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Recreational Impact on Wildlands

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FOREWORD

This conference and its proceedings were conceived from the thought that solutions to wildland impact problems could be defined and identified by bringing together land managers, recreation users and natural resource researchers.

This was an ambitious goal. The reader will not find in these proceedings any magic panaceas or even a definitive answer as to what constitutes an impact or what level of impact is unacceptable. Conference participators did learn that there are no simple, single answers to these questions, that the only single answer is one that says, "It depends. . . ." Impacts and their acceptance depend upon physical, biological and social factors. And what is acceptable depends to a considerable extent on the management objectives for an area.

The spirit and intent of the conference were well expressed by a 4-wheel drive enthusiast when he confessed that "this is the first time that I have been with other recreationists and managers that I haven't been made to feel the total blame, the bad guy for wildland problems." Recreationists representing diverse activities, resource managers from several different public agencies and researchers working in public agencies, universities and private consulting firms recognized that the first step in identifying, isolating and solving resource damage problems was for everyone to accept responsiblity for a share of the problem.

The specific conference objectives were no less ambitious than the goal. These proceedings are dedicated to:

- Understanding different perceptions of impact and their meaning to management.
- Integrating research findings into management practices regarding soil, wildlife, vegetation and changes caused by recreation activities.
- Examining first-hand experiences in efforts to prevent and remedy recreational impacts.
- Suggesting direction for management, research and the user.

The scope of discussion was limited for practical reasons. For example, winter and water-based recreation as well as developed campsite recreation were not featured. Emphasis was placed on the physical and biological changes resulting from wildlands recreation. Access methods included foot, horse, trailbike and 4-wheel drive. "Wildlands" included wilderness, backcountry, roadless and roaded areas used for dispersed recreation.

These proceedings reflect the conference objective to approach the issue of recreational impacts on wildlands from a variety of perspectives. The reader will find an introductory philosophical paper followed by the pragmatic experiences of two land managers and a representative of the land-using public. Researchers present technical papers featuring perceptions of recreational impacts and specific findings from studies on soil, vegetation, water/noise and wildlife. No less important are the experiences reported by user and user groups as well as techniques used by field managers for preventing and

REDUCING THE IMPACT OF HIKERS ON VEGETATION
AN APPLICATION OF ANALYTICAL RESEARCH METHODS

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ABSTRACT--After a brief review of several approaches for studying the impact of hikers on backcountry vegetation, this paper describes a study of vegetation alteration along trails located in different vegetation types. Results show that in Eagle Cap Wilderness, Oregon, hiker impact on vegetation is more pronounced in dense forests than in meadows or open forests. Similar investigations of impacts on environmental characteristics (other than) vegetation would help managers locate recreational facilities where undesirable ecologic change would be minimized.

INTRODUCTION

In recent years there have been dramatic increases in the number of recreationists entering backcountry areas. Recreational use of most wilderness areas, for example, has increased at a rate of 10% per year or more (Frissell & Stankey 1972). This essentially unrestricted recreational use has already destroyed the integrity of natural plant communities in many areas where management objectives call for preservation and protection. Anticipated increases in use threaten to accelerate this destruction unless managers can effectively resolve the conflict between use and preservation.

Impacts resulting from this conflict are inevitable because even light use produces some ecologic change. The basic problem, then, is to define the "limits of acceptable change," the maximum amount of deviation from pristine conditions consistent with the management objectives for the affected area (Frissell and Stankey 1972). Management, not research, must ultimately establish these limits. The role of research is to study user/environmental...interactions in sufficient detail to suggest management actions that can confine recreational impacts within these established limits.

To limit recreational impacts on vegetation, researchers must be able to predict the effects of various use configurations on different vegetation types. Use configuration incorporates differences in the absolute amount of use; the type of use, whether by hikers, packstock, or some other type; the season of use; and the frequency of use by parties of various sizes. Differences in any of these use variables will result in different types and intensities of impact on the vegetation. Vegetational changes resulting from use will also vary with vegetation type due to differences in the susceptibility of habitats and species assemblages to alteration.

RESEARCH APPROACHES

Accurate prediction of the effect on vegetation of a change in use configuration will depend on careful experimentation. This is the most practical means of controlling use and environmental variables so that the effect of a change in one of these variables can be assessed.

Unfortunately, this type of study often requires many years to complete. Most researchers to date (e.g., Wagar 1964, Bell and Bliss 1973, Liddle and Greig-Smith 1975, and Holmes and Dobson 1976) have only investigated short-term responses to trampling. This limits conclusions to initial deterioration of vegetation and ignores long-term deterioration processes, recovery rates, and vegetative reestablishment. Longer-term experimental studies should be given high priority and initiated as soon as possible.

