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Nesting Raptors in Southwestern Alaska: Status, Distribution, and Aspects of Biology

by David P. Mindell

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT
ALASKA

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TO THE READER

This report is printed in two editions. One edition contains sensitive information which pertains to locations of eyries that has not been distributed to the public. Only those individuals and agencies with an active responsibility for the endangered species program in Alaska have received reports containing the sensitive information (Appendix 6).

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The author conducted surveys of the presence and abundance of nesting raptors on 16 rivers in southwestern Alaska from 1979 to 1982. Objectives of the surveys were to locate nesting pairs and nesting habitat of peregrine falcons and other raptors; to collect information on species distribution and abundance, nest site characteristics, and food habits; and to analyze findings to provide information on species status, distribution, nesting, food habits, and factors influencing raptor populations in southwestern Alaska.

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by David P. Mindell

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Introduction

As development increases throughout Alaska, resource management agencies face the challenge of meeting multiple land use objectives. Wildlife surveys, particularly of sensitive and endangered species, provide managers with information that is vital in making land use decisions. Federal agencies are required by the Endangered Species Act of 1973 to protect endangered species habitat and, when possible, to aid in endangered species recovery. This study was instigated and funded largely as a result of these requirements. Species not considered to be endangered are an equally valuable resource and deserve consideration during management planning. Base line information on abundance, distribution, and other aspects of species' natural history is needed as reference to gauge status of local populations over time and aid their continued survival.

Objectives of this study were:

1. To locate pairs and nesting habitat of peregrine falcons and other raptors within areas of Bureau of Land Management (BLM) jurisdiction;

2. To collect information for all raptors on species abundance and distribution, nesting densities, productivity, general nest site characteristics, and food habits; and

3. To analyze findings of the present study along with those from the literature in providing information on species status, distribution, nesting and food habits, and factors influencing size and health of raptor populations in southwestern Alaska.

This report presents results of raptor surveys conducted by boat on 16 different southwestern Alaska rivers during June, July, and August of 1979 through 1982.

Study Area

The study area comprises a section of southwestern Alaska north of the Alaska Peninsula from 60^{o} to 65^{o}N and 154^{o} to 162^{o}W. Rivers surveyed for nesting raptors by boat may be divided into two geographic groups. Study rivers in the Kuskokwim River drainage are the Kuskokwim, Selatna, Tatlawiksuk, Cheeneetnuk, Gagaryah, East Fork George, Oskawalik and Tuluksak and those west of the Yukon River include the North, South, Chiroskey, Old Woman, Golsovia, Otter Creek, Canyon Creek and Stuyahok (Figure 1). Survey dates and put-in locations are listed in Appendix 1. Helicopter surveys were conducted on portions of the Nushagak, Nixon, Sulukna, Nowitna, Susulatna, Holokuk, Stony, Kolmakof, and Owhat Rivers, as well as in some of the lower valleys in the Horn and Russian Mountains.

Most of the rivers surveyed by either boat or helicopter lie within the range of boreal forest. Predominant riparian vegetation types are needleleaf forest, broadleaf forest, or mixed forest, and less frequently scrub and herbaceous plant communities (Viereck et al. 1982). Wooded areas consist of closed forest to open woodland (Figure 2) with white spruce, paper birch, quaking aspen and balsam poplar in some areas and black spruce stands mixed with bog areas elsewhere. Bog areas are characterized by grasses, sedges, mosses, especially sphagnum, and on drier sites shrubs such as dwarf birches, willow, Labrador tea and bog cranberry. Gravel bars along most rivers support dense alder and willow thickets. Topography varies from mountainous to nearly flat. Riparian cliff heights were greatest on the Kuskokwim River with some over 110 m high. Cliffs along other rivers averaged between 15 m and 60 m in height. The cliff faces were often unstable and frequently formed of sedimentary rocks, shale, graywacke, and conglomerate with granite occuring less often.

The study area climate is subarctic and varies from mild and wet to cold and dry. Average daily temperature during July is 15^{o}C (59^{o}F). The extremes of high temperature vary between 23^{o} and 35^{o}C (73^{o} and 95^{o}F), while low extremes vary between -50^{o} and -60^{o}C (-58^{o} and -76^{o}F). Total mean annual precipitation for the study area is 400 mm (16 in.) (Hultén 1968).

Most of the study rivers are in remote wilderness, and the nesting raptors on them are not impacted by intensive land use practices. Exceptions are the Tuluksak River area, which has been extensively dredged for gold, and portions of the Kuskokwim River near villages.

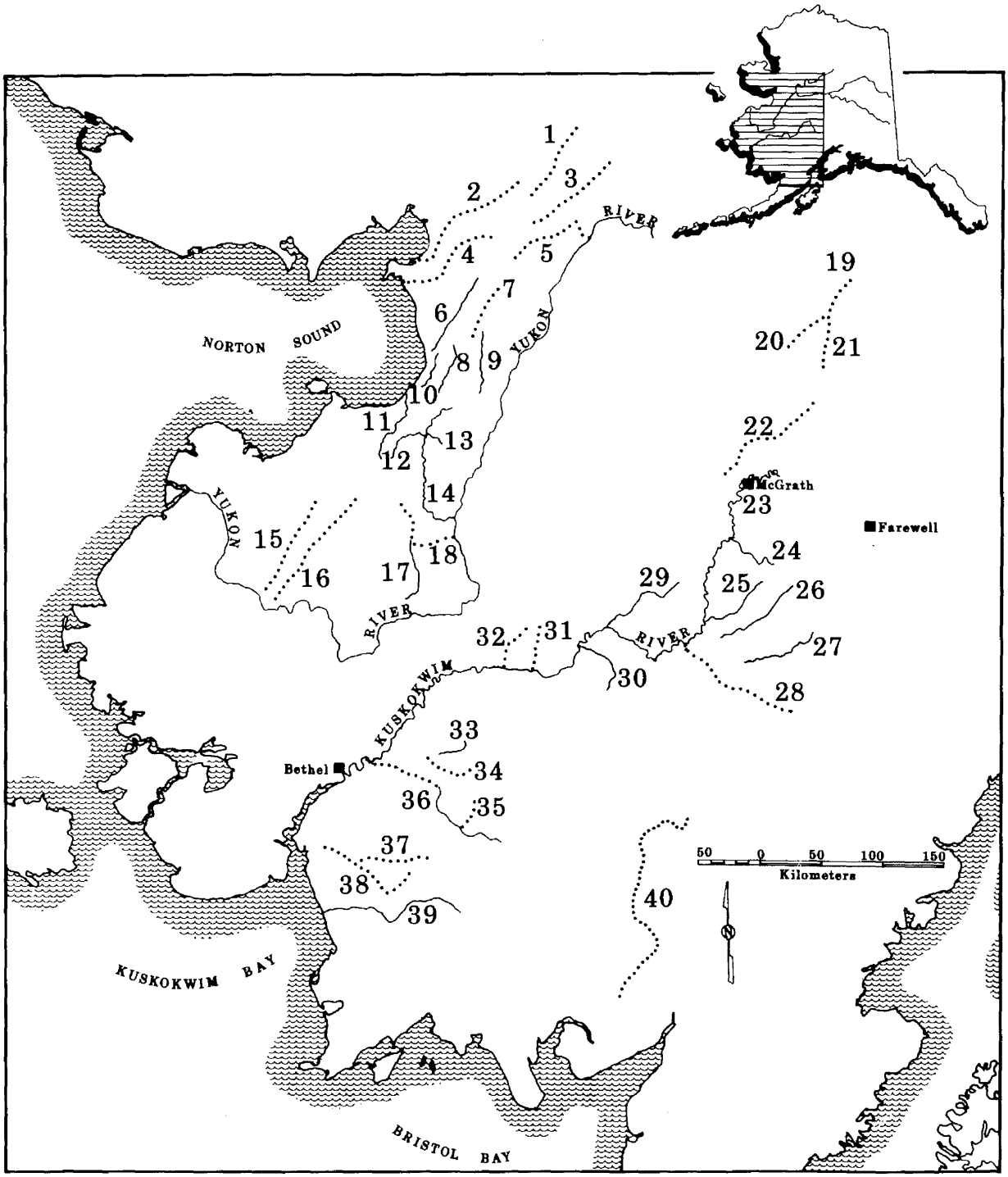

Figure 1. Map of study area and rivers surveyed for nesting raptors.

Key to survey river numbers in Figure 1.

1.	Kateel	11.	Golsovia	21.	Sulukna	31.	Kolmakof
2.	Ungalik	12.	Otter Creek	22.	Nixon Fork	32.	Owhat
3.	Gisasa	13.	Canyon Creek	23.	Kuskokwim	33.	Tuluksak
4.	Shaktoolik	14.	Anvik	24.	Selatna	34.	Fog
5.	Nulato	15.	Andreafsky	25.	Tatlawiksuk	35.	Quicksilver Creek
6.	North	16.	E. Fork Andreafsky	26.	Cheeneetnuk	36.	Kisaralik
7.	N. Fork Unalakleet	17.	Stuyahok	27.	Gagaryah	37.	Eek
8.	Chiroskey	18.	Bonasila	28.	Stony	38.	Middle Fork Eek
9.	Old Woman	19.	Nowitna	29.	E. Fork George	39.	Kanektok
10.	South	20.	Susulatna	30.	Oskawalik	40.	Nushagak

Methods

Boat surveys of nesting raptors were conducted on 16 rivers during June, July, and August of 1979 and 1980. The Kuskokwim River section between McGrath and Aniak was surveyed each year during 1979 through 1982. An inflatable boat, 4.5 m long, was used during 1979 and 1980, and a 5.2 m long metal boat was used during 1981 and 1982. Outboard motors used ranged in size from 35 to 55 horsepower. All the other rivers were floated without a motor in a 3.5 m long inflatable raft. Helicopters and fixed-wing aircraft were used in transport to and from the rivers. Study rivers were selected on the basis of being within BLM jurisdiction (all or in part) and having potential for cliff-nesting raptors.

Field notes were kept recording raptor sightings and behavior, presence and abundance of non-raptorial birds (Appendix 2), nest and nesting habitat descriptions, mammal observations, and river characteristics. At each raptor nest, active or inactive, the following was recorded: location of nest on a topographic map (1:63,360 scale), nest substrate, height of substrate, height of nest, distance from nest substrate to river, number of eggs or young, exposure, elevation, and a brief vegetation description. Heights and distances were estimated visually. The term "nest site" is used to describe locations of actual nests and locations with actively defending adult pairs.

