9 Visitor Use

Many characteristics of visitor use influence the degree, type, and distribution of ecological impacts in wildland recreation areas. The amount of use an area receives obviously has some effect on impact patterns in the area. This fact spurred the interest in the concept of carrying capacity that was discussed in Chapter 1. Beyond the amount of use an area receives, impacts are strongly influenced by other use characteristics—who the users are, where they go, and what they do. In wilderness, for example, Hendee, Stankey, and Lucas (1990) suggest ranking various groups in the following order of decreasing environmental impact:

1. Large parties of horse users
2. Small parties of horse users
3. Large parties of overnight campers
4. Small parties of overnight campers using wood fires
5. Large parties of day hikers
6. Small parties of overnight campers using camp stoves and not building wood fires
7. Small parties of day hikers

From this it is clear that the potential to cause impact varies with party size (large vs. small), type of user (overnight campers vs. day hikers), behavior (using wood fires vs. camp stoves), and mode of travel (horse users vs. hikers). The potential to cause impact also varies with where users go—use distribution—and various characteristics that can influence behavior, specifically knowledge of low-impact camping techniques, motivations, experience level, social groups and structure, and place bonding. For example, impacts such as human litter, harassment of wildlife, and pollution of water sources are inappropriate or illegal behaviors that have a serious impact on recreational resources and experiences. In most situations a variety of visitor use and behavioral variables must be examined to accurately determine the consequences of recreational use on wildland park resources. In this chapter we will discuss these user characteristics.

AMOUNT OF USE

Conventional wisdom has often held that amount of use is the most important factor influencing amount of impact. Such thinking has been supported by describing the cause of impact with terms like "overuse" and proposing that solutions can be found

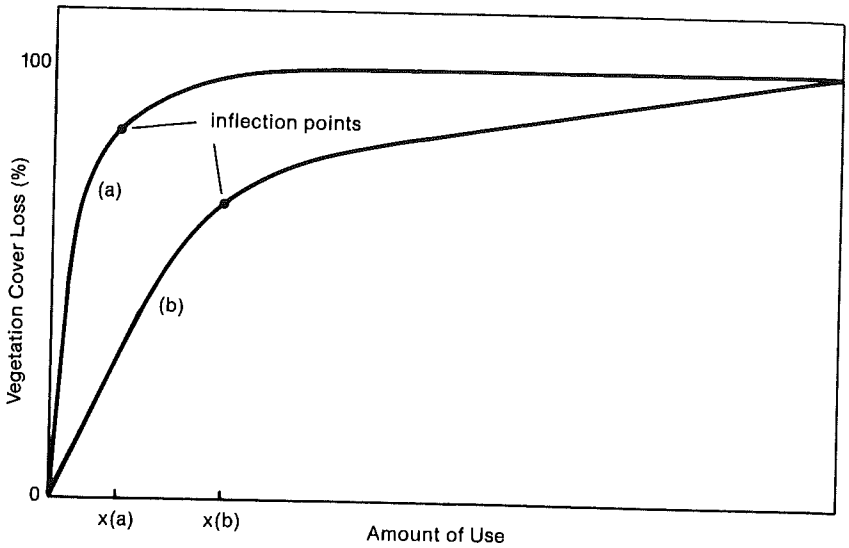

FIGURE 1. The general relationship between amount of use and loss of vegetation cover for (a) a fragile vegetation type and (b) a more resistant type. (*Source:* D. N. Cole.)

by prescribing a "carrying capacity." Research shows such thinking to be oversimplified at best and erroneous at worst. The importance of amount of use varies between environments, between activities, with impact parameter, and with the range of use levels being examined. In addition, effects differ depending on whether concern is with rate, intensity, or areal extent of change.

Research on the relationship between use and impact began in the early 1960s with Frissell and Duncan's (1965) cross-sectional analysis of Boundary Waters Canoe Area campsites and Wagar's (1964) experimental trampling study. Both studies examined the effect of various use levels on amount of vegetation cover. Frissell and Duncan found that the most lightly used campsites (with use estimated at 0 to 30 nights/year) had lost 80 percent of their inferred original cover and heavily used sites (60 to 90 nights/year) had lost 87 percent. Impact increases as use increases, but lightly used sites are almost as highly impacted as heavily used sites. This asymptotic curvilinear relationship between amount of use and loss of ground cover vegetation has been seriously contradicted only by one of six similar studies in wilderness, five on developed campsites, and about 30 experimental trampling studies (Fig. 1).

The asymptotic curvilinear relationship between amount of use and vegetation loss demonstrated by so many studies suggests a number of generalizations. First, at very low use levels, differences in amount of use are related to rapid changes in ground cover vegetation. Second, at higher use levels vegetation loss continues to gradually increase (toward a maximum possible limit of complete cover loss) as use increases, but differences in cover loss are seldom substantial, even when use levels of several orders of magnitude are compared. These two generalizations describe the curvilinear relationship between use and intensity of vegetation impact. Third, degree of curvi-

linearity increases as fragility increases. In fragile environments cover loss increases rapidly with increases in use at the very lowest use levels, and the inflection point, above which even substantial increases in use cause only minor increases in cover loss, comes at a low use level. In resistant environments cover loss increases more slowly with increasing use at the lowest use levels; the inflection point also comes at a higher use level. In Fig. 1 differences in amount of use are likely to have a substantial effect on vegetation cover if at least one of the use levels is well below X(a) or X(b). Most studies have examined only sites with use levels beyond those that correspond to the inflection points on the curve; consequently, cover differences are not substantial.

The relevance of the relationship demonstrated in Fig. 1, particularly the location of the inflection points of the curves, is substantial to wildland recreation management. Attempting to minimize cover loss by keeping use levels low will be effective only where use levels can be kept substantially below the use thresholds that correspond to the inflection points. In several fragile subalpine forest vegetation types, even use levels of no more than five nights/year exceeded threshold levels (Cole and Fichtler 1983). However, use thresholds are likely to be much higher on resistant vegetation types. For example, on developed campgrounds in the Atlantic Coastal Flatwoods region of South Carolina, Dunn, Lockaby, and Johnson (1980) found no significant loss of vegetation cover except on heavy use sites. As in most other studies, lack of adequate use measures makes it impossible to establish use thresholds for these South Carolina campsites. More research, employing better use estimates, and controlled experiments could enable us to establish use thresholds for important environments across the country (Marion and Cole 1996).

