
**Surveys and Reproductive Success of Cliff Nesting Raptors
in Wrangell-St. Elias National Park**

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Introduction

Because they are high trophic-level predators, density and reproductive success of raptors are considered sensitive environmental indicators of biotic and abiotic conditions that exist within their breeding areas. Although many factors can potentially impact nesting raptors, human activity has been shown to adversely affect their nesting behavior, foraging ecology, survival, and reproductive success (Thelander 1973, Weeks 1974, Fraser 1981, Grubb 1981, Henson and Grant 1991, Fernandez and Azkona 1993). In general, however, human-raptor conflicts have not been studied and are poorly understood. This deficiency is perhaps most obvious for cliff nesting raptors, especially in remote wilderness areas such as those found throughout Alaska. For successful management of raptors and mitigation of human-raptor conflicts, we need to understand how human activity impacts both short-term behaviors and long-term trends in nesting density and reproductive success.

Much of Wrangell-St. Elias National Park and Preserve (WRST) consists of large expanses of high elevation, mountainous terrain that contains exposed rock faces suitable as breeding habitat for cliff nesting raptors, particularly golden eagles (*Aquila chrysaetos*) and gyrfalcons (*Falco rusticolus*). Several of these same areas also include active or potential mining operations. Mining may reduce the available habitat for raptors *directly* from exploration and mining activities and *indirectly* through the human presence associated with these activities. Ultimately, human disturbance from mining or other activities near nesting areas during the breeding season may significantly disrupt a pair's behavior or use of foraging areas which could result in breeding failure.

The purpose of these surveys is to provide baseline data on nesting locations and reproductive success of cliff nesting raptors in WRST, especially in areas subjected to current or proposed mining or other human disturbance. With a large sample of nests and an adequate number of years of reproductive and occupancy data, we will be able to assess how mining and other human activities may influence the reproductive success of cliff nesting raptors. These data will provide managers with the information necessary to evaluate and mitigate mining and recreational activities.

Study Area

The 4 study areas established in 1992 were re-surveyed in 1993 (Table 1). These areas were selected because they had either current or potential mining activities (National Park Service 1988). Additional areas were surveyed along the Nabesna and McCarthy Roads during both the occupancy and productivity surveys, and near the White River during the productivity survey to begin establishing a "control area" in an undisturbed section of WRST.

Table 1. Study Areas for nesting raptors in WRST, 1992-93. Areas are listed in order of survey priority, based on current or recent exploration and mining activity, access, ore deposit type, and habitat potential for nesting raptors.

Location	Claims	Mining Method	Status
Study Area 1			
Bonanza Creek	#1-6 AA029712-7	Placer	Approved/In operation Plan amended to include 2 more claims
Bonanza Creek	#1 AA029712	Placer	Submitted plan: rejected
Big El	A027002-121	Lode	Plan of operation submitted, exploration activity proposed
Big Eldorado Creek	AA027052-58	Placer	Approved/In operation Supplement under review
Gold Run Creek	AA02759-61 AA026817	Placer	Submitted plan: rejected
Carl Creek	AA029679-711 AA019373-422	Lode	Plan of operation submitted, exploration activity proposed
Study Area 2			
Dan Creek	MS923 and others	Placer	Operating without an approved plan in 1991-93
Green Butte	MS1098A&B	Lode	Submittal of plan expected
Chititu	A005519 & others	Placer	Past approved plan (1980's), not currently mining
Study Area 3			
Orange Hill	AA055512-82	Lode	No plan submitted but industry is interested
Nabesna	MS1591	Lode	No plan. Exploration activity in the 1980's
Study Area 4			
Berg-MacDougal	MS1558A	Lode	No plan. High potential for mineral development
Clear Creek	MS918	Lode	No plan. High potential for mineral development
Nugget Creek	A001410-1	Lode	No plan

All 4 study areas encompass approximately 1800 km² (Figure 1). Study areas 1 and 3 are north of the Wrangell Mountain Range whereas study areas 2 and 4 are south of the Wrangells. Study area 1 encompasses about 400 km² and extends from Chisana, north to Warrick Peak, southeast to include the entire Carl Creek drainage, southwest to Black Hill, and west to Chisana. Study area 3 encompasses about 525 km² and extends along the Nabesna River drainage from the terminus of the Nabesna Glacier north to Devil's Mountain. Study area 2 encompasses 580 km² and begins at the park/preserve boundary on Bonanza Ridge and extends south to include the access road east of McCarthy, southeast to the confluence of Swede Gulch and Young Creek, northeast to Joshua Peak, northwest to the source of Lubbe Creek, and west to the starting point. Study area 4 covers 300 km², which includes the entire Kuskulana River drainage and its major tributaries from its source southwest to Strelina. Additional areas surveyed along the Nabesna and McCarthy Roads and between survey areas cover about 100 km². The White River survey area is about 60 km².

