

1 Wildland Recreation and Resource Impacts

Recreational use of wildland areas has increased dramatically in recent decades. Along with this increase in recreational use have come human disturbance and degradation to the natural conditions of wildland areas. Examined in this book are the nature and degree of these disturbances and ways they can be managed. First, we need to define wildland recreation and recreation resource impacts. Then, we must consider the importance of recreational-ecological impacts and the role of the wildland recreation manager in balancing use and preservation of wildland areas.

WHAT IS WILDLAND RECREATION?

Although most types of recreation are fun and nonwork oriented, their goals and benefits are usually diverse. The notions of recreation as constructive, rewarding, and restorative are at least as important as the notion of recreation as fun (Brockman and Merriam 1973). For our purposes recreation is defined as activities that offer a contrast to work-related activities and that offer the possibility of constructive, restorative, and pleasurable benefits.

This broad definition provides room for a tremendous variety of activities. We are restricting ourselves here to recreational activities conducted outdoors in wildland areas that are dependent on the natural resources of these areas (Fig. 1). In *wildland* recreation the importance of the environment or setting for activities is greater than in *developed* recreation situations. Moreover, these wildland settings are largely natural, and management strives to maintain a natural appearance. Facility development is limited both in areal extent and function. Facilities in wildland areas are limited to small sites, if present at all, and are more likely to enhance visitor safety and resource protection than visitor comfort and convenience (Fig. 2). Accessibility is more difficult with wildland recreation. Distances from urban populations are greater. Roads tend to be low standard and less frequently maintained, if present at all. Where absent, trails may or may not be provided. Finally, use tends to be dispersed, creating a social environment with less emphasis on certain types of social interaction. Interaction takes place in smaller groups, with less interparty contact.



FIGURE 1. Recreational activities in wildland areas are greatly dependent on the natural resources of these areas. (*Photo: National Park Service.*)



FIGURE 2. Recreational facilities in wildland areas are limited in both areal extent and function, and are more likely to enhance visitor safety and resource protection than visitor convenience. (*Photo: W. E. Hammitt.*)

Most wildland recreation takes place on public lands such as those managed by the Forest Service, National Park Service, other federal agencies, or state park departments. These lands may or may not be specifically designated for recreational use. For example, trails, campgrounds, and other visitor use areas are designated and specifically managed for visitor enjoyment on National Park Service lands, whereas adjacent and intervening Forest Service land permits recreational use but emphasizes other uses, such as timber production. Similarly, wildland recreation use also occurs on private lands not specifically designated recreation areas. However, most wildland recreation occurs on public lands, and most of the management responsibility falls on public agencies.

This book, then, deals primarily with the recreational use of publicly owned and managed lands. Although many different activities are involved, they are generally dispersed over large areas, resulting in low user density. This dispersal makes management difficult because such a large area is used and disturbed. Moreover, because maintenance of natural or natural-appearing conditions is so important, considerable management of both users and resources is required to avoid excessive resource damage.

WHAT IS RECREATION RESOURCE IMPACT?

Disturbance to natural areas as a result of recreational use has typically been defined as *resource* or *ecological* impact. As pointed out by Lucas (1979), the term *impact* is a neutral term. When combined with *ecological*, it refers to an objective description of the environmental effects of recreational use. Objectively, an impact can be a positive or negative change. In wildland recreation a value judgment has been placed on the term *impact*, denoting an undesirable change in environmental conditions. Of concern to the recreation manager are the type, amount, rate, and duration of undesirable change occurring to the resource base as a result of recreational use. We define undesirable change to the resource base to mean degradation to the soil, vegetation, wildlife, and water resources of a wildland area.

Recreation resource managers are understandably concerned with ecological impacts because many of them have the responsibility of maintaining the quality of recreational resources. This is particularly true for wildland recreational areas, as many are national parks or designated wilderness areas where a major goal is to preserve natural conditions. (When using the term *wilderness*, we mean areas specifically designated as wilderness by Congress; *backcountry* is a more generic term for areas that are not roaded.) To deal effectively with the problem of environmental disturbance in recreation and natural areas, resource managers need to understand recreational impacts in sufficient detail to determine how much and what kind of change is occurring and is acceptable (Cole and Schreiner 1981).