Trampling studies are one means of correlating visitor use to impacts under field experiment conditions. When trampling experiments were applied to six different vegetation types for three successive summers in the northern Rocky Mountains, use thresholds varied for each of the six vegetation types (Cole 1987). Thresholds were lower for vegetation cover loss than for species loss or increase in soil penetration resistance. However, there are some limitations in translating or equating experimental passes as an estimate of use. For example, how do you compare trampling number of passes to number of visitors, considering the fact that use of a site involves more impacts than those resulting from trampling passes? Through a series of observation studies of camping behavior and some use assumptions, Cole (1985) has estimated that 75 to 150 passes per year simulates the amount of trampling that occurs in the central part of a campsite during one night of use by a typical party of three backpackers. Validity checks of actual campsite use measures with experimental trampling passes have shown vegetation impacts to be quite similar.

Other research also suggests a strong relationship between amount of use and the *rate* of vegetation loss. For example, in an experimental trampling study on alpine meadows in Mt. Rainier National Park, vegetation cover was reduced to 50 percent of control values in three weeks when trampled at 75 passes/week. At 18 passes/week, it took eight weeks of trampling for cover to be reduced to 50 percent of controls (Singer 1971). The areal extent of vegetation loss is also strongly related to amount of use (Bratton, Hickler, and Graves 1978; Cole 1982). The finding that most levels of increased use have little effect on amount of vegetation loss but a pronounced

effect on area of loss suggests the value of concentrating and channeling use on a small proportion of any area (Cole 1981; Cole and Hall 1992).

Many other impact parameters have been examined on campsites receiving different amounts of use. Those, like vegetation cover, for which a highly curvilinear relationship exists (Fig. 2), include bulk density, penetration resistance, macropore space, infiltration rate, changes in soil chemistry, loss of tree seedlings, and tree damage (Cole and Hall 1992; Cole and Fichtler 1983; Dunn, Lockaby, and Johnson 1980; Legg and Schneider 1977; Marion 1984; Young and Gilmore 1976). Loss of organic horizons, exposure of mineral soil, severe root exposure, and site enlargement are all changes related to use in a less curvilinear manner (Cole and Fichtler 1983; Coombs 1976; Marion 1984; Young 1978); there is more inherent resistance to these types of change, and use thresholds are higher. Changes in these parameters are easier to limit through manipulation of use intensities on campsites.

On trails, vegetation cover, bulk density, penetration resistance, and trail width relationships are highly curvilinear as they are on campsites (Crawford and Liddle 1977;

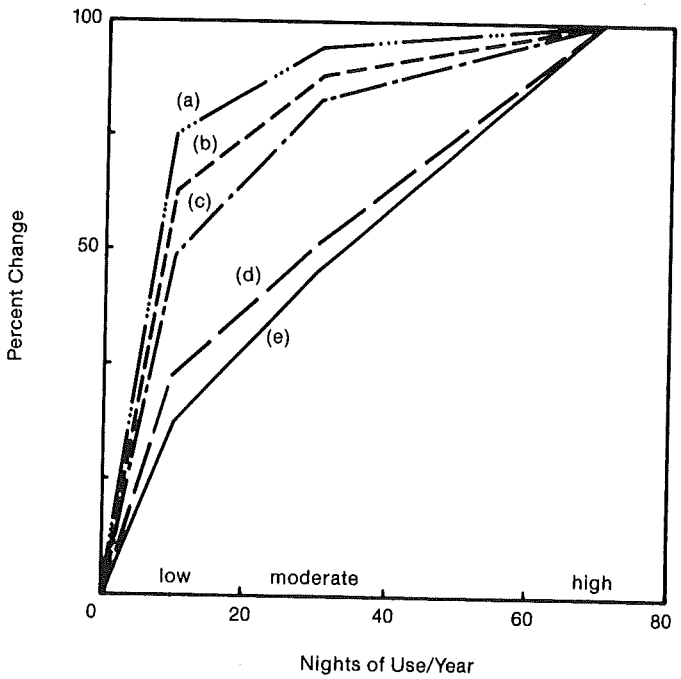

FIGURE 2. Relationship between amount of use and amount of impact in the Boundary Waters Canoe Area. (*Source:* Marion 1984). Numeric use levels are estimated from ordinal classes of low (0–12 nights/year), moderate (20–40 nights/year), and high (> 60 nights/year). Impact parameters are (*a*) tree damage, (*b*) loss of vegetation cover (*c*) increase in soil penetration resistance, (*d*) increase in exposed roots, mineral soil and rock, and (*e*) campsite area. Percent change is expressed as a percentage of the change on high-use sites.

Dale and Weaver 1974). Trail depth and the frequency of impact problems such as muddiness are generally not related to amount of use (Dale and Weaver 1974; Helgath 1975; Leung and Marion 1996). Such situations relate more to location and design features, although they obviously must be triggered by some use or construction.

In sum, these results suggest that there is little value, in terms of reduced impact, in limiting use of constructed trails. On campsites, limiting use is likely to be effective only if use levels can be kept very low. This is possible in some wildernesses but not in popular destination areas. In popular areas, channeling and concentrating use will have to be practiced to counteract the tendency for increased use to enlarge the areal extent of impact. Because the tipping point for each of these opposing strategies—dispersing use to keep levels low or concentrating use to minimize areal extent—varies greatly among environments, use thresholds need to be identified for major ecosystem types.

USE DISTRIBUTION

Visitors of wildland recreation areas often concentrate use in a few popular places, campsites, and trails. Such use behavior results in some zones of recreational areas being overused while other zones are seldom used. Because distribution of use is related to the distribution of resource impacts, use distribution is a major management concern for recreation resource managers. For example, if visitors are concentrating use on impact-resistant trails and campsites, management will want to encourage existing patterns of use. Also, use occurring on already heavily impacted sites does less damage than on new sites. However, in fragile areas or low use areas, management may want to disperse users from areas of concentrated use.