All study areas are comprised of mountainous terrain containing tundra habitat, cliffs, and rock outcrops. In high elevation areas (above treeline), dwarf shrub and tundra communities composed of willows (*Salix* spp), dwarf birch (*Betula* spp), dryas (*Dryas* spp), lichens, and other small shrubs predominate. Balsam poplar (*Populus balsamifera*), spruce (*Picea* spp), willow, and alder (*Alnus* spp) grow in riparian areas along drainages and river and stream corridors (U.S. Department of Interior 1973).

Climatic conditions are characterized by extreme temperature variations. Generally, summers are cool, especially at higher elevations, with low to moderate amounts of precipitation. However, precipitation tends to be higher south of the Wrangell Mountains compared to north of the mountains due to coastal influences. For example, precipitation averages 20 cm in the Mentasta-Nutzotin area whereas McCarthy averages 58 cm. Lower elevations of the Copper River basin average about 25-30 cm annually (U.S. Department of Interior 1973).

Methods

We conducted 2 aerial surveys for cliff nesting raptors, predominantly golden eagles and gyrfalcons, using a Bell Jet Ranger 206 helicopter. The first survey, to determine nest occupancy and locate new nests, was flown on May 4-6 with C. McIntyre and B. Steidl as observers. The second survey, to determine nesting success and productivity, was flown on July 21-23 with G. Dodge and B. Steidl as observers. R. Warbelow was the pilot during both surveys. Because the White River area was surveyed only once, late in the season, data from these nests are not included in productivity calculations.

For each breeding territory located, observers photographed the nest site, recorded nest condition (good, poor, remnant), occupancy, the number of adults present, and the number