ECOLOGICAL IMPACTS OF WILDLAND RECREATION

All wildland recreation activities disturb the natural environment. Although the specific impacts associated with each activity differ to some extent, they all potentially can affect soil, vegetation, wildlife and water. These effects and their interrelationships are laid out in Fig. 3. Some activities can also affect basic geology and air, as shown in Fig. 3; however, these impacts are less direct and often originate on areas adjacent to wildlands. Presented in this section is an overview of the major resource impacts that will be discussed in more detail in subsequent chapters. In particular, we want to stress the interrelated nature of these different types of impact. One theme that should emerge in this book, particularly when we get to management, is that impacts do not occur in isolation; single activities cause multiple impacts, and each impact tends to exacerbate or compensate for other changes. Management solutions to impact problems must recognize this, or the solution to one problem is likely to be the cause of another.

Impact to soils starts with the destruction of surface organic matter and the compaction of soil or snow. Each of these changes alters basic soil characteristics related to aeration, temperature, moisture, nutrition, and the organisms that live in the soil. These changes, which adversely affect the ability of the soil to support plant life, are most visibly obvious in the barren, compacted soils of campsites (Fig. 4). Compaction, by reducing water infiltration rates, increases runoff and, therefore, erosion. Erosional impacts are most severe on trails and in off-road vehicle areas (Fig. 5).

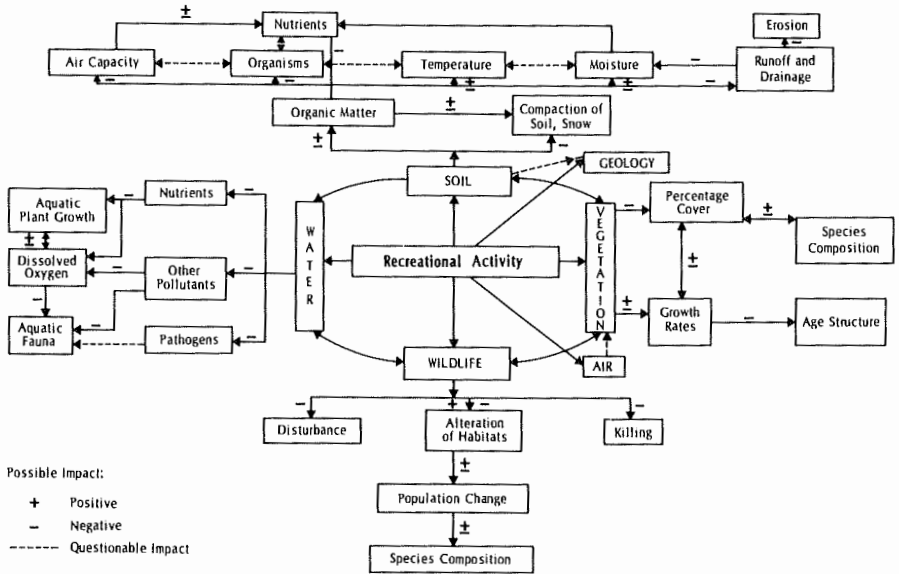


FIGURE 3. Recreational impact interrelationships in wildland areas. (Source: "Recreational Impact Interrelationships," by G. Wall and C. Wright in *The Environmental Impact of Outdoor Recreation*, 1977. Reprinted with permission.)



FIGURE 4. Campsites in wildland areas are typically characterized by a heavily impacted zone of compacted soil and the absence of vegetation. (*Photo: W. E. Hammitt.*)



FIGURE 5. Hiking trails on steep slopes and at higher elevations where greater rainfall occurs are easily eroded. (*Photo: W. E. Hammitt.*)

Most of these changes in soil condition inhibit the establishment of new plants and adversely affect the growth of existing vegetation. Moreover, trampling by feet and horse hooves and abrasion by skis and off-road vehicles directly injure and kill existing plants. Plant cover, growth rates, and reproductive capacities are all diminished. For trees, in particular, this alters the age structure of the population. On many campsites, for example, tree populations consist entirely of middle-aged and older trees; reproduction is totally lacking. Even these older trees are often scarred by ax marks, lantern burns, and nails (Fig. 6). Understory vegetation varies greatly in its ability to tolerate recreational impact. Since more tolerant species are more likely to survive on recreation sites, changes in species composition shift toward these more tolerant species. An ability to grow close to the ground is one important survival mechanism that partially explains the reduced height of most vegetation on recreation sites.

