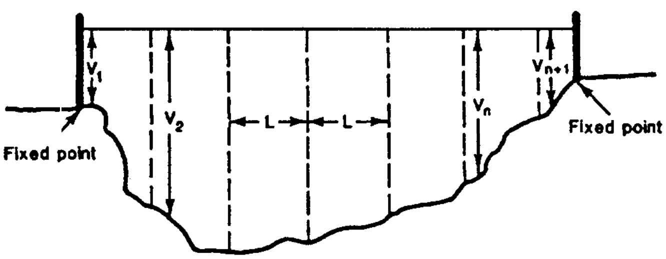


Figure l-Location of the Sweeney Creek, Big Creek, South Fork, and Bear Creek trails in the Montana portion of the Selway-Bitterroot Wilderness.



$$A = \frac{V_1 + 2V_2 + \ldots + 2V_n + V_{n+1}}{2} \times L$$

Where A = cross - sectional area

$V_1 - V_{n+1}$ = Vertical distance measurements, starting V_1, the first fixed point, and ending at V_{n+1}, the last vertical measurement taken.

were taken in 1978 and repeated in 1989. During this period, several of the transects were disturbed or bypassed by trail reroutes. Thus, data are available for 10 transects on the Big Creek trail, 13 transects on the Bear Creek trail, and six transects on the Sweeney Creek trail.

In addition, four segments were selected along the Big Creek trail, where trail incision was unusually pronounced. Permanent trail transects were established at these purposively located sites. Five transects were established 2 m apart in each segment. Initial measurements were taken in 1979 and repeated in 1989.

The accuracy of these trail transect measurements was assessed by taking 10 replicate measures of one transect. The mean cross-sectional area of loss for these 10 measures was 540 cm^2. The 95 percent confidence limits around this mean were +/-26cm^2. This suggests a measurement error of about 5 percent.

In 1980 a rapid survey of trail conditions was conducted along the Big Creek trail and the South Fork trail, which branches off from the main Big Creek trail (fig. 1). Observations of total trail width (the zone obviously disturbed by trampling), bare ground width, and maximum depth were taken every 0.2 mile. This survey was repeated in 1989. With this technique, observation points were not relocated precisely. The resulting loss of precision was compensated for by the relatively large number of observations taken-83.

RESULT'S AND DISCUSSION

There were no significant differences between the three different trails either in cross-sectional area or change in area; consequently, the data from the three trails were pooled. Mean cross-sectional area was 1,187 +/- 47 cm^2 in 1978. In 1989, mean cross-sectional area was 1,155 +/- 43 cm^2. This change was not statistically significant. Given a measurement error of about 5 percent, changes on 10 of the 29 transects were less than the measurement error. Of those transects that clearly did change, 8 experienced erosion and 11 experienced deposition. Individual trail locations are prone to change, but the trail system, as a whole, was relatively stable. Over the 11-year period, there was virtually no net erosion or deposition.

These results are remarkably similar to those reported at Guadalupe Mountains National Park (Fish and others 1981; Tinsley and Fish 1985). On those trails, deposition was slightly more common than erosion. Although individual trail locations were more changeable than off-trail locations, the trail system as a whole was no more unstable than off-trail areas. Summer (1996) has described trails as "conveyor belts" that transport material downslope.

Upslope segments are prone to long-term erosion, while low-lying segments are subject to long-term deposition. Moreover, intermediate positions are changeable; their cross-section is influenced by whether or not material is currently passing through (Tinsley and Fish 1985).

The four purposively located segments on the Big Creek trail that were deeply incised were places where erosion was expected. Surprisingly, on three of the four segments, mean change in cross-sectional area did not exceed measurement error. Of the 20 individual transects, only five experienced an increase in cross-sectional area and only two of these increases exceeded 15 percent. One segment did experience substantial net erosion with cross-sectional area on one transect, increasing from 7,991 cm^2 in 1979 to 10,230 cm^2 in 1989.

The rapid survey along the Big Creek and South Fork trails provides a slightly different perspective on change. Total trail width increased significantly between 1980 and 1989, from 100 ± 10 cm in 1980 to 125 ± 9 cm in 1989. Total width is a measure of the width of the zone disturbed by trampling. Increases in trail widths are commonly reported in the literature (for example, Lance and others 1989) and are prevalent on relatively flat, valley-bottom trails (Summer 1986). The vast majority of the sample points along the Big Creek and South Fork trails were in flat, valley-bottom positions.

Bare width is a measure of the zone devoid of vegetation. It did not change significantly, going from 70 ± 8 cm in 1980 to 76 ± 8 cm in 1989. Maximum depth also increased, but not significantly. Depth was 12 ± 2 cm in 1980 and 14 ± 2 cm in 1989. These results suggest greater change at the periphery of the trail corridor-increasing total width-than in the central portion of the trail zone, where cross-sectional area is recorded.