Numerous studies have documented the concentrated use patterns of wildland recreationists. In one of the most heavily used wildland areas, the Boundary Waters Canoe Area of Minnesota, nearly 70 percent of the user groups entered through only seven of the area's 70 entry points in 1974. Two entry points near population centers accounted for one-third of all user groups. Impacts are concentrated not only on these few entry points but also on the few portages and campsites near these entry points. In the Mission Mountains in Montana, more than 90 percent of user groups entered at only two of the area's 19 trailheads (Lucas, Shreuder, and James 1971). When one considers that backcountry trips average only three to four days, there is little chance for these heavy concentrations of trailhead users to disperse. Visitor solitude and resource impacts are both concerns with these patterns of concentrated use.

Over longer periods of time, campers commonly shift use from some existing sites to newly located sites that they "pioneer" (Cole 1993). Certain trails and lake routes within areas also show an uneven distribution of use. The Appalachian Trail within Great Smoky Mountains National Park (Tennessee-North Carolina) comprises only 12 percent of the park's trail system yet receives 45 percent of the overnight use. In the Spanish Peaks Primitive Area (Montana) 10 percent of the trail system accounted for 50 percent of the trail miles hiked in 1970, and a third of the trail system accounted for three-fourths of trail use. Many other wildland recreation areas show similar patterns of concentrated trail use, particularly areas receiving large percentages of horse

and day use. Both activities tend to concentrate use on main trails. As day use of wildlands has increased in popularity, so has the concentration of impacts near trailheads and sightseeing destinations.

Although less concentrated than trails, campsites and scenic sites also show an uneven pattern of use. In the Desolation Wilderness (California) 50 percent of all use occurred on only 16 percent of the most popular campsites. Preferred sites for camping and hiking are often lake and stream edges, scenic overviews, and well-known physiographic attractions (i.e., peaks, gorges) of an area. Brown and Schomaker (1974) showed the most preferred and used campsites in the Spanish Peaks Primitive Area to have the following characteristics in common:

1. Proximity to both water and fishing opportunities
2. Scenic and lake views
3. Location within 700 ft of a trail
4. Availability of at least 500 ft^2 of level land
5. Availability of firewood within 300 ft

They found that about one-half of the campsites were within 50 ft of the shoreline of a lake or stream, almost two-thirds were within 100 ft, and 85 percent were within 200 ft. The shorelines of lakes and streams are considered to be particularly sensitive to ecological impacts, although research by Cole (1982) suggests that lakeshore sites may have impacts little different from sites set back from lakeshores. In trampling experiments conducted in Waterton Lakes National Park (Canada), Nagy and Scotter (1974) found less vegetation change in a subalpine lakeshore meadow community than in the coniferous forests around the lake.

TYPE OF USER GROUP

Obviously, not all types of user groups produce the same type or amount of impacts. Certain types of users, because of length of stay, the activities they engage in, and the demands they place on wildland resources, cause more impacts than do other groups of users. Overnight campers produce more and different types of impacts than day hikers. Campers use wildland resources for a longer period of time, use a larger proportion of the resource (i.e., campsites), and use a greater diversity of the available resources (i.e., firewood, water). Because they stay overnight, they concentrate use on campsites, meaning that these nodes receive a proportionately larger amount of impact per person than do trails. Spatial patterns of impacts of overnight campers tend to be more nodal, whereas those of day hikers are, for the most part, linkage-oriented.

In addition to length of stay, the type of activity the user group is engaged in influences environmental impacts. For example, canoe parties in the Boundary Waters Canoe Area and hunting parties in many of the Western wildland areas tend to be more destination-oriented and spend more time in camp than backpacking parties (Fig. 3). They also tend to carry more equipment and nonburnable materials, which

FIGURE 3. Destination-oriented use parties that spend several nights in the same camp (e.g., hunters) often manipulate the site, such as by building campsite furniture. (*Photo:* D. N. Cole.)

serve as potential sources of litter, than hikers do into the backcountry. Many of these activities cause specific environmental impacts that are in addition to those impacts directly related to backcountry camping. Campers fishing at alpine lakes often deposit fish entrails at the lake's edge and cause more trampling impacts to the riparian zone of lakes than do nonfishing campers.

PARTY SIZE

Large parties of users are thought to cause greater impacts to certain aspects of the biophysical resource than smaller parties. Large parties are typically defined in wilderness areas as groups larger than 8 to 10 members. Although large parties tend to make up a small proportion of all parties visiting wildland recreation areas, they can contribute a disproportionate amount of certain environmental impacts. Expansion of campsite boundaries is a particular impact attributed to large groups. Large parties often expand campsites by clearing areas to facilitate additional tents, other equipment, eating space, and space for tying horses and storing canoes. Most backcountry campsites, like developed campsites, are designed for a capacity of one tent party per site. However, recreation parties often consist of more than one tenting subgroup. When multiple tenting parties want to camp together on a site, it is only natural that they expand the existing site or develop satellite sites adjacent to the boundaries of the existing site to facilitate their spatial needs.

Larger parties of users are also often associated with horseback, canoe, and vehicular modes of travel (Fig. 4). Both horses and vehicles, particularly when overnight use is involved, require additional space at campsite locations and lead to impacts beyond the specific campsite boundaries.

In addition to needing greater space, larger groups commonly exhibit behavioral use patterns that can lead to greater impacts. In the Boundary Waters Canoe Area large canoeing parties were characteristically found to stay longer, move camp more often, and penetrate farther into the backcountry than small parties (Lime 1972). This high mobility of larger groups suggests that they utilize more campsites and portages than small parties do and consequently have the potential for damaging more places. As pointed out by Lime (1972, p. 4):

> Because more than half of the large parties kept moving, their impact on individual campsites was dispersed rather than concentrated. Staying in one location might be less damaging than using many sites, because the disturbance is increased by making and breaking camp several times.

However, extended length of stay can often lead to greater amounts of impact to a given area.

Large parties are also capable of increasing the rate at which impacts occur. They concentrate a heavy amount of use in a short period of time on a site. Two nights of camping by a party of 30 individuals on a previously unused site in New York resulted in a 10 to 15 percent decrease in ground cover (Bogucki, Malanchuk, and

FIGURE 4. Larger parties of users are often associated with horseback, canoe, and vehicular modes of travel. (*Photo:* R. C. Lucas.)

Schenck 1975). The results of this study and others suggest that even short-term use by large parties may severely alter the ground cover vegetation of fragile environments. Large parties are a particular problem in more pristine areas.