Although the indirect effects of soil impacts on vegetation are particularly obvious, the same is not true for the indirect effects of vegetation impacts on soils. Loss of vegetation cover exacerbates such impacts as loss of organic matter and increased erosion. It also is related to wildlife impacts, particularly through alteration of habi-



FIGURE 6. Trees on older campsites are often scarred by the burns of gasoline lanterns. This tree has 13 lantern scars. (Photo: W. E. Hammitt.)

tats. For large animals the most serious impacts of recreation are direct, either outright killing or unintentional disturbance (harassment). Disturbance can reduce reproduction, as when a disturbed bird leaves her nest, lead to migration to more remote areas, or result in adaptation, as when a bear learns to rely on garbage as a food source. Smaller animals are more affected by habitat alterations. For example, soil impacts, such as loss of organic matter, remove a home and food source for many insects; vegetation impacts, such as a chopped-down tree snag, eliminate homes for cavity-nesting birds. Many of these animals have important effects on soils and vegetation, from their roles as decomposers and grazers and their place in ecosystem nutrient and energy cycles. Altered population structures, spatial distribution and abundance, and even behavior will, consequently, have an influence on soil, vegetation, and water as well.

Water quality is reduced by inputs of nutrients, other pollutants, including increased sedimentation resulting from erosion, and contamination with pathogens. Pathogenic contamination may result from improper disposal of human waste; more commonly, contamination is caused by wild animals that carry disease organisms. Nutrients and pollutants may enter waters as a direct result of recreational use, as when surface films of oil and gasoline pollute lakes with heavy motorboat use. More insidious are the indirect sources such as the reduction in water quality caused by erosion triggered by recreational use. Again, this erosion is promoted by soil and vegetation impact. Water pollution, from many sources, depletes dissolved oxygen and alters aquatic plant and animal growth and survival.

In considering interrelationships among soil, plants, animals, and water, the concept of an *ecosystem* is important. An ecosystem consists of all the organisms in an area, their environment, and the linkages and interactions between them. Ecosystems vary in size from small ecosystems (such as your stomach) to the largest wilderness. According to Franklin (1990, p. 250) human activities can affect several key attributes of ecosystems. First, they can affect the *functional ability* of the ecosystem, the capacity to perform key actions—to fix and cycle energy, conserve and cycle nutrients, and provide suitable habitat for an array of inhabiting species. Second, they can affect the *structure*, or spatial arrangement of the parts, of the ecosystem—whether it is a savanna, meadow, even-aged or uneven-aged forest, or some other type. Third, they can affect the *composition* and *population structure*, that is, the number of species and their relative abundance as well as the densities and age- and size-class distributions of individual species. Finally, human actions can alter the basic *successional patterns*, or trajectories, characteristic of a given site.

RECREATION ECOLOGY

The study of wildland recreation resource impacts and their management has its academic grounding in the field of Recreation Ecology. *Recreation Ecology* deals with the impact of wildland-outdoor recreation on natural or semi-natural environments (Liddle 1991, p. 13). Although this field of study has gained major recognition only since the mid 1960s, its antecedents go back to at least 1759 when Stillingfleet

reported differences in the survival of plant species in trampled paths of England (Stillingfleet 1759, as in Liddle 1991). (Cole 1987) suggests that the field as we know it today began about 65 years ago with Meinecke's (1928) work on recreational impacts at California Redwood State Parks. Many of the early, and current, studies in Recreation Ecology have dealt with the effects of trampling on the morphological and physiological characteristics of plants and the ability of various species, plant forms, and environments to resist and recover from trampling damage (Cole 1995; Bayfield 1971; Liddle 1988, 1989). Today, Recreation Ecology deals with the impacts of recreation on all resources (not just vegetation) of wildland areas and with other means of recreational disturbance besides trampling.

Liddle credits Neil Bayfield (1971) as being the first systematic student of Recreation Ecology, based on his many years of work in United Kingdom. Much of the trampling impact research has been concentrated in Europe, examining the effects of trekking and picnicking in the countryside. David Cole, coauthor of this book, has been the leading Recreation Ecology researcher during the last 25 years in the United States. In Australia, Liddle's work on sand dune communities, tropical areas, biological features and strategies of resistance, and impact theory are well recognized (Liddle 1988). His contributions in the area of impact theory are particularly welcomed in an applied field such as Recreation Ecology. Interested readers are encouraged to see Cole (1987) for a more detailed historical development of Recreation Ecology.

