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EFFECTS OF NONCONSUMPTIVE RECREATION ON WILDLIFE: A REVIEW¹

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Interest and participation in nonconsumptive outdoor recreation have increased rapidly during the past 20 years (U.S. Dep. Inter. 1982, Diamond et al. 1983). Recreational demands and the nature and behavior of participants have been reviewed elsewhere (Potter et al. 1973, More 1979, U.S. Dep. Inter. 1979, 1982).

Approximately 145 million Americans (72% of the U.S. population) engaged in nonconsumptive outdoor recreation in 1980 (Diamond et al. 1983), and substantial increases in numbers of participants are expected in the next 2 decades (U.S. Dep. Inter. 1979). By some analyses, nonconsumptive recreational values of wildlife may outweigh direct consumptive values (Shaw and King 1980, Lyons 1982).

Governmental agencies are interested in developing a sound basis for management of nonconsumptive outdoor recreation (Diamond et al. 1983). Agency planners and managers must not only assess and provide for recreational demands, but also assess effects of recreational activities on natural resources, including wildlife and wildlife habitat. This paper evaluates available information on the effects of nonconsumptive outdoor recreation on wildlife in order to bring attention to, and provide a better understanding of, the relationship between recreationists and wildlife.

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METHODS

We identified 536 references concerning effects of nonconsumptive outdoor recreation on wildlife (Boyle and Samson 1983). References were restricted to those concerning terrestrial vertebrates of North America and included technical and semi-technical articles, books, agency publications, private organization reports, theses, dissertations, and Federal Aid Reports collected at the Denver (Colorado) Public Library.

Articles reporting original data were selected and classified according to type of recreational activity, major taxon, and the nature of effect on wildlife. Recreational activities included a selection from those used in the U.S. Department of the Interior Third Nationwide Outdoor Recreation Plan (1979). Studies were classified according to emphasis on birds, mammals, or herpetofauna. Reported impacts were characterized as positive, negative, or none/undetermined on the basis of reported changes in individual condition or population numbers. Articles that included >1 activity or taxon, or reported diverse types of impacts, were listed in >1 category.

REPORTED EFFECTS

Of 166 articles containing original data, authors reported effects on wildlife from hiking and camping (52), boating (37), wildlife observation and photography (27), off-road (wheeled) vehicle use (20), snowmobile use (12), swimming and shore recreation (8), and rock climbing (7). The most common subjects of study were birds (61%), followed by mammals (42%), with few studies of herpetofauna (4%).

Negative effects were reported most commonly for most activity types and all major taxa (Table 1); reports of positive effects are few. A brief review of each recreational activity describes some representative examples of the literature.

Hiking and camping may affect wildlife through trampling of habitat (Liddle 1975), disturbance of animals (Ward et al. 1973, Aune

Table 1. Categorization of reports of original studies concerning impacts of nonconsumptive outdoor recreation on wildlife.

Type of recreation	Impact birds			Impact mammals			Impact herpetofauna		
	Positive	Negative	None/ Undetermined	Positive	Negative	None/ Undetermined	Positive	Negative	None/ Undetermined
Hiking and camping	4	17	6	5	24	4			
Boating		25	9		1	2		1	
Wildlife observation and photography		19	2	1	5	4			
Off-road wheeled vehicles		7	2		5	2		7	1
Snowmobiles		1	1	1	7	3			
Spelunking					8				
Swimming and shore recreation		6	2						
Rock climbing		2	3		1	1			

1981), and less directly through discarded food or other items (Noake 1967, Foin et al. 1977). Additionally, large recreational developments introduce disturbances such as air, water, and noise pollution, garbage dumps, and potentially high densities of recreationists (Houston 1971, White and Bratton 1980). Local habitat changes caused by trampling are typically simplification of vegetation and ground surface and compaction of soil, resulting in overall loss of habitat diversity (Speight 1973, Liddle 1975). Inadvertent disturbance of large mammals by hikers can result in displacement of animals from trails, although disturbance usually has a negligible influence on large mammal distributions and movements (Chester 1976, Hicks and Elder 1979, Aune 1981). Food provided by recreationists or left in garbage dumps has profoundly influenced bear (*Ursus* spp.) behavior and distributions in national parks (Beeman 1975, Cole 1976, Merrill 1978), and may be responsible for high densities of small mammals in campgrounds (Clevenger and Workman 1977, Foin et al. 1977). Vegetation changes in and near campgrounds appeared responsible for increases of alpha diversity in bird species in campgrounds (Garton et al. 1977, Guth 1978), although birds favored by campground development were mostly common and widespread species, whereas several rare forest species present in adjacent control areas were absent.