Large parties probably have no more resource impact on trails than many small parties as long as they remain on the trail tread. In the case of wildlife impacts, large parties may have less impact than several small parties if the frequency of disturbance is important, as is the situation with bird life.

USER BEHAVIOR

In any setting the actions of individuals may be considered appropriate, inappropriate, or even illegal, depending on the normative behavior and conditions accepted for the situation and setting. In addition, these actions are determined by many behavioral factors. The motivating force behind one's actions, the group context within which an action is carried out, and one's education and past experience with a particular action all have an influence on whether the action will be conducted in an appropriate or inappropriate manner. In the case of resource impacts, all these factors affect the on-site behavior of recreationists, which in turn influences the appropriateness of their actions and the level of impacts that they can cause to wildland resources. Understanding the factors that determine user behavior and their relationship to resource impacts allows management to modify the inappropriate actions of users and thus reduce resource impacts. Next, we will discuss these behavioral factors and their relationship to impacts.

Minimum Impact Knowledge

Many of the techniques involved in conducting wildland recreational activities can be performed in a number of ways that lead to differing levels of impact. As a result, most agencies involved with the management of wildland resources have informational programs aimed at educating users about how to reduce resource impacts (Fig. 5). An example is the Leave No Trace (LNT) program, an effort that unites four federal agencies—The National Park Service, U.S. Forest Service, Bureau of Land Management, and U.S. Fish and Wildlife Service—and outdoor retailers, manufacturers, user groups, educators, and individuals who have a responsibility to maintain and protect wildlands (Marion and Brame 1996, p. 24). The program emphasizes the education and skills necessary to reduce visitor impacts, along with promoting the outdoor ethics and judgment necessary to guide the selection and application of low-impact skills. Often, visitors are simply unaware of certain skills and techniques that result in minimum levels of resource disturbance. By educating visitors about wildland resources and their proper use, managers hope to create a minimum impact ethic that will eventually lead to a permanent behavioral change in visitors. Minimum impact camping techniques are a prerequisite if impacts are to be limited in wilderness areas where policy prohibits major site development practices (Cole 1990).

Certain impacts can be greatly reduced or nearly eliminated through the practice of minimum impact techniques, but other impacts are essentially inevitable if use

FIGURE 5. Minimum impact information, such as the proper use of lanterns in campgrounds, is a useful management tool. (*Photo:* W. E. Hammitt.)

occurs to any degree. The replacement of campfires with light-weight stoves, the nontrenching of tents, the packing out of all garbage, the proper disposal of human waste, and campsite landscaping on leaving a site can produce a backcountry campsite with the appearance of having been used minimally (Hampton and Cole 1995). Simply requiring camp stoves and educating users of proper firewood practices should eliminate some obvious campsite impacts. In the Eagle Cap Wilderness, Oregon, researchers observed that 95 percent of the overstory trees in campsites had been damaged by people collecting firewood and causing physical impacts to tree trunks (Cole and Benedict 1983). Particularly disturbing was the fact that more than one-third of the trees had been cut down. Requiring the use of camp stoves, along with a minimum impact education program, could modify inappropriate behavior of this nature among future users. On the other hand, trampling impacts on campsites and trails are inherent changes that occur if people recreate in natural areas.

Knowledge of minimum-impact techniques and education programs in achieving low impact are key components in managing wildland recreation impacts and have been quite successful in reducing certain types of impacts. The early Pack It In, Pack It Out program has been quite successful at reducing the amount of litter left in wild-

land recreation areas. However, it cannot be expected to eliminate backcountry litter. The Leave No Trace program, with its many publications, videos, and other materials aimed at specific activities (e.g., horseback riding and climbing) and specific areas (e.g., the LNT brochure for Great Smoky Mountains National Park) are having an influence on how recreation visitors select sites and use them. Even books, like *Soft Paths: How to Enjoy the Wilderness Without Harming It* (Hampton and Cole 1995), are available to educate users, organized groups, and managers on reducing resource impacts in wildland recreation areas.

Experience Level

Experienced visitors, in terms of amount of on-site experience, have been found to be more sensitive to social impacts and to take more precautions to avoid situations of social conflict (Heberlein and Dunwiddie 1979; Vaske, Donnelly, and Heberlein 1980). The same should hold true for ecological impacts. While observing actual campsite selection behavior of wilderness users, Heberlein and Dunwiddie found that experienced visitors distinguished themselves from novices by selecting campsites that were (1) farther from other visitors, (2) farther from the nearest campsite, whether it was occupied or not, and (3) in an area with few other sites. It is usually the more experienced visitor who is displaced from crowded or heavily impacted areas. In a study of visitor perception of river environmental impacts, Hammitt and McDonald (1983) found that the more experienced users were, the more perceptive they were of river impacts and the more willing they were to support management controls aimed at correcting the problems. More experienced users often have an earlier "frame of reference" and set of norms of what an area "used to be like" and use this frame of reference when evaluating current impacts.

Because experienced visitors are more aware and sensitive to social impacts, it follows that they are also likely to be more sensitive about causing ecological impacts to recreational resources. Certain forms of visitor behavior, such as littering, trenching around tents, hanging lanterns on trees, or camping in fragile meadows, may not be considered inappropriate behavior by novice campers, yet experienced campers are likely to recognize the potential impacts caused by each of these actions.

User Motivation

The *reasons* that recreationists engage in certain activities or that they are motivated to visit certain recreational environments can influence the impacts they contribute to a recreational area. For example, the individual who is motivated to visit an area for solitude and a passive form of recreation is likely to produce fewer impacts than the individual who is motivated to visit by a desire to affiliate with others in a motorized form of recreation. Similarly, the person *attracted* to wildland areas to experience and observe nature is likely to produce fewer impacts than the individual who visits wildland areas as simply a means to *escape* the home and work environment. However, caution is necessary when speculating on the influence of user motivations on resources impacts, for little research has been conducted in this area, and visitor

behavior is a complex phenomenon, seldom determined by one variable.