THE IMPORTANCE OF ECOLOGICAL IMPACTS

All of the aforementioned impacts occur, but so what? We can go out and measure most of the impacts, determining the *magnitude* of environmental change. It is a very different matter, however, to assess the *importance* or *significance* of these impacts. We might all agree that 95 percent of the spiders on the forest floor of a campsite have been eliminated by recreation use; we are unlikely to agree about how important a change this is. We might not even be able to agree on whether this is a positive or a negative change. In a recreational context, impacts become good or bad, important or insignificant, only when humans make value judgments about them. Those judgments are determined primarily by the type(s) of recreation an area is managed to offer, the objectives of various user groups, and the objectives of resource management.

Different areas offer different types of recreation. This fact has been formalized in the recreational opportunity spectrum, a classification of land based on the types of recreational opportunities they offer. More will be said about this in Chapter 11. The spectrum distinguishes, for example, between the opportunities for primitive recreation of a wilderness area and the ball-playing opportunities of an urban park. Both areas may have experienced, in some places, a conversion from native vegetation to a turf of Kentucky bluegrass. In the wilderness this presents a problem because loss of natural conditions is undesirable in wilderness. The importance of this change is probably related to how large an area is affected and the uniqueness of the vegetation

that was lost. In the urban park the conversion is both important and beneficial because it greatly improves the quality of ball playing. As we move along the recreational opportunity spectrum from developed and urban areas to remote and primitive areas, the same impact is likely to become increasingly negative and significant.

Even within the same area people vary in their opinions about impacts. Different recreationists have different ideas. A hiker, confronted with erosion of a hill used by motorcyclists, is more likely to react negatively than the motorcyclists themselves. Conflict, resulting from different perspectives on ecological impact, commonly occurs between motorized and nonmotorized recreationists whether recreation occurs on land, water, or snow. Similar conflicts and differing perspectives occur between hikers and users of horses and pack animals.

It is also interesting to compare the perspectives of the ecologist, recreationist, and manager. The ecologist is most likely to be concerned about impacts that impair the function of ecosystems or destroy unique features. Examples include removal of dead woody debris to burn in fires or elimination of an inconspicuous endangered plant, neither of which is likely to be noticed by many recreationists. Ecologists are also likely to evaluate the importance of a change in terms of how long it takes for recovery to occur. Using this criterion, erosion is extremely serious because it will take centuries to regenerate soils to replace eroded ones.

The spatial scale at which impacts occur is also of interest to ecologists. Today there is particular interest in impacts occurring at large spatial scales, such as landscapes. Some ecologists question the importance of recreation impacts because they tend to be confined to concentrated linkages and nodes. Consequently, impacts may be severe at the scale of the site but negligible at the scale of the landscape. We suggest that there are two reasons recreation impacts should be considered relevant to the ecologist. First, site-scale impacts are not inherently less important than landscape-scale impacts. They are less widespread, but they are often even more intense than landscape impacts. Second, some recreation impacts do have landscape implications. For example, exotic fish and game species have often been introduced to improve fishing and hunting opportunities. Native fish may be displaced or eliminated entirely as a result. This has happened in the Great Smoky Mountains National Park where the introduction of rainbow trout has caused the native brook trout to now be found only in high, isolated, small streams. Other recreation impacts that can have effects at landscape scales include displacement of wildlife through unintentional harassment and extensive livestock grazing (Cole 1990).

Cole and Landres (1996) suggest that the most serious ecological impacts are those that affect large areas, are long lasting and intense, or that affect rare ecosystem attributes. In assessing the importance of any recreation impact, one needs to understand the attribute that is being impacted as well as characteristics of the disturbance itself. The rarity and irreplaceability of the attribute must be considered. One also needs to know whether the disturbance to the ecosystem's function, structure, composition, and dynamics is large or small and whether it is transient or essentially permanent.

