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RECREATION, ECOLOGICAL IMPACTS

Recreation can be defined as activities that are undertaken because people want to do them. This is in contrast to work, which is characterized by activities undertaken because they need to be done. Recreational activities can occur indoors or outdoors. When they occur outdoors, in relatively natural environments, recreational activities can cause adverse ecological impacts. Outdoor recreation use has increased dramatically during the past half century. In the United States, for example, between 1960 and the early 1980s, canoeing and kayaking increased almost 500 per cent, bicycling increased about 350 per cent, camping increased about 250 per cent, and hiking increased about 200 per cent. These increases are related to a number of factors, including increased population, more leisure time, greater mobility, greater affluence, and improved recreational technologies.

As outdoor recreation participation increased, adverse ecological impacts also increased. Concern about recreation impacts led to development of the discipline of *recreation ecology*. The earliest antecedents of recreation ecology include E.P. Meinecke's 1928 examination of tourist impacts on the root systems of redwood trees in some heavily used state parks in California, and G.H. Bates's 1935 study of trampling effects on vegetation adjacent to footpaths in England. Recreation ecology studies increased in frequency during the 1960s. Two conferences on the subject were held in 1967, one sponsored by Great Britain's Nature Conservancy, the other by the International Union for the Conservation of Nature and Natural Resources. A substantial body of information on recreational impacts has slowly built up since that time, with contributions from scientists around the world (for citations see Cole and Schreiner, 1981).

Types of recreation impact

The most common recreational activities that impact natural and semi-natural environments are hiking, horseback riding, climbing, picnicking, camping, hunting, fishing, photography, nature study, bicycling, boating (motorized and non-motorized), skiing, snowmobiling, and off-road driving. The impacts caused by each of these activities are unique to some extent. Useful distinctions can be made between motorized and non-motorized activities; land-, snow-, and water-based activities; dispersed and concentrated activities; and activities that occur at activity nodes (e.g., campsites, scenic overlooks) and those that occur along travel routes (e.g., trails). The impacts of all

these recreational activities can be divided into effects on soils, vegetation, animals, and water. However, there are important linkages between these components of the ecosystem. A more detailed treatment of these impacts and linkages has been provided by Hammitt and Cole (1987).

Impacts upon soil

Trampling by humans, horses, and bicycle tires disturbs the physical, biological, and chemical characteristics of soils. Trampling causes soil compaction, a process by which mineral soil particles are packed more closely together, eliminating much of the pore space that normally exists between particles. Loss of large pores – those that promote good soil drainage and that normally are occupied by air – is particularly pronounced and ecologically significant. Compacted soils have high bulk density, penetration resistance, and conductivity, and low permeability. Structural development is reduced, as is aeration and water availability. Compaction can reduce germination success and the vigor of established plants and be detrimental to soil biota. Reduced infiltration capacity leads to increased surface runoff following precipitation events and usually increased erosion.

Trampling also pulverizes the dead organic material that is concentrated in the uppermost layers of soil. Frequent trampling will generally eliminate organic soil horizons, exposing the underlying mineral soil. Organic matter buffers the mineral soil from erosion and compaction, and promotes soil structural development, biological activity, and nutrient cycling. Loss of organic matter, as a result of trampling impact, exacerbates problems with soil compaction, erosion, poor water relations, and reduced biological activity.

Trampling effects on soil biology and chemistry are poorly understood. Case studies of trampled soils have reported reductions in arthropods, earthworms, and nitrifying bacteria, and increases in anaerobic bacteria. Increases in pH have been reported on campsites. Changes in the concentrations of various soil nutrients in disturbed soils have been inconsistent, with some studies reporting increases and others reporting decreases, for the same nutrient.

Impacts caused by motorized recreation are similar but generally more pronounced. For example, compared to human trampling off-road vehicles (*q.v.*) cause both more extreme and deeper soil compaction. Soil erosion is a particular problem with motorized recreation because, in addition to making soils more vulnerable to erosion, motorized vehicles are also significant agents of erosion. At an off-road vehicle site in California, the erosion rate was 30 times greater than the rate that the Bureau of Reclamation considered to be a serious problem (Webb and Wilshire, 1983).

Impacts upon vegetation

Trampling can crush, bruise, shear off, and uproot vegetation. In trampled places, plants may have reduced height, stem length, leaf area, flower and seed production, and carbohydrate reserves. Such changes adversely affect plant vigor and reproductive success and can lead to death. Consequently, the vegetation of trampled places generally has reduced biomass, sparser cover, reduced stature, and a different species composition than undisturbed places. . .

Species composition changes because species vary in their response to the direct and indirect effects of trampling. Species vary in their ability to resist being damaged by trampling and

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also in their ability to recover from trampling damage. Characteristics that individually or in combination make a plant resistant to trampling include: (a) being either very small or very large; (b) growing flat along the ground or in dense tufts; and (c) having leaves and stems that are tough or flexible. Characteristics that make a plant susceptible to damage include: (a) having moderate stature; (b) having an erect growth form; and (c) having woody, brittle, or delicate stems and leaves. The ability to recover from trampling is largely a reflection of reproductive strategy and the location of growing points on the plant. The ability to recover is greatest in annuals, plants that produce numerous seeds, and plants with growing points at or below the ground surface. Species also vary in their ability to flourish in the soil and microclimatic conditions caused by recreational disturbance. In addition to the soil impacts discussed above, trampling frequently increases light intensities and temperatures, both above and below the soil surface.

