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ENVIRONMENTAL IMPACTS: THE DARK SIDE OF OUTDOOR RECREATION?

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by Scott G. Miller

Outdoor recreation is increasing in popularity throughout the United States (Flather and Cordell 1995). Heretofore, many believed that nonconsumptive outdoor recreation was an environmentally benign activity. Increasing evidence, however, indicates that these activities are, in fact, not benign. On the contrary, data suggest that outdoor recreation can affect wildlife individuals, populations, and communities (Knight and Cole 1995). For example, a recent survey of factors responsible for the decline of federally listed threatened and endangered species finds that outdoor recreation is the second leading cause (Losos et al. 1995).

Recreational Impacts and Wildlife Responses

Outdoor recreation has the potential to affect wildlife at the level of the: individual, population, and community. There are four primary ways by which outdoor recreational activities can impact wildlife: 1) harvest, 2) habitat modification, 3) pollution, and 4) disturbance (Knight and Cole 1995). Although all of these deserve consideration and are extremely important, for the purposes of this summary, attention will be focused on disturbance, considering that this form of impact is wide spread and difficult to manage in wildland settings. Disturbance can be intentional (i.e., harassment) or unintentional, of which, the latter is most likely the primary means by which nonconsumptive recreational activities impact wildlife. Unintentional disturbance can take place in a variety of forms, such as hiking, mountain biking, bird watching, and wildlife photography.

Responses of Wildlife to Outdoor Recreation

Immediate response:

The most extreme response of wildlife to disturbance is death. Although this is the intended result of consumptive activities (i.e., hunting), nonconsumptive activities can also result in the death of animals. For example, small mammals inhabiting the subnivean space between snow and ground can be crushed by snowmobiles (Schmid 1972). Additionally, numerous piping plover chicks were found dead in tire tracks on eastern beaches (Melvin et al. 1994). Other types of immediate

responses are changes in behavior, such as a flight or flush response, nest abandonment, and elevated heart rates.

Long-term effects on individuals:

Although much of our understanding of recreational disturbance is limited to the immediate behavioral responses of individuals, long-term effects can result. Wildlife may abandon preferred nesting or feeding areas for less suitable, undisturbed sites. For example, Thornburg (1973) noted that when food-rich areas were disturbed, ducks redistributed to less productive areas to avoid human activity. Cottam (1939), Cronan (1957), Dennis and Chandler (1974), and Hohman and Rave (1990) also noted an alteration in use of feeding areas by diving ducks due to human disturbance. Displacement into new environments can lead to a number of further behavioral changes such as altered feeding ecology, which could lead to a reduction in energy acquisition, and ultimately affect its survival. Altered movement and home range patterns can also result from disturbance. For example, mule deer shifted feeding into darkness and left their home ranges more frequently (Yarmoloy et al. 1988).

Numerous studies have documented a decrease in productivity due to recreational disturbance. For example, mule deer experimentally harassed by all-terrain vehicles produced fewer off-spring the following year (Yarmoloy 1988). Miller et al. (1998) found that nesting success of grassland and forest birds was reduced in close proximity to heavily used recreational trails.

Long-term effects on populations:

Our knowledge of how outdoor recreational activities affect populations is rudimentary. We can only speculate that increased mortality, reduced productivity, and displacement of individuals (all documented, at least anecdotally) will result in decreased populations. Some information, however, does exist. For example, areas receiving moderate levels of all-terrain vehicle use had 50% fewer species of songbirds and 24% fewer breeding pairs compared to control areas (Bury et al. 1977). The heavily used areas had no breeding pairs. Flemming et al. (1988) found that the number of breeding pairs of piping plovers decreased by about 25% in areas frequented by

pedestrians and off-road vehicles. Documenting long-term effects on populations has been problematic because of the difficulty in establishing a cause-and-effect relationship.

Long-term effects on communities:

There is a lack of information in the literature documenting long-term effects on wildlife communities. Because there is interspecific variation in wildlife response to disturbance, we could anticipate that changes in species diversity would result. Those species with higher levels of tolerance to disturbance would be expected to be more prevalent in areas where disturbance occurs while species less able to tolerate disturbance would be absent or occur in lower numbers A simplification in bird communities was found near recreational trails along the Front Range of Colorado (Miller et al. 1998). American robins, a human commensal, were more numerous near recreational trails while other species, such as western-wood pewees, Townsend's solitaires, solitary vireos, etc., were less numerous. Skagen et al. (1991) documented a decrease in species diversity of an avian scavenging-guild due to human disturbance.

Factors That Influence Wildlife Responses

Type of activity:

Different activities may elicit different responses. As one might expect, wildlife may respond differently to a loud, fast moving motorcycle than to a quiet, slow moving pedestrian. Although we lack sufficient knowledge regarding responses to different types of activities, some information does exist. For example, white-tailed deer allowed closer approaches by a vehicle than to a pedestrian (Kucera 1976). Five of 6 species of raptors showed greater response to pedestrians than vehicles (Holmes et al. 1993).