Wildlife observers and photographers actively seek and approach wildlife, unlike other recreationists who mostly encounter wildlife accidentally (Speight 1973). Thus, these activities are potentially more disturbing to wildlife, as encounters are likely to be more frequent and of longer duration. Additionally, rare or unusual species are often sought. Human visits to passerine and waterfowl nests can increase the chances of nest losses through predation (Dwernychuk and Boag 1972, Bart 1977, Lenington 1979). Colonially nesting birds are particularly vulnerable to disturbance (Buckley and Buckley 1978, Manuwal 1978), as breeding populations concentrate in small areas and eggs and young are defenseless when adults are absent. Human disturbance of waterbird colonies has been shown to cause nest losses through interspecific predation (Schreiber and Risebrough 1972, Anderson and Kieth 1980), intraspecific predation (Hand 1980), trampling (Johnson and Sloan 1976), and nest abandonment (Hunt 1972, Ellison and Cleary 1978).

Where large mammals are habituated to human presence, disturbance by wildlife observers appears to be minor (Tracy 1977, Schultz and Bailey 1978), although Geist (1978) theorized that harassment of big game animals results in inefficient foraging patterns. Habituated animals may also become more vulnerable to poaching (Singer 1975).

Effects of boating and swimming have been reported primarily for birds (Table 1). In a comprehensive review, Liddle and Scorgie (1980) noted that wildlife is affected through sight and sound of recreationists, pollution from boats and recreational facilities, and habitat changes caused by vegetation control practices and facility construction. Waterfowl behavioral changes and movements to less disturbed areas in response to boating have been documented (Thornburg 1973, Batten 1977). Beach and shore recreationists can disrupt shorebird breeding (Norman and Saunders 1969) or force birds into less preferred habitats (Erwin 1980).

The large increase in use of off-road vehicles (ORVs) since the 1960s has generated concern over environmental effects (Baldwin and Stoddard 1973, Brander 1974, Webb and Wilshire 1983). Recent studies in the Southwest have demonstrated severe effects of wheeled ORVs on wildlife of arid regions through direct mortality, harassment, noise, and habitat destruction (Webb and Wilshire 1983). ORV use has been linked with population declines of the desert tortoise (*Gopherus agassizii*) (Bury 1980) and Couch's spadefoot (*Scaphiopus couchi*) (Berry 1980) in California. Other studies have shown decreases in density and diversity of desert birds and mammals where use of ORVs was extensive (Busack and Bury 1974, Bury et al. 1977, Luckenbach 1978).

Snowmobile use can also result in mortality, habitat loss, and harassment of wildlife (Bury 1978). Snowmobiling occurs during winter, when many animals may be stressed by climate and food shortages (Moen 1976), and could influence survival of wildlife. However, the few studies conducted have produced conflicting results. Studies of snowmobile effects on white-tailed deer (*Odocoileus virginianus*) showed significant displacement and increased movement of deer (Dorrance et al. 1975), negligible changes in deer activities and home range (Eckstein et al. 1979), and that

deer actually benefited by following snowmobile trails where the snow was firmer (Richens and Lavigne 1978). However, snow compaction alters the mild subsnow microclimate and can increase winter mortality of subnivean wildlife (Schmid 1971).

Recreational cave exploration has been implicated in the decline of several populations of bats in the United States. Hibernating bats are particularly vulnerable to harassment, expending critical energy stores when aroused by even unintentional disturbance (Harvey 1975, Humphrey 1978). For rare bats, such as the endangered gray myotis (*Myotis grisescens*), each colony may contain a significant proportion of all living individuals and disturbance may accelerate local extinction (Tuttle 1979, Harvey 1980).

