Human Disturbance and Bald Eagles

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The decline of Bald Eagle populations in the lower 48 states has been attributed largely to habitat destruction, shooting and the effects of DDT and other contaminants (e.g., Belding 1890, Harlow 1918, Broley 1958, Howell 1962, Sprunt et al. 1973, Wiemeyer et al. 1984). However, as early as 1960, some workers suggested that human disturbance may also be detrimental to the species (e.g., Cunningham 1960). In this paper, we examine the effects of human disturbance on Bald Eagle populations and focus on anthropogenic sources of disturbance. We define human disturbance as any human presence or activity that causes an eagle to alter its physiological state or behavior (e.g. Fraser 1985).

Behavioral Responses to Human Presence

Disturbance in foraging areas

The 1970s and 1980s saw the beginnings of experimental efforts to determine the distance at which various human activities produce behavioral responses by eagles. Most studies were conducted in feeding areas and involved intentional approaches to eagles to determine the distance at which birds flushed. Most flush distance obtained in this way was less than 500 m.

Distance within and among studies varied somewhat, apparently for a variety of reasons. Stalmaster and Newman (1978) reported that flush distances of adults were greater than those of immature and subadult birds. That result, however, could not be repeated by other workers who conducted similar studies in different regions (Russell 1980, Knight and Knight 1984, Wallin and Byrd 1984, Smith 1988, Buehler et al. 1991).

Several workers reported that flush distances were greater in areas that had little human use than in areas used more frequently by people; they cited this as possible evidence that eagles in the high human use areas became habituated to the presence of people (Stalmaster and Newman 1978, Russell 1980). Similarly, Buehler et al. (1991) reported greater flush distances in winter on the Chesapeake Bay than in summer, when human use of the bay was greatest. In contrast, flush distances in a North Carolina reservoir increased from spring to late summer (Smith 1988).

As Knight and Knight (1984) pointed out, there may be differences among areas or over time and unrelated to habituation, that result in changes of a population's flush distance. In Washington, for example, eagle flush distance appeared to be negatively related to food availability (Knight and Knight 1984). In Smith's North Carolina study, limited radiotelemetry data indicated that some individuals stayed in the study population only briefly. Thus changes in flushing response could have reflected the changing composition of the study population.

Perhaps the most important variable affecting flush distance is the visibility of the intruder. In most studies, the disturbance stimulus was clearly within sight of the subject eagles. However, in studies on the Nooksack and Skagit rivers in Washington (Stalmaster and Newman 1978), flush distances caused by people approaching eagles in open river and riverbank habitats were greater than those caused by people approaching through dense vegetation. This was probably because the eagles did not detect people in the vegetation until they were quite close. These results support the idea of providing vegetative buffers near eagle areas to prevent eagles from seeing people.

Flush distances provide a measure of the extent to which eagles will tolerate people, but there is also an "agitation distance" (McGarigal et al. 1991) which is greater than the flush distance and within which humans elicit behavioral and physiological responses from eagles even though the birds do not flush. McGarigal et al. (1991) estimated the agitation distance for eagles foraging on the Columbia River estuary by determining the usual foraging areas of breeding eagles, placing an occupied boat within those areas and then noting the distances from the boat where use declined. Almost all eagles in that study avoided perches within 300-400 m of the boat and some eagles avoided perches within 800 m.

The work by McGarigal et al. (1991) also showed that disturbance to eagles depends on the type of human activity involved, the distance to the activity, the time of day and the eagle location and activity. One must also consider the encounter rates of the various human activities under consideration. In the Columbia River estuary, for example, encounter rates were highest for trains, followed by aircraft and boats; eagles rarely encountered automobiles or pedestrians because of the large wetlands between the roads and the eagle use areas. Eagles were most frequently disturbed by automobiles and next most frequently by pedestrians, aircraft and boats; trains did not disturb eagles.

One might interpret these results as evidence for habituation, but this is not necessarily correct. Although disturbance rates were low for boats (6.4%), the number of encounters with boats was much higher, so that boats caused 80% of all flush responses by eagles. Only a few flush responses were caused by pedestrians, automobiles or aircraft because of the low encounter rates. All eagles flushed when boats approached within 100 m. No differences in flush rates or distances were attributed to nesting stage, cloud cover, eagle appetite, age, breeding status, or residence. However, eagle perch height, eagle activity and time of day influenced flush rate and distance. Eagles that were perched on or near the ground flushed in response to approaching humans more often than eagles perched in trees (Table 1).

Eagles flushed in response to human activities more often before 0800 than after 1000, but the time of day did not have a significant effect on flush distance. Although flush distances have varied from study to study, trials conducted under similar conditions resulted in comparable flush distances (Table 2). This suggests that there may be a general tolerance threshold for foraging eagles.

