

# Recommendations for protecting raptors from human disturbance: a review

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In a survey of resource managers, LeFranc and Millsap (1984) identified human-associated disturbance as a primary threat to raptor populations. Several studies have demonstrated declines in raptor populations resulting from human-associated disturbance (Voous 1977, Swenson 1979, Craighead and Mindell 1981). Resource managers can successfully use spatial and temporal buffer zones in concert to protect raptors from the effects of recreational activity (Swenson 1979, Knight and Skagen 1988, Holmes et al. 1993), human development (Ramakka and Woyewodzic 1993), and oil development (Squires et al. 1993). Spatial and temporal restrictions (buffer zones) are useful tools for resource managers to protect raptors during periods of extreme sensitivity (Knight and Skagen 1988, Knight and Temple 1995). We present information relevant to the establishment of buffer zones and the guidelines for assessing spatial and temporal buffer zones for a variety of raptors in North America. This review may serve as a general guideline for resource managers and others interested in protecting raptors.

## The need for nest site protection

Human activities are known to impact raptors in at least 3 ways: (1) by physically harming or killing eggs, young, or adults; (2) by altering habitats; and (3) by disrupting normal behavior (Postovit and Postovit 1987). Due to the broad range of direct and indirect human-associated impacts and the fluctuating levels of sensitivity for individual raptors, depending on life stage and time of year, buffer zones are most effective when spatial and temporal restrictions are congruent.

The direct effects of human disturbance may seem inconsequential to uninformed or unconcerned outdoor recreationists. Activities like rock-climbing, can have severe impacts on nesting raptors, even when climbers do not have direct contact with eggs, young, or adults (Lanier and Joseph 1989, Kelly 1996). This sport often involves shouting and other noises which are disturbing enough to raptors to keep them away from their nests (Call 1979, Ratcliffe 1980). Even brief absence by parent birds can lead to missed feedings, predation on eggs or young, or to overheating, chilling, or desiccation of eggs or young (Call 1979, Suter and Jones 1981). Rock-climbing near peregrine falcon (*Falco peregrinus*) eyries during the nesting season can cause nest abandonment; some peregrine falcons are extremely sensitive and refuse to breed if humans have been in the vicinity of their eyries (Snow 1972, Olsen and Olsen 1980). Ferruginous hawks (*Buteo regalis*) tend to desert their nests if adults are exposed to human activity during incubation (White and Thurow 1985). Van Daele and Van Daele (1982) found that incubation at successful osprey (*Pandion haliaetus*) nests occurred during 99.5–100% of daylight hours. Human disturbance during the critical periods of incubation and the early nesting stages can be fatal to embryos and nestlings.

The presence of humans detected by a raptor in its nesting or hunting habitat can be a significant habitat-altering disturbance even if the human is far from an active nest. Impacts of human activities on wild animals are often reduced when animals are shielded visually from such activities (Postovit and Postovit 1987, Knight and Temple 1995). A clear line of sight is an important factor in a raptor's response to a par-

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ticular disturbance (Suter and Jones 1981). A Geographic Information System-assisted viewshed approach combined with a designated buffer zone distance was found to be an effective tool for reducing potential disturbance to golden eagles (*Aquila chrysaetos*) in Northern Colorado (R. L. Knight, Colo. State Univ., Fort Collins, pers. commun.).

Human disturbance was listed as the cause of 85% of all known nest losses occurring during Boeker and Ray's (1971) study of golden eagles. Disturbance of wintering bald eagles (*Haliaeetus leucocephalus*) resulted in both increased energy expenditures due to avoidance flights and decreased energy intake due to interference with feeding activities (Stalmaster 1983). The enforcement of spatial and temporal buffer zones can protect raptors from the effects of visual disturbances (e.g., human development or recreation), audible disturbances, and direct disturbances (e.g., shooting, recreational rock-climbing).

## Determining adequate protection

Several authors have provided general recommendations for determining adequate site-specific buffer zones (Postovit and Postovit 1987, Pomerantz et al. 1988, Holmes et al. 1993). Postovit and Postovit (1987) detailed steps for mitigation planning. Pomerantz et al. (1988) gave a useful set of guidelines that could be used to determine the compatibility of recreational activities in sensitive resource areas. In designing appropriate buffer zones the most important factors are: site-specific information on the horizontal and vertical proximity of a nest to a potential disturbance, source or duration of disturbance, and disturbance history of the individual raptors (Suter and Jones 1981, Postovit and Postovit 1987, Knight and Skagen 1988, Holmes et al. 1993).