In the interim, however, vegetation will continue to deteriorate as a result of recreational use, and management responses will remain largely intuitive because of poor data.

Non-experimental research methods such as the analytical approach described by Liddle (1975), can also provide valuable input. The analytical approach investigates sites already subjected to recreational use. Long-term analytical studies are possible and have been undertaken (LaPage 1967, Merriam et al. 1973), but more significantly, short-term analytical studies can provide information useful to managers before the completion of long-term experimental work.

The analytical approach compares adjacent used and unused areas with similar environmental characteristics. The implicit asumption is that any difference between the two areas is the result of recreational use.

There are two major advantages to this approach: first, long-term responses to recreational use can be identified in a short-term study because the plant populations selected for study have had time to adjust to use; and secondly, investigations of this type deal with real situations. The vegetation along trails, for example, is affected by soil changes resulting from trampling, site development such as tree removal and drainage alteration, and new vectors of plant dispersal, in addition to the direct mechanical effect of trampling on plants (Cole 1978). These changes can not all be realistically simulated in an experimental study.

The major disadvantage of the analytical method is the difficulty in unraveling cause and effect. There is no means for effectively controlling the large number of ecological and human-use variables which affect the existing conditions of any recreation site. Furthermore, accurate assessments of the past use history of any site are rarely possible, even if information on current use configurations can be obtained.

Nevertheless, analytical studies provide several types of valuable information. Assessments of the relative susceptibility of vegetation types to changes resulting from recreational use are particularly useful because they contribute to the rationale behind locational decisions.

Most research shows that above relatively low threshold values, amount of use is not highly correlated with amount of ecologic change. Most change on a recreational site results from initial, light use and continued or increased use results in little additional change (Frissell and Duncan 1965, LaPage 1967, Merriam et al. 1973, Young 1978). This suggests that site impact could be more effectively managed by facility location and design than by regulations on the amount of use and that ecologic change could be minimized by concentrating use on particularly resistant sites rather than dispersing use in space. Furthermore, because recovery rates can be many times slower than deterioration rates, most closure and rest-rotation schemes to allow site rehabilitation seem merely to increase the area of alteration without significantly reducing the intensity of alteration (Merriam et al. 1973). These research findings emphasize the importance of locating facilities permanently in places where undesirable change is minimized and the value of collecting information that contributes to more objective locational decisions.

VEGETATION CHANGE ALONG TRAILS IN EAGLE CAP WILDERNESS

Methods

An attempt by Cole (1978) to assess the susceptibility of vegetation types to trailside alteration serves as an example of the analytical technique. In this study the change in understory species composition and amount of plant cover was investigated along trails in the eight most common vegetation types of the Eagle Cap Wilderness Area in northeastern Oregon. Within each vegetation type, ten pairs of quadrats - each measuring 0.5 m x 1 m - were established. One quadrat of each pair was located immediately adjacent to the trail; the other quadrat was 10m from the trail in essentially undisturbed vegetation. Percentage cover of each understory species was estimated in each quadrat. Total cover in the paired quadrats was compared using the formula

$$CR = \frac{(C_2-C_1)}{C_2} \cdot 100\%$$

where CR is percentage cover reduction, C_1 is the cover in the trailside quadrat, and C_2 is the cover in the quadrat 10m from the trail. This provides a measure of cover loss along the trail in each vegetation type.

The species composition of the quadrats was compared using the formula

$$FD = 0.5\Sigma|P_1 - P_2|$$

where FD is a coefficient of floristic dissimilarity, the difference in species composition between two quadrats, P_1 is the importance value (see Cole 1978 for discussion) for a given species in the trailside quadrat, and P_2 is the importance value for the same species in the quadrat 10m from the trail. This provides a measure of the change in species composition that occurs along trails in each vegetation type.

For this study, use configuration at the sample points was considered constant because sampling was confined to the West Fork of the Wallowa River trail, a transportation route to high-elevation lakes. Most trail users hike the entire trail so that use is relatively evenly distributed.