Table 1. Mean flush distances for factors with significant effects on Bald Eagle flush rates and distance for human activities on the Columbia River estuary, 1985-86 (from McGarigal et al. 1991).

Factor and level	Flush distance		KW or MWa	
	n	Mean	SE	P
Eagle perch height				
1 m	17	251	24	10.34
1-10 m	17	146	21	(0.006)
10m	16	180	24	
Eagle activity Foraging or feeding	33	167	15	175
Resting or other	17	242	26	(0.030)
Time of Day 0600 hrs	11	153	31	5.17
0600-0800 hrs	18	224	21	(0.160)
0800-1000 hrs	10	189	32	
1000 hrs	11	185	35	

KW = Kruskall-Wallis analysis of variance for factors with >2 levels; MW = Mann-Whitney U-Statistic for factors with 2 levels.

Disturbance at nests

In contrast to studies of foraging eagles, less work has been done to examine the distances at which humans elicit behavioral responses from nesting eagles. In Minnesota, a single person slowly approaching a nest in open view resulted in flush distances averaging 476 m (Fraser et al. 1985). Flush distance increased with the number of previous disturbances at a nest, decreased as the season progressed and was greater in mid-day than in the morning or the evening.

The strong positive correlation between flush distance and the number of previous disturbances suggests that, rather than becoming habituated to disturbances at the nest, eagles became sensitized. In this study, the same observer approached the nest from the same direction at each subsequent disturbance. Thus, it is possible that the eagles began to recognize a behavior pattern that would result in a very close approach to the nest, which might account for the increasing flush distance.

Disturbance at roosts

Most information about disturbance at roosts is anecdotal. However, Smith (1988) fired rifle and shotgun blasts at 200 m increments while approaching a roost in North Carolina after eagles had settled in for the evening. Eagles flushed when shots were fired at 600 m and 400 m, but not when shots were fired at 800 m and 1000 m. Eagle use of this roost on the nights of the shooting was lower than on other nights, but rebounded to pre-experiment levels on the nights after the shooting.

Population Responses to Human Activities

Information about behavioral responses to human activities is important because it provides managers with an empirical framework they can use to design buffer zones around important habitats. Ultimately, however, disturbance is only a problem for eagles if it changes their population parameters. In this section we examine the evidence that human activities change natality, mortality and dispersion in eagle populations.

Table 2. Bald Eagle flush distances (M) in response to various human activities.

Activity at Foraging Areas	Average distance	Range	Source
Pedestrian (River, Riverbank)	131	15->300	Stalmaster and Newman 1978
Boat	393	112-540	Wallin and Byrd 1984
Canoe	178		Knight and Knight 1984
Boat	137	0-395	Smith 1988
Pedestrian	270	191-246	Smith 1988
Boat	215	40-475	Buehler et al. 1991
Boat	197	50-468	McGarlgal et al. 1991
at Nests Pedestrian	497	57-991	Fraser et al. 1985

Effects on Natality Rates

Early studies of the effects of human disturbance on Bald Eagles focused on the impact of disturbance on natality rates, in part because of the many nest failures observed in the 1960s and 1970s and in part because nesting parameters are far easier to measure than survival or dispersion parameters.

Grubb (1976) found that, for nests within 0.25 miles of human developments, successful nests were significantly farther from the development (mean distance = 130 yards) than nests that did not produce young. Similarly, Anthony and Isaacs (1989) reported that mean productivity was lower at sites altered by logging or other human activities than it was in pristine, unaltered sites. They also found that productivity was negatively correlated with proximity to clear cuts, main logging roads and non-recreational activities. In contrast, McEwan and Hirth (1979), Mathisen (1985) and Fraser et al. (1985) failed to find evidence that human activities in their study sites were depressing reproduction. Similarly, Grier (1969) found no difference in the productivity of nests where young had been banded when compared to nests that had been censused only from a distance. The differing results in these studies may be attributable to differing levels of disturbance in the various study areas, or to methodological variation.

Effects on Eagle Distribution

Nest sites: A number of observations of eagles abandoning nests after local disturbances have been reported (Broley 1947, Murphy 1965, Thelander 1973, Anthony and Isaacs 1989). Movement away from developments may have been partly responsible for Grubb's finding that productive nests were farther from disturbances than unproductive nests since 30 of 52 unproductive nests were not active. In Minnesota, new nests adjacent to developed shoreline were farther from the water than nests on undeveloped shoreline and nests were farther from houses than would be expected if shoreline sections were chosen randomly (Fraser et al. 1985). Similarly, in Maryland, nests were significantly farther from structures and paved roads than were random points (Andrew and Mosher 1982). In Oregon, Anthony and Isaacs (1989) found that recently used nests within a breeding territory were farther from logging roads, recreational facilities and improved roads than old nests, suggesting a shift in nesting away from human activities.