Recreationist's behavior:

The behavior of recreationists can influence wildlife response. For example, Klein (1993) reported that of all visitors to a National Wildlife Refuge, photographers were most likely to disturb waterbirds because of their tendency to closely approach the birds. She also found that visitors who spoke to refuge personnel early in their visit were significantly less likely to disturb

waterbirds than those who did not. Fast moving snowmobiles appeared to be more disturbing to white-tailed deer those moving at slower speeds (Richens and Lavigne 1978). Furthermore, when snowmobilers stopped to view the deer, the deer invariably flushed.

Timing:

Although an animal's inclusive fitness can be affected any time of year, recreational disturbance may elicit different responses depending on the season. Disturbance during the breeding season may affect an individual's productivity while disturbance during other times of the year may alter habitat use or foraging patterns and, thus, its survival. During the breeding season, nesting success was lower near recreational trails, where human activity was common, than at greater distances from trails (Miller et al. 1998). Even within the breeding season, the severity of impacts can depend on when during the breeding phenology the disturbance occurs. For example, disturbance during the middle of the incubation period was most severe for nesting ospreys (Swenson 1979). Additionally, some species may be more sensitive to disturbance during certain times of the year. Disturbance during winter when animals are energetically stressed may be more severe than during summer when food is, presumably, more abundant.

Location:

Responses of wildlife can be influenced by the spatial context in which disturbance occurs. For example, when vegetative cover was abundant white-tailed deer did not flee from nearby snowmobile traffic, however, in open areas deer readily fled the vicinity (Richens and Lavigne 1978). Pedestrians approaching from over a over a ridge above big horn sheep elicited a greater response than did pedestrians approaching from below (Hicks and Elder 1979, MacArthur et al. 1982). Wildlife responses can differ whether activities occur on or off recreational trails. Marmots (Mainini 1993), western meadowlarks, vesper sparrows, American robins, and mule deer (Miller et al. *In Review*) showed greater reactions when pedestrian use occurred off-trail.

Frequency:

The number of disturbance events that occur during a given time period can influence the level of

response. For example, in Denmark the disturbance distance of roads on pink-footed geese increased with increasing traffic volume (Madsen 1985). Reproductive success of a variety of avian species has been shown of to decrease due to frequent visits to the nests (see Götmark 1992). Densities for 8 of 13 breeding bird species were negatively associated with the intensity of recreational activity by park visitors in the Netherlands (van der Zande et al. 1984). In another study, abundance of 11 of 12 species were lower in areas where recreation intensity was high than in areas with fewer visitors (van der Zande and Vos 1984). Home-range size and daily movement of white-tailed deer increased with increasing snowmobile activity in Minnesota (Dorrance et al. 1975).

Predictability:

When disturbance is perceived by wildlife to be expected, either in time or space, responses may be minimal. For example, although western meadowlarks, vesper sparrows, American robins, and mule deer still exhibited a flush or flight response to pedestrians on recreational trails, a greater response occurred when the same activity took place off-trail (Miller et al. *In Review*). In this study, it was concluded that wildlife have habituated to on-trail activities because they are predictable spatially, whereas off-trail activities are spatially random and, thus more disturbing. Bighorn sheep in the Sheep River Wildlife Sanctuary, Alberta exhibited minimal response to road traffic which was routine, and thus predictable (MacArthur et al. 1982). In areas were human activity was common, birds tolerated closer approaches than in areas receiving less activity (Cooke 1980, Burger and Gochfeld 1991).

Origin of Wildlife Responses to Recreational Activities

It has been shown that there can be a tremendous amount of both intra- and inter-specific variation in wildlife response to recreational activities. For example, peregrine falcons in New Mexico showed large (22-fold) differences in flush distance when exposed to similar stimuli (Johnson 1988). Numerous studies have reported that different avian species exhibit varying levels of response when exposed to the same recreational activity (Cooke 1980, Burger and Gochfeld 1991, Holmes et al. 1993, Klein 1993, Miller et al. *In Review*). Additionally, vehicular

traffic in Denali National Park elicited greater responses by moose than by caribou (Singer and Beattie 1986). Both learned and innate components influence the degree of intra- and inter-specific variation in wildlife response.

Learned responses:

The learned component of wildlife response is influenced by the number and outcome of interactions between individuals and stimuli over the individual's lifetime (Poole 1981, Buitron 1983, Knight and Temple 1986). There are three categories of learned responses wildlife may exhibit to recreationists: 1) avoidance, 2) attraction, and 3) habituation. Interactions between recreationists and wildlife individuals resulting in a negative experience, such as pain, could produce avoidance behavior, while a positive experience, such as feeding wildlife, could result in attraction behavior. Interactions involving neither a negative or positive experience could result in wildlife habituating to recreationists.

