The Context for Wilderness Restoration

This chapter includes three sections. The first section provides a historical context for wilderness restoration projects. The second section explains the relationship between wilderness impacts and ecological processes. The third section is an overview of the ecological concepts that influence the success of restoration projects.

1.1 Wilderness Restoration in the Past, Present, and Future

The Wilderness Act directs agencies to protect and manage wilderness "so as to preserve its natural conditions," ensuring that wilderness "generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable." Although the Wilderness Act does not specifically mention restoration, increasingly managers are turning to restoration to preserve wilderness character. Heavy scars on the land—whether from past practices or ongoing uses—compromise the goals of the Wilderness Act. Restoration (figures 1–1a and 1b) is one way to reduce the scars. Interest in wilderness restoration is at an all-time high.

Figure 1–1a—Cascade Pass in North Cascades National Park, WA.

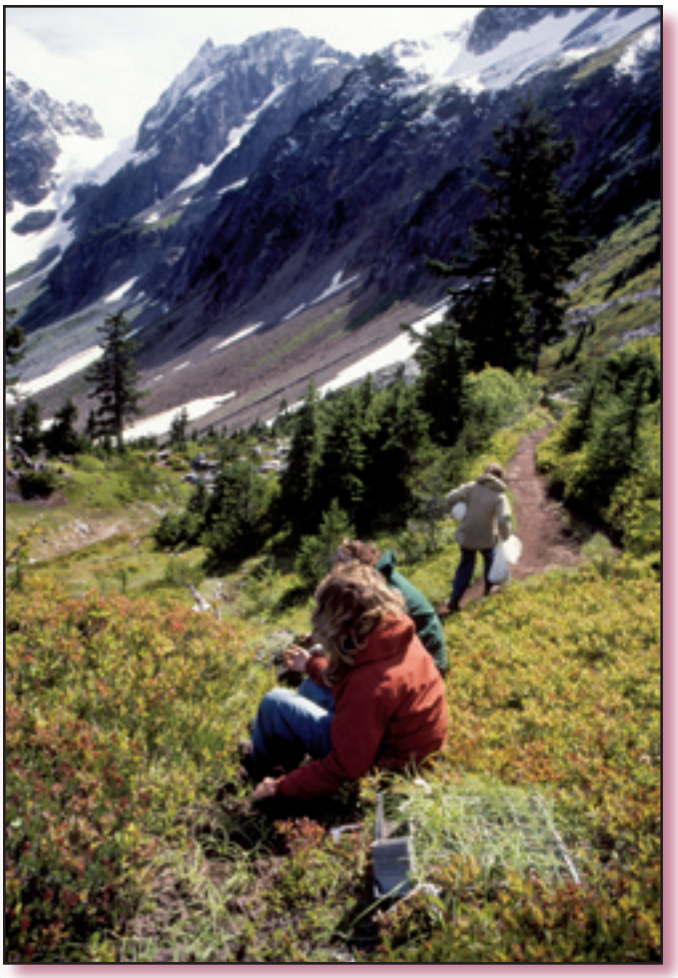


Figure 1–1b—Since the 1970s and continuing to this day, North Cascades National Park has worked to restore meadows at Cascade Pass using native plants grown in the park's greenhouse.

1.1.1 The Past

It is difficult to trace the true beginnings of wilderness restoration. Recent related efforts consist of attempts to reforest areas of timber harvest, to rehabilitate overgrazed rangelands, and to revegetate roadcuts and other disturbances in parks. In the 1960s, research was conducted on maintaining or restoring vegetation at developed campgrounds (Wagar 1965, Jollif 1969).

In wilderness, most efforts can be traced to the Pacific Northwest and several projects undertaken by the Forest Service and the U.S. Department of the Interior National Park Service, based on the research and recommendations of Dale Thornburgh, a forestry professor at Humboldt State University (1962, 1970). These projects were undertaken in 1970 and shortly thereafter—first in the Glacier Peak Wilderness (figures 1–2a and 2b) and North Cascades National Park and then at Mt. Rainier and Olympic National Parks. By the mid-1970s, wilderness restoration projects had spread to a number of other national parks, such as Rocky Mountain and Yosemite.

Figure 1–2b—By the 1960s unregulated recreational stock use had severely degraded meadows and forested campsites. In response, the Forest Service closed the lake basin to all stock use and overnight backpacker use and began restoration. The lush meadows responded quickly to the elimination of stock use, but the drier shaded campsites have responded slowly to treatments.