Recreationists, as a whole, seem to be more concerned with impacts that decrease the functional use of a site or with "unnatural" objects left by other parties. In

Yosemite National Park, facilities (toilets, tables, etc.) and litter detracted more from enjoyment of backcountry campsites than other impacts (Lee 1975). To an ecologist such impacts are likely to be of little importance because they are easily reversible and do not greatly harm the function of natural ecosystems. Most recreationists do not even recognize ecological impacts (Martin and McCool 1989). Knudson and Curry (1981) asked campers in three Indiana state park campgrounds for their opinions about ground cover conditions. Then they compared these judgments with actual conditions (Table 1). More campers felt conditions were satisfactory or good on the less devegetated sites; however, even at Turkey Run State Park where 99 percent of the sites were more than 75 percent denuded, most campers found conditions satisfactory or better. More than two-thirds of campers saw no tree or shrub damage, despite the fact that virtually every tree was damaged.

Although this lack of recognition and concern for impact characterizes most recreationists, there are exceptions. In wilderness areas there are undoubtedly visitors who are bothered by such impacts. Visitors to four wilderness areas, three in the southeastern United States and another in Montana, found that littering and human damage to campsite trees were among the factors that most affected the quality of their wilderness experiences (Roggenbuck, Williams, and Watson 1993). Shindler and Shelby (1992) compared interest group standards for ecological conditions found at campsites with those of wildland managers. They presented various audience groups with photographic slides of wilderness campsites to measure the acceptability or tolerance for campsite conditions. The authors found that although visitor sensitivity to resource conditions is similar to that of managers at a general level, differences become apparent as one refines the impact level. In fact, small amounts of impact are often considered more acceptable to visitors than no impact at all. For example, small fire rings (less than 16 in. in diameter) were rated more acceptable than no fire rings and small areas of bare ground (less than 156 sq. ft.) were more acceptable than no

TABLE 1. Campsite Ground Cover Conditions and Visitor Opinions

Cover Conditions	Versailles		
	New	Old	Turkey Run
As rated by campers	--- Percent of Campers ---		
Very poor	2	3	14
Poor	11	20	29
Satisfactory	53	39	47
Good	30	37	8
Excellent	4	1	2
Actual	--- Percent of Sites ---		
≥75 percent bare and disturbed	6	23	99

Source: Knudson and Curry 1981. Reproduced with permission of the Society of American Foresters.

bare ground (Shelby, Vaske, and Harris 1988). However, other studies of visitor perceptions of wilderness impact show little relationship between visitor satisfaction and amount of impact (Lucas 1979). Many visitors do not notice ecological change; of those who do, many do not conceive of change as “damage” or undesirable change. Most visitors do not change their behavior or have less satisfactory experiences even when confronted by impacts that they consider undesirable. For example, even those who dislike the heavy evidence of horse use in the Bob Marshall Wilderness are likely to continue to camp in the same places and travel the same trails and, on the whole, enjoy the experience. In dramatic contrast, site impacts are the foremost concern of managers (Godin and Leonard 1979). Managers are often well aware of such impacts and are charged, as managers, to deal effectively with them.

Maintenance of natural or natural-appearing conditions is important to the wildland manager; so is providing recreational opportunities—and recreation *always* disturbs natural conditions. Impacts that affect visitor enjoyment, particularly those that impair the functionality or desirability of sites, are a particular concern. Legislative mandates and agency guidelines provide additional constraints. Wilderness designation, for example, places some bounds on the types and levels of impact that can be tolerated. Different agencies also have differing perspectives. Even in designated wilderness, presumably subject to the same mandates, each managing agency has a different style. For example, the Fish and Wildlife Service has a particular concern with wildlife. The National Park Service is much more likely to restrict recreational activities to avoid resource impact than the Forest Service (Washburne and Cole 1983). In dealing with recreational impacts, managers must balance the concerns of ecologists, recreationists, other user groups, and the constraints of legislation and agency policies, and tailor all these to the peculiar situation of the areas they manage.

THE MANAGER'S ROLE

While considering the importance of recreational impacts in wildland areas, it is easy for one to develop an antiuser bias toward these areas. Would these wildland recreation areas not be better off if recreational use did not occur in them? This is an unrealistic position to adopt and is certainly not the intent of this book.

Society and public policy have made these areas available for recreational use, and we must accept the propriety of use of wildland resources for recreational purposes. Humans, as recreationists, are to be part of these wildland ecosystems. Because humans are a part of all ecosystems, wildland management is an effort to maintain a natural site environment in which human impact and influence are minimized as much as possible, while still allowing for recreational use. We should *accept* the principle that recreational use can occur in wildlands, and that no matter how small, will produce an impact of some type. Management's role, in general, is not to *halt* change within wildland areas, but to manage for acceptable levels of environmental change.