Binoculars and a spotting scope were used to locate and identify raptors and nests. All cliffs within 100 m of a river were thoroughly checked for raptor nests. Cliffs up to 2 km distant from a river were hiked to and examined when nests or whitewash were visible or if they were the only potential nesting cliffs in the vicinity (approximately 2 km radius). We searched for castings, molted feathers, and whitewash-stained rocks as indications of raptor presence. Tree nests were located by searching the shoreline with binoculars, observing movements of defending adults, and listening for "food begging" calls of young.

Time was not available for hiking through wooded areas to locate all nests; thus owls, goshawks and sharp-shinned hawks were not censused. Due to their conspicuous habits, red-tailed hawks were accurately surveyed along all survey rivers except the Kuskokwim during 1979 and 1980. The greater width of the Kuskokwim and the need for motorized travel to save time on

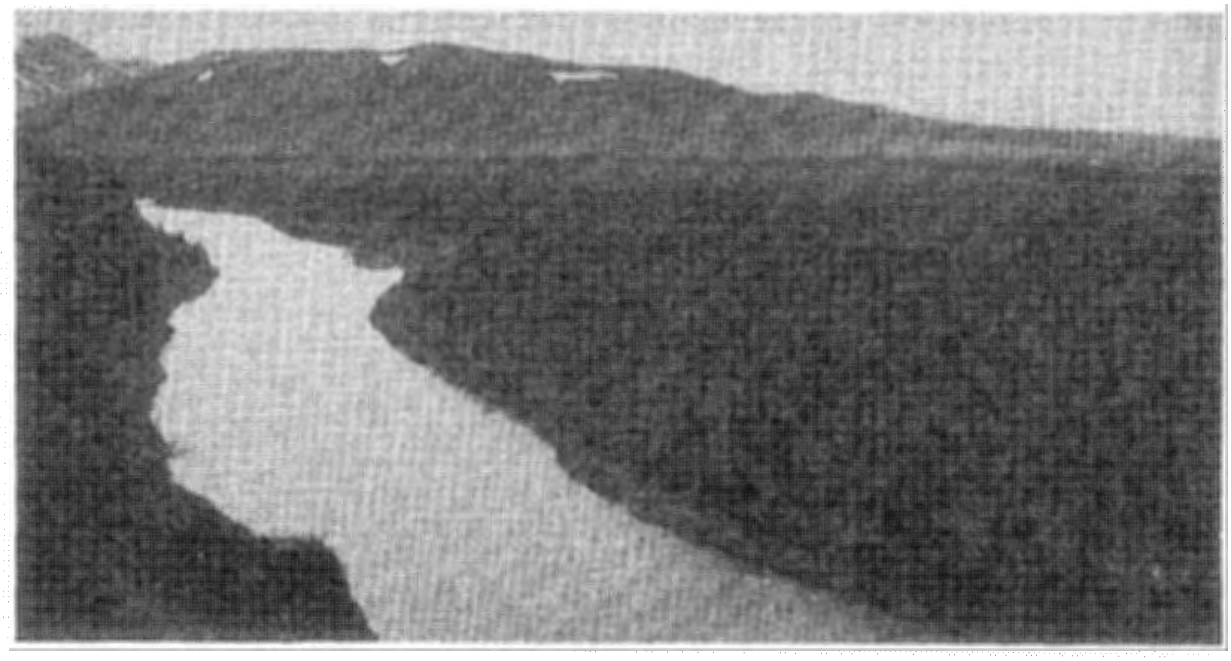

Figure 2. Open needleleaf forest bordered many of the study rivers providing nesting habitat for red-tailed hawks. Riparian cliffs were used as nest sites by golden eagles (lower left corner of photograph), rough-legged hawks, gyrfalcons and peregrine falcons.

this long river reduced accuracy in censusing red-tailed hawks. During 1981 both sides of the Kuskokwim were surveyed by boat and particular emphasis was placed upon locating all breeding red-tailed hawks along the river. If defending adults remained in an area but no nest was located after 30 minutes to an hour of searching, the location was plotted as a nest site and used in determining nesting density.

During 1979 on several occasions a handgun was fired in the air near large cliff complexes in an attempt to flush concealed birds. This technique may be of limited usefulness as on two occasions single raptors perching within 90 m did not fly off at the sound of the gun.

Raptor nests were examined, if possible, to determine number of eggs or young and to obtain prey remains. Tree-climbers (leg-irons) and ropes were used where necessary. Some nests could be seen into without climbing or rapelling to them. All nest visits were as brief as possible to minimize disturbance. Unhatched eggs or egg shells were collected from peregrine falcon eyries for pesticide analysis (Figure 3). Prey remains were identified by comparison with feathers of known origin, photographs, mensural characteristics (i.e. wing length), and museum study skins at the University of Alaska, Fairbanks and Oregon State University, Corvalis.

Results and Discussion

Peregrine Falcon

Distribution and Status

Peregrine falcon pairs were found at seven different sites, and single defending adults were seen at four additional locations (Table 1). Five of the seven known nesting pairs were on the Kuskokwim River and single pairs were found on two Kuskokwim River tributaries. I saw defending adults at cliff sites in the Lime Hills region during the last week of July 1981 and was unable to determine whether they represented nesting pairs. Although peregrines nest in relatively high densities along the middle and lower Yukon River

sections (Roseneau et al. 1980, Mindell and Craighead 1981), none were found on surveyed rivers west of the Yukon.

Little is known of historical peregrine abundance on the study rivers. An 1899 report of peregrines as "common all along the Kuskokwim on rugged bluffs" (Hinkley 1900) may be less than reliable as it contains a few errors in species identification, and another pre-pesticide era survey done in 1912 (Dice 1920) located only one peregrine nest. I learned of four historic sites occupied prior to 1955, from talks with longtime residents (Sinka Gregory, Pete Shepard), making a total of nine known sites on the Kuskokwim between the North Fork confluence and Aniak. In 1976, Ritchie and Ambrose (1976, 1978) found peregrines near two Kuskokwim River sites that have subsequently been active during 1979-1982. One of the Kuskokwim tributary sites (T1 Table 1) has been

Figure 3. Unhatched eggs were collected from peregrine falcon eyries for pesticide analysis. Uneaten prey remains, such as feathers, were saved and identified to determine food habits.

active at least sporadically since the late 1960's (P. Shepard pers. comm.). In 1981, number of nest sites increased by two on the Kuskokwim, and a new sighting location was occupied by a lone adult during part of May. In 1982, number of active nest sites increased by one more, resulting in an increase of three active nest sites and one lone adult territory over recent surveys in 1976, 1979 and 1980. I am unaware of any historical information for the H1 site (Table 1), the Lime Hills region, or for the other surveyed rivers.

Approximately 95% of the cliff sites suitable for nesting peregrine falcons on the Kuskokwim occurred within a continuous section 160 km in length. Present density of occupied sites (n = 5) on this Kuskokwim section of one per 26.6 km of river length is similiar to a density of one occupied site per 25.6 km on the middle Yukon River section (179 km long), but low compared to densities of one site per 17.7 km on the lower Yukon section (760 km long) (Mindell and Craighead 1981), one site per 13.4 km on the upper Yukon, and one site per 13.7 km on the Colville (Ambrose 1980).

Based on the limited historical evidence, it seems likely that once peregrines were more abundant on the Kuskokwim River than they are at present, and they were at least distributed over a greater length of river. Small population increases noted in 1981 and 1982 on the Kuskokwim are encouraging. Consistent reoccupation of known sites in the present study area and normal brood sizes, averaging 2.7 young from 14 nests (Table 1), reflect the general rebuilding trend for peregrine populations throughout Alaska during the last four years. On the upper Yukon River, the number of pairs increased from a low of 10 in 1973 to 16, 19,

Table 1. Occupancy and brood size at peregrine falcon nests and sighting locations of defending adults in the Kuskokwim drainage

	1979		1980		1981		1982	
Site No.	Occupancy[1]	Brood Size	Occupancy	Brood Size	Occupancy	Brood Size	Occupancy	Brood Size
K1	no		no		no		1 ad 1 im	0
K2	no		no		2 ad	2	2 ad	3
K3	no		no		1 ad, 1 im	0	2 ad	3
K4	1 ad, 1 im -	2	2 ad	2	2 ad	3	2 ad	0
K5	2 ad	3	2 ad	3	2 ad	3	2 ad	2
K6	no		no		1 ad[2]	0	1 ad	0
T1	2 ad	3	2 ad	3	2 ad	3	2 ad	nc
H1	nc		2 ad	3	no on 25 July		no	
L1	nc		nc		1 ad seen 25 July		nc	
L2	nc		nc		1 ad seen 25 July		nc	
L3	nc		nc		1 ad seen 25 July		nc	

[1]Occupancy abbreviations: no= not occupied; nc=not checked; ad=adult; im=immature (brown plumaged bird)

[2]Pers. comm. David Marshall

17 and 18 successively during the breeding seasons of 1978-1981 (summarized in Ambrose and Riddle 1982). On the Colville River, pairs increased from a low of 10 in 1975 to 15, 16, 21 and 24 successively during 1978-1981 (summarized in Dittrick and Swem 1981). On the lower Yukon River, increasing annual populations since 1978 have been 20, 23, 32, and 35 pairs (Springer et al. 1979a, 1979b, Roseneau et al. 1980, Mindell and Craighead 1981). After a precipitous decline on the Tanana River from a high of 18 peregrine pairs before 1963 to 1 or 2 pairs in 1975 (Haugh in Fyfe et al. 1976), 5 pairs were present in 1981 (R. Ritchie pers. comm.). Annual surveys on the Porcupine during 1979-1981 (summarized in Ritchie and Curatolo 1981) and on the Charley River (Haugh and Halperin 1976, Ambrose 1980, Amaral 1981) show these populations to be stable during recent years.

Peregrine falcons were known for their general population stability before the widespread decline of the past 30 years (see discussion by Hickey and Anderson 1969). Nesting peregrine populations from different geographic regions, however, experienced different degrees of population density change during the period of declines. Nesting peregrines disappeared from the eastern United States (see Hickey 1969) while a few populations, although reduced, have persisted to the present in regions of the western United States (Fyfe et al. 1976, Porter et al. 1978). The best documented example of differing decline rates within Alaska is the drastic decline of nesting peregrines on the Tanana, as mentioned previously, compared to smaller percentage declines on the upper Yukon River and the Colville River.