Figure 1–2a—Image Lake in the Glacier Peak Wilderness, WA, wasn't always this scenic.

Much of the credit for the blossoming of wilderness restoration in the Pacific Northwest goes to volunteer biologists Joe and Margaret Miller (figure 1–3). In 1970 they were given the task of carrying out Thornburgh's suggestions. They started with a few of his ideas, and developed and tried many more of their own. Concerned managers from neighboring areas adopted the Millers' ideas and developed others.

Many revegetation efforts in Pacific Northwest national parks were documented. It is possible to learn from the early progress of the Millers (Miller and Miller 1979) and other practitioners at North Cascades (Lester 1989), Mt. Rainier (Dalle-Molle 1977), and Olympic National Parks (Scott 1977).

Figure 1–3—Volunteer biologists Joe and Margaret Miller deserve much of the credit for the blossoming of wilderness restoration in the Pacific Northwest. (This photograph was digitally altered to remove distracting elements.)

1.1.2 The Present

Restoration appears to have become one of the jobs of wilderness management. The number of wilderness rangers with rudimentary site restoration skills is increasing rapidly. Many national parks now have greenhouses or nurseries. Restoration skills are being taught both by agencies and by outside specialists, such as the Student Conservation Association.

The most important lessons of site restoration have been:

- Practical methods for restoring damaged sites
- Improved perspectives on restoration's role in wilderness management

1.1.2a Practical Methods of Restoration

The initial restoration projects in the Pacific Northwest usually involved transplanting plugs of vegetation from neighboring areas. This technique, while simple and generally successful, affects adjacent areas. It is impossible to find much material for revegetation without causing substantial impacts elsewhere. This problem has been alleviated by off-site propagation and improved methods of revegetation from seeding.

At North Cascades National Park, the Millers pioneered the technique of removing plant plugs from the field, dividing and growing them at low-elevation greenhouses, and transporting plants back to the damaged site for planting. This technique was effective, but costly and time consuming. Moreover, it had the added disadvantage of reducing the genetic diversity of the population because all individuals were clones of a few original plants.

Some of these problems were overcome when workers discovered effective means of propagating plants from seed in the greenhouse. Now it is possible to collect seed in the field, germinate these seeds, grow plants in the greenhouse, and then transplant the seedlings to the field. The key to successful germination of subalpine plants includes sunlight, high humidity around the seed, and high soil temperatures (Lester 1989). Through trial and error, workers have come up with more effective means of propagating difficult species, such as the heathers.

In some parts of the country, such as the Colorado Rocky Mountains, rangers have had considerable success using direct seeding to revegetate damaged sites. However, in the Pacific Northwest, seeding has been used effectively only in recent years. Through trial and error, managers found that seeds would germinate in abundance if they were kept warm and moist. The key was to cover the site with polyethylene

sheeting (Visqueen). Difficulties still remain, such as the cost of collecting seed. Generally, seeding will be the most cost-effective means of revegetating damaged sites.

