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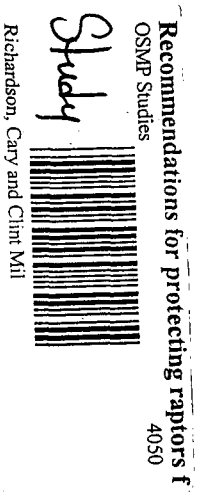
Recommendations for protecting raptors from human disturbance: a review.



Cary T. Richardson

and

Clinton K. Miller

City of Boulder

Open Space/Real Estate Department

Operations Center

66 South Cherryvale Road

Boulder, Colorado 80501

INTRODUCTION-- In a survey of resource managers, LeFranc and Millsap (1984) identify human associated disturbance as one of the primary threats to raptor populations. Vulnerability of nest sites to recreational activity (Holmes et al. 1993, Knight and Skagen 1987, Swenson 1979,) human development (Lramarkka and Woyewodzic 1993), and oil development (Squires et al. 1993) has resulted in the use of spatial and temporal buffer zones. Spatial and temporal restrictions, or buffer zones are a useful tool for resource managers to protect raptors during periods of extreme sensitivity (Knight and Skagen 1988, Knight and Temple 1995). This paper compiles information available on nest site closure rationale, recommended spatial buffer distances, and temporal closure recommendations for a variety of raptors in North America (research was exclusive to American publications excluding one). This review can serve as general guidelines for resource managers and others interested in protecting nesting raptors.

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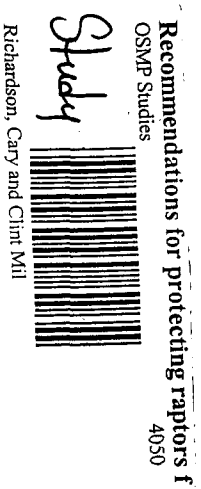

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NEST SITE CLOSURE RATIONALE--Human activities are known to impact raptors in at least 3 ways: by causing mortality to eggs, young, or adults; by altering habitats; and by disrupting birds' normal behavior (Postovit and Postovit 1987). In a study of golden eagles by Boeker and Ray (1971), human disturbance is listed as the cause of 85% of all known nest losses during their study. Disturbance of wintering bald eagles results in increased energy expenditures due to avoidance flights and decreased energy intake due to interference with feeding activities (Stalmaster 1983- see Knight and Knight 1984 for citation). Ferruginous hawks are prone to desert nests if exposed to human activity during incubation (White and Thurow-cite?). 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 (e.g., motorized and non-motorized recreation), and direct disturbances (e.g., shooting, recreational rock climbing).

Effects of Visual Disturbance-- Wildlife are often less affected when visually shielded from human activities (Knight and Temple 1995, Postovit and Postovit 1987). Suter and Joness (1981) state that a clear line of sight is an important factor in determining a raptor's response to a particular disturbance. Disturbance of nesting raptors can result in complete desertion of nest. eggs, and young. Even a temporary departure by adults can lead to overheating, chilling, or desiccation of eggs or young, predation on eggs or young, or missed feedings (Suter and Joness 1981).

Effects of Audible Disturbance--Rock climbing normally involves various amounts of shouting or other noises which, when occurring close by, are sufficiently disturbing to raptors to keep them away from their nests. The young birds may miss feedings or be subjected to intolerable heat or cold in the absence of brooding (Call 1979). For example, osprey eggs must maintain a temperature of 29-36 degrees to remain viable (Spitzer 1977). Van Daele and Van Daele's

(1982) observations reveal that successful osprey nests incubated 99.5-100% of daylight hours. Disturbance during the critical periods of incubation and early nesting stages can be fatal to embryos and nestlings if adults are kept away from their nests.

Effects of Direct Disturbance--Rock climbing conducted at peregrine eyries during the nesting season usually causes falcons to abandon their nesting attempts. Some are exceedingly sensitive and will refuse to breed if humans have been anywhere near their eyries. (Snow 1972).