Differences in food habits, amount of human disturbance and possible changes in breeding habitat suitability could influence decline rates and have been discussed by Cade and White (1976) who felt that they were not the principal cause. Differences in pesticide levels (DDE) found in eggs correlate well with, and are generally considered to be a main cause of, differences in degree of population decline. Tanana River peregrine eggs have shown some of the highest average residue levels of DDE found in Alaska populations (Cade et al. 1968, Lincer et al. 1970, Peakall et al. 1975). Although supportive evidence is still lacking, a hypothesis to explain the different pesticide levels is possible use of different winter quarters by different peregrine populations that feed on prey subjected to varying levels of contamination (Cade and White 1976).

In southwestern Alaska, detailed historical evidence on peregrine populations is lacking for both the lower Yukon River and the Kuskokwim River drainage (the Kuskokwim and its tributaries), and it cannot be determined whether they have

Table 2. Nearest neighbor distances between peregrine falcon nests in the Kuskokwim River drainage, Alaska.

Sites	Separating Distance (km)
K1-K2	22.3
K2-K3	9.0
K3-K4	47.0
K4-K5	12.8
K5-K6	21.2
T1-K1	112.5
H1-K4	28.7

Table 3. Organochlorine residues in eggs of peregrine falcons in southwestern Alaska, given in parts per million of dry weight.

	Kuskokwim River 1980-whole egg	Kuskokwim River tributary[1] 1979-eggshell	Kuskokwim River 1980-eggshell
p, p' -DDE	46.00	88.00	56.00
p, p' -DDD	0.26		
p, p' -DDT	0.06		
Dieldrin	6.20	1.30	3.30
Endrin	0.20		
Heptachlor epoxide	2.30		
Oxychlordane	1.00		
t-nonachlor	0.32		
α -BHC	0.02		
β -BHC	2.60		
γ -BHC	.02		
Δ -BHC	.02		
Mirex	2.10		
HCB	0.23		
Percent H_2O	82.00		
Percent Lipid	3.80		

[1]Site T1 Table 1

fluctuated by similar percentages or in relative synchrony. In the lower Yukon section below Grayling, nesting densities have been similar to those found in the pre-decline period along the upper Yukon River at least since 1978. Within this lower Yukon section, five peregrine eyries active in 1981 were within 80 km of a Kuskokwim River eyrie. The shortest distance separating active eyries on the two rivers in 1981 was 65 km, which falls within the range of the nearest neighbor distances for peregrines in the Kuskokwim River drainage (Table 2). The proximity of the lower Yukon and the Kuskokwim River peregrine breeding areas suggest that mixing of individuals may occur between areas. If the density on the Kuskokwim River increases further while the lower Yukon River density downriver from Grayling remains approximately the same, the implication would be that the populations may have fluctuated independently.

DDE residues of the three inviable eggs or egg shell fragments collected in the Kuskokwim River drainage in 1979 and 1980 (Table 3) average slightly lower than the level of 75-100 parts per million (ppm) and higher associated with reduced reproduction (Peakall et al. 1976), although they are still higher than levels found in the Aleutian

Islands of Alaska (White et al. 1973) where peregrines are resident and relatively unexposed to DDE sources. Eggs from arctic Alaska (Colville and Sagavanirktok Rivers) had higher DDE residues (205 ppm average) than found in interior Alaska eggs from the Yukon and Kuskokwim Rivers (51 ppm average) (Springer et al. In press).

Nesting Habits

Peregrines in the study area occur and nest over a broad range of environmental conditions. Height of breeding cliffs ranged from 105 m to 21 meters. Actual nest heights ranged from 54 m to 7 m above river level, and nest site elevations ranged from 300 m to 25 m above sea level. Direction of exposure for seven peregrine nesting cliffs (six successful) were: three south, one southeast, two east, and one east-northeast. Ten broods were raised on ledges protected by overhangs, and four wet broods were found on ledges lacking shelter, including one brood in a totally exposed abandoned rough-legged hawk nest.

Of ten nest areas, six were in extensive riparian cliff sections that were 0.6 km to 1.5 km long (Figure 4). Surrounding areas for these six sites varied from high to moderate topographic relief. One nest was on a small isolated riparian cliff within a surrounding area of low topographic relief. Three occupied cliff sites were clustered along an isolated line of mountains. Although actual nests were not found at these three locations, each defended by a single adult, this was not surprising due to the lateness in the season (25 July) of the survey. One of the occupied sites was 3.1 km from a river, while the other two were each within 2 km of large lakes and more than 8 km from a river.

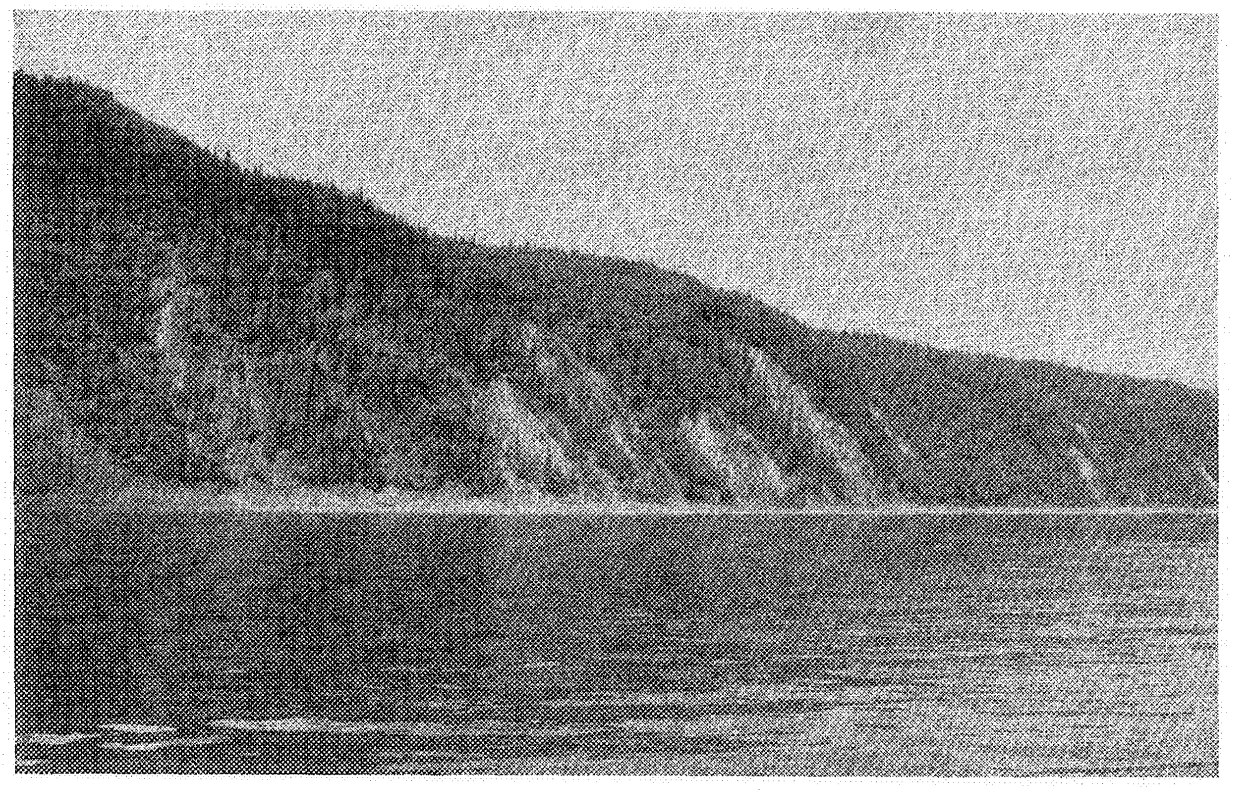

Figure 4. Peregrine falcon breeding cliffs ranged from 105 m to 21 m in height, and were generally slopes of loose rock rather than vertical, solid rock faces.

These two defended sites are the only known lake-associated sites within the study area; other known sites are river associated. In the past, nearly all survey efforts have been concentrated along rivers. Lake-associated peregrine nests are unusual in Alaska. They have been reported from Lake Minchumina in 1951 (Clayton White and Richard Bishop pers. comm.), and a Tetlin Lake site, inactive at least since 1959, was reported to Don McKnight by Natives (D. McKnight pers. comm). A peregrine-occupied cliff on Lake Clark was reported to John Haugh in 1975 (in Fyfe et al. 1976), although he found no peregrines there in late July. In the past, most survey efforts have been concentrated along rivers, although many lakeside cliffs have been checked for peregrines without finding any. The location of a few lake-associated sites shows potential for use of that nesting habitat (Figure 5) and suggests that further searches of lake-associated cliffs may be worthwhile.

Distances between successful peregrine nests and nearest human habitation, small villages in most instances, varied from 3 to 22 kilometers. Nesting peregrines on the Kuskokwim River

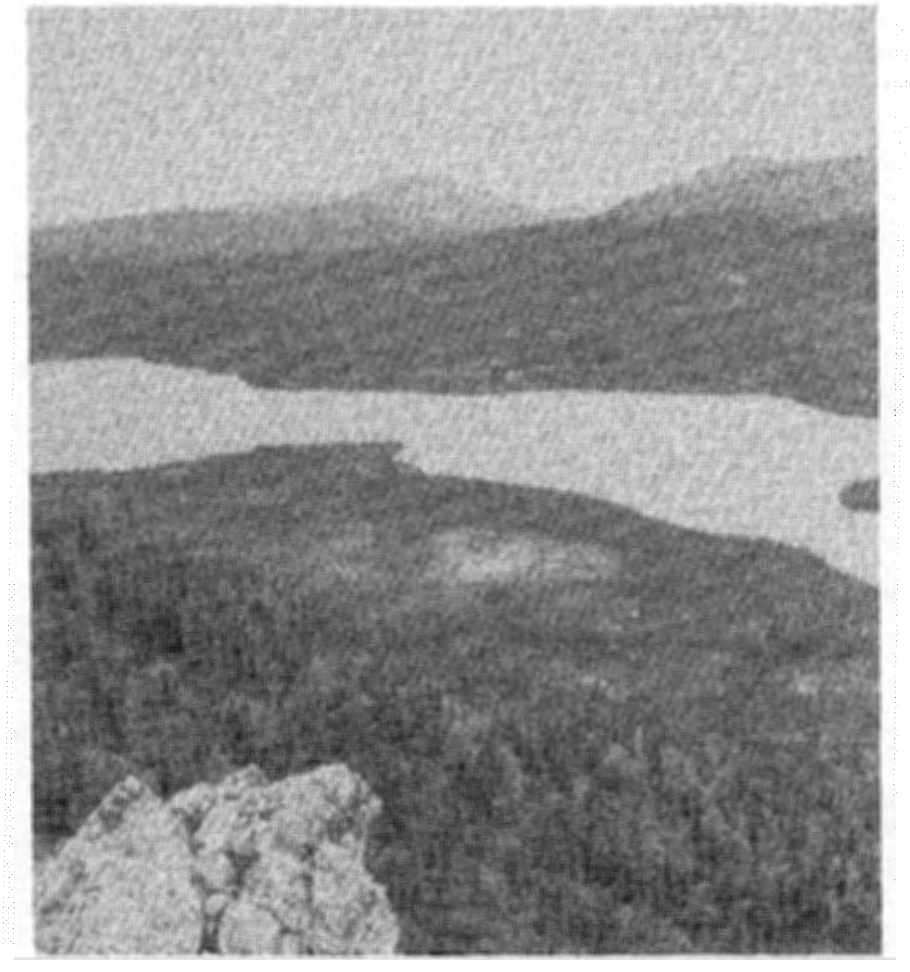

Figure 5. Two lake-associated peregrine sites found suggest a greater potential for that type of nesting situation. Most previous surveys have been concentrated in riparian zones.