### Site-specific information

Physical characteristics (i.e., topography, vegetation) are important variables to consider when establishing buffer zones based on raptors' visual and auditory-detection distances. Horizontal spatial restrictions can be shortened or lengthened depending on the height of perching or nesting sites (Holmes et al. 1993). Given variable nesting phenology of different species and regional climatic variation, exact dates of nest-site closures should be modified according to local situations (U.S. Fish and Wildl. Serv. 1984). White and Thurow (1985) recommend that the degree to which a nest is exposed or concealed should be considered when designing buffers for ferruginous hawks. They also suggested that information on the general health and status of

individual populations be considered. For example, in years of food scarcity, spatial buffers should be expanded substantially.

### Source or type of disturbance

Management plans should be tailored to each species, habitat, season, and source of disturbance. For example, Holmes et al. (1993) argued that, because humans in vehicles are less disruptive to raptors than pedestrians, management plans should offer different restrictions based on disturbance type. Squires et al. (1993) suggested that prairie falcons (*Falco mexicanus*) could cope with limited development on their foraging areas if their nest sites were secure from direct human disturbance. Nonthreatening activities, such as those occurring on recreational trails, may be compatible with a nest or perch location in close proximity if that activity is visually or aurally buffered by vegetation or topography (Knight and Temple 1995).

### Prior disturbance history of individual raptors

Due to variation of tolerance between bald eagle populations, Stalmaster and Newman (1978) suggested monitoring adult behavior prior to the establishment of management recommendations and buffer zones to determine to what extent the individuals had been sensitized to human disturbance. They noted that although a single direct disturbance may have insignificant impacts, repeated direct disturbances may cause abandonment of a nest or perch location.

## Spatial and temporal buffer recommendations

### Spatial buffers

Spatial buffer-zone recommendations depend on site specific considerations, and vary considerably for species such as osprey, Cooper's hawk (*Accipiter cooperii*), northern goshawk (*Accipiter gentilis*), sharp-shinned hawk (*Accipiter striatus*), golden eagle, red-tailed hawk, (*Buteo jamaicensis*), ferruginous hawk, bald eagle, prairie falcon, peregrine falcon, and American kestrel (*Falco sparverius*; Table 1). Median distances recommended for buffer zones for nesting raptors (based on the information summarized in Table 1) are as follows: osprey = 1,000 m (range = 400-1,500 m,  $n = 3$ ), Cooper's hawk = 525 m (range = 400-600 m,  $n = 2$ ), northern goshawk = 450 m ( $n = 1$ ), sharp-shinned hawk = 450 m ( $n = 1$ ), golden eagle = 800 m (range = 200-1,600 m,  $n = 3$ ),

Table 1. Summary of recommendations for spatial and temporal buffer-zones for nesting raptors.

Species	Spatial (m)	Temporal	Reason for closure	Source
osprey	1,500	not discussed	human activity	Van Daele and Van Daele 1982
	400	Apr 1–Aug 31	no explanation	Colo. Div. Wildl. 1995
	1,000	during incubation	recreational disturbance	Swenson 1979
Cooper's hawk	600	not specified	habitat alteration	Bosakowski et al. 1993
	400–500	not specified	unspecified disturbance	Jones 1979
northern goshawk	400–500	not specified	unspecified disturbance	Jones 1979
sharp-shinned hawk	400–500	not specified	unspecified disturbance	Jones 1979
golden eagle	200 from cliff tops; 400 from base	Mar 1–Jun 30	human disturbance	M. Ball, U.S. For. Serv., Fort Collins, Colo., pers. commun.
	800	Feb 1–Aug 1	noise	Call 1979
	200–1,600	Mar 1–Sep 1	visual, audible	Suter and Jones 1981
red-tailed hawk	800	Feb 1–Jul 15	no explanation	Colo. Div. Wildl. 1995
	800	Feb 1–Aug 1	noise	Call 1979
ferruginous hawk	200–800	arrival–post fledging	visual, audible	Suter and Jones 1981
	250	during incubation	human activity	White and Thurow 1985
bald eagle	800	Feb 1–Jul 15	no explanation	Colo. Div. Wildl. 1995
	400	Feb 1–Aug 15	human disturbance	D. Flath, Mont. Dep. Fish, Wildl. & Parks, Bozeman, pers. commun.
	800	Feb 1–Aug 1	noise	Call 1979
	500	not discussed	human disturbance	Fraser 1983
	250	prior to egg laying through incubation	human activity	Grier et al. 1983
	800	Nov 15–Jul 31	no explanation	Colo. Div. Wildl. 1995
prairie falcon	200 from cliff tops; 400 from base	Mar 1–Jun 30	human disturbance	M. Ball, U.S. For. Serv., Fort Collins, Colo., pers. commun.
	800	Feb 1–Aug 1	noise	Call 1979
	200–800	arrival–post fledging	visual, audible	Suter and Jones 1981
	800	Mar 15–Jul 31	no explanation	Colo. Div. Wildl. 1995
	50	Mar 15–post fledging	visual	Natl. Park Serv. 1995
	800	Feb 1–Jul 15	climbing disturbance	S. Johnson, Natl. Park Serv., pers. commun.
	800–1,500	not discussed	recreational disturbance	Windsor 1975
	800	Feb. 1–Aug. 1	noise	Call 1979
	1,600	Feb 1–Aug 31	human activity	U.S. Fish and Wildl. Serv. 1984
American kestrel	800	Mar 15–Jul 31	no explanation	Colo. Div. Wildl. 1995
	200 from cliff tops; 400 from base	Mar 1–Jun 30	human disturbance	M. Ball, U.S. For. Serv., Fort Collins, Colo., pers. commun.
	50	Mar 15–post-fledging	visual	Natl. Park Serv. 1995