SPATIAL AND TEMPORAL BUFFER RECOMMENDATIONS-- Many authors give descriptions on how to determine adequate buffers without listing blanket numbers. Postovit and Postovit (1987) provide steps that "should be followed in any mitigation program." Pomerantz et al. (1988) cites the USFWS for a set of guidelines that can be used to determine the compatibility of a refuge to recreational activities (U. S. Fish and Wild. Serv. Man. 5RM 20.8 A-F, 1985). Our review has revealed that it is crucial to consider the following variables when designing buffers: site specific information on proximity of nest to potential disturbance (Postovit and Postovit 1987)(both horizontal and vertical proximity) (Holmes et al), source or type of disturbance (i.e., visual, audible, duration), and prior disturbance history of the individual raptors (Holmes et al. 1993, Knight and Skagen 1987, Postovit and Postovit 1987, Suter and Joness 1981).

Site Specific Information--Camp et al. (1996) recommends the establishment of protected areas for golden eagles using a combination of buffer zone and a viewshed. A viewshed approach may reduce the amount of area needed for a buffer (Camp et al.). Horizontal spatial restrictions can be shortened if perching sites with greater vertical height are made available (Holmes et al. 1993). In the American peregrine falcon recovery plan it is stressed that exact dates of closures

vary by individual eyrie sites and should be modified to fit local situations (Rocky Mountain/ Southwest Peregrine Falcon Recovery Team, 1984).

Source or Type of Disturbance-- Holmes et al. (1993) suggests that management plans should be tailored to each species, habitat, and season. They also argue that because humans in vehicles are less disruptive to raptors than pedestrians, management plans should offer different restrictions based on disturbance type. White and Thurow recommend that the degree to which a nest is exposed or concealed should be considered when designing buffers for ferruginous hawks. They also suggest that physiological information also be considered. For example, in years of food scarcity, spatial buffers should be expanded substantially. Squires et al. (1993) study suggests that prairie falcons can cope with limited development on their foraging areas if their nest sites are secure from human disturbance.

Prior Disturbance History of Individual Raptors-- Due to variation of tolerance between populations, Stalmaster and Newman (1978) suggest monitoring adult eagle behavior prior to the establishment of management recommendations and buffer zones

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The quantitative buffer zone recommendations for bald eagles (*Haliaeetus leucocephalus*), golden eagles (*Aquila chrysaetos*), osprey (*Pandion haliaetus*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*Buteo regalis*), American kestrels (*Falco sparverius*), prairie falcons (*Falco mexicanus*), and peregrine falcons (*Falco peregrinus*) are listed in Table 2. The median distances recommended for buffer zones are as follows: bald eagle =650m (445m-800m range), golden eagle = 800m (800m-900m range), osprey =1000m (400m-1500m range), red-tailed hawk =800m (800m-800m range), ferruginous hawk =500m (250m-800m range), prairie falcon =650m (50m-800m range), and peregrine falcon= 800m (50m-1600m range). Table 1

summarizes general flushing distances from walking and vehicle disturbances.

Temporal Buffers--Temporal buffers should include all nesting activities but must at least extend from the arrival of the adult birds in the nesting area through the first few weeks of nestling development (Suter and Joness 1981). For temporal restrictions to be effective they must be tailored to individual populations (Knight and Skagen 1988). Knight and Skagen (1988) also say that temporal restrictions need only be in effect when raptors are utilizing a critical resource. Grier et al. states that the most critical period of disturbance for bald eagles begins one month prior to egg laying and continues through the incubation period. The most critical time for ferruginous hawks is prior to and during incubation (Fyfe and Olendorff, White and Thurow). Grier and Fyfe argue that disturbance is most dangerous during days just prior to and just after hatching. This is because the parent birds sit tightly on the eggs as long as possible before flushing from a disturbance. They often fly off abruptly increasing the chances of ejecting an egg or nestling. Recommended dates of closures are shown in Table 1.