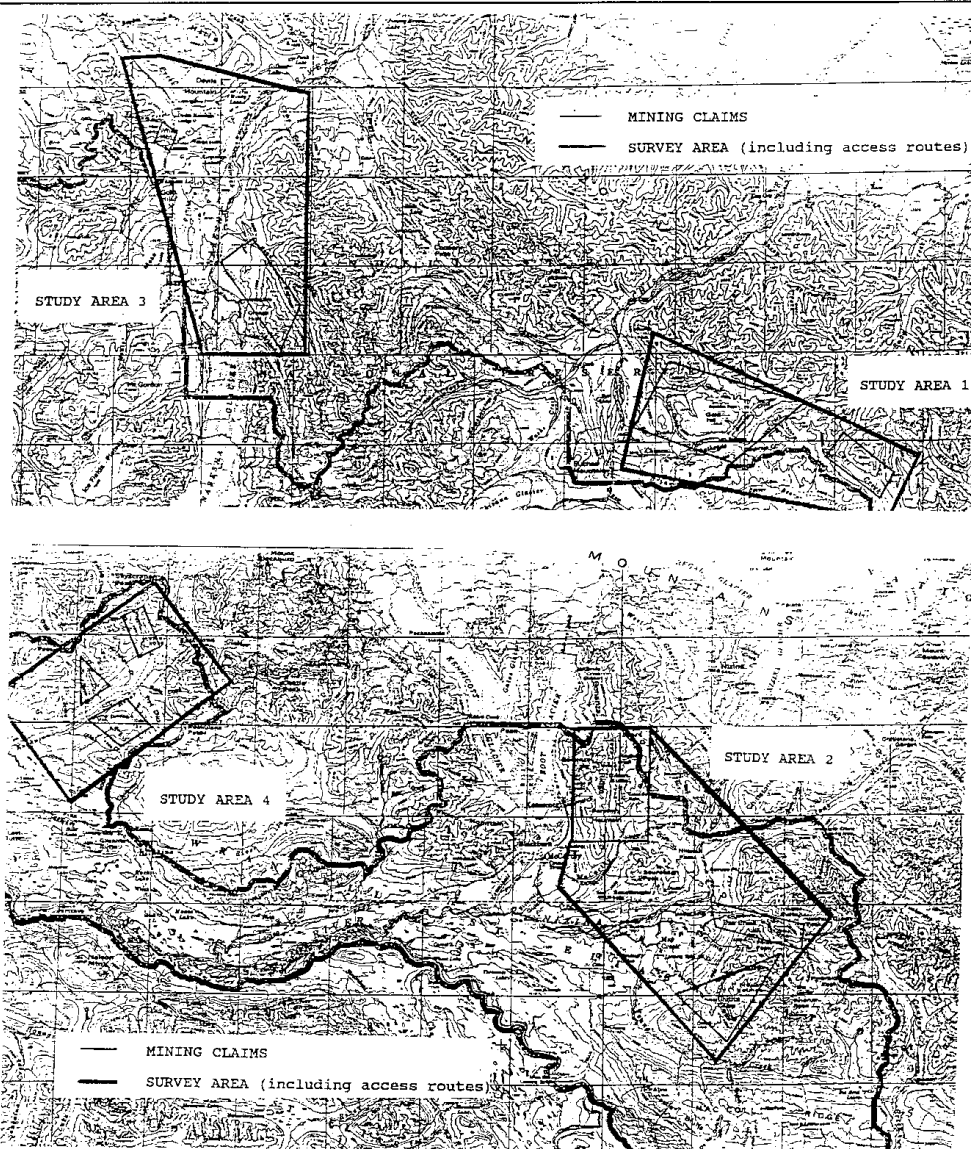


Figure 1. Location of 4 Study Areas near active or potential mining claims in Wrangell-St. Elias National Park.

of young produced. Only nests which were occupied during the occupancy survey in early May were re-checked during the productivity survey in July. Nest locations and elevations were plotted on 1:63,360 topographic maps. Latitude and longitude were determined using a Global Positioning System (GPS) and elevations using the helicopter's altimeter. These data were entered directly into corresponding dBase files D:NESTOBGE.DBF and D:NESTREC.DBF maintained in the Resource Management Office at WRST.

To describe the status of breeding territories, we followed terminology from Postupalsky (1974, 1981) and Steenhof (1987). A breeding territory was defined as an area containing 1 or more nests within the exclusive breeding home range of 1 pair of mated birds (McIntyre 1989). For golden eagles, we considered nests >3 km apart as separate territories, based on the closest known distance between breeding territories in Denali National Park (C. McIntyre, National Park Service, Anchorage, AK, pers. comm.). A territory was considered occupied if 1) a pair of adults were within 1 km of a nest (on either survey), 2) a lone adult was seen defending the territory, incubating, or brooding, 3) eggs or young were observed in the nest, or 4) a nest had been recently repaired.

Results and Discussion

Golden Eagles

Reproduction.-- Twenty one of 56 (37.5%) golden eagle territories surveyed in early May 1993 were occupied. This is a slight increase over an occupancy rate of 29% in WRST in 1992 (Kozie and Bouton 1993). The 1992 occupancy rate represents the lower limit of the "true" occupancy rate and is not really comparable since this was a single survey conducted late in the breeding season after many nests may have already failed. Only 7 of the 21 (33.3% nest success) territories occupied in 1993 were successful, each of which fledged 1 young (0.33 young/occupied nest and 1 young/successful nest). Twenty-four new breeding territories were found near the White River during the productivity survey, 4 of which contained 1 young, corroborating the low brood sizes found in our sample of nests surveyed twice. These nests were not included in reproductive calculations. Since 1992, a total of 106 breeding territories have been located within WRST.

Low rates of territory occupancy, nest success, and brood size all suggest that overall reproductive success in WRST was low in 1993. Golden eagle productivity in Denali National Park (DENA) was similarly low, with the exception of territory occupancy which was 76%. Nest success and number of young/occupied nest were only 27% and 0.38, respectively (C McIntyre, unpubl data). Low nest success and brood size suggest poor productivity within an individual year. A low occupancy rate, however, may suggest a larger problem since adults may not be returning to territories (C McIntyre, pers commun). Because we observed no overt factors that may have adversely impacted nest success and brood size, we can only speculate as to its cause. A variety of environmental factors are known to affect the breeding success of raptors,

including prey availability and adverse weather conditions (Newton 1979).