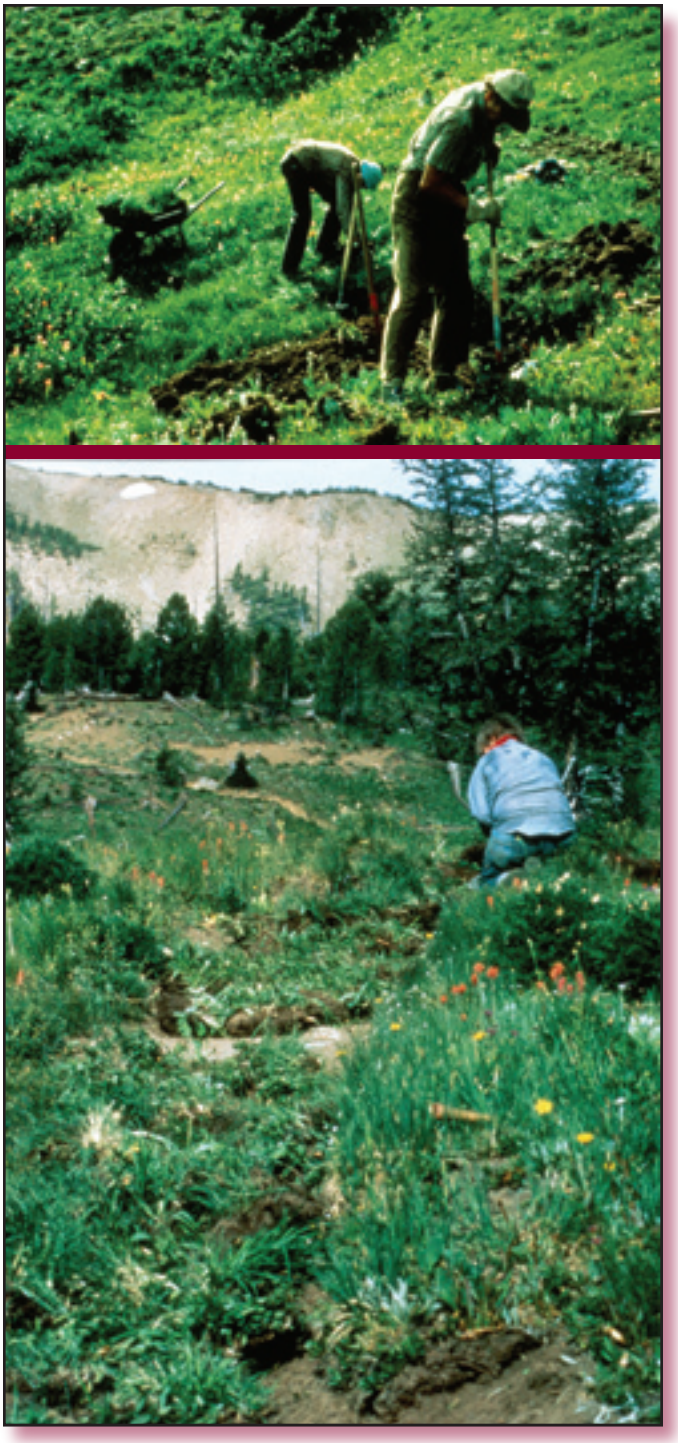
Progress also has been made in understanding the importance of mulches, which help retain moisture and prevent seeds from blowing or washing away. While native mulch is the best option, commercial mulches are often a more feasible alternative. Initially, jute netting was the most commonly used mulch. However, jute often decomposed too slowly, was too obtrusive, and entangled emerging plants. Jute is still used, but practitioners now use a wider variety of mulches that can be tailored to individual needs.

Most of these advances in technique were made through trial and error. A few individuals experimented with different techniques, monitored the effectiveness of each technique, and communicated what they had learned to others. It is imperative that all of us continue this process. This means we must experiment, document, monitor, and communicate our successes and our failures.

1.1.2b How Restoration Fits With Wilderness Management

Any time visitor use is shifted, impacts will shift as well. New impacts are created, while scars from old impacts may remain. These scars should be healed as quickly as possible. For example, restoration should be an integral part of trail relocation programs. Eroded trail segments frequently are abandoned without rehabilitation when trails are relocated. Restoration should be part of the original trail reconstruction plan. Building a trail may leave a substantial amount of soil and plant material that can be used to revegetate old tread (figures 1–4a and 4b). The key is to time the work and to have resources available to use the soil and plant materials as they become available.

In many wildernesses, camping is prohibited near lakeshores, where the impacts of past use are pronounced. This prohibition often has been ineffective and managers may have expended little effort trying to enforce it. If management is serious about a lakeshore setback, restoration should



Figures 1–4a and 4b—If the vegetation type matches, plugs of sod salvaged during trail relocation (top) can be used to restore (bottom) an abandoned section of trail.

be part of the program. Because the impacts of visitors will be extended into new areas farther from the lakeshore, it is important to restore at least some of the lakeshore. Restoration generally will require keeping all use (not just camping) off the restoration sites for a substantial period. One way of proceeding might be to fence off 20 percent of the lakeshore until that area has been restored and then move to the next 20 percent of the lakeshore. It might take 100 years to restore the lakeshore, but at least restoration could occur.

As we become more aware of the decades required for restoration and the difficult odds that must be overcome, some workers are becoming more conservative. Increasingly, they decide that it may be better to allow an impacted area to continue being used than to move that impact elsewhere while attempting to restore the old site. Or they decide to restore the fringes of damaged sites (figures 1–5a and 5b), reducing the size of the area being damaged without moving use elsewhere.