Acceptability of impact is a function of both the ecological significance of the alteration and human perception. The ecological significance of an alteration, as measured

by its magnitude and permanence, may be far different from the degree to which it is sensed as unnatural by the lay person. Ecologically, the most significant human alterations of natural ecosystems are not necessarily the most obvious. What a visitor perceives as natural may have been profoundly and permanently altered. Both managers and users need to broaden their perspectives so they can distinguish between cosmetic and profound ecologic impacts (Franklin 1987).

RECREATIONAL CARRYING CAPACITY

One of the primary tools for meeting the challenge of site and ecosystem impact management is the development of management objectives related to visitor use and acceptable levels of resource impact. This important topic will be introduced in this section and developed in more detail in Chapter 10.

In an attempt to plan for the increases in resource disturbance associated with increasing recreational use, managers and recreation researchers have repeatedly looked to the concept of carrying capacity for solutions. The concept of carrying capacity was borrowed from the disciplines of range and wildlife management. In these fields, carrying capacity refers to the maximum number of animals a given unit of land can support on a sustained basis without destruction of the resource base. In managing recreation areas it was hoped that a maximum number of users could be specified, above which recreation quality could not be sustained. Agency directives, from both the National Park Service and the Forest Service, have actually mandated determination of appropriate use levels or carrying capacities for parks and wilderness areas.

For a number of reasons, determining carrying capacities is neither simple nor particularly useful. First, managing recreation use and associated impacts differs considerably from managing cattle or other animals. In addition to concern with the physical ability of the resource to sustain use, there is an equally important concern with the effect of use on the recreational experience of the user (Graefe, Vaske, and Kuss 1984; Hendee, Stankey, and Lucas 1990; Shelby and Heberlein 1986; and Wagar 1974). Social carrying capacity refers to these visitor experience aspects, and ecological carrying capacity refers to resource aspects. Both are inextricably intertwined. As Frissell and Stankey (1972) note:

The soil compaction and dying vegetation that accompanies excessive use of a site is of significance not only to the ecologist, but also to the social scientist, for the perception of declining esthetic quality might well be a more important constraint than reduced soil pore space.

More important than the greater complexity of recreational carrying capacity was a misunderstanding of how carrying capacity was used in a field such as range management. Setting carrying capacities for range animals became common practice only when private users were allowed to graze public lands and land managers did not have the time to oversee the operation and monitor changes in conditions. Capacities were conservative, set low so that private users would not damage public lands even

in years when forage production was low. Actually, ranges suffered from overgrazing in unproductive years whereas in productive years the limits were wasteful because many more animals could have grazed. On private lands experienced ranchers do not set carrying capacities; they monitor conditions—rainfall or forage condition, for example—and adjust the numbers of animals to achieve their objectives.

In recreation it is possible to select a carrying capacity, but by itself it too will be wasteful. As we will see in subsequent chapters, the relationship between amount of use and amount of impact is not direct. Amount of impact is also affected by the timing, type, and distribution of use, the setting where use occurs, and mitigative actions taken by management. As Washburne (1982) notes:

There is a separate carrying capacity for horses in meadows in the spring and another in the summer, one for campers who use previously established sites, one for campers who bring stoves rather than build fires, one for noisy and inconsiderate campers who walk through the camps of others . . .

We will explore the importance of many of these variables that affect amount of impact. The point we want to make here is that although carrying capacities *can* be set, they must either be wasteful of legitimate recreational opportunities—set very low to allow for variations in all of the other factors affecting amount of impact—or they must be only a part of a management program. They are not the key to management for which some have been looking. The key to management, in recreation as in range and wildlife management, is specifying management objectives and monitoring conditions.

These key elements of management will be discussed more fully in Chapters 10 and 11. In the following four chapters the ecological effects of recreation are described. The first task for management, once these impacts are understood, is to set objectives for how much impact is too much. In the terminology of Frissell and Stankey (1972) and Stankey, Cole, Lucas, Petersen, and Frissell (1985), managers must set “limits of acceptable change” (Fig. 7). Change in nature is the norm; the natural variation in the rate and character of change is acceptable, except where it poses a safety hazard or, in nonwilderness areas, where it detracts substantially from desired recreation opportunities (i.e., insect infestations). Changes beyond this constitute human-caused change or impact. A certain amount of impact must be considered acceptable even in wilderness. The limit of acceptable change, a management judgment, divides acceptable impact from unacceptable. Management must decide where to draw the line and then hold that line through prescription of management programs (Stankey, McCool, and Stokes 1984).