Considerable research has been conducted on user motivations from a psychological and visitor management perspective in outdoor recreation (Driver, 1976; Knopf 1983, 1987; Manning 1986; McDonald and Hammitt 1983; Schreyer and Roggenbuck 1978). This research has demonstrated that (1) visitors engage in different activities for different reasons and in different ways, (2) visitors participate in the same activities for different reasons, and (3) they utilize recreational environments in different ways to achieve the experiences they desire. The information generated from these and similar studies has been quite useful in planning recreational areas and in managing visitors for the different recreational opportunities and experiences desired (Brown, Driver, and McConnell 1978; Driver and Brown 1978). However, all of the motivational studies have involved the experience outcomes desired by visitors, with little emphasis devoted to the influence of user motivations on the impacts to resource settings. Clark and Stankey (1979) have come as close as anyone in applying user motivations and resource settings to impacts through an application of the "recreation opportunity spectrum" concept. Others have suggested that many vandalism-associated impacts are related to the moods and motivational forces underlying individual behavior while on site. For example, the need for excitement may lead to the chopping of trees, whereas the need for skill development and achievement may lead to the building of furniture within backcountry campsites.

Application of user motivation in managing site impacts can be illustrated through use of campground data reported by Hendee and Campbell (1969). They found that many of the campers of developed campgrounds desired to camp with two or more other families or their extended family (e.g., grandparents) on the same campsite. Seven out of 10 campers preferring developed sites thought all campgrounds should have several units so two families can camp together. For these campers the desire to affiliate with another family is a major motive for their camping, and they require a double-sized site if resource impacts are to be restricted to the designed campsite and to a minimum. This same phenomenon applies to multiunit backcountry groups that are motivated to share their backcountry experience with others on the same site.

Social Group and Structure

Almost all activities that occur in wildland recreation areas occur in the context of a group. Even in wilderness use where solitude is particularly important, we find that less than 3 to 4 percent participate alone. Most individuals participate as members of a family, friendship, mixed family and friendship, or organized group. The group in which one participates and the structure of members within the group are determinants of outdoor recreation behavior and can influence the amount and type of impacts occurring to the resource base.

As an example, two backcountry camping parties made up of eight members each, one consisting of two families and the other of early aged teenagers, would function as two distinctly different groups. Peer pressure and sanctions toward certain behaviors in the two groups of users would likely be different. Disposal of human waste,

size of fires, and activities beyond the boundaries of the campsite impact zone are more likely to be a problem among the teenagers. Vandalism, which can greatly impact wildland resources, is particularly prominent among groups of preteens and young teenagers (Clark, Hendee, and Campbell 1971). Unsupervised children are the headache of many campground managers, with many inappropriate actions of children leading to resource impacts.

In a study of inner-tube floaters of National Park Service and U.S. Forest Service rivers, we observed that organized groups of users (e.g., church, clubs) utilized the river resource in a gregarious fashion, necessitating more area use of resources than the resource base was physically capable of or designed to accommodate (Hammitt and McDonald 1981; McDonald and Hammitt 1981). Because organized and friendship groups often utilize resources differently from family groups, areas sensitive to impacts may have to be designed for these user groups or restricted from their use.

Place Bonding

Wildland recreation places, whether wilderness areas, campsites, or favorite fishing holes, matter to people, and an emotional bond commonly develops between visitors and these places during recreation engagements. This developmental process is commonly referred to as place bonding, place attachment, sense of place, or other such terms. People often develop an emotional bond, a sense of belonging, and even a dependence on a wildland recreation area, to the extent that it becomes "their place," "a favorite place," or the "only place" for wildland recreation pursuits. Through an emotional bonding process that occurs over repeated exposures to certain places and associated transactional place-people interactions, these places can take on identities of their own.

The place-bonding behavior that commonly develops between recreationists and wildland places can have both negative and positive effects on wildland impacts. When the strength and character of the place bond is very strong, visitors become deeply attached to their favorite place. They will consider no other place to fish or camp, and become "rooted" in that specific place. Many individuals are known to have specific campsites, trails, or fishing sites that they use again and again. Such repeated use, particularly if other visitors have an emotional bond with the same specific place, can result in serious site and place impacts. Worst of all, it is commonly difficult to shift or distribute use from such places because of the strong emotional bonds that exist between place and user. On the other hand, one could speculate that those visitors who are strongly bonded to a place—specific place on which they are dependent for their particular activity—would take better care of the place and cause fewer impacts.

The relationship between place bonding and wildland recreation resource impacts has been little researched. It is likely to be quite complex, for the phenomenon of place bonding itself is known to be quite complex, according to Stokols and Shumaker (1981). Adapting the thinking of these authors to wildland recreation, we know that emotional bonding with a recreation place does not refer only

to the perceptual prominence of physical environments, but rather to the functional, motivational, and evaluative significance of place. Perception, and not just physical presence (e.g., a recreation setting visit), is certainly relevant in discussing emotional bonding with recreation settings. The *strength* and *character* of emotional bonds developed with wildland recreation places are associated with a set of collectively held images that evolve as a result of direct or indirect interaction with a particular place.

Hammitt and Stewart (1996) have proposed a taxonomy of recreation place bonding, in which many of the dimensions of emotional bonding with place are classified (Fig. 6). The taxonomy is based on a proposed graduated intensity of emotional bonding and character of the bonding relationship. The emotional bond between an individual and a particular place may vary in intensity from an immediate sense of familiarity to a long-lasting and deeply rooted attachment (Tuan 1974). Place bonding also contains an element of character or specificity, whereby the functionality, necessity, and dependence on a recreation place may vary from a less focused mode to a very focused, specialized emotional dependence on a particular place. It is proposed (Fig. 6) that both the intensity and the character of place-bonding relationships ascend the taxonomy of the emotional bonding pyramid, moving from familiarity to rootedness. However, a hierarchical order of ascending from lower to the next higher level within the pyramid is not necessarily implied.