Several studies have documented flushing distance[1] responses to a variety of activities during breeding and non-breeding seasons (Table 2), however, other than anecdotal and incidental documentation few studies have experimentally documented disturbance distances for use in buffer zone recommendations (Holmes et al. 1993, White et al. 1985). The wide range of recommendations (Tables 1 and 2) is probably reflective of site specific human related and environmental conditions (Fraser 1983, Suter and Joness 1981). For buffer zones to be effective they need to be based on empirical evidence of wildlife responses to disturbance (Knight and

[1] Distances at which raptors take flight to avoid a disturbance.

Skagen). Several other authors suggest the need for further disturbance studies to determine flushing responses among different species (Knight and Temple 1995, White and Thurow 1985, Postovit and Postovit 1987).

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

Species	Spatial (m)	Temporal	Reason for closure	Source
golden eagle	800	Feb. 1 - Aug. 1	noise	Call 1979
	800	Feb. 1 - Jul. 15	no explanation	Craig 1995
	200 - 1600	Mar. 1 - Sep. 1	visual, audible	Suter et al. 1981
bald eagle	800	Feb. 1 - Aug. 1	noise	Call 1979
	800	Nov. 15 - Jul. 31	no explanation	Craig 1995
	500	not discussed	human disturbance	Fraser 1983
	250	prior to egg laying through incubation	human activity	Grier et al. 1983
	75-100 in areas where human activity is screened from view 250-300 in open country	not specified	human disturbance	Stalmaster 1987
sharp-shinned hawk	400-500	not specified	disturbance	Jones 1979
cooper's hawk	400-500	not specified	disturbance	Jones 1979
northern goshawk	400-500	not specified	disturbance	Jones 1979
red-tailed hawk	800	Feb. 1 - Aug. 1	noise	Call 1979
ferruginous hawk	800	Feb. 1 - Jul. 15	no explanation	Craig 1995
	200 - 800	arrival - post fledging	visual, audible	Suter et al. 1981
	250	during incubation	human activity	White et al. 1985

osprey	400	Apr. 1 - Aug. 31	no explanation	Craig 1995
	1000	incubation	recreational disturbance	Swenson 1979
	1500	not discussed	human activity	Van Daele et al. 1982
American kestrel	50	Mar. 15- post-fledging	visual	NPS 1995
	75	winter	reduction of fitness	Holmes et al. 1993
prairie falcon	800	Feb. 1 - Aug. 1	noise	Call 1979
	800	Mar. 15 - Jul. 31	no explanation	Craig 1995
	50	Mar. 15 - post fledging	visual	NPS 1995
	200-800	arrival - post fledging	visual, audible	Suter et al. 1981
peregrine falcon	800	Feb. 1 - Aug. 1	noise	Call 1979
	800	Mar. 15 - Jul 31	no explanation	Craig 1995
	50	Mar. 15 - post fledging	visual	NPS 1995
	1600	Feb. 1 - Aug. 31	human activity	USFWS 1984
	800-1500	not discussed	recreational disturbance	Windsor 1975

Table 2. Flushing Distances for Walk and Vehicle Disturbances

Species	Flushing Distances (m) for Walk Disturbance	Flushing Distances (m) for Vehicle Disturbance	Source
golden eagle	105-390	14-190	Holmes et al. 1993
bald eagle	50-990	50-990	Fraser 1983
	57-991 (91% >200 m)	not studied	Fraser et al.1985
ferruginous hawk	13-165	110-280	Holmes et al. 1993
	136.4 (range: 29-291) (averages from 5 nests)	117.2 (range: 24-316) (averages from 5 nests)	White et al. 1985
rough-legged hawk	55-900	9-170	Holmes et al. 1993
American kestrel	10-100	12-115	Holmes et al. 1993
merlin	17-180	44-85	Holmes et al. 1993
prairie falcon	24-185	18-200	Holmes et al. 1993