This Bald Eagle nesting tree is within 30 m of two homes. Two years after this nest was built the eagles switched to a more remote nesting tree 400 m away and 100 m from the nearest home. Photo by Bruce Wright.

Foraging areas: The effect of recreational boating and shoreline use was examined at Jordan Lake, North Carolina by Smith (1988). Eagle densities were greatest along the segments of shoreline that received the lowest use by people. That fact alone could have been accounted for by differential habitat selection by people and eagles. For that reason, Smith compared eagle densities and human densities on weekdays with densities found on weekends. Jordan Lake is a favorite recreational area for many people from the Raleigh-Durham area and human use was much greater on weekends than during the weekdays. Eagle numbers, counted by shoreline surveys, were significantly lower during weekends than during weekdays. Smith estimated that the threshold density of boats which caused changes in eagle density was 0.5 boats/km^2.

In a similar analysis, Buehler et al. (1991) showed that eagles were less likely to be found on Chesapeake Bay shoreline segments with pedestrian traffic or adjacent boat traffic than on segments without such traffic. Moreover, they found that eagles were less likely to use developed shoreline (i.e. shoreline with buildings) than undeveloped shoreline. Any level of development on a 250 m long shoreline strip was sufficient to reduce the probability of eagle use, but development at or above a density of one building per hectare resulted in a probability of eagle use approaching zero. Thus, they assumed that Chesapeake Bay shoreline developed to that extent no longer serves as eagle habitat.

Effects on Survival

We are unaware of evidence that disturbance has negatively affected Bald Eagle survival. This is not surprising given the number of confounding variables that would affect such an analysis and the difficulty of even estimating survival rates. However, based on energetics modeling, Stalmaster (1983) predicted that disturbance could increase total energy needs of eagles and could also interfere with food acquisition. In a food stressed population, this could lead to reduced survival rates. Such effects would be more likely to occur in Canada and Alaska than in the 48 conterminous states because eagle populations in the former areas are more likely to be at or near the carrying capacity of the environment than other populations. Populations in the lower 48 states were depressed to well below carrying capacity by DDT and shooting and are still recovering from those effects.

Summary and Conclusions

The normal activities of eagles can be disrupted by human activities. The distance at which any given activity disrupts normal behavior varies with the nature of the activity, the individual eagle involved, the visibility of the activity from the eagle's point of view and a variety of other environmental factors. Nevertheless, a conservative rule of thumb is that when humans walk or boat within 400-500 m of eagles in the lower 48 states, many eagles will be disturbed. Our casual observations suggest that Alaska eagles may be more tolerant of humans than are birds in the rest of the United States, but this remains to be tested.

In some cases, human disturbance may cause nesting failure. Moreover, eagles that are subjected to disturbance during the breeding season may seek new, more remote nest sites. Non-breeding eagles avoid pedestrians, boaters and human dwellings such that excessive human presence on the shoreline can depress the carrying capacity of habitat that is otherwise quite suitable.

While some have suggested that eagles may habituate to human disturbance, there is no hard evidence that this is happening in the areas which are currently experiencing the greatest human densities. Thus it appears that the long-term well-being of eagles depends upon maintenance of more or less remote shorelines where human-eagle interactions are minimized.

*Editor's Note: During 1985-1992, D. G. Roseneau. and P. J. Bente designed and tested methods for building. artificial Bald Eagle (*Haliaeetus leucocephalus*) tree nests and directly and indirectly relocated nesting pairs (Roseneau 1990; Roseneau and Bente 1987, 1989, 1993; Roseneau et al. 1986, 1987). The work was conducted for the Alaska Energy Authority as part of a multiyear study to develop management techniques for mitigating potential impacts of hydroelectric projects built in areas supporting Bald Eagle nesting populations. The above photograph shows a natural appearing, weather resistant nest designed to provide drainage and withstand high winds and heavy snow loads. By the conclusion of the 1992 breeding season, Bald Eagles had used nine (60%) of 15 nests installed in spruce (*Picea sitchensis *and* Picea glauca*) and balsam poplar (*Populus balsamifera*) trees in the Tanana and Susitna river drainages and upper Kachemak Bay and a nest mounted on top of an experimental tripod erected in the Susitna River Valley. Also, during the study, one pair of eagles was successfully relocated from their natural nesting territory to an artificial territory about 488m away by moving their eight-week-old young to an artificial nest and temporarily blocking their natural nest with a steel* *cone (the first direct relocation of breeding Bald Eagles) and another pair was indirectly moved to a new location in their nesting territory by coning their nests.*

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