red-tailed hawk = 800 m ( $n = 1$ ), ferruginous hawk = 500 m (range = 200–800 m,  $n = 3$ ), bald eagle = 500 m (range = 250–800 m,  $n = 5$ ), prairie falcon = 650 m (range = 50–800 m,  $n = 4$ ), peregrine falcon = 800 m (range = 800–1,600 m,  $n = 5$ ), and American kestrel = 50–200 m ( $n = 2$ ). Several studies have recorded flushing distances for raptors responding to disturbances from pedestrians and vehicles (Table 2).

Table 2. Flushing distances (m) for raptors in response to disturbance by pedestrians and vehicles.

Species	Pedestrian disturbance	Vehicle disturbance	Source
golden eagle	105–390	14–190	Holmes et al. 1993
ferruginous hawk	13–165	110–280	Holmes et al. 1993
	136.4 (range = 29–291)	117.2 (range = 24–316)	White and Thurow 1985
rough-legged hawk	55–900	9–170	Holmes et al. 1993
bald eagle	50–990	50–990	Fraser 1983
	57–991 (91% > 200 m)	not studied	Fraser et al. 1985
prairie falcon	24–185	18–200	Holmes et al. 1993
American kestrel	10–100	12–115	Holmes et al. 1993
merlin	17–180	44–85	Holmes et al. 1993

## Temporal buffers

For temporal restrictions to be effective, they must be tailored to individual populations. In addition, temporal restrictions need only be in effect when raptors are using a critical resource such as a nest site or foraging area (Knight and Skagen 1988). Temporal buffers should encompass all nesting activities and extend at least from the arrival of the adult birds in the nesting area through the first few weeks of nestling development (Fyfe and Olenhoff 1976, Suter and Jones 1981, Grier et al. 1983, White and Thurow 1985). Adult birds often sit tightly on eggs or young nestlings, and when adults flush abruptly due to disturbances, there is increased likelihood of their ejecting the contents of their nests (Grier and Fyfe 1987).

## Summary

Several studies have documented flushing distance responses of raptors to a variety of activities during breeding and nonbreeding seasons (Table 2); however, except for anecdotal and incidental reports, few studies have experimentally documented disturbance distances for use in buffer-zone recommendations (White and Thurow 1985, Holmes et al. 1993). The wide range of recommendations (Table 1) probably reflects site-specific anthropogenic and environmental conditions (Suter and Jones 1981, Fraser 1983). To be effective, buffer zones should be based on empirical evidence of wildlife responses to disturbance (Knight and Skagen 1988). Several authors suggest the need for further disturbance studies to determine flushing responses among different species (White and Thurow 1985, Postovit and Postovit 1987, Knight and Temple 1995).

The City of Boulder Open Space Department and Mountain Parks Division have used spatial and temporal buffer zones successfully for a number of years to protect cliff-nesting peregrine falcons, prairie falcons, and golden eagles. Closures are in effect from February through July annually and vary in distance by 50–400 m depending on topography, nest location, and species. Extensive public education accompanies the closures, including direct mailings to outdoor recreation shops in the area, closure signs at trailheads, press releases, and access to a 24-hour telephone information line and a site on the World Wide Web. In addition, nest sites are monitored weekly by trained volunteers. With proper planning, extensive observations of target individuals and groups, and aggressive public education, spatial and temporal buffer zones provide a useful tool for protecting raptors to resource managers.

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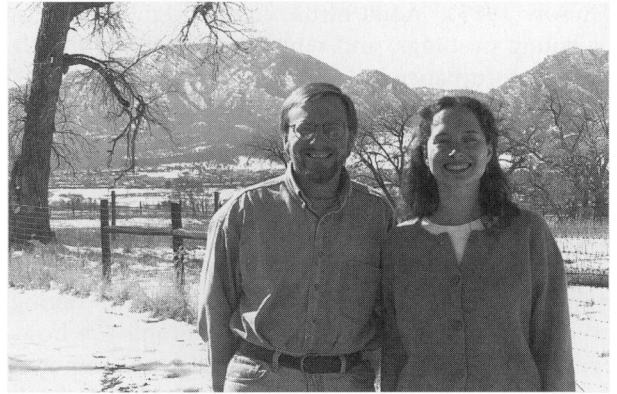
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