Results

As Table 1 illustrates, there are significant variations in the amount of cover loss and change in species composition along trails in the vegetation types of the Eagle Cap Wilderness. These changes are greatest in the three most densely forested vegetation types: Pseudotsuga menziesii/Physocarpus malvaceous (Douglas-fir/ninebark), Picea engelmannii/Thalictrum occidentale (Engelmann spruce/meadowrue), and Abies lasiocarpa/Vaccinium scoparium (subalpine fir/grouse huckleberry) forests. These forests have understories dominated by woody shrubs and erect forbs, growth forms poorly suited to trampling survival (Wagar 1964, Dale and Weaver 1974, Holmes and Dobson 1976). In comparison to heliophytes (sun-loving plants), these shade-tolerant species usually have more supportive and conductive tissue (Treshow 1970), greater leaf areas, and thinner cuticles, cell walls, and stems (Daubenmire 1959) - morphological characteristics that make them extremely susceptible to breakage. In addition, light intensities along trails are increased by trail construction in dense forests and this increase can result in significant shifts in species composition.

In contrast, vegetation change in the three open vegetation types, the Pseudotsuga menziesii/Calamagrostis rubescens (Douglas-fir/pinegrass) open forest, the Stipa occidentalis (needlegrass) grassland, and the Carex (sedge)-forb subalpine meadow, is relatively insignificant. These vegetation types have understories dominated by grass-like plants (graminoids). The trampling tolerance of this growth form has been consistently noted (Bates 1935, Dale 1973, Liddle 1975, Liddle and Greig-Smith 1975) and derives from such preadaptations to

Table 1. Mean cover reduction and floristic dissimilarity values along trails in the most common vegetation types of Eagle Cap Wilderness

Vegetation type	Cover reduction	Floristic dissimilarity
	- - - - percent	- - - -
Pseudotsuga menziesii/Physocarpus malvaceous forest	73	82
Picea engelmannii/Thalictrum occidentale forest	64	64
Abies lasiocarpa/Vaccinium scoparium forest	57	67
Pinus contorta/Vaccinium scoparium forest	53	41
Pinus albicaulis/Vaccinium scoparium open forest	22	62
Pseudotsuga menziesii/Calamagrostis rubescens open forest	37	36
Stipa occidentalis grassland	38	44
Carex-forb subalpine meadow	12	37

trampling stress as basal meristems, small protected flowers, tough and flexible vegetative parts, basal leaves, underground stems, and the ability to reproduce vegetatively.

Additionally, site manipulation associated with trail construction, particularly tree and brush removal, is often unnecessary. Consequently, environmental alterations that lead to changes in species composition are less profound than in dense forests.

The indices of vegetation change in the two remaining vegetation types respond in opposing manners. The Pinus contorta/Vaccinium scoparium (lodgepole pine/grouse huckleberry) forests lose a considerable amount of cover, but the change in species composition is slight. This results from reductions in the cover of Vaccinium scoparium, a brittle shrub highly susceptible to damage from trampling, and a lack of invasion by other species. In the Pinus albicaulis/Vaccinium scoparium (whitebark pine/grouse huckleberry) stands, cover loss is slight but change in species composition is high. In these forests, Vaccinium cover is reduced but open areas are colonized by species from adjacent alpine openings.

Vegetational responses along trails are confined to a zone seldom more than several meters wide. Cover loss and change in species composition only 2 m from the Eagle Cap trails are negligible when compared to trailside changes (Cole 1978). Trail width differs between forested and open areas, however, with open areas having wider trample zones since hikers can easily walk abreast or leave the trail. For example, in forested areas researchers have found that impact is usually confined to 1 m on either side of the trail (Bayfield 1971, Dale and Weaver 1974). In the alpine meadows of Glacier National Park, the zone of greatest change occurred within 2 m of the trails' edge, but some vegetational response was noted more than 5 m from the trail (Hartley 1976). Similarly, along meadow trails in Yosemite Valley, Foin et al. (1977) found that although severe disturbance was confined to 2 m on either side of the trail center some changes were noted at a distance of 7 m from the center.

Discussion

On the basis of these results it must be concluded, for the Eagle Cap Wilderness at least, that the vegetation of meadows and open forests changes less following the construction and use of trails than the vegetation of dense forests. Ecologically this makes sense, because open vegetation types have understories dominated by species with growth forms and organ structures that facilitate trampling survival. Moreover, these types are less altered by trail construction and they have evolved in conjunction with trampling stress from native animals.

In a study of campsites in the Eagle Cap Wilderness Area (Cole 1977), the use of a paired-plot method similar to that used in the trail study illustrated that the understory vegetation on campsites in forested areas is also more highly altered than the vegetation on campsites in meadows. With the inclusion of the frequent elimination of downed wood and mutilation of live trees in and around forested campsites, this greater impact becomes even more obvious.