Golden eagles are opportunistic feeders that consume a wide variety of prey species, but the majority of their diet is probably arctic ground squirrel (*Citellus parryi*) (Murie 1944, Ritchie and Curatolo 1982, Steidl et al. In Prep.), snowshoe hare (*Lepus americanus*) (Lawrence 1988), and ptarmigan (*Lagopus spp*)(C McIntyre pers commun). Ground squirrels are non-cyclic but their populations are eruptive, undergoing irregular highs and lows. Although we observed ground squirrels commonly in several areas within WRST, no attempt was made to estimate their relative abundance. Populations of snowshoe hares were in the decline phase of their 10 year cycle (B. Route, WRST, Glennallen, AK, unpubl data) and were never observed near eagle nesting territories or being delivered as prey during over 500 hours of nest observations (Steidl pers. obs.). No data are available on ptarmigan abundance. Because the weather in WRST was unusually mild during the 1993 breeding season (April-August), we suspect that it had no part in the low reproductive success observed.

The cause of low occupancy rates is less clear and should be examined. It is possible some error was incurred through a failure to locate all alternate nests, thereby missing some incubating adults. This error was not significant over time, however, in DENA (C McIntyre, pers commun). If prey availability was exceptionally low, breeding attempts may have failed early and forced adults to forage further away from nest sites where they could be missed during brief aerial checks. It is also possible a larger problem exists, most likely on wintering grounds, and adults are not returning to territories to breed in spring.

Nest aspect and elevation.--Golden eagles in Alaska generally nest on southeast facing cliffs (Palmer 1988). Over 59% of the nest cliffs located in WRST ($n = 211$) had an aspect ranging from 135°(SE) to 225°(SW) (Figure 2), whereas less than 15% of cliffs had an aspect from 45° (NE) to 315° (NW). The elevation of golden eagle nests ($n = 208$) ranged from 850 m to 1920 m and averaged 1340m (Figure 2).

Breeding phenology.--During behavioral observations at nests (Steidl et al. 1993), we were able to age nestlings at 7 nests based on plumage characteristics. At July 21-23, these nestlings ranged from approximately 7.5 to 9 weeks old ($x = 8.3$ weeks). During productivity surveys (July 21-23) we aged 4 additional nestlings at 4 new nests; 3 were ≥ 8 weeks old, the other was 5-6 weeks old. Based on a 45 day incubation period (Nice 1954), we estimate that eggs were laid from about 4-16 April.

Nests potentially affected by mining activity.--A total of 16 golden eagle territories may be affected by current or potential mining activities in the areas surveyed. Nine territories had nests located within 0.8 km ($\frac{1}{2}$ mile) of mining claims and an additional 7 territories had