showed no apparent ill-effects from moderate to heavy amounts of local boat traffic. On one occasion I watched as a barge passed noisily beneath a peregrine nesting cliff. The barge took 40 minutes to pass the nest cliff, and throughout that time the female remained on the nest ledge brooding young. Every year, light to moderate amounts of fixed-wing and rotor aircraft traffic pass within 1 km of two Kuskokwim peregrine sites that continue to be successful. The site occupied by a lone adult during portions of the 1981 and 1982 breeding seasons is within 4.2 km of a relatively large village, and it is possible that village related disturbances may have had some negative effect. No fish wheels or fish camps have been seen at the base of nesting cliffs on the Kuskokwim as occurs frequently on the Yukon River.

Numerous cliffs unoccupied by peregrines on the Kuskokwim are similar in height, composition, and form to cliffs occupied by peregrines on the Yukon River. The McGrath to Aniak section of the Kuskokwim has fewer adjacent wetlands than the lower Yukon. This is likely reflected by a difference in waterfowl and shorebird abundance. Based only on numbers seen during river travel, waterfowl were nearly twice as abundant on the Yukon between Tanana and St. Marys during the first half of June 1981 as on the Kuskokwim section from McGrath to Aniak during the second half of June 1981. Peregrines are opportunistic feeders, however, using a wide variety of avian prey species in Alaska (Tables 4 and 5) (Cade 1960, Ritchie 1979). It seems unlikely that a difference in availability of certain prey species is the main reason for lower abundance of peregrines on the Kuskokwim.

The lower population density of peregrines on the Kuskokwim section containing cliffs does not signify a lower density of cliff-nesting raptors on the whole when compared to similar habitat on the lower Yukon. Rough-legged hawks were found at a maximum density of one nest per 4.7 km of river (n = 14) along the Kuskokwim, leaving few suitable sites unoccupied by cliff-nesting raptors. Conversely, the lower Yukon River section with a high density of nesting peregrines has a relatively sparse nesting rough-legged hawk population. This suggests the possibility that peak densities of the two species may be mutually exclusive. If competition does exist between peregrines and rough-legged hawks, it is likely to be for the nest sites, and peregrines are generally dominant. White and Cade (1971) found that peregrines sometimes force rough-legged hawks to move nesting location, although there are many instances of rough-legged hawks and peregrines successfully nesting within 60 m of each other. Rough-legged hawk populations normally fluctuate and these fluctuations could only be separated from any possible effects of release from competition with peregrines by many years of data.

Food Habits

A total of 562 individuals were identified from prey remains collected in the vicinity of 37 peregrine nest sites in southwestern Alaska. Fifty-six different species (or species groups) of birds are represented and three classifications of mammlian prey were made. The findings are separated into two groups, those from the middle and lower Yukon River where larger sample size allowed a more detailed analysis (Table 4), and those from the Kuskokwim River drainage (Table 5).

On the middle and lower Yukon River, waterfowl and grebes accounted for 36.92% of the total prey sample by weight. Shorebirds constituted 22.32%, followed by passerine birds at 16.12%, jaegers, gulls, and terns as a group at 14.26%, mammals at 5.46%, and woodpeckers and king-fishers at 3.8 percent. Forty-six percent of the individuals identified were passerine birds, while only about 8% were waterfowl and grebes. In descending order, the most frequently taken individuals were: common snipe, varied thrush, gray jay, *Catharus* sp. (either Swainson's or gray-cheeked thrush), lesser yellowlegs, and solitary sandpiper. The number of mammalian prey represented is closely related to the quantity of castings analyzed, as most small mammal individuals were identifed from regurgitated pellets.

Along the middle and lower Yukon, 107 castings were collected and analyzed. Considering only amounts of hair or feathers per casting, 59% were entirely feathers, 13% were over 50% feathers, 13% were over 50% hair, 8% were entirely hair, and 7% were equal amounts of each. Several small bird crops were found intact in castings. Seeds and insect exoskeletons fre-

Table 4. Prey analysis for peregrine falcons on the middle and lower Yukon River, Alaska, 1981.

Species	Weight[2] class in grams	Number identified	% nests[3] represented	% total individuals	% total weight
Red-necked grebe	500	1	3.03	0.23	1.02
Pintail	900	1	3.03	0.23	1.84
Green-winged teal	300	2	6.06	0.45	1.23
Northern shoveler	550	6	18.18	1.34	6.75
American widgeon	550	4	12.12	0.89	4.50
Unident. scaup	600	2	6.06	0.45	2.45
Bufflehead	350	1	3.03	0.23	0.72
Unident. duck	500	18	45.45	4.05	18.41
Grebe and Waterfowl subtotal		35	66.66	7.87	36.92
Rock ptarmigan	550	1	3.03	0.23	1.12
Galliformes subtotal		1	3.03	0.23	1.12
Hudsonian godwit	250	2	6.06	0.45	1.02
Bar-tailed godwit	250	1	3.03	0.23	0.51
Whimbrel	300	9	27.27	2.02	5.52
Lesser yellowlegs	80	16	36.36	3.60	2.62
Solitary sandpiper	40	15	42.42	3.37	1.23
Spotted sandpiper	40	8	24.24	1.80	0.65
Northern phalarope	25	2	6.06	0.45	0.10
Common snipe	100	33	57.57	7.42	6.75
Long-billed dowitcher	100	6	18.18	1.34	1.23
Semipalmated sandpiper	30	1	3.03	0.23	0.06
Least sandpiper	25	2	6.06	0.44	0.10
Unident. *Calidris*	25	7	12.12	1.57	0.36
Pectoral sandpiper	60	1	3.03	0.23	0.12
Unident. sandpiper	50	20	51.51	4.49	2.05
Shorebird Total		123	93.93	27.64	22.32
Unident. jaeger	500	3	9.09	0.67	3.07
Mew gull	500	4	9.09	0.89	4.09
Bonaparte's gull	250	8	21.21	1.80	4.09
Unident. gull	250	5	12.12	1.12	2.56
Arctic tern	110	2	6.06	0.45	0.45
Gulls, Terns, Jaegers subtotal		22	39.39	4.93	14.26
Overall Charadriiformes subtotal		145	96.96	32.57	36.58
Belted kingfisher	250	3	9.09	0.67	1.53
Common flicker	90	10	24.24	2.25	1.84
Downy woodpecker	50	3	9.09	0.67	0.31
Unident. *Picoides*	60	1	3.03	0.23	0.12
Piciformes, Coraciiformes subtotal		17	36.36	3.82	3.80
Unident. *Empidonax*	10	3	9.09	0.67	0.06
Bank swallow	10	2	3.03	0.45	0.04
Violet-green swallow	15	1	3.03	0.23	0.03
Tree swallow	10	1	3.03	0.23	0.02
Unident. swallow	10	5	15.15	1.12	0.10
Gray jay	80	24	45.45	5.39	3.93
Unident. Chickadee	10	11	30.30	2.47	0.22
American Robin	80	3	6.06	0.67	0.49
Varied thrush	70	28	63.63	6.29	4.01
Unident. *Catharus*	30	22	45.45	4.94	1.35
Townsend's solitaire	30	1	3.03	0.23	0.06

(continued)

Table 4. Continued

	Weight[2] class in grams	Number identified	% nests[3] represented	% total individuals	% total weight
Bohemian waxwing	60	5	15.15	1.12	0.61
Yellow warbler	10	1	3.03	0.23	0.02
Yellow-rumped warbler	10	12	30.30	2.69	0.25
Unident. warbler	10	3	6.06	0.67	0.06
Rusty blackbird	50	5	15.15	1.12	0.52
Pine grosbeak	40	1	3.03	0.23	0.08
Unident. redpoll	10	1	3.03	0.23	0.02
White-winged crossbill	30	2	6.06	0.45	0.12
Dark-eyed junco	15	10	24.24	2.25	0.32
Tree sparrow	15	1	3.03	0.23	0.03
White-crowned sparrow	25	1	3.03	0.23	0.05
Fox sparrow	35	2	6.06	0.45	0.14
Lapland longspur	15	2	6.06	0.45	0.06
Unident. *Fringillid*	25	3	9.09	0.67	0.15
Unident. passerine	30	55	78.79	12.36	3.38
Passerine Subtotal		205	96.96	46.07	16.12
Unident. vole[4]	30	39	39.39	8.77	2.39
Snowshoe hare	500	3	9.09	0.67	3.07
Mammal subtotal		42	51.51	9.44	5.46
Grand Total		445	100.00	100.00	100.00

1 Scientific names for species as listed in Appendix 3.

2 Figures represent only approximate weights. Weight class for groups (i.e. Unident. passerines) are based on an average (Cade 1960).

3 Prey remains were collected from 33 different nest sites.

4 Based on size of skulls and bones, voles were likely *Clethrionomys* sp. and the smaller species of *Microtus*.

quently encountered in pellets likely originated from crops of prey species, although invertebrates in the peregrine diet have been reported previously (Snyder and Wiley 1976). Small twigs and/or pebbles (up to 11 mm wide) were found in 21% of the castings. Some of the pebbles may have been ingested intentionally to aid in removing grease and mucus from the stomach lining (Fox 1976). Items found in pellets consisting almost entirely of hair and without feathers include an eggshell fragment (6.5 mm wide), a land snail (Gastropoda), and body parts from dark ground beetles (Coleoptera) found in 10 pellets.