However, it must be recognized that the decision of where to draw the line is one that cannot be determined *entirely* by ecological criteria. The manager must be prepared to weigh policy, economic, and public use considerations as well when setting limits of acceptable resource change. This is particularly true in wildlands that are not congressionally established wilderness, for they are managed under a broader range of social and economic considerations. Management prescriptions can be based on ecological criteria, but only under the broad umbrella of these other factors.

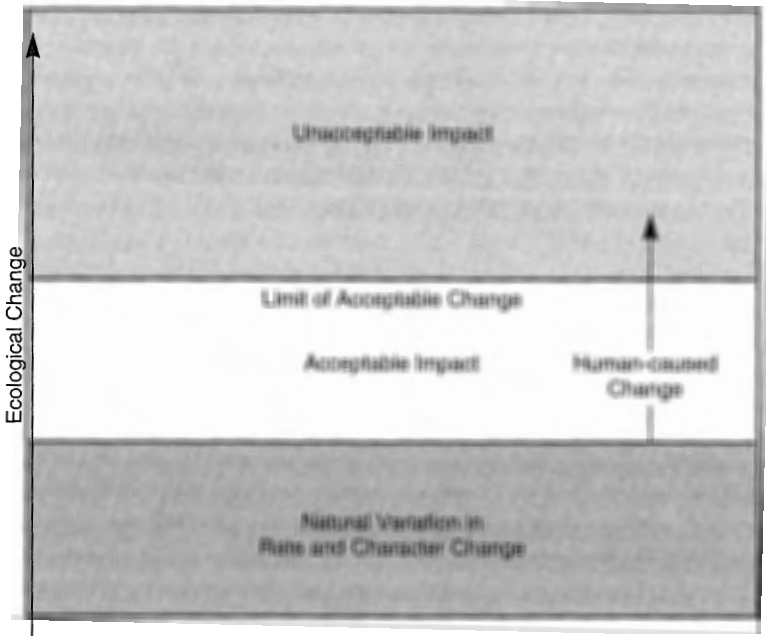


FIGURE 7. Model of acceptable ecological change in wildlands. (Source: Adapted from Frissell and Stankey 1972.)

THEMES OF THIS BOOK

This chapter has introduced the topics of wildland recreation and resource impacts. It has defined each topic and its importance to the management of wildland areas. Following this introductory chapter are four major parts to the book: the first dealing with ecological impacts to the four major resource components of wildland areas; the second concerning spatial-temporal distribution and trend changes in impacts; the third describing some key factors that affect resource impacts; and last, a section on the management of recreation resource impacts. Throughout the chapters comprising these topic sections will be a number of recurring themes. These themes form the basis for organizing the material of the book and are summarized as follows to serve as a guide to the reader.

1. The impacts caused by recreation use can be direct or indirect, are interrelated, and are often either synergistic or compensatory. Some are immediately obvious even to untrained eyes. Initials in trees and trampled vegetation are good examples. Others are visible only with microscopes, and some effects have never been identified or studied. Many of these more obscure impacts may be among the more significant. For example, the impact of recreation on soil organisms is very poorly understood, yet it is undoubtedly considerable. Moreover, soil organisms are particularly important to the energy and nutrient cycles of ecosystems, so their disruption

is serious. Some impacts such as disturbance of large wildlife species are almost impossible to identify because there is no way to know what their distribution and behavior were like prior to disturbance, and because of the many other factors that can affect animal behavior.

Many of the more obvious impacts are *direct*; that is, the observed change is a direct result of recreation use. Vegetation loss as a direct result of trampling is an example. Vegetation loss can also reflect poor growth and reproduction in soils that have been compacted by recreation use. This is an *indirect* impact, the result of soil compaction. Indirect impacts illustrate the interrelated nature of many impacts. Many synergistic relationships exist. Loss of organic matter makes a soil more susceptible to erosion, which in turn tends to carry away organic matter. However, sometimes impacts are compensatory. For example, loss of native vegetation cover reduces competition for weedy species, which increases the vegetation cover. Soil moisture levels tend to be reduced because water infiltration rates are reduced, but the soil's capacity to hold water increases at the same time; the result is often little change in available moisture.