As supportive evidence for these conclusions, Foin et al. (1977) concluded that visitor impacts on forested areas in Yosemite National Park are much greater than impacts on meadow trails. Their rationale was that forests regenerate slowly and that thorough destruction of the understory increases the probability of accidents affecting the canopy. Dale (1973), in a study in the Madison Range, Montana, also noted that trails in meadows recover from use more rapidly and completely than trails in forests. Thornburgh (1970), working in North Cascades National Park, noted severe disturbance on campsites in mountain hemlock/silver fir forests and a relative lack of disturbance on campsites in alpine Carex nigricans meadows. One of the most heavily used sites in his study area, a Carex spectabilis meadow near the sign at Cascade Pass, retained an 88% vegetative cover.

Merriam et al. (1973) studied campsites in the Boundary Waters Canoe Area of Minnesota. Although only two campsites in open areas were investigated, it is significant that after five years of use, the nonvegetated area on these open sites was only 3% and 13% of the original campsite area, while the lowest value for any of the 21 forested campsites was 26%.

In a study of backcountry campsites in Banff National Park, Lesko and Robson (1975) concluded that subalpine meadows provide much better campsites than forested areas because of thicker organic horizons, deeper effective rooting mediums, and a higher proportion of trampling-resistant species.

Finally, in a study conducted in Finland, Kellomaki and Saastamoinen (1975) suggested that camping is less destructive to meadows than to forested areas, although this greater tolerance of meadows is not apparent in short-term experimental studies. They illustrate the need for long-term experimental studies by noting that grasses are heavily damaged by short-term trampling and relatively resistant to prolonged trampling.

MANAGEMENT IMPLICATIONS

These results imply that vegetation alteration could be minimized by locating trails and camps in meadows and open forests where understories are dominated by graminoids and heliophytic plants. Densely forested areas should be avoided, particularly where understories are dominated by woody shrubs and erect forbs.

This is a surprising conclusion, considering the common practice of encouraging camping and routing trails into forests rather than meadows. Although the justification for this practice is usually that it reduces ecological damage, this conclusion may be based more on evident visual deterioration than on actual ecological deterioration. Human impact on meadows is much more obvious to visitors than impact is on forests, even if meadow impact is less severe. This emphasis on visual criteria would be justified if it were consciously recognized that management actions were minimizing visual impacts at the expense of maximizing impacts on the vegetation. The concern is that this trade-off situation has not been recognized, and that this visual emphasis has occurred by default because of the lack of comparative data for different ecosystems.

Ultimately, locational decisions must be based on an understanding of the susceptibility of many environmental variables--not just vegetation--to changes resulting from recreational use. Although locating trails and campsites in meadows may minimize vegetation alteration, such an action may maximize soil erosion, wildlife disturbance, visual changes and the likelihood of seeing other parties. For example, many subalpine meadows have fine-textured soils and a perennially high water table, so that trails often become knee-deep in mud when subjected to heavy use.

The following procedure is suggested for backcountry managers who need to make decisions regarding locations of trails and campsites. Determine for each major ecosystem type the changes in environmental characteristics associated with the construction and use of trails or campsites. Both the biophysical nature of the backcountry area and the inclinations of the area's manager will determine the parameters to be considered. Vegetative cover, species composition, wildlife populations, soil compaction, soil texture, soil depth, and organic-matter content consistently change along trail corridors and on camp-sites.

Ideally, a paired quadrat method, similar to that described above should be used to generate the type of quantitative data presented in Table 1. This information on susceptibility to change could be gathered in only a few field seasons. If objective, empirical results of this type are not obtainable due to financial constraints or manpower shortages, managers could assess the susceptibility of ecosystems on the basis of personal observations and previous experience. As funding becomes available, these "educated guesses" could be confirmed or rejected by an improved data base.

This information, regardless of the data-collection method, could be arrayed in a matrix similar to Table 2. The number of susceptibility categories is not important as long as the number remains manageable.

At this point the manager must assign priorities to each environmental parameter. For example, a manager might decide that wildlife disturbance and soil depth change are particularly undesirable because they are difficult to reverse. Weighting factors, based on these priorities, can then be assigned to each parameter (Table 3) and multiplied by the relative susceptibility ratings (1 for low, 2 for moderate, and 3 for high). Summing all of these weighted susceptibility ratings for an ecosystem type provides an overall rating. In the case shown in Table 3, ecosystem types C and D are particularly susceptible to undesirable changes; ecosystem types A and E are relatively resistant. Therefore, trails should be concentrated in ecosystems A and E, and ecosystems C and D should be avoided.