Small mammals constituted 36.4% of all prey individuals identified in the Kuskokwim River drainage (Table 5) in contrast to 9.4% on the middle and lower Yukon. However, this large percentage is due almost entirely to the prey collected during 1979 from a nest on a Kuskokwim River tributary where small mammals comprised about 78% of all individuals (n = 50) identified. This large percentage of mammalian prey is unusual for Alaska and the remainder of the *anatum* peregrine subspecies' range as well. Peregrines feeding mostly on small mammals, relatively free from pesticides compared to migrant birds, would be at a distinct reproductive advantage. Eighty percent of the pellets containing small mammal remains, however, came from a ledge used as a roost site by the male,

Table 5. Prey findings from peregrine falcon nests in the Kuskokwim River drainage, Alaska.

Prey Species	Number of Individuals Found							
	Site K2	Site K4 and K5		Site T1		Total	% of Grand Total
	1981	1979	1980	1979	1981		
Red-necked grebe	1					1	
Horned grebe					1	1	
Green-winged teal					1	1	
Goldeneye sp.			1			1	
White-winged scoter			1			1	
Unident. duck	1		1	1	2	5	
Grebe and Waterfowl subtotal						10	8.5
Unident. grouse				1	2	3	
Willow ptarmigan				1		1	
Unident. ptarmigan		1				1	
Galliformes subtotal						5	4.2
Hudsonian godwit		1				1	
Whimbrel		1			1	2	
Lesser yellowlegs	1		5	1	1	8	
Northern phalarope			4			4	
Common snipe	1		3	1		5	
Shorebirds subtotal						20	16.9
Sabine's gull					1	1	
Bonaparte's gull					3	3	
Short-eared owl					1	1	
Belted kingfisher		1				1	
Gulls, Owls and Kingfisher Subtotal						6	5.1
Gray jay	1					1	
American robin					1	1	
Varied thrush	1		3		1	5	
Swainson's thrush			1			1	
Unident. *Catharus* sp.	1		1	1		3	
Bohemian waxwing	1		1			2	
Yellow-rumped warbler			1		1	2	
Yellow warbler	2				1	3	
Unident. warbler				1		1	
Rusty blackbird					1	1	
Dark-eyed junco			1			1	
White-crowned sparrow	1					1	
Fox sparrow			1		1	2	
Unident. passerine	3		1	4	2	10	
Passerine Subtotal						34	28.8
Red-backed vole				22		22	
Unident. vole	3		1	17		21	
Mammal subtotal						43	36.4
GRAND TOTAL						118	

located about three m away from the nest ledge. An eggshell collected from that nest in 1979 (Site T1, Table 1) had greater DDE residues (Table 3) than were found in two 1980 eggshells from Kuskokwim River eyries (Sites K4 and K5, Table 1). This suggests that the female's diet at the Kuskokwim tributary site was as high in pesticide content as the two Kuskokwim River females and that she ate a smaller percentage of small mammals than her mate.

Excluding the small mammal findings, avian prey species groups of grebes and waterfowl, shorebirds, and passerines were found in approximately the same percentages in the Kuskokwim drainage as on the middle and lower Yukon. Differences in species diversity are likely due to the different sample sizes. Alaska prey analyses reported by others (Cade 1960, Cade et al. 1968, Ritchie 1979) are similar to those presented here. Percentage of total weight was somewhat

Table 6. Rivers surveyed by boat, distances covered, and numbers of raptor nest sites found in southwestern Alaska during 1979-1982. (Nest sites include actual nests as well as some locations strongly defended by adults where the actual nest was not found.)

River	Km Surveyed	Number of Raptor Nest Sites: Rough-legged Hawk	Red-tailed Hawk	Golden Eagle	Bald Eagle	Osprey	Gyrfalcon
Selatna	44	0	3	0	0	0	0
Tatlawiksuk	71	0	5	0	0	3	0
Cheeneetnuk	95	1	4	0	0	0	0
Kuskokwim 1979	422	10	10	0	2	0	0
Kuskokwim 1980	422	13	17	0	3	2	0
Kuskokwim 1981	422	19	35	0	3	4	0
Kuskokwim 1982	422	17	19	0	2	4	0
Golsovia	50	1	0	1	0	0	2
Chiroskey	35	2	0	0	0	0	0
Otter Creek	18	0	0	1	0	0	0
Canyon Creek	8	2	0	0	0	0	0
South	54	2	0	1	0	0	0
East Fork George	97	1	2	0	0	1	0
Stuyahok	87	0	0	0	0	1	0
Gagaryah	78	2	5	0	0	1	0
Oskawalik	48	6	7	0	0	0	0
Tuluksak	16	0	0	3	0	0	1
Old Woman	46	2	0	0	1	0	0
North	88	1	1	0	0	0	1
TOTAL	2523	79	108	6	11	16	4

lower for waterfowl and grebes and higher for passerines on the middle and lower Yukon River in 1981 than in the prey analyses mentioned above. Percent of total weight constituted by mammals was also slightly higher throughout southwestern Alaska, even with the Kuskokwim River drainage findings excluded. Cade et al. (1968) found that primarily migrant sandpipers and secondarily migrant insectivorous passerines contained higher DDE residues than did migrant seed-eating passerines and resident birds. Tables 4 and 5 show that these groups with elevated DDE levels are also among the favored prey in southwestern Alaska.

Red-tailed Hawk
Distribution, Status, and Nesting Habits

Red-tailed hawks were the most abundant raptor species found, although they were not distributed evenly throughout the study area. In the Kuskokwim River drainage, red-tailed hawks were common to abundant, occurring on all seven rivers surveyed by boat where a four-year total of 107 nest sites was found (Table 6). However, red-tailed hawks were rarely found west of the Yukon River, where only one nest was seen during eight different river surveys. During another study along the Yukon River between Fort Hamlin and St. Marys, red-tailed hawks were present, but at a comparatively low density (Mindell and Craighead 1981). The scarcity of red-tailed hawks on the rivers surveyed west of the Yukon was striking as extensive river sections of seemingly potential nesting habitat were unoccupied. Within the Kuskokwim River drainage, clusters of nests often were found along certain river sections bordered by large unoccupied sections of similar appearing habitat on each end. Average inter-nest distances show high local densities, particularly when lone distant nests were omitted from the sample (Table 7). Fifty-three of 70 inter-nest distances found during 1979 to 1981 were less than nine kilometers.

Trees suitable for nesting were abundant in many unoccupied areas west of the Yukon River and between clusters of nests in the Kuskokwim drainage, and favored prey species such as red squirrels and voles were commonly seen throughout the study area. These same prey species were frequently seen in the nests of other raptor species in areas without red-tailed hawks. More detailed analysis is needed to determine whether there are local abundances in food supply to correspond with high local breeding densities. Red-tailed hawks take a wide variety of prey in Alaska and throughout their range (Lowe 1978, see summary in Sherrod 1978) and are less apt to be limited by the range or abundance of any

Table 7. Average distances between red-tailed hawk nest sites (actual nest or defended site) in southwestern Alaska. Average distances shown in parentheses were calculated by omitting single distances greater than 9.0 kilometers.

Rivers	Average distance between nest sites in km	Number of nest sites
Selatna	5.3	3
Tatlawiksuk	6.5 (2.9)	5 (4)
Cheeneetnuk	5.8 (1.7)	4 (3)
Gagaryah	4.6	5
Oskawalik	3.9 (2.9)	7 (6)
Kuskokwim 1981	9.6 (4.3)	35 (26)

particular prey species than are raptor species with more specified feeding habits. Nest clusters may be due in part to the tendency of some raptors to return to the vicinity of their own fledging areas to nest (see Newton 1979: 361, Galushin 1974).

The relatively sparse settlement and lack of dispersal into the far western portion of Alaska and the study area (west of the Yukon River) by red-tailed hawks is not unusual when considering the region as the western limit of the species' range. Irregular occurrence and fluctuation in numbers can generally be expected in the region of a species' border due to a limiting environmental gradient (Mayr 1970). Often, environmental conditions on either side of the species' border are only slightly different. However, if further detailed study shows no differences in nest site and prey availability, climate, soil fertility, or other environmental conditions, then the possibility of limitation through competition in wintering areas for this migratory species might be considered (Newton 1979: 74)

Spacings between nests found along the study rivers (Table 7) describe local densities similar to those found for red-tailed hawks elsewhere in North America. In central Alberta, McInvaille and Keith (1974) found a mean distance of 2.1 km between nests. Measurements of red-tailed hawk pairs per sq. km can be compared indirectly with inter-nest distances. Researchers from other North American locations have found densities of one pair per: 13 sq. km in California (Fitch et al. 1946); 4.4 sq. km in Wyoming (Craighead and Mindell 1981); 5.7 sq. km in New York (Hagar 1957); 7.0 sq. km near Rochester, Alberta (Luttich et al. 1971); 7.4 sq. km in Green County, Wisconsin (Orians and Kuhlman 1956); and 10.5 sq. km in east central Wisconsin (Gates 1972). Average inter-nest distances of less than 3 km on three southwestern Alaska rivers (Table 7) are comparable to those found in the two highest density areas of the studies previously mentionted. This indicates similarities in local abundances within suitable habitats for the different study regions, and shows the suitability of wooded river bottoms and their prey base in the Kuskokwim drainage to support high densities of nesting red-tailed hawks.

The present river surveys were limited by their nature to edge types of habitat. Linear surveys along particular types of habitat are not as representative of the overall species density as a large block area survey would have been. Within some drainages surveyed in Alaska, trees suitable for red-tailed hawk nesting were concentrated in a narrow band along the river course. In such areas, it follows that riparian nest densities would be greater than in adjacent nonriparian areas. Alaska breeding densities, including larger nonriparian areas without suitable nesting habitat, would be low compared to

Figure 6. Eighty percent of the red-tailed hawk nests were in mature white spruce trees. The nest tree is the central one with a flattened crown.

many nest densities reported in the literature. Extensive tundra and alpine areas lack trees for nesting; in black spruce stands trees are often too slight to support nests. In the Fairbanks vicinity, red-tailed hawks occurred one pair per 46.6 sq. km, although nest clusters in two areas had similar local densities to those found during this study (Lowe 1978). Although Alaska red-tailed hawks nest in dense forest, it is not known whether this is more or less common than nesting near open areas. Lowe found that 35 percent of all nests were located within 15 m of creeks, sloughs, or rivers.