Figure 1–5a—The margin of this campsite was revegetated with locally native plants grown in a greenhouse. The flat portions of the site remain open for camping at Little Caroline Lakes in the Alpine Lakes Wilderness, WA.

Figure 1–5b— This trail at Lake Mary was narrowed using rocks so the margins could be restored.

Restoration should be undertaken only when adequate resources are available and success is likely. The causes of the impacts must be identified and a feasible means of keeping the impacts from recurring elsewhere must be laid out. Preventing impacts usually involves a variety of visitor management techniques, from access restrictions to visitor education. Site restoration becomes just one technique among a suite of techniques needed to deal with impacts.

1.1.3 The Future

We do not have a crystal ball allowing us to predict the future. However, if current trends continue, the future of site restoration in wilderness will bring:

- More specific skill development
- An increase in holistic planning

1.1.3a Skills Development

The blossoming of restoration ecology as a discipline, along with the acceleration of wilderness restoration, should lead to dramatically improved restoration skills. The rate of improvement will depend primarily on the rigor that goes into experimentation and documentation of restoration trials. Everyone can contribute to the long-term success of restora-

tion techniques by documenting their restoration projects and communicating their results.

Often, nurseries and greenhouses are being used as restoration tools. Techniques for propagating species that are difficult to grow are being developed. More commercial nurseries are taking an interest in native species and more volunteer organizations are available to help.

1.1.3b Holistic Planning

A good plan doesn't guarantee a good project, but it can help. Plans are likely to improve in comprehensiveness, scale, and integration. In the past, most restoration plans dealt primarily with the specific techniques that were used to get plants growing on the site again. Increasingly, we are seeing plans that start with goals, assess constraints, set targets, and monitor success in relation to these targets. Such programs are more likely to be successful and are more likely to help us learn from the failures that inevitably occur.

In the future, planners are more likely to:

- Consider one specific site in the context of larger areas or even an entire wilderness.
- Link site restoration to other management actions needed to keep problems from recurring or simply being shifted elsewhere.
- Recognize the long timeframes that generally are required, such as the more than 20 years needed to restore Cascade Pass (figures 1–6a and 6b) in the North Cascades.
- Consider issues of genetics, which were given little thought a decade or two ago.

Finally, future plans will do a better job of integrating people and ecosystem management. Research on visitors and visitor management is as important to success as research on plant propagation and site management. An excellent example of planning that integrates people and ecosystem management is the work done to rehabilitate Paradise Meadows at Mt. Rainier (Rochefort and Gibbons 1992). Ecosystem management is a recent buzzword, but the interdisciplinary approach it implies is critical to the success of wilderness restoration.

Figures 1–6a and 6b—These photos, taken 28 years apart, show the effects of restoration at Cascade Pass in North Cascades National Park, WA.

1.2 Impacts of Recreation and Similar Small-Scale Disturbances

There is always a tendency to jump into a restoration project. The impacts are obvious and the desired outcome is easy to visualize. This section describes the nature of site impacts and discusses the types of impacts that are likely to be considered problems. An understanding of site impacts guides decisions about the site conditions and processes that need to be repaired. Problem definition makes it possible to measure success and also helps set priorities for projects.

For restoration to be a long-term success, it is important to:

- Understand the nature of impacts caused by recreational use.
- Decide which impacts are significant problems that require restoration.
- Identify the causes of those problems.
- Devise ways of changing visitor use so that the problems do not recur.

The planning process and management techniques described in chapter 2 address these issues.

Management techniques focus on identifying the causes of problems and selecting management actions to decrease the likelihood that problems will recur or simply be shifted elsewhere.

1.2.1 What Are the Impacts of Recreational Use?

This discussion of the impacts caused by recreation use is divided into linear impacts, such as those caused by trails (figure 1–7), and the impacts of concentrated use on larger sites. Trails are linear and may run up and down steep slopes, making them susceptible to erosion. Impacts of primitive roads are similar to those of trails. Recreation sites—campsites, picnic sites, vista points, or popular fishing spots—have a different pattern of impacts caused by people or animals that trample one spot. These sites usually are relatively flat and, in most wilderness areas, are created by users. Impacts around administrative improvements, such as water guzzlers for wildlife, and around other areas of concentrated use have impacts that are similar to those around campsites.