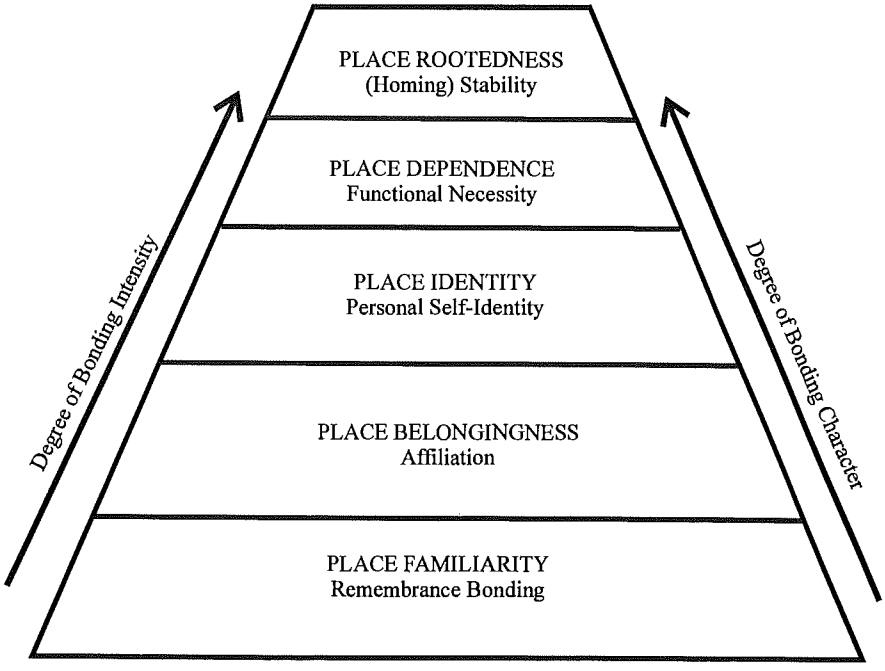

FIGURE 6. A taxonomy of dimensions of emotional bonding with recreation places.

As a demonstration of how the proposed taxonomy can enhance the classification and differentiation of levels of emotional bonding with recreation places, two of the levels will be briefly described. *Place familiarity* is proposed as the most elementary of the types of emotional bonding, both in terms of bond intensity and character. It implies both a sense of knowing and recognition of a place that results from acquaintances and remembrances associated with a recreation place. And because places visited during wildland recreation engagements involve an element of free choice and self-selection, the acquaintances, memories, and lasting images are usually part of fond and affectionate experiences that promote emotional bonding with these places. During the familiarity process, environmental spaces are emotionally identified, boundaries are developed to define them as places, and a human-place "structural coupling" begins (Roberts 1996). It is possible for wildland recreation visitors to have a feeling of familiarity with a place, yet in no way feel a strong identity with or dependence on that specific place. However, certain familiar places can come to mind when a person is selecting a place for recreation. Thus, repeat visits and resource impacts are likely to be associated with the place familiarity phenomenon.

At the other extreme of the pyramid is *place rootedness.* Tuan (1980, p. 4) characterizes place rootedness as a very strong and focused emotional bond that "in its essence means being completely at home—that is, unreflectively secure and comfortable in a particular locality." It is the only place, a one-of-a-kind place, for people who have formed this bond.

Wildland recreationists sometimes speak about a certain deer hunting or fishing locality in the same sense that Tuan speaks about a native place of habitation. A deer hunting camp in Northern Michigan may be the only place an extended family has gathered in the fall for decades to hunt deer, or a hut in Norway may be the only place that family members have recreationally fished for generations. Such people long for no other place to hunt, fish, or hike, for traditional usage has made the recreation place a second home. There is a recreational genealogy associated with these places, rooted in family members, environmental settings, and activities of the past. To acquire rootedness in a sense of extended time and genealogical depth, it may be necessary only to recreate in a particular place traditionally used and spoken about by one's grandfather and father. In these situations, the wildland recreation place takes on more meaning than the present situation has to offer, for its emotional bond and meaning are deeply steeped in the past. The stories told and rituals performed are stable components of the recreation experiences in rooted places.

For those wildland recreationists rooted in only one specific recreation locality, and for those dependent on one or even a few recreation places, the management alternative whereby these visitors are distributed to other sites to reduce resource-related impacts is not a possibility. Neither are we likely to persuade them to use these areas less frequently or in alternative ways. Their perception of recreation resource impacts are likely to be viewed differently in these strongly bonded places, for the meaning and perceptions of these special places go beyond the conditions of their resources and natural states. Management of resource impacts where place bonding is very strong will have to rely on other strategies than those related to use distribution. More will be said about management strategies and techniques in Chapter 13.

MODE OF TRAVEL

The means by which recreationists travel in wildland recreation areas also has an important effect on both ecological and sociological impacts. For example, the impacts associated with motorized travel are very different from those caused by horses which, in turn, are quite different from those caused by recreationists on foot. Even for motorized travel, there are pronounced differences among those impacts caused by terrestrial off-road vehicles, snowmobiles, and motorboats. In Chapters 2 through 5 we described what is known about the impacts associated with these different modes of travel. Managers will need to understand differences between these modes of travel, because an important management strategy is to restrict the means of travel. Wilderness areas by definition, with a few minor exceptions, prohibit all motorized recreational use. In other areas, certain modes of travel can be completely prohibited, prohibited in certain areas, allowed only in certain areas, or regulated in some other way. In this section we will compare impacts caused by common sets of travel modes a manager may face. These are (1) snowmobiles and skis, (2) motorboats and nonmotorized boats (e.g., rafts, canoes, rowboats, and kayaks), and (3) off-road vehicles, stock, and recreationists on foot.

Snowmobiles/Skis

Impacts caused by travel over snow are different from those caused by travel on land. When snow depth is great, impacts on soil, vegetation, and water are minimal. When the snow is shallow, impacts on these ecosystem components can be as severe as when use occurs on snow-free ground. Generally, the most significant impacts are those associated with disturbance of wildlife. This has been described in some detail in Chapter 4.

Unfortunately, there is little research into differences in the disturbances caused by snowmobiles and skis. We can offer a few speculations, however. On roads and well-established trails, differences are probably not pronounced. The major difference is that snowmobiles produce more noise and can travel farther more easily (Figs. 7 and 8). Therefore, more remote portions of an area are more likely to be affected frequently by snowmobiles than by skiers. Off roads and trails, differences become more pronounced. Because snowmobiles cover more ground in a shorter period of time, they can disturb more wildlife and compact snow over a larger area. Compaction of snow is particularly significant, because it can kill small mammals and destroy the subnivean layer, between snow and the ground, where many small mammals live. This may also have an effect on species that prey on small mammals such as owls, eagles, hawks, foxes, coyotes, and bobcats (Bury, Wendling, and McCool 1976).

In general, then, snowmobiles have more potential to cause impact, particularly if they are not confined to established roads and trails. Differences between motorized and nonmotorized travel appear to be considerably less pronounced than for travel on land or over water, however. Differences in the impact each mode of travel has on the experience of other recreationists in the area may be more serious than differences in ecological impact.