It has often been assumed that more heavily used trails deteriorate more than more lightly used trails. Previous examinations of the relationship between trail impact and amount of use have produced mixed results. Bayfield and Lloyd (1973), Dale and Weaver (1974), and Coleman (1981) all found that trail widths increased as trail use increased. Coleman (1981) also reports increased maximum depth where use was heavy, but Dale and Weaver (1974) found no significant differences in depth related to amount of use. In experimental studies of trail formation, Weaver and Dale (1978) found that the first increments of trail use caused most of the increase in trail depth that they recorded, while trail width continued to increase substantially with further increases in use. In contrast to these studies, Helgath (1975) and Tinsley and Fish (1985) found no relationship between cross-sectional area and amount of use. Summer (1986), taking an intermediate position, reported that use intensity was not the "controlling factor in trail stability."

The South Fork trail, which branches off from the main Big Creek trail about 12 km from the trail-head, receives less than 10 percent of the usage that the main trail does. In 1980 the total width and bare width of the South Fork trail were significantly less than on the Big Creek trail (table 1). Trail depth was also less, but the difference was not statistically significant. Between 1980 and 1989, total width increased significantly on both the South Fork and Big Creek trails. The increase was larger on the South Fork trail; consequently, by 1989 the difference between the two trails was not significant.

Bare width increased significantly on the South Fork trail between 1980 and 1989 but was virtually unchanged on the Big Creek trail. The bare width of the South Fork trail doubled in just 9 years. The difference between the two trails decreased over the period, but was still statistically significant. Depth increased slightly on both trails, but not enough to be significant in 1989.

These results indicate that the more lightly used trail is less impacted than the more heavily used trail; however, it is also deteriorating more rapidly. There are a number of potential explanations for the greater deterioration on the South Fork trail. This trail receives minimal maintenance, while most of the Big Creek trail is well maintained. This was the explanation Helgath (1975) offered for finding larger cross-sectional areas on lightly used trails than on heavily used trails. Alternatively, there may be a maximum width that trails tend to attain for any given environmental situation. If the Big Creek trail was closer to this maximum in 1980, it might be expected to have changed less over the period. In Scotland, Lance and others (1989) found that trails became more uniform in width over time. On any trail, narrow places tended to widen more than places that were already wide. Finally, use levels

Table l- Conditions on a light-use trail (South Fork) and a heavy-use trail (Big Creek)

	South Fork trail	Big Creek trail	Significance
	------- *Centimeters* -------		
Trail width			
1980	73 ± 21	107 ± 10	0.01
1989	115 ± 22	128 ± 12	NS
Bare width			
1980	28 ± 12	80 ± 9	.00l
1989	54 ± 20	81 ± 9	.0l
Maximum depth			
1980	9 ± 3	13 ± 3	NS
1989	10 ± 4	15 ± 3	NS

may have increased more on the South Fork trail. We noticed several new campsites and encountered more people in the area than in previous years.

The finding that width varied more than depth, with amount of use, is not surprising. Trampling is the primary agent of trail widening, while the primary agent of deepening is running water. Consequently, the critical factors that influence depth are more likely to be related to environment (for example, soil characteristics or slope steepness) rather than use.

MANAGEMENT IMPLICATIONS

The primary objective of this study was to assess amount of deterioration on a system of trails in wilderness. Little information is available on how wilderness trails change over time. The general conclusion is that this system of trails in the Selway-Bitterroot Wilderness is relatively stable, as a whole. Overall, there was no net erosion of material from the trail system. In fact, deposition slightly exceeded erosion. This corroborates the results of the only similar study of a trail system (Fish and others 1981). That study was conducted in Guadalupe Mountains National Park, which has a semiarid environment that is very different from the Bitterroot Mountains. This suggests that similar results might be expected in a wide variety of situations.

Although the system as a whole was generally stable, many trail segments changed markedly. This suggests that the focus of management should be on specific problem segments, rather than on trails or trail systems. The probability that any trail segment will deteriorate is a function of the trail's immediate environment, its design and maintenance, and the amount, type and timing of the use it receives. Of these influential factors, there is abundant evidence that use characteristics are the least important (Helgath 1975; Summer 1986; Tinsley and Fish 1985). This is vividly illustrated by the fact that the same stretch of trail can have places that are in good shape and other places that are in bad shape, despite no difference in use characteristics.

The factors that most influence trail conditions, then, are trail location and design. This suggests that the principal solutions to trail problems involve increasing the ability of the trail to withstand use (through improved design and engineering) or changing the location of the trail to one that is more capable of withstanding use. In fact, these are common practices. Problem segments are identified, and those segments are either redesigned or relocated. From the manager's perspective, a log of trail problems and prescriptive actions will usually be more useful than a system of trail monitoring samples.

Most problems on the Selway-Bitterroot trails are (1) muddy conditions where the trail traverses soils that are frequently water saturated and (2) trail incision where the trail climbs steep slopes. Where such conditions cannot be avoided through a change in trail location, engineering provides an alternative solution. The muddy soils can be bridged, with turnpiking, and water can be diverted off the steep trail sections with ditches, water bars, and/or steps.

The choice between engineering and relocation is a difficult one. In recent years, the relocation option has perhaps been overdone. Now, increasingly, trail workers are questioning this practice. Much of this shift in attitude comes from the difficulty of rehabilitating the closed trails that are left after trails are relocated. The choice between engineering and relocation will depend on the proximity of more durable surfaces, the extent of problem segments, the resilience of the environment, the availability of resources to facilitate rehabilitation, and the ease of keeping hikers off the closed trail.

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