Figure 1–7—Recreational use that exacerbated past damage from sheep grazing was responsible for these parallel trails in the Selway-Bitterroot Wilderness, ID.

1.2.1a Trampling

At recreation sites, most of the damage that requires restoration is caused when visitors or their stock trample vegetation. If the damage is light, most plants may survive, even though their height, vigor, and reproductive capacity may decline. If the damage is more severe, certain plants may be killed. Vegetation cover will decline and species composition will change. If the damage is severe, all plant cover will be eliminated. This is the situation that most frequently confronts the restorationist.

Trampling also affects soil characteristics (figure 1–8). These changes further degrade the vegetative community. Trampling disturbs the soil's organic horizons, the dead and decomposed plant matter that form the uppermost layer of most soils. If the disturbance is pronounced, the organic horizons may be lost completely. Loss of surface organic horizons makes the underlying mineral soil horizons more vulnerable to compaction and erosion. It also can reduce the amount of organic matter that becomes incorporated into the soil, leading to a number of detrimental effects. Organic matter promotes the aggregation of soil particles into clumps, increasing the soil's ability to retain water and nutrients. Aggregation allows proper soil aeration and promotes root elongation and growth. Organic matter is particularly important to water and nutrient retention in sandy soils. Without organic matter, these soils may be susceptible to drought and become infertile.

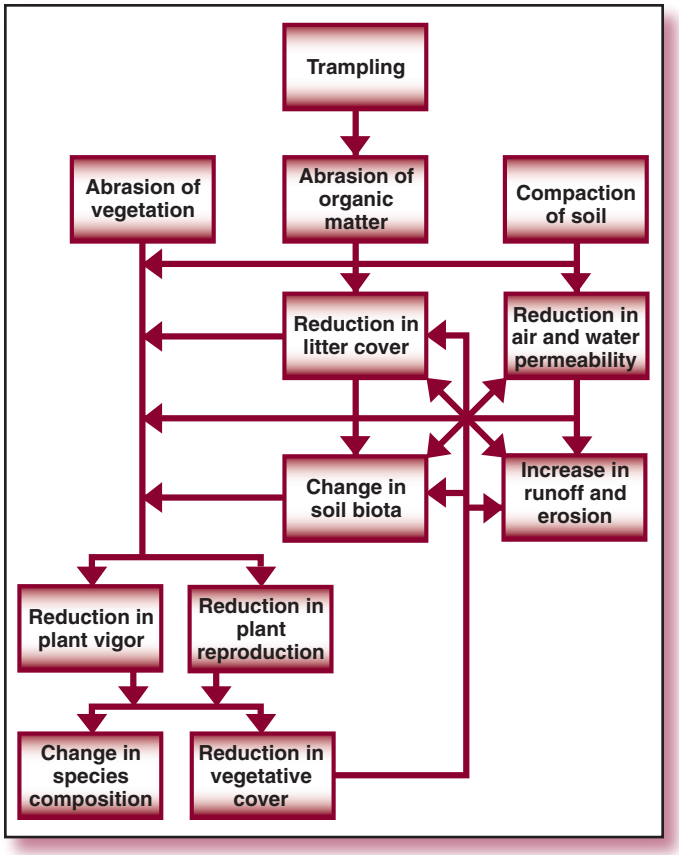


Figure 1–8—A conceptual model of trampling effects, based, in part, on Liddle (1975) and Manning (1979).

Trampling also compacts the underlying mineral soil. Normally, less than half the volume of soil is solid matter; the rest is pore space occupied by air and water. Compaction presses soil particles close together, eliminating pore space, particularly the larger pores that allow water to percolate rapidly after rain. By decreasing the permeability of the soil, compaction can increase surface runoff and erosion.

Generally, compaction reduces water availability to plants, but in certain situations, compaction can increase a soil's water-holding capacity, increasing water availability. Reduced soil aeration can shift conditions from aerobic to anaerobic, creating an environment that is less favorable for soil biota, including mycorrhizal fungi. These changes adversely affect nutrient cycling.

Compacted soils often are so smooth that they offer no safe sites where seedlings can germinate and establish successfully. Rough surfaces have small depressions that collect moisture and organic matter, increasing the chance that seeds will lodge there and contact the soil. Even if seedlings become established in compacted soils, plant growth may be limited because it is difficult for roots to penetrate soils with low porosity.