Fifty-three (80%) of 66 red-tailed hawk nests visited were in white spruce (Figure 6), nine (16%) were in balsam poplars, and two (4%) were in paper birch trees. One red-tailed hawk pair on the Kuskokwim River used a stick nest on a cliff. Nests were frequently located in one of the dominant trees in a stand. Dominant trees facilitated nest access and visibility for the hawks, especially if the tree was located away from the forest edge. White spruce with large spreadin gbranches near the top were most frequently chosen and nests placed at the extreme top were not uncommon. Height of nests varied from 5 m to 34 m and averaged 23 meters. Elevation of nests ranged from 35 m to 305 m above sea level. A nest near Farewell, Alaska, was found 5 m high in a 6 m-tall charred black spruce snag. The nest tree was in a seven- year old burn where new herbaceous growth supported an abundance of voles.

Mean brood size from 21 southwestern Alaska nests over a four-year period was 2.16 (Table 8). Henny and Wight (1972) estimate that above latitude 42°N 1.33 to 1.38 young red-tailed hawks must be fledged per breeding aged female (two years old and older) to maintain a stable population. All but three broods seen during the present study were 14 days old or older; however, clutch sizes, actual fledging success, and percent of nests successful were not known. Lowe (1978) found a mean of 1.33 young fledged from successful nests in the Fairbanks vicinity with only 46.4% of nests found during incubation (n = 28) being successful. The largest brood size seen in the Kuskokwim drainage was three young, and the most common size was two young. Individuals from three nests were considerably smaller and weaker than nest mates. At two nests, small chicks already showed signs of having been attacked by siblings.

Food Habits

The small set of red-tailed hawk prey findings from southwestern Alaska (Table 9) indicates the wide prey base used. Red squirrels and voles were the prey species most frequently found in nests, although prey remains or pellets were found in only five of 18 nests visited. In

Table 8. Average brood sizes for rough-legged and red-tailed hawks in southwestern Alaska. (Numbers in parentheses represent number of nests visited.)

Species	Year	Average Brood Size	
		Entire study area	Kuskokwim River only
Rough-legged hawk	1979	2.28 (11)	2.00 (7)
	1980	2.86 (14)	2.10 (7)
	1981		3.54 (11)
	1982		2.09 (11)
Red-tailed hawk	1979	2.16 (6)	
	1980	1.77(9)	
	1981		2.66 (3)
	1982		2.00 (3)

greater detail Lowe (1978) found that at least 10 species of mammals accounted for 62% of the diet by weight and at least 33 species of birds constituted 38% of the diet by weight for red-tailed hawks near Fairbanks. Greatest use was of snowshoe hares (47% of diet by weight) followed by mallards (11% of diet by weight) and red squirrels (8% of diet by weight). Birds comprised a much larger proportion of the diet for these Alaskan red-tailed hawks than was found in studies from Utah (Smith and Murphy 1973), Wyoming and Michigan (Craighead and Craighead 1956) and California (Fitch et al. 1946). This difference may reflect the relative abundance of breeding waterfowl, shorebirds, and passerine birds in interior Alaska. On the Kuskokwim River, red-tailed hawks were seen hunting redpolls and varied thrushes by feinting dives, landing in tree tops, or flying low over tree tops at river's edge, apparently trying to force birds out into the open.

Subspecies Identification

Based solely on tail plumage characteristics, adult red-tailed hawks seen at 108 nest sites or nest areas were either *Buteo jamaicensis harlani* (Harlan's hawk) or *harlani* intergrades with other red-tailed hawk subspecies (see Friedmann 1950 for subspecies plumage descriptions and ranges). Some adults on the Kuskokwim River were likely reobserved during successive years. Based on known ranges and identification of collected specimens from central and eastern Alaska (Gabrielson and Lincoln 1959), red-tailed hawks intergrading (interbreeding) with *harlani* were *calurus*.

These observations showing that *harlani* does have a breeding range exclusive of other red-tailed hawk subspecies in pure form support *harlani's* subspecific status and help to solve a longstanding puzzle concerning taxonomic status

Table 9. Prey findings from raptor nests in southwestern Alaska, 1979 - 1982.[1]

	Red-tailed hawk	Rough-legged hawk	Golden eagle	Gyrfalcon	Goshawk
Nunber of nests	5	28	2	8	1
Prey Species	Number of Individuals				
Red squirrel	4	2			
Arctic ground squirrel		2	4	10	
Red-backed vole	1	5			
Microtus sp.		13			
Vole sp.	8	36		2	
Snowshoe hare	1	2	23	3	8
Unidentified ptarmigan		8		24	
Spruce grouse		4	3	3	
Unidentified passerine	3	11			

[1]Time was not available to include analysis of rough-legged hawk castings and prey remains collected in 1982.

of the Harlan's hawk (see Mindell 1983). This *harlani* breeding range apparently exclusive of other red-tailed hawk subspecies in pure form is unique to an area comprised principally of southwestern Alaska. This range can presently be described as follows: west to Norton Sound and the western limit of the taiga approaching the Yukon-Kuskokwim Delta: east to the Alaska Range west slope; north at least to the Koyukuk River mouth and likely up to tree line south of the Brooks Range; and south to the Iliamna Lake region. Further observations may cause some change in this description.

Rough-legged Hawk

Distribution, Status and Nesting Habits

Rough-legged hawks occur throughout the study area; however, they are limited in local density and distribution by availability of cliff nesting sites. Rough-legged hawks showed no adaptability to nesting in trees as they are known to do elsewhere in the southern portion of their breeding range (Godfrey 1966, Brown and Amadon 1968). Predictably, nests were clustered in river sections with abundant cliffs.

Four rivers contained two rough-legged hawk pairs each, with the following distances between nests: 5.8 km on the Chiroskey, 2.5 km on Canyon Creek, 8.9 km on the Gagaryah and 12.9 km on the Old Woman. The Oskawalik River held six nesting pairs separated by an average of 4.9 km. The Kuskokwim River from Red Devil to the Oskawalik River confluence was the longest river section with frequent cliffs surveyed in the study area and had the greatest density of rough-legged hawks found (Table 10). Seven of the nine active cliff sites in 1979 were reoccupied in 1980. Of the two sites not reoccupied in 1980, one was occupied by tree nesting red-tailed hawks, and the other was only 1.0 km distant from a rough-legged hawk nest that has been active all four years. In 1980, four new cliff sites were used, including three relatively widely spaced adjacent territories at one end of the river section, accounting for different average nest spacings during 1979 and 1980 (Table 10). All the sites occupied in 1980 were reoccupied in 1981. Four additional active sites in 1981 included two that had been active in 1979. The number of active sites was the same in 1982 as in 1981 (n=15). Two new cliff areas were occupied in 1982 leaving two sites from 1981 unoccupied. This suggests that availability of suitable cliff sites is not limiting rough-legged hawk population size on this Kuskokwim River section.

The increase in rough-legged hawk breeding pairs from 1979 to 1981 (Table 10) was accompanied by an increase in brood sizes over the

Table 10. Average distances between rough-legged hawk nests in southwestern Alaska. Kuskokwim distances are taken only within the Red Devil to Oskawalik River section.

River	Average distance between nest sites in km	Number of occupied nest sites
Kuskokwim 1979	3.6	9
Kuskokwim 1980	4.9	11
Kuskokwim 1981	3.6	15
Kuskokwim 1982	3.6	15
Oskawalik	4.9	6

three years (Table 8). Average brood sizes from 1979 and 1980 are near the lower end of the average range for rough-legged hawks (Hagen 1969, White and Cade 1971). In 1980, three of the 11 nest attempts had failed by the early nestling period. In 1981 only one of 15 nest attempts had failed by the mid-nestling period. Although numbers of occupied nest sites in the Red Devil to Oskawalik section of the Kuskokwim were identical in 1981 and 1982, average brood size was lower, and three of the 15 nest attempts were known to have failed by the early nestling period in 1982. Three nest sites between New York Creek and Aniak that were active in 1981 were unoccupied in 1982.

Rough-legged hawk populations from northern tundras appear to fluctuate normally. In Dovre, Norway, Hagen (1969) found that breeding pairs varied in numbers from zero during years of low vole abundance, to nine during years of high vole abundance, suggesting a close association between food abundance and rough-legged hawk population size. Hagen also noted that increasing brood size and nest success accompanies an increase in breeding pairs as found on the Kuskokwim River.

Two additional examples of fluctuating rough-legged hawk populations in Alaska are on the Seward Peninsula and the Colville River. On the Seward Peninsula, the number of rough-legged hawk breeding pairs during 1968 through 1972 ranged from 82 to 10 (Swartz et al. 1975). During 1971, major declines and lowest populations for rough-legged hawks as well as gyrfalcons, ravens, and golden eagles, suggested food shortages as a limiting factor. On the Colville River the number of rough-legged hawk pairs found during 1967, 1968, and 1969 varied respectively from 64 to 57 to 78 (White and Cade 1971). Average percentages of annual change in number of breeding rough-legged hawk pairs in Alaska was greatest on the Seward Peninsula and relatively similar on the Kuskokwim and Colville Rivers, implying that, during the periods surveyed, availability of favored prey species varied most on the Seward Peninsula. Reasons for this difference are unclear, but they may involve harshness of weather and differences in prey species habits, such as possible greater fluctuations in coastal populations of *Lemmus* compared to interior microtine rodents.

Although small mammal abundance was not directly censused on the Kuskokwim, there is indirect evidence of increasing prey abundance during the rise in numbers of rough-legged hawks. During years of average or high prey abundance, adults often keep the nest stocked with prey items. In 1979 and 1980 on the Kuskokwim, two of 20 nests visited contained one uneaten prey item, while 18 held no uneaten prey. In 1981, eight of 11 nests visited contained a total of 17 uneaten items. In 1982, only two nests of nine visited contained one uneaten vole each.

A total of 98 inactive stick nests on cliffs were found on survey rivers during 1979 and 1980. One or more inactive nests occurred within 100 m of 25 (66%) of 38 active nests. In 18 instances unused nests were found one km or more distant from active nests, representing potential rough-legged hawk territories, based on a minimum distance of 1 km between active nests seen on the Kuskokwim River. Groups of adjacent unused territories were found at several locations. Although rough-legged hawks were apparently not at peak breeding densities throughout the study area during 1979 and 1980, it is not well known how many, if any territories are unoccupied during years of peak breeding numbers.