The presence of exotic species also alters species composition. Seeds of exotic species can be carried into an area by recreationists or the animals they bring with them. Exotic species are often well adapted to periodic disturbance and thrive on recreation sites.

Again, motorized recreation causes similar but often more severe impacts. In particular, larger plants are susceptible to being damaged by motor vehicles. For example, at an off-road vehicle area in California, shrub cover was reduced 90 per cent. Snowmobiles can be particularly damaging to shrubs and saplings, which are often stiff and brittle during winter and readily snap when run over. Ground-level vegetation is usually protected by snow cover.

Vegetation is altered by forces other than trampling. Shrubs and trees are felled for firewood and tent poles. They also endure various other mutilations, from hacking and carving with knives and axes, collecting firewood, scarring by lanterns, and root exposure when stock are tied to trees. Finally, a substantial amount of impact to vegetation occurs with the construction of recreational facilities – trails, campgrounds, picnic areas, ski areas, and so on. Tall vegetation is removed or thinned and shorter vegetation is frequently disturbed.

Impacts upon animals

Impacts to animals can be more far-reaching, both spatially and temporally, than impacts to vegetation and soil. Because many animals are mobile and capable of remembering their experiences, they can be impacted in one place and carry the effects of that disturbance to another location. Because many animals are capable of teaching their offspring, reactions to disturbance can be passed from one generation to another.

Recreational activities impact animals in five general ways. First, animals can be unintentionally killed; for example, they can be crushed by motor vehicles or trampled underfoot. Secondly, animals can be harvested through hunting, fishing, or collecting. For game species, this is probably the primary mechanism of recreational impact. Thirdly, animal habitats can be modified by the impacts to vegetation and soil described above. These impacts tend to be localized but this is probably the primary mechanism by which recreation impacts invertebrates and smaller vertebrates. Fourthly, animals can suffer from the effects of pollutants left by recreationists, particularly food and litter. The most significant example of this impact mechanism is problems with bears that have grown accustomed

to human food. As bears become habituated to human food, bear-human contact increases and bears usually end up being destroyed. Finally, animals can be disturbed when recreationists approach them too closely, a type of disturbance that is often called harassment even though it is often unintentional. This is a primary means by which recreationists impact birds and large mammals. Studies have identified numerous short-term behavioral responses to harassment including interrupted feeding, abandonment of nests, increased heart rates, and flight (see Boyle and Samson, 1983, for citations). Unfortunately, little is known about the long-term effects of disturbance on individuals, populations or animal communities.

Impacts upon water

Water and aquatic ecosystems are impacted by both water-based recreational activities, primarily boating, and land-based activities, such as fishing, hiking, camping, and associated activities. The impacts of water-based activities are caused by the wash created by a moving boat, increased turbulence and turbidity, propeller cutting of vegetation, pollution from outboard motors, the discharge of sewage, and disturbance of aquatic animals. The impacts of shore-based activities include animal disturbance and the effects of trampling (e.g., increased sedimentation due to accelerated bank erosion). They also include chemical impacts associated with pollution and sewage disposal (Liddle and Scorgie, 1981). Another source of impact is the planting of exotic fish species. This impact has been most serious in high mountain lakes, where trout species have been widely planted in lakes that formerly had no fish.

The ultimate effects of recreation on aquatic ecosystems are poorly understood and probably highly variable. The most significant effects are probably nutrient influxes that accelerate eutrophication (*q.v.*), the natural aging process that occurs in most aquatic systems. Eutrophication has ripple effects throughout the system, causing changes in physical characteristics (e.g., decreased water clarity and increased turbidity), chemical characteristics (e.g., decreased dissolved oxygen), and biological characteristics (e.g., increased phytoplankton and algal densities and changes in the species composition of both aquatic plants and animals).

From a public health standpoint, most concern about impacts to water is related to contamination by pathogenic bacteria and the parasite, *Giardia lamblia*. Inadequate disposal of sewage and human waste, either from recreational developments or individual recreationists, can make water sources unfit for body contact or drinking.

Management of recreation impacts

Managers of recreation areas attempt to minimize ecological impacts by managing visitors and manipulating sites. One common visitor management technique is to limit the amount of recreational use. Entry permits can be required and only a certain number can be issued. The type of recreational use can be controlled by prohibiting certain destructive types of use or by establishing different zones that can accommodate different types of use. Temporal zoning is another management alternative. Certain types of use or all use can be prohibited during seasons when critical ecosystem elements are particularly vulnerable. User behavior can also be influenced, either by requiring certain behaviors or by educating visitors about less-destructive ways of recreation.

Impacts can also be minimized by controlling the distribution and location of visitor use. Concentrating use and resultant impacts in a few places will leave most of the area relatively undisturbed. This strategy is particularly useful if those places that receive concentrated use are sites that are relatively durable. Where recreation use levels are relatively light, impacts can sometimes be reduced by dispersing use more widely, so that no sites are regularly used or substantially impacted. The general consensus is that this is a risky strategy due to its potential to increase the number of impacted places.

The primary site management strategies are to harden, shield, or restore sites. Site hardening involves doing something to the site to increase its durability (e.g., adding soil cement to a trail to make it less vulnerable to erosion or placing check dams at off-road vehicle areas to prevent off-site erosion). Shielding involves separating the recreational user from the environment so that direct impacts are minimal (e.g., building a boardwalk across a fragile area on a nature trail). Restoration attempts to repair impact problems, without correcting the cause of the problems.

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Cross-references

Ecotourism
Off-the-Road Vehicles (ORVs), Environmental Impact