The conceptual model of trampling impacts shows that some ecosystem components are affected along multiple pathways and that there are numerous positive feedback loops (vicious cycles). Populations of soil biota are altered by all three of the direct effects of trampling—elimination of vegetative cover, loss of surface organic horizons, and soil compaction. Loss of vegetative cover eliminates the primary energy source of soil microbes; loss of organic horizons eliminates another energy source; and compaction reduces pore size and aggregation, influencing critical habitat characteristics, such as the mobility of water. Even if just one or two of these impacts can be dealt with effectively, soil biota will benefit.

1.2.1b Trampling Damage to Ecosystem Components

Positive feedback loops are of particular concern because impacts may continue to intensify even if disturbance from the original source has been reduced. One positive feedback loop involves soil compaction, erosion, and litter loss. Soil compaction reduces porosity and rates of water infiltration. Runoff increases, increasing erosion of mineral soil and organic horizons. Loss of organic horizons aggravates compaction problems, leading to more erosion, and so on.

Another cycle involves loss of vegetation, soil organic matter, soil biota, and favorable conditions for plant growth. Loss of vegetation removes a major source of organic matter. Reduced organic matter leads to changes in the soil biota and less favorable conditions for plant growth. With less plant growth, vegetation cover declines further, organic matter

inputs to the soil decline further, soil conditions decline further, and so on.

Compacted soils, loss of organic matter, and altered soil biotic populations lie at the center of many of these vicious cycles. Perhaps the most critical task for the restorationist is to mitigate impacts to these ecosystem components and break these vicious cycles of impacts.

Many different ecological changes, working together, contribute to the lack of vegetation on a disturbed recreation site. Even if recreation use is eliminated, the changes to the soil may prevent vegetation from becoming reestablished. Plants may not flourish because soils have been altered so severely. For the system to regain its normal function, soil organic horizons, soil biota, and soil structure all need to be repaired. Making soils more receptive to plants—by improving soil structure and biotic communities—may be more important than introducing plant propagules, such as seeds or cuttings.

1.2.1c Campfire-Related Impacts

Impacts associated with collecting and burning wood in campfires aggravate problems caused by trampling (Cole and Dalle-Molle 1982). The removal of fallen wood further reduces sources of soil organic matter. Removal of large decaying wood is particularly detrimental. Large woody debris has an unusually high water-holding capacity; stores nitrogen, phosphorus, and sometimes calcium and magnesium; and serves as a significant site for the establishment of nitrogen-fixing micro-organisms and mycorrhizal fungi. When wood is burned in a campfire, soil organic matter, nitrogen, and microbes all are reduced dramatically. Special attention may be required when rehabilitating firerings at campsites or at other areas where soils have been altered.

1.2.1d Damage to Standing Trees

Damage to standing trees is another common impact at campsites. Campers damage trees by:

- Tying horses to them (figure 1–9)
- Cutting down saplings for tent poles or firewood
- Carving initials in their bark
- Hacking them with axes
- Pounding nails into them

If trees are not chopped down or girdled, usually they can survive injuries, even though their vigor may be reduced. Opportunities to reverse damage are limited. However, if the behavior of recreational users can be changed, additional damage can be prevented.

Figure 1–9—Trees damaged by stock pawing the ground at Lake Augusta in the Alpine Lakes Wilderness, WA.

1.2.1e Trail Impacts

Trampling also occurs on trails. When trails are constructed, vegetation and organic matter are removed, and soils are compacted. These impacts are intentional and make the trail convenient to use. When trails need to be restored, the impacts of trampling and trail construction must be repaired. In areas where trails cross slopes, construction commonly leaves a cutbank above the trail and some fill material below the trail. When a trail is restored, often fill should be pulled back on the trail to reestablish the original contour. This is particularly true for primitive roads.

Trails may intercept drainages. Problems with erosion (figure 1–10) may be particularly severe in such areas. It is not unusual for several feet of soil to have been lost on or

Figure 1–10—A deeply incised trail at Lake Valhalla in the Henry M. Jackson Wilderness, WA. Once an erosion channel forms, water—rather than foot traffic—causes most of the damage.

along trails, exposing lower soil horizons, which typically are less capable of supporting vegetation. Soil structure is less developed in the subsoil. Organic matter and soil biota are negligible. Restoring productive soil processes is particularly challenging. In areas where it is possible, trails should be filled with topsoil to bring them back to grade.