Nest heights (n = 62) ranged from 6 m to 86 m and averaged 35 meters. Nest site elevations ranged from 60 m to 440 m above sea level. Mean distance of the vertical nest plane to rivers was 10 meters. Three active rough-legged hawk nests were built using a tree base on a slope for support rather than a rock or dirt ledge.

Food Habits

Eighty-three individuals were identified from pellets or remains found at 28 rough-legged hawk nests between 1979 and 1981 (Table 9). Sixty-five percent of the prey items were voles, 28% were birds (14% Tetraonidae, 14% passerines), 2% were arctic ground squirrels, 2% were snow-

Table 11. Dates of raptor breeding chronology.[1]

Species[2]	Number of Nests Observed				Average Laying				Average Hatching			
	1979	1980	1981	1982	1979	1980	1981	1982	1979	1980	1981	1982
Rough-legged hawk	12	10	14	11	5/21	5/11	5/16	5/22	6/20	6/10	6/15	6/21
Red-tailed hawk	6	8	3	3	5/19	5/12	5/13	5/23	6/18	6/11	6/12	6/22
Peregrine falcon	2	2	4	3	5/20	5/14	5/22	5/29	6/18	6/12	6/20	6/28
Gyrfalcon	1			2				5/6				6/10
Golden eagle		2		2		4/17				5/21		5/31
Goshawk		1				4/21				5/29		
Hawk owl		3				5/2				5/30		
Bald eagle			2			4/20				6/2		

[1]Hatching dates were calculated by aging nestlings. Average laying dates and fledging dates (departure of young from the nest) were estimated using average incubation and nestling periods of: 44 and 62 days for golden eagles, 44 and 70 days for bald eagles, 39 and 40 days for goshawks, 30 and 41 days for red-tailed and rough-legged hawks, 29 and 39 days for peregrines, 35 and 52 days for gyrfalcons and 28 and 25 days for hawk owls.

[2]Young ravens and great-horned owls were already fledged by 6/8, date of earliest surveys during 1979-1981. In 1982 nestling great-horned owls were seen as late as 6/5.

shoe hares, and 2% were red squirrels. Birds comprised only 10% of the prey individuals identified during 1979 and 1980 on the Kuskokwim River. Birds increased to 28% of all prey individuals identified on the Kuskokwim in 1981. High percentages of birds in the diet may make rough-legged hawks less susceptible to change in population size caused by cyclic small mammal abundance. The factors of small mammal and avian prey abundance and extreme weather conditions, particularly in early spring (Swartz et al. 1975), likely all have some effect on rough-legged hawk population size and productivity in the Alaska study areas discussed above.

Competition Between Red-tailed and Rough-legged Hawks

Breeding rough-legged hawks and red-tailed hawks within Alaska have certain characteristics that could cause some competition. The two species share several prey resources, including voles (*Microtus* sp., *Clethrionomys rutilis*), red squirrels, arctic ground squirrels, ptarmigan, and smaller birds (Table 9, Lowe 1978). Overlap in prey may be increased where snowshoe hare are unavailable to red-tailed hawks. Similar body sizes and shapes of red-tailed and rough-legged hawks are likely related to overlap in prey species, although red-tailed hawks have larger and stronger feet (Friedmann 1950).

Table 11. Continued.

Range of Hatching				Average Fledging			
1979	1980	1981	1982	1979	1980	1981	1982
6/15-28	6/5-12	6/11-20	6/20-29	7/30	7/22	7/26	7/31
6/10-28	6/7-19	6/10-13	6/21-23	7/28	7/23	7/24	8/1
6/15-21	6/1-21	6/14-25	6/23-7/1	7/27	7/21	7/29	8/7
			6/10-11		7/4		8/1
	5/16-27		5/29-6/3		7/21		8/1
					7/13		
			5/25-6/5		6/23		
		5/31-6/5				9/10	

Riparian nest sites are frequently used by both species. In southwestern Alaska, both trees and cliffs are often concentrated along rivers. Rough-legged hawks may be more limited than red-tailed hawks in off-river nesting on the study area because cliffs are relatively less abundant than trees away from the rivers. Average dates of egg laying, hatching and fledging of young for the two species were found to occur within several days of each other for each of the survey years (Table 11) and suggest that time of arrival on breeding grounds and nest site selection are also similar.

A high degree of spatial overlap between rough-legged hawks and red-tailed hawks is shown by their inter-nest distances. On the Oskawalik River, seven distances between red-tailed and rough-legged hawk nests averaged 3.1 km and ranged from 1.4 to 5.7 kilometers. On the Kuskokwim River, 11 interspecific nest distances of less than 10 km, including two distances of 0.8 km, averaged 2.8 kilometers. Single interspecific nest spacings were 10 km on the Gagaryah and 8.6 km on the Cheeneetnuk. Some of these distances are clearly larger than the intraspecific nest distances (Tables 7 and 10) and the nesting territories can be considered as non-overlapping. However, seven of the 20 (35%) interspecific nest spacings are less than 3.0 km and the two 0.8 km nest intervals are smaller than any intraspecific spacings found.

The close nesting distances imply that areas used by adjacent nesting pairs of the two species are not necessarily mutually exclusive. At the

two 0.8 km intervals and one other Kuskokwim location, I saw red-tailed hawks soaring at high altitudes (approx. 100 m) over rough-legged hawk nest areas. On two occasions I saw red-tailed hawks fly by rough-legged hawk nests at low elevations, although they stayed over the river and at least 60 m away from the nest cliff. Confrontations in areas of potential overlap seemed to be avoided. Where inter-nest distances for the two species were as small as 1.5 km, rough-legged hawks were less vocal and more reluctant than usual to fly from the nest and defend against biologists. Red-tailed hawks showed a similar reluctance, although to a lesser degree. When nesting at such close distances, the two species share certain flight areas, and possibly even hunting areas, although not simultaneously.

Despite the demonstrated overlaps in prey species used, range, and general nesting habitat for rough-legged and red-tailed hawks in southwestern Alaska, there must be sufficient differing characteristics which allow the two species to coexist successfully (Lack 1971). Comparisons of behavior, hunting methods and habitat use in areas where both species occur have been conducted in winter quarters. In Illinois, red-tailed hawks made greater use of taller trees and groups of trees, while rough-legged hawks were more often found on lower perches, such as fence posts or in a lone tree. Red-tailed hawks were more sedentary and apparently spent more time hunting from a perch than did more active rough-legged hawks (Schnell 1968). Red-tailed hawks were found to be dominant in territorial disputes during winter in Oklahoma, and dominance by more aggressive red-tailed hawks likely continues during migration and on the breeding grounds, as observed by Lowe (1978).

Although similar detailed comparative studies in breeding areas are lacking, the present study provides some pertinent evidence. Differences in nest substrate for red-tailed hawks and rough-legged hawks serve to ecologically isolate and reduce interspecific competition between the two species because river shore sections with extensive cliffs generally lacked trees.

In light of the association between numbers of breeding rough-legged hawks and the abundance of favored prey species, relative stability of red-tailed hawks compared to rough-legged hawks suggests different use of the available prey resource, another potential means for reducing interspecific competition. Differences in number of red-tailed hawk nests or nest areas found along the Kuskokwim River (Table 6) are not comparable between years because a thorough effort to find all nests was only made in 1981. However, within the Kuskokwim River, Red Devil to Oskawalik River mouth section, the number of red-tailed hawk nests or nest areas found were three in 1979, and two respectively during 1980, 1981, and 1982. This is the only Kuskokwim section where increased searching in both 1980 and 1981 did not reveal more breeding pairs. For this reason, it is felt the red-tailed hawk population in that section is represented accurately. During all four years, boat travel in this section is represented accurately. Suitable nesting trees were less common than in most other sections, allowing searches for red-tailed hawks to be more thorough. On this same Kuskokwim River section, rough-legged hawk breeding populations changed by an average of 19.5 percent between years (Table 10). Red-tailed hawks in Alberta (McInvaille and Keith 1974) and Wisconsin (Orians and Kuhlman 1956), maintained fairly constant annual population sizes. However, a trend to stability of red-tailed hawk populations on the Kuskokwim should be considered tentative until more data are available.

Table 12. Proposed nest site disturbance restrictions.

Species	Sensitive Time Period	Disturbance Distances from Nest Sites: Aerial Activity[1]	Ground Activity[2]	Permanent Facility[3]
Gyrfalcon	15 Feb - 15 Aug	0.25 mi. horiz. or 1,000 ft. vert.	0.25 mi.	0.50 mi.
Merlin	15 Apr - 15 Aug	0.25 mi. horiz. or 800 ft. vert.	0.25 mi.	0.50 mi.
Golden Eagle	15 Mar - 15 Aug	0.25 mi. horix. or 1,000 ft. vert.	0.25 mi.	0.50 mi.
Bald Eagle	15 Mar - 15 Aug	0.25 mi. horiz. or 1,000 ft. vert.	0.25 mi.	0.50 mi.
Osprey	1 Apr - 20 Aug	0.25 mi. horiz. or 1,000 ft. vert.	0.25 mi.	0.50 mi.
Great Gray Owl	15 Feb - 5 Aug	0.25 mi. horiz. or 800 ft. vert.	0.25 mi.	0.50 mi.

[1]Both fixed-wing aircraft and helicopters.

[2]Includes short term reconnaissance type activities involving few people and limited equipment or noise as well as more intensive disturbances with significant surface alteration, equipment or noise.

[3]Refers to structures where frequent vehicular or human activity and noise would occur.

Gyrfalcon

Gyrfalcons are widely scattered but generally uncommon in southwestern Alaska, as they are throughout much of their range. Nineteen different active nests were found within study river drainages (including White and Boyce 1978): seven along lower Kuskokwim River tributaries and 12 west of the Yukon River. In the riparian habitats surveyed for cliff-nesting raptors, gyrfalcons are associated with river sections surrounded by tundra rather than taiga. Gyrfalcons are generally outnumbered by peregrines and rough-legged hawks in wooded river sections containing cliffs. This is particularly striking on the Kuskokwim River and the middle and lower Yukon River (Stevens Village to St. Marys). Gyrfalcons are not as rare as the low number of nests and sightings suggest, because they also inhabit mountainous terrain above timberline and coastal areas which are largely unsurveyed within the study area.