FIGURE 7. Snowmobiles extend recreational impacts into the winter season, reaching remote areas that normally receive little recreational use during this time of the year. (*Photo:* R. C. Lucas.)

FIGURE 8. Tour and cross-country skiing are increasing in popularity as wildland recreation sports. (*Photo:* D. N. Cole.)

Motorboats/Nonmotorized Boats

Motorboats have greater potential than nonmotorized boats for causing impact, primarily because they pollute water with fuel and oil. As described in Chapter 5, considerable quantities of oil and gasoline residue are discharged by outboard motors. This affects water quality and aquatic life. Nonmotorized craft obviously do not have such an effect. Nonmotorized craft are able to reach more remote parts of wildland areas, however. This can result in more pronounced impacts to remote portions of recreation areas. For example, the use of rubber rafts to float people down the Grand Canyon and other remote desert canyons has greatly increased the amount of impact occurring in these areas.

In areas that are used primarily by nonmotorized craft, the most prominent impacts are usually along the banks of the lakes and streams in places where recreationists camp, picnic, fish, and take their boats in and out of the water. These impacts are little different from those caused by recreationists on foot. Impacts to water quality and aquatic life will usually be more serious in places where most use is by motorboats. There are exceptions to this generalization, of course. For example groups traveling in motorized rafts through the Grand Canyon probably have more effect on land than on the waters.

Off-Road Vehicles/Stock/Foot Travel

For several reasons, the potential for off-road vehicles to cause substantial impact is particularly high (Webb and Wilshire 1983; Parikesit, Larson, and Matthes-Sears 1995). Because they can cover distances rapidly, they are able to impact large areas on single trips. If the terrain is conducive to ORV travel, remote areas can be reached, even on day trips (Fig. 9). This is certainly the case in large dune and desert areas where remote places are likely to be inaccessible on foot or horseback. The forces that result from spinning wheels, in association with the effect of cleated tires, dislodge soil and vegetation rapidly. This damage is compounded by the tendency for many ORV users to seek out steep, unstable slopes where erosion is easily triggered (Fig. 10). Other modes of travel tend to avoid steep and unstable slopes. Consequently, problems with erosion—one of the most significant of impacts because of its irreversibility and its tendency to get progressively worse even without continued use—are much more serious with ORVs than with nonmotorized use. Motorized recreational use can be damaging to water quality as well. Eroded soil, deposited in streams, increases sediment loads and turbidity; this can be particularly detrimental to certain fish species such as trout.

Horses, mules, and other types of recreational stock have less potential for causing erosion. The potential is still much higher than for foot travelers, however. Stock are much heavier than humans, and their weight is concentrated on a smaller surface area. Thus, they exert much greater pressure on the ground surface. Problems resulting from this high potential for trampling disturbance are compounded by the tendency for shod hooves to loosen the soil (McQuaid-Cook 1978), making it more susceptible to erosion. Thus, equestrian trails are more prone to erosion and more

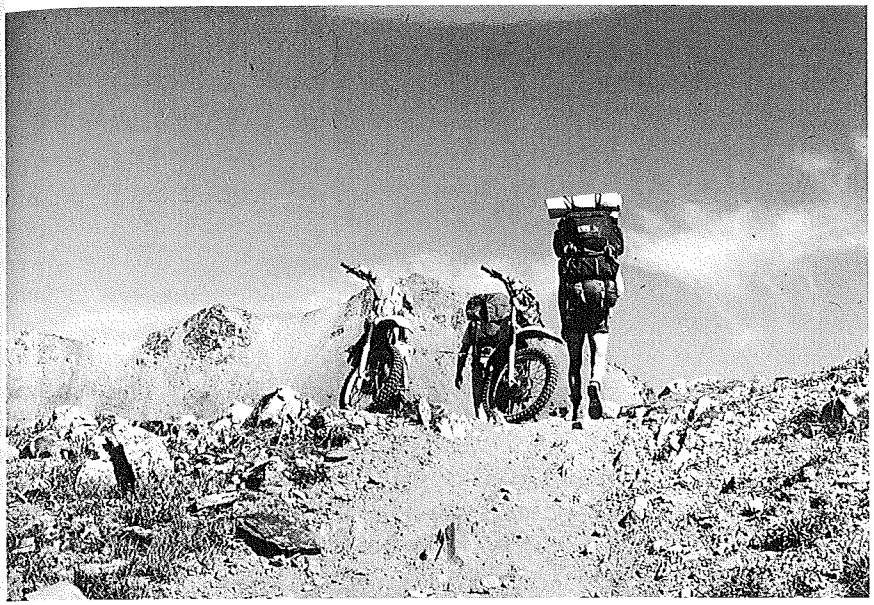

FIGURE 9. Trail bike use impacts both the wildland recreation resource and the experience of other user types. (*Photo:* D. N. Cole.)

FIGURE 10. Off-road vehicle impacts are compounded by the tendency of many ORV users to seek out steep, unstable slopes, where erosion is easily initiated. (*Photo:* D. N. Cole.)

likely to require hardening. In forests in the Rocky Mountains in Montana, Dale and Weaver (1974) found that trails used by horses and hikers were 2.5 times deeper than trails used only by hikers. Stock are also damaging to the banks of streams and lakeshores.

In an experimental study in Montana, Weaver and Dale (1978) examined the effects of horses, hikers, and a lightweight, slowly driven motorcycle. Trails produced by 1000 horse passes were two to three times as wide and 1.5 to 7 times as deep as trails produced by 1000 hiker passes. Impacts caused by the motorcycle were intermediate in severity. Bulk density increased 1.5 to 2 times as rapidly on horse trails as on hiker trails. The effect of motorcycles, again, was usually intermediate in severity. Vegetation loss occurred much more rapidly on horse and motorcycle trails than on hiker trails. The investigators also found that motorcycle damage was greatest when going uphill, whereas horse and hiker damage was greatest when going downhill. Thus, they concluded that trail wear can be minimized if motorcycle trails ascend gentle slopes and descend steep slopes, and that horse and hiker trails should ascend steep slopes and descend gentle slopes.

On campsites, differences between impacts caused by motorized users, stock parties, and hikers are pronounced. Ground cover disturbance and soil compaction are particularly severe where vehicles drive across campsites. More gear can be carried in vehicles, and this is also often translated into higher impact. Campfire impacts are often more pronounced; tree damage is more severe; lengths of stay are longer; and party sizes are larger, so campsites are larger and more highly developed.