The elements of subjectivity in this system must be kept in mind. Overall susceptibility ratings will vary with the measures taken, the accuracy of the individual susceptibility ratings, and the weighting factors used. This subjectivity is

Table 2. A hypothetical matrix of the relative susceptibility of ecosystems to changes resulting from trail construction and use

Parameter	Ecosystem type				
	A	B	C	D	E
	- - - - susceptibility rating[1] - - - -				
Vegetative cover	3	3	1	1	1
Species composition	2	3	1	2	1
Wildlife disturbance	1	2	3	3	1
Soil compaction	1	1	3	3	2
Soil texture	1	2	2	3	1
Soil depth	1	2	3	3	2
Organic matter content	2	1	3	1	2

[1] Susceptibility: 3=high; 2=moderate; 1=low

Table 3. Overall susceptibility ratings[1] of the ecosystem types in Table 2

Parameter and Weighted factor	Ecosystem type				
	A	B	C	D	E
	- - - - susceptibility rating - - - -				
Vegetative cover (1X)	3	3	1	1	1
Species composition (1X)	2	3	1	2	1
Wildlife disturbance (3X)	3	6	9	9	3
Soil compaction (1X)	1	1	3	3	2
Soil texture (2X)	2	4	4	6	2
Soil depth (3X)	3	6	9	9	6
Organic Matter content (2X)	4	2	6	2	4
Overall Susceptibility Rating	18	25	33	32	19

[1] Weighted ratings are calculated by multiplying the susceptibility ratings in Table 2 by the weighted factor assigned to each type of change. The overall susceptibility rating for the ecosystem type is the sum of these values.

unavoidable because the ratings reflect both environmental conditions and management objectives; they are not absolute and unchangeable. Nevertheless, this method provides a framework for integrating various types of human impact, displaying trade-offs to be made, and summarizing the overall susceptibility of ecosystem types to particularly undesirable changes.

This illustrates how analytical methods can generate information capable of guiding locational decisions. The technique involved is simple and the information can be gathered quickly. With the resulting data base, locational decisions would have a scientific foundation that could constantly be improved, particularly when long-term experimental results become available.

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DISCUSSION

Comments: Your evaluations show percent cover reduction. Is this relative cover? Our results in Olympic National Park substantiate what you've shown, but I've often wondered about the importance of noting that percent cover reduction is less in meadows. In terms of actual plant loss, have we lost more total plants in a dense meadow community than in a forested community with a sparse shrub layer?

Cole: That's a good point. I used a relative measure, expressing cover loss as a percentage of the vegetation that you started with. The alternative is absolute cover loss which is highly dependent on the amount of original cover.

Let's say you have an undisturbed community with a cover of 20%. If you lose all the cover, that's a 100% cover loss using my system. Otherwise, it would be only a 20% absolute cover loss. Compare that to a community with 60% initial cover and 30% cover after use. In this case, there has been a greater absolute cover loss, 30%, but you have only lost half of the cover. In my opinion, this is less significant and that is why I chose relative cover. As I've said before, this is a subjective decision based upon a management decision as to which is better or worse. Maybe we need both.

Comment: Did you try applying the overall susceptibility rate to your own studies?

Cole: No, I only measured cover loss and change in species composition. I have not had a chance to use the expanded susceptibility rating system.

Comment: Off the top of your head, what ecosystem do you think would come out most susceptible? The forest type?

Cole: I'm not really in a position to say because, as I have stressed, susceptibility can only be defined in terms of management priorities. Forests are probably least susceptible if visual impact is given overriding importance, while meadows are least susceptible to vegetation alteration. Before this question can be answered, we need to know more about wildlife disturbances and soil changes and managers need to assign priorities to the various types of change. The answer will vary from place to place due to differences in environment and management objectives.

Comment: I'm one of the land managers for the Eagle Cap Wilderness and I really enjoyed your comments. We're really concerned about lake shores and the vegetation changes there. I was wondering if you noticed in your studies if these same patterns held true at lake shores--are forested lake shores more impacted than open lake shores?

Cole: Many of the areas I studied were around lakes, such as Horseshoe Lake. I did find that forested areas around these lakes were more highly impacted by camping than subalpine meadows. On the other hand, trails through perennially wet meadows around lakeshores may be particularly damaging to soils. In terms of vegetation change, however, even under these conditions, trails cause less change in meadows than in forests.