Another problem with trails is that once drainage systems have been disrupted, erosion can continue even if the trails are no longer used. Once trails become lower than their surroundings, water tends to be channeled down trails. The first priority of trail restoration is to deal with drainage and erosion problems.

1.2.2 Which Impacts Should Be Considered Problems?

Problems on campsites and other sites that receive concentrated use (picnic sites, vista points, fishing spots, and so on) are relatively easy to define. Any site that has been substantially altered by humans could be considered a problem. But such an approach is not tenable. With repeated use, mineral soil will be exposed, compacted, and inevitably lost. Numerous studies have shown that substantial impact occurs within a short time, even with relatively light camping use (Cole 1987). We must accept that any sites that receive repeated use will be substantially impacted. In these places, managers can more effectively control the number and distribution of impacted sites than the level of impact on individual sites.

At popular wilderness destinations, the most appropriate objectives for a site restoration program are to reduce the number of impacted sites (figure 1–11) or to eliminate sites in undesirable locations. For instance, a restoration program

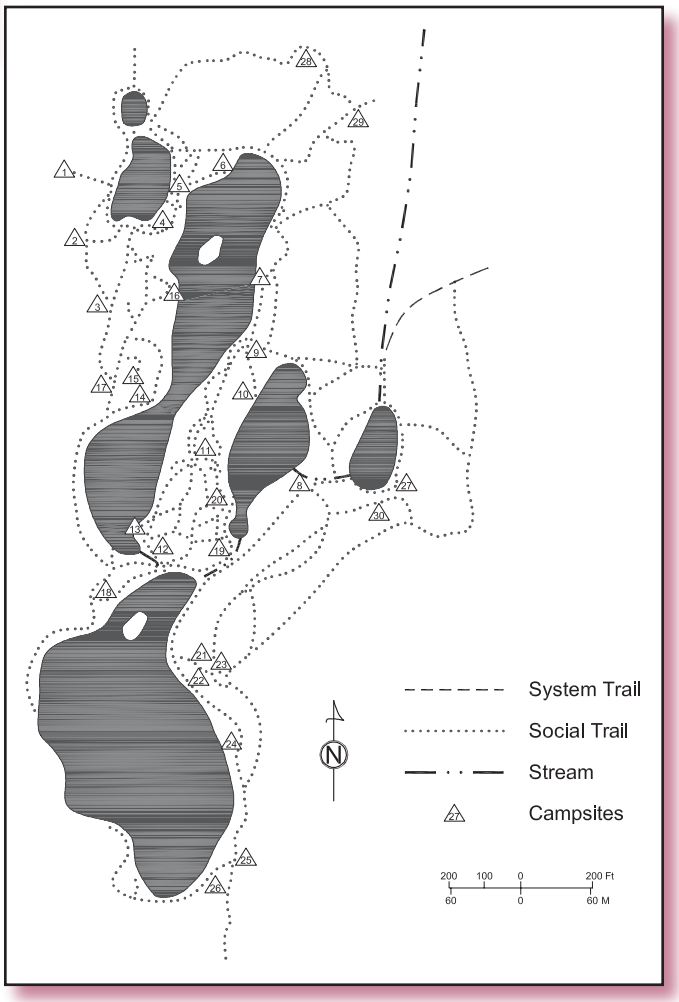


Figure 1–11—This map shows impacts around Rampart Lakes in the Alpine Lakes Wilderness, WA. In such cases, it is easier to reduce the number of trails and sites that are being impacted than it is to reduce the severity of impact on any particular trail or site.

could be beneficial in areas where campsites are too close to lakes or other fragile locations. In remote, lightly used areas, it may be desirable to attempt to close and restore all sites that show signs of use and impact. But in other areas, it is probably not reasonable to close sites simply because they have been altered substantially.

The problems caused by user-created (social) trails and off-trail routes are similar. Wherever consistent use occurs, these impacts cannot be eliminated (figure 1–12). The most realistic options are to keep trails to a minimum and to try to eliminate them in undesirable locations. When deciding which trails to eliminate and which to keep, carefully consider people's desires (where they are trying to go) and the physical constraints that affect trail development (such as snowmelt patterns or the visibility of sites from the trail).

Figure 1–12—Will restoration of these social trails meet with success? Probably not, because the lakeshore and big rock are magnetic attractions in the Enchantment Lakes Basin in the Alpine Lakes Wilderness, WA.