Avoidance:

When humans are perceived as a threat, wildlife will tend to avoid humans or habitats where human activity is common. For example, in areas of where common ravens, American crows, and black-billed magpies were persecuted they exhibited strong avoidance behavior and decreased nest defense than individuals in areas without persecution (Knight 1984, Knight et al. 1987, Kenney and Knight 1992). Many species, even though not actively persecuted, will avoid areas where human activity is common. For example, grassland nesting songbirds were less likely to establish nest sites in close proximity to recreational trails where nature viewing, hiking, and jogging were the primary activities taking place (Miller et al. 1998).

Attraction:

Attraction is defined as the strengthening of an individual's behavior because of rewards or reinforcement (Knight and Temple 1995). The most common example of attraction behavior is wildlife such as squirrels, chipmonks, or gray jays gathering at campsites or picnic areas anticipating a food reward. In some cases attraction behavior can result in potentially dangerous

interactions between humans and wildlife. For example, in Great Smoky Mountains National Park, 33% of interactions between bears and park visitors resulting in injury occurred while people were feeding or petting bears (Singer and Bratton 1980). In extreme cases, ecosystem function may be altered due to attraction behavior. For example, in Rocky Mountain National Park, Clark's nutcrackers are attracted to scenic turnouts where they are fed by park visitors. Because this species plays a key role in the dispersal of limber pine seeds, it is hypothesized that if park visitor activities discourage normal foraging behavior, a decline in afforestation rates of limber pine may result (Tomback and Taylor 1986). Although the best examples of attraction behavior involve some sort of food reward, other situations will also cause wildlife to be attracted to humans. For example, red fox track counts revealed an attraction to snowmobile trails, presumably because the packed trails allowed for easier movement (Neumann and Merriam 1972).

Habituation:

Habituation is defined as a waning of response to a repeated stimulus which results in neither a positive or negative interaction (Eibl-Eibesfeldt 1970). Numerous studies have documented, at least anecdotally, that wildlife can habituate to recreational activities if they are predictable and perceived as non-threatening. Bighorn sheep appeared to habituate to predictable vehicular traffic, which they have learned is not a threat (MacArthur et al. 1982). Miller et al. (*In Review*) found that wildlife responded less to activities occurring on-trail than to the same activity off-trail. Presumably because on-trail activities are spatially predictable and off-trail activities are spatially random and, therefore, unpredictable.

Genetic responses:

Although it is accepted that animals are genetically predisposed to certain behaviors which can be stimulated by environmental factors (Hailman 1967), few studies have documented the innate component in wildlife response to recreational activities. Newton (1979) hypothesized that intraspecific variation in nest-defense behavior was influenced by historic levels of persecution (through the elimination of aggressive individuals). Knight et al. (1989) found a negative correlation between the number of years since European settlement (assumed to be positively

correlated with the duration of persecution) and the aggressive behavior of red-tailed hawks to humans, with the most aggressive birds occurring in the areas of most recent Anglo settlement. The alarm response exhibited by chamois to airplanes is believed to be due to their innate fear of golden eagles (Hamr 1988).

Case Studies

I will present two case studies which illustrate many of the topics discussed above. The first involved investigating the influence of recreational trails on breeding bird communities along the Front Range of Colorado. The second involved investigating wildlife responses to pedestrians and dogs, both on- and off-trail.

Influence of recreational trails on breeding bird communities:

We investigated the influence of recreational trails on breeding bird communities in forest and mixed-grass prairie ecosystems in Boulder County, CO during 1994 and 1995. Species composition, nest predation, and brood parasitism by brown-headed cowbirds was examined near and away from existing recreational trails. Bird species composition was altered due to the presence of trails in both ecosystems. Generalist species were more abundant near trails whereas specialist species were less common. Within the grassland ecosystem, birds were less likely to nest near trails. Within both ecosystems, nest success was reduced alongside trails. In forests, rate of brood parasitism was not influenced by trails. No brood parasitism was found in the grassland ecosystem. Our results may be useful to natural-lands managers faced with implementing management policies regarding the spatial arrangement of trails and trail-use restrictions.

Wildlife responses to pedestrians and dogs:

We measured the responses of two grassland passerines, one forest passerine, and mule deer exposed to a pedestrian, a pedestrian accompanied by a dog-on-leash, and a dog alone, both on- and off-trail. Responses measured were flush response (whether the animal flushed or not), flush distance (distance between treatment and animal when flushed), distance of flush (distance animal

moved after flushing), and the perpendicular distance between the animal and the trail (on-trail treatments) or our line-of-movement (off-trail treatments). All wildlife species in our study exhibited greater responses when the treatment occurred off-trail than when on-trail. In the grasslands, the dog alone treatment elicited the least response by vesper sparrows and western meadowlarks, whereas pedestrian alone and dog-on-leash treatments elicited greater responses. In the forest, American robins responded similarly to pedestrian alone and dog-on-leash treatments. Mule deer exhibited the greatest response when a pedestrian was accompanied by a dog. Our results have implications for the design and implementation of management policies, such as using spatial and behavioral restrictions, to promote the coexistence of wildlife and recreationists.

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