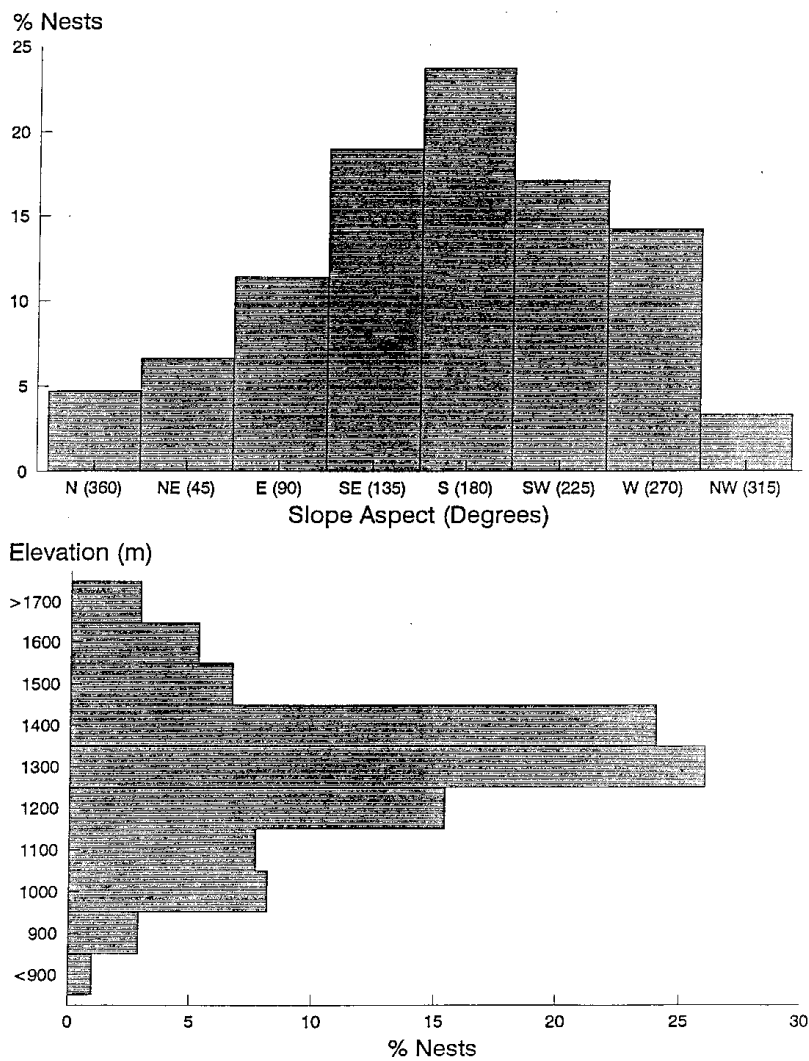


Figure 2. Aspect of slopes on which golden eagle nests are located ($n = 211$) and their elevation ($n = 208$).

nests within 0.8 km of probable access routes (Appendix I).

Gyrfalcons

Reproduction.--Given our current protocols, estimates of gyrfalcon reproductive success within WRST are considerably more tentative than those for golden eagles for several reasons. First, gyrfalcons occur at very low densities throughout their range (Palmer 1988), so our sample of occupied nests is small. Second, our survey flights were timed for golden eagles, which have a longer nestling period than gyrfalcons; therefore productivity flights took place after young had already fledged. Third, gyrfalcons often use nests of golden eagles for breeding, hence determining territories that were occupied but where no eggs were laid was nearly impossible during our brief aerial check. Given these limitations, we located only 4 occupied gyrfalcon territories during the occupancy survey, 2 of which were known from previous years. We are confident about productivity results for only 2 nests, 1 of which failed and the other of which fledged 3 young. During the productivity survey, we found an additional 4 territories at least 1 of which successfully fledged young.

Nests potentially affected by mining activity.--A total of 2 gyrfalcon territories may be affected. One territory had a nest located within 0.8 km (½ mile) of mining claims and 1 additional territory had a nest within 0.8 km of a probable access route.

Recommendations

We recommend the following:

1. Aerial surveys to document productivity of cliff nesting raptors should be continued in the 4 impact areas as well as expanded into areas without predicted future impacts to establish "control" areas by which to compare with potential "impact" areas. With the substantial number of nesting territories now known (106 for golden eagles and 12 for gyrfalcons), determining occupancy rates and reproductive success in future surveys will be both more time efficient and provide more data. These data will also allow us to better evaluate the cumulative impacts that mining and other human disturbance may have on the density, occupancy rates, and reproductive success of these populations.
 2. In future years, we recommend that observers examine as many known territories as possible during the occupancy survey, as all productivity calculations are based on the number of occupied territories found during this survey. Additional reconnaissance should be done only while traveling between study areas and after occupancy has been determined at all previously known territories.
 3. Site specific management plans should be written for all nests that may be affected by
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mining to document more detailed information on each pair's use of their territory and to establish *territory-specific* buffer zones. These observations will allow us to better evaluate the potential impacts of mining and other human activities on the behavior and nesting success of these pairs.

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Appendix I. Golden eagle and gyrfalcon territories located within 0.8 km (½ mile) of mining claims and/or potential access routes.

USGS Quadrangle	Species	Territory Number	Located within 0.8 km of:		
			Claim	Access	Both
Nabesna A-2	GOEA	2	X	X	X
		3		X	
		4		X	
		5		X	
		7		X	
	GYRF	9		X	
		7	X	X	X
		8		X	
Nabesna A-4	GOEA	15	X		
		67	X		
Nabesna B-4	GOEA	17	X		
Nabesna B-5	GOEA	23	X	X	X
McCarthy B-4	GOEA	78	X	X	X
McCarthy B-5	GOEA	40		X	
McCarthy C-5	GOEA	81	X	X	X
McCarthy C-8	GOEA	47	X		
		49		X	
		50	X		