Restoration may be considered when a road or constructed trail is being relocated or decommissioned. Restoration also is appropriate when users have created multiple or shortcut trails. The initial goal of restoration is to eliminate further use of the road, trail, or shortcut. Longer term goals involve restoring the natural topography and plant communities.

The reasons why recreation site impacts are considered problems are more likely to be anthropocentric (based on human preferences) than biocentric (based on biology). Campsites may be considered to be too close to each other or too large. Trails may be considered to be too muddy, too rocky, or too rutted—problems for humans, but not for nature. By carefully defining why we consider problems to be serious (and in need of restoration), we are more likely to make good decisions about what we are trying to accomplish and how we should invest our limited restoration resources. Also, it is helpful to get input from the public.

Our goals must be articulated carefully. Restoration implies trying to return a site to its historical condition, making it like it would have been before it was affected by recreation. If rare or highly vulnerable species have been lost, this goal may be unrealistic. In such cases, rehabilitation may be a more feasible goal. In situations where it is impossible or undesirable to restore species composition and structure (Society for Ecological Restoration Science and Policy Working Group 2002), the goal of rehabilitation is the repair of ecosystem processes. There may be cases where reclamation is the most appropriate goal. Reclamation attempts to stabilize terrain and return it to a useful purpose (Society for Ecological Restoration Science and Policy Working Group 2002). In other cases, revegetation—establishing native species on an abandoned trail or around the periphery of a campsite that is still in use—may be the only realistic goal.

Good sources of additional information on the impacts of recreation include Cole (1987), Hammitt and Cole (1998), and Liddle (1997).

1.2.3 Alternative Management Techniques

Site restoration is just one of a number of management techniques that can be used to address wilderness impacts (Cole and others 1987; Hendee and Dawson 2002). It is important to recognize the broad array of techniques that are available and to understand how restoration fits with other techniques. Restoration treats the symptoms rather than the root cause of problems. If sites cannot be managed in a way that reduces the damage, they can be restored endlessly without making any substantial progress. This makes no more sense than constantly picking up litter without simultaneously working to convince people not to litter. It is critical to understand the primary management actions that must be undertaken before considering restoration.

The effectiveness of alternative management practices can be assessed by understanding why certain sites and trails become severely impacted while others do not. Four factors that can influence the severity of impacts are:

- Amount of use
- Type of use
- Environmental conditions
- Spatial distribution of use

Managers can manipulate each of these factors when attempting to reduce impacts.

The amount of use often has been considered the most critical of these factors. Frequently, managers use terms such as overused and used beyond its carrying capacity to describe a seriously impacted site. Most studies of campsites suggest that the amount of use a site receives is seldom the most critical factor in determining whether impacts at a site represent a problem or not (Cole 1987). Even relatively infrequently used sites can have serious problems. The amount of use does not explain much of the variation in impacts, except when very lightly used campsites are compared.

The same principle applies to trails. Trail segments with problems frequently alternate with segments that are in good condition. Because the amount of use is relatively constant along the trail, something other than the amount of use must explain these differences. There are few situations where reducing the amount of use by itself will reduce impacts substantially.

More variation in the amount of impact can be explained by the type of use and visitor behavior. Large camping parties are likely to create larger campsites than small parties. Parties that have campfires cause impacts that parties using cooking stoves do not. Parties that travel on packstock cause impacts that travelers on foot do not. Hikers who shortcut trails or leave the trail tread cause impacts that hikers who are careful to keep to the main tread do not. Many—but not all—problems result from inappropriate behavior. Large campsites, excessive tree damage, and multiple parallel trails are examples of such problems. These problems can be reduced by changing the behavior of visitors, either through regulation or education.

Other problems result primarily from the location of use. Sometimes trails and campsites are located in particularly fragile environments. For example, problems commonly occur where trails traverse soils that are saturated with water. Trails along fragile shorelines also may affect ecological values. Cole (1995a) has shown that some vegetation types are 30 times as tolerant of trampling as other vegetation types. More often, the problem is the desirability of the location rather than its fragility. For example, campsite impacts are more visually obtrusive in meadows than forests, even though meadow vegetation is generally more durable than forest understory vegetation.

Campsites also may be located too close to each other or to the main trail. These campsite and trail problems can be eliminated by shifting use to more durable locations or to locations where the impacts cause less disturbance.