Overwintering gyrfalcons have been seen in the Cheeneetnuk and Gagaryah River drainages (P. Shepard pers. comm.) and at Aniak and Upper Kalskag (David Marshall pers. comm.). These winter sightings are in the vicinity of mountainous terrain with cliffs suitable for nesting gyrfalcons and may represent local resident birds.

In the Goodnews Bay region of southwestern Alaska, 12 nest sites were located during the 1930's in an area of about 2,600 sq. km and at least eight were active during 1934 (Bull in Bent 1938, Cade 1982). In Alaska outside the study area, gyrfalcons are also generally uncom-

mon. Average population of gyrfalcons on the Seward Peninsula has been estimated to be 70 pairs (Swartz et al. 1975, see Roseneau 1972). In an inhabitable area of 5,120 sq. km within Denali National Park which borders the study area, five eyrie sites are known with a maximum of three known to be active during any one year, giving a density of one pair per 1,700 sq. kilometers. Over 175 gyrfalcon nest sites are known statewide in Alaska (summarized in Cade and White 1976, White and Boyce 1978, this study, Weir pers. comm.). Total breeding population of the Arctic Slope has been estimated to fluctuate at around 100 pairs, for a density of about one pair per 1,300 sq. km, and the entire Alaskan breeding population has been estimated to fluctuate at about 500 pairs (Cade 1982).

Gyrfalcons were common locally in several study area drainages. Between 1977 and 1979 along the Kisaralik River and one of its tributaries, Quicksilver Creek, an average of four territories were occupied annually (summarized in Weir 1982). In the same area, four nests with young and a territorial single adult were found during a survey in 1982 by David Spencer and me. Spacing between pairs in the Kisaralik River drainage is fairly regular with nearest neighbor distances between nest sites (nest or defended site) in 1982 ranging from 14.7 km to 4.3 km and averaging 10.0 kilometers. In 1977, along the Ungalik River four nests were found at approximately 8 km intervals, and two nests on the East Fork Andreafsky were about 7 km apart (White and Boyce 1978). In 1979, two nests on the Golsovia River were 22 km apart. Five reported breeding territories in the upper Salmon River, and Cripple Creek area in the lower Kuskokwim River drainage are spaced at an average interval of 8 km with an average annual occupation at three of the territories of 55% (Weir pers. comm.).

All gyrfalcon nests located were on cliffs and on slopes directly bordering the survey rivers. Nonriparian cliffs and coastal areas were not surveyed. Gyrfalcons frequently used stick nests previously built by golden eagles, rough-legged hawks or ravens. Horizontal distances (n = 9) from the rivers to nesting cliffs ranged up to 1,000 m and six of the distances were less than 45 meters. Heights of nesting cliffs ranged from 18 m to 135 m and averaged 58 meters. During 1980 in the Tuluksak River area, two young gyrfalcons fledged from a nest located 1.1 km from an active gold dredge. Brood sizes of both nestlings and fledgings from 13 nests averaged 2.9 (White and Boyce 1978, this study).

Prey species identified from remains found in and near nests were predominantly either rock or willow ptarmigan followed in decreasing abundance by arctic ground squirrels, snowshoe hare, spruce grouse, and voles (Table 9).

Golden Eagle

Golden eagles have a wide range in Alaska and have been reported from Admiralty Island in the southeast to Point Barrow in the north and Amchitka Island in the west (Gabrielson and Lincoln 1959). Breeding pairs tend to be widely scattered, although higher densities do occur in some areas of abundant prey. Maximum local densities for southwestern Alaska golden eagles are lower than maximum densities found for smaller bodied raptors such as red-tailed hawks, rough-legged hawks and peregrine falcons.

Along the Kisaralik River section, six to seven active golden eagle nests were found annually during 1977, 1978, and 1979, for an average density of one nest per 12.5 km along a straight air route (Weir 1982). In the Tuluksak River drainage, four breeding territories with an annual occupation of 90% over six years occurred one territory per 12 km along a 48 km air route (Doug Weir pers. comm.). During 1980 in the Tuluksak River area, three nests were separated by a mean distance of 8 km, and a subadult also ranged in the area as had been found in the past by Weir. Pairs of golden eagle nests were located on the Eek, Andreafsky, Anvik and Ungalik Rivers (White and Boyce 1978). I found no golden eagle nests along the shores of seven rivers surveyed by boat in the upper Kuskokwim River drainage. The only three nest sites located in this region were in mountainous areas 1 to 8 km away from a river at elevations over 400 m and above timberline. Golden eagles were more common in the lower Kuskokwim River area and west of the Yukon River where breeding pairs were found on nine of the 12 rivers surveyed by boat.

In the Tuluksak River valley, which has been extensively dredged for gold, golden eagle prey remains found in 1980 were predominantly snowshoe hare (77% of 30 prey individuals from two nests) (Table 9). Based on observations made while hiking, the willow and alder thickets lining many of the old gravel tailing piles seemed to support a greater abundance of snowshoe hare than adjacent undisturbed areas did, although no quantified data were collected. Of 33 prey individuals identified at Tuluksak and Kisaralik River nests by Weir (pers. comm.), 61% were ground squirrels, 18% were ptarmigan and 15% were snowshoe hare.

Twenty-three (92%) of 25 golden eagle nests located in the study area during surveys of 1977 (White and Boyce 1978), 1979 and 1981 were on cliffs, and two were in trees. Tree nests may be under-represented because they are more likely to be missed during both aerial and boat surveys. In the Kilbuck and Ahklun Mountains of southwestern Alaska, Weir found two nests on the ground among boulders, two nests in the superstructure of old placer dredges, and approximately 60% of 61 active or used nests at or above timberline.

During surveys in 1977 and 1979 through 1981 in southwestern Alaska, 33 young golden eagles were seen in 18 nests, yielding an average brood size before fledging of 1.8 young. This figure is likely higher than the final fledging rate; however, it is indicative of normal clutch sizes and a healthy reproduction rate (Brown and Amadon 1968). Only one subadult golden eagle was seen during 1979 to 1981. Young golden eagles without the responsibilities of nesting have greater freedom of movement than adults and may wander, exploiting temporary food abundances closer to southern winter quarters as has been reported for other raptors (Newton 1979). This tendency may contribute to the low number of subadult golden eagles seen. However, Weir has seen adults and at least one subadult during winter months in the Tuluksak and Salmon River drainages. While the majority of Alaskan breeding golden eagles appear to be migratory (Gabrielson and Lincoln 1959), actual proportion of migrants to overwintering birds likely varies with the severity of winter weather, and the location of winter quarters for those that migrate remains little known.

Bald Eagle

Bald eagles occurred throughout the study area at low population density. Adult bald eagles were seen on eight of 18 rivers surveyed by boat during June and July (Table 12), with only five actual nests located. Any nests occurring away from the riverbanks on lakes or sloughs were missed. Four nests were located on the Kuskokwim during 1979 to 1982, and one was found near the confluence of the Old Woman and Unalakleet Rivers in 1980. One nest along the Kuskokwim 25 m high in a balsam poplar tree was active each year during 1979-1981, but the nest tree was knocked down and washed away during the 1982 spring ice break-up and subsequent high water. The other two nests were 20 and 30 m high in white spruce trees. Bald eagles were seen in six different areas on the Kuskokwim River between McGrath and Aniak with three to five occupied annually. The six areas were spaced at an average interval of 52 kilometers. A total of 17 adults and 13 subadults were seen during 1979, 1980 and 1981. During 1976 to 1979, Weir (pers. comm.) found one to three bald eagle nests annually along the lower Kuskokwim River between Bethel and Tuluksak and two on the Aniak River below the Salmon River confluence in 1979. A relatively large interior Alaska breeding bald eagle population has been described along the Tanana River, where some have been observed overwintering (Ritchie 1982).

The dispersed bald eagle population found along the wooded southwestern Alaska study rivers is much less dense than populations reported in Alaskan coastal areas such as Seymour Canal (Hodges 1982), Amchitka Island (Sherrod et al. 1976) and Kodiak Island (Troyer and Hensel 1965). Suitable nest substrate is not limiting for bald eagles on the southwestern Alaska study rivers, and overlap in food habits with other raptor species appears small. The different breeding bald

eagle densities are likely influenced by differences in food abundance. Sea bird colonies, waterfowl concentrations, large fish resources (including frequent salmon runs) and even garbage dumps in some coastal areas provide a greater concentration and abundance of food than found on the inland study rivers. On some study rivers, the first salmon runs may not begin until late June or early July. Prey remains collected from the base of two Kuskokwim River nests represent one Barrow's goldeneye, one mallard, four unidentified ducks, one Canada goose, one snowshoe hare, one sheefish, and four unidentified fish.

Osprey

Ospreys also occurred throughout the study area at low density and were seen on seven of 19 rivers surveyed by boat. Active nests were found along the Tatlawiksuk, Kuskokwim, East Fork George, Stuyahok and Gagaryah rivers. Ospreys were seen where nests were not found at the mouth of the Golsovia River, along the Yukon River near Pilot Station and along the Old Woman River. Findings along the Tatlawiksuk and Kuskokwim Rivers illustrate maximum nesting densities found. Three nests on the Tatlawiksuk in 1980 were separated by intervals of 17 km and 52 km air distance. In 1981, four osprey nests occurred at irregular intervals along a 185 km section of the Kuskokwim River for an average of one pair per 46 km of river with a closest straight line distance between nests of 13.5 kilometers. Weir found nests or adults with calling young on the Salmon, Kanektok and Aniak Rivers. No nesting concentrations that could be considered colonies were found in the study area as sometimes occur in the osprey's range where fish are abundant and accessible. Abundance of osprey in other regions of Alaska is not known, although reports available suggest fairly dispersed populations (Gabrielson and Lincoln 1959, Hughes 1982). Many kilometers of study rivers with fish present, especially arctic greyling, and apparently suitable nest trees, lacked breeding osprey. Turbidity of water may reduce prey availability; however, no trend was apparent between clear and turbid study rivers.

The 10 different nesting trees located were all white spruce. Diameter breast height measurements of the nest trees varied from 50 cm to 125 cm and averaged 90 cm. Nest tree heights ranged from 21 m to 35 m and averaged 29 meters. Five of the nest trees were live, and five were standing dead. Tops of six of the nest trees had broken off. Osprey nests were characteristically built in tops of trees rather than in a crotch among lower branches. All nest