An increasing form of travel in wildland areas during the 1990s involves mountain bicycles (Jacoby 1990). Although some research has concentrated on the social impacts of mountain bike use, few studies have focused on the ecological impacts (Ramthun 1995). The most common form of resource impact resulting from mountain bike recreation is trail erosion and expansion. Wilson and Seney (1994) examined the relative impact of hikers, horses, motorcycles, and off-road bicycles in terms of water runoff and sediment yield on existing trails in Montana. They found that horses and hikers (hooves and feet) made more sediment available than wheels (motorcycles and off-road bicycles) and that the effect was most pronounced on prewetted trails. However, the study was limited to tests of only 50 and 100 passes by the four modes of travel.

Two studies have compared impacts on horse and hiker campsites—both in wilderness areas in Montana. In the Lee Metcalf Wilderness, campsites used by stock were ten times as large and had seven times as much exposed mineral soil as sites used by backpackers. Cole (1983) found the same results on sites in the Bob Marshall Wilderness. Stock sites were six times as large, with a bare area four times larger than backpacker sites. Stock sites had more than ten times as many damaged trees, had been much more severely compacted, and had many more introduced plant species (Fig. 11).

The larger size of stock sites is primarily a result of the requirement for an area adjacent to the campsite to keep stock. The animals are frequently tied to trees, and this accounts for the more serious tree damage in stock camps (Fig. 12). Trees are also more likely to be cut down for tent poles, hitching rails, corrals, or firewood. The

FIGURE 11. In the Bob Marshall Wilderness, Montana, campsites used by horse parties had more than 10 times as many damaged trees as sites used only by hikers. (*Photo:* D. N. Cole.)

FIGURE 12. Horses tied to trees are a major source of damage to tree trunks and root systems. (*Photo:* R. C. Lucas.)

greater compaction is a result of the stock being heavier than humans, with their weight concentrated on a smaller surface area. Introduced plants are spread by seeds in horse manure or feed or by being stuck to the horses' bodies; this accounts for the greater amounts of these species in stock camps.

A further impact caused by stock results from their need to graze. Where this is allowed (where horses are not confined to corrals and fed only pelletized feed), grazing areas are trampled and plants are defoliated. This leads to further increases in the size of disturbed areas. In a portion of the Eagle Cap Wilderness, the area disturbed solely by stock amounted to three-fourths of the entire area disturbed by recreational use, although stock use accounted for only about 20 percent of the total use of the wilderness (Cole 1981). Grazed areas experience decreased vegetation cover, changes in vegetation composition, soil compaction, and in many cases accelerated erosion.

Horse manure is another unique impact associated with stock. This is a major source of exotic plant seeds. It can find its way into streams and pollute waters. Its major impact, however, is social, reflecting the objection of many hikers to its presence on trails and campsites. In many areas, horseback use is separated from hiking use, on different trails, to avoid problems of conflict between stock and hiking parties.

Because foot travel is the most common mode of travel, its impacts are particularly pronounced and widespread. In addition, wildlife are often more readily disturbed by hikers than by motor vehicles (MacArthur, Geist, and Johnston 1982). Hikers are more unpredictable, more likely to approach animals, and may be considered more of a threat by animals. Hikers may also be somewhat more disturbing to wildlife than recreationists on horseback, although this has not been studied. Impacts on soil, vegetation, and water caused by hikers, however, are much less severe, per capita, than those caused by other types of recreationists.

Several writers have postulated that the type of shoe recreationists wear has a great effect on amount of impact. The popularity of the lug-soled boot has been blamed repeatedly for reported increases in trail wear (Harlow 1977; Ketchledge and Leonard 1970; Zaslowsky 1981). Nobody has been able to demonstrate, under realistic conditions, that this is the case, however. Kuss (1983) found no significant differences between two types of hiking boot when comparing loss of organic matter and soil from experimentally trampled trails. There were no significant differences in amount of loss after either 600 or 2400 passes, although both boot types caused significant disruption of the soil surface. This study substantiated the results of earlier studies by Whittaker (1978) and Saunders, Howard, and Stanley-Saunders (1980). Neither of these studies found significant differences in impact related to type of footwear.

All footgear, regardless of type, will cause substantial impact to vegetation and soils. Heavily worn trails are common in nature areas and urban parks where lug-soled boots are uncommon. More research may still uncover important differences under circumstances that have not yet been studied. For now, however, there appears to be little gained by asking hikers to wear any particular type of boot.

SUMMARY

1. Recreational resource impacts can be determined as much by visitor use as by the durability of the resource site. For example, impacts vary with party size (large vs. small groups), type of user (overnight campers vs. day hikers), user behavior (using wood fires vs. camp stoves), and mode of travel (horse users vs. hikers). The potential to cause impact also varies with where users go. Various user characteristics that can influence behavior are knowledge of low-impact techniques, motivations, experience level, and social groups and structure.

2. The amount of use is not directly related to the amount of impact. Amount of use varies among environments, between activities, with impact parameter, and with range of use levels being examined. Effects also differ depending on whether concern is with rate, intensity, or areal extent of resource change.

3. Dispersal of concentrated campers in wildland areas is not always a good management practice. For example, if visitors are concentrating use on impact-resistant trails and campsites or on very popular and already heavily impacted sites, management will want to encourage existing patterns of use. However, in fragile areas of low use, management may want to disperse users from places of concentrated use.

4. Certain types of users, because of length of stay, activities they engage in, and the demands they place on wildland resources, cause more impacts than do other groups of users. Horseback parties typically tend to be large, require additional space for horses at campsite locations, and cause impacts beyond the specific campsite boundaries.

5. The motivating force behind one's recreation, the group context within which activities are carried out, and one's education and past experience with a particular activity all have an influence on whether wildland recreation is conducted in an appropriate manner that leads to minimal levels of resource impact.

6. Different modes of travel in wildland areas cause different types and levels of impact. Off-road vehicles can travel a much greater distance than hikers and cause large areal impact in a short period of time. Snowmobile impacts can greatly compact snow and influence the wildlife/soil environment beneath it. Horse trails and campsites have been shown to be 10 times as impacted as sites used only by backpackers.

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