2. In addition to understanding what impacts occur—their severity and their interrelationships—it is also important to understand the spatial distribution of impacts and how they change over time. Most impact is highly concentrated. McEwen and Tocher (1976) note, for example, that probably no scenic site in North America is more heavily impacted than that at Athabasca Falls in Jasper National Park, Canada, yet the forest a few yards on either side of the falls is essentially undisturbed. In this book we will be concerned both with areas of concentrated use—primarily camp and picnic sites, but also water-recreation sites, off-road vehicle areas, and scenic sites—and with linear routes, trails, and roads. In all cases undisturbed land is likely to exist a short distance from these places.

There is usually a tendency for these areas and routes to increase in number and size over time. In contrast to these changing spatial patterns, the severity of most impacts tends to increase rapidly with initial use, stabilize, and then remain relatively constant for long periods of time. Thus, trends in various types of impacts will vary over time.

3. Both the nature and severity of impacts vary with type of recreational activity. We will be primarily concerned with impacts associated with picnicking, camping, hiking, skiing, or riding on trails, and recreational boating. Each of these activities is unique in the impacts that result, their spatial distribution, and how they change over time. For example, water pollution is most serious with boating, whereas erosion is most serious on trails and vegetation damage is most serious with camping and picnicking.

4. Although more use tends to cause more impact, the use-impact relationship is seldom direct or linear. Usually, a little use causes most of the impact, and additional use causes less and less additional impact. The nature of this relationship varies widely between different types of impact. Because limits on amount of use are a frequently considered management response to impact, it is very important to understand how each type of impact responds to different levels of use.

5. Even within an activity such as camping, parties vary greatly in their potential to cause impact. This variation between parties is part of the reason that the use-impact relationship is not direct. The method of travel a party uses—foot, horse, or motorized vehicle—has a great effect on amount, type, and spatial distribution of impact. Other important user characteristics are the type of party, its size, and the behavior of individuals within the party. Knowledge and use of low-impact techniques are extremely variable between parties and have much to do with the impact they cause.

6. Another factor affecting impact is the ability of different environments to resist change. For example, different plant species and soil types vary in their ability to resist damage in areas used for recreation. Both *resistance* and *resilience* are important. Resistance is the ability to absorb use without being disturbed (impacted); resilience is the ability to return to an undisturbed state after being disturbed. Resistant sites may or may not be resilient and *vice versa*. Let's compare a bare rock site with a site of lush vegetation. The rock is highly resistant; it would take a stick of dynamite to disturb it, but once dynamited, the scar would be there for a long time. The lush vegetation is not at all resistant, being easily disturbed by a few footprints. However, it would recover in time even if it were greatly disturbed. Resistance varies with the type of activity. The bare rock would never show much evidence of trampling impact, but one campfire would leave a lasting scar. Obviously, it is best to locate recreation sites on resistant and resilient sites and to avoid use of sites that are neither. Approximate management of sites that are resistant but not resilient is very different from management of those that are resilient but not resistant. Resistance and resilience vary seasonally with climatic conditions and the growth stage of plants.

7. In managing impacts, it is important to understand their nature and their spatial and temporal patterns and then decide on limits of acceptable change. Then, armed with knowledge of how impacts relate to amount and type of use and environmental conditions, the manager can manipulate these variables in such a way that impacts are minimized.

8. Another factor to consider in managing recreational impacts is the need to accept wildland recreation as an appropriate use of wildlands. However, recreational use of these areas, because they are easily impacted, is appropriate only if managed. The challenge of the recreation resource manager is to balance the public's desire for wildland recreation and, at the same time, to maintain the natural conditions of wildland areas. We must manage for an acceptable level of recreational use and resource protection.

9. A final theme involves the international occurrence of recreation resource impacts. Wildland recreation impacts are not limited to the temperate environment of the United States, but are common to wildland recreation areas around the world. Whenever recreation occurs in wildland/natural environments around the world, there will be disturbance to natural conditions. The planning and setting aside of international parks, wildernesses, and preserves will not be enough to protect their ecological integrity for future generations if much recreational and ecotourism use occurs in these areas. The human use and resource conditions of international areas require management, in addition to planning and protection.

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