Rock climbers may disturb nesting raptors (Olsen and Olsen 1980), mountain sheep (*Ovis canadensis*) (Hicks and Elder 1979), and other cliff-dwelling species, although effects are mostly seasonal and local. Disturbance of even 1 nesting pair of rare or sensitive species, such as the peregrine falcon (*Falco peregrinus*), can be significant (Olsen and Olsen 1980).

RESEARCH NEEDS

Research on recreation impacts on wildlife has produced conflicting reports of animals' responses to nonconsumptive recreation. Wildlife populations are subjected to various influences which produce substantial natural variability in population sizes from year to year (Lack 1966, Kluyver 1970, Watson 1970). Separating these background variations from recreational effects can be especially difficult if the effect is indirect or the response is not immediate (Goldsmith 1974).

Much of the current information on recreational effects on wildlife consists of casual observations or reported incidents of disturbance or mortality, without quantitative assessments of long-term ecological effects (McCool 1978).

Recent well-planned investigations, in which hypotheses were evaluated, have begun to reveal the complexities of recreationist-wildlife interactions (Foin et al. 1977, Webb and Wilshire 1983). More systematic studies of impacts of many activities in all ecoregions are needed. The consequences of observed changes in wildlife behavior or habitat use must be examined critically to determine if biological impacts have occurred. Some general hypotheses that need to be explored include: Does disturbance force animals from better to poorer habitats, or from public to private lands where the result may be increased property damage or altered hunting patterns? Does disturbance cause measurable changes in population fecundity or mortality rates? Are these effects age- or sex-related? Is recreation-caused mortality partly or wholly compensatory, permitting the loss of an annual "nonconsumptive surplus?"

Changes in wildlife distribution, habitat use, or survival are difficult to attribute to specific causes without experimentation. Regulation or simulation of recreational pressure (Vollmer et al. 1976, Aitchison 1977) has been used successfully to control extraneous factors by permitting comparisons of treated and untreated systems through space and time.

MANAGEMENT IMPLICATIONS

As demands for outdoor recreation increase, management of both recreationists and wildlife resources become increasingly important (Ream 1979). Speight (1973) suggested 4 management alternatives: (1) minimize all effects of recreation, (2) manage to retain specified essential characteristics of ecosystems, (3) manage to replace some ecosystem characteristics with others, and (4) permit recreation irrespective of effects. Combinations of strategies can be constructed to fit management plans to specific needs: for example, a "sacrifice area" managed under alternative 4 can be

used to relieve recreational pressure from an adjacent area managed under alternatives 1 or 2.

In order to determine specific management needs and set priorities, managers must be able to judge what species may be most affected by which recreational activities, at what intensities, and when annually. As discussed earlier, some species are much more sensitive to disturbance than others because of colonial behavior, unique breeding patterns, restricted distribution, or rigid habitat requirements. Other species may need special protection during brief critical periods, such as breeding time or during severe winter weather. Certain birds and large carnivores may require a minimum size of contiguous undisturbed habitat to maintain populations (Robbins 1979, Harris et al. 1982, Samson 1983, and others).

Typically, recreation management involves restrictions on human-related influences on the environment. Methods of limiting effects of recreationists on wildlife include location and design of facilities, designation of local viewing or special-use areas, and establishment of larger refuges in which certain activities may be prohibited or regulated. Data are often unavailable for use as guides in planning habitat size and juxtaposition for optimum recreation and wildlife management. Research into these areas is beginning, but more is needed to facilitate planning at regional and national levels.

CONCLUSIONS

Burgeoning numbers of nonconsumptive outdoor recreationists are creating increasing impacts on wildlife and wildlife habitat, but proper management is hampered by the complexity of cause-and-effect relationships and the incompleteness of existing knowledge. Recreationists can affect wildlife through habitat alteration, disturbance, or direct mortality. Mechanized forms of recreation present the most serious potential impacts, but even the

most casual intrusion by a person on foot may significantly affect vulnerable populations. Individuals, populations, and species vary in their sensitivity to disturbance; and researchers have begun to identify some mechanisms of human-wildlife interactions. Wildlife conservationists are challenged to identify recreational impacts on wildlife, establish priorities for management, and implement schemes to conserve wildlife resources while providing for increasing use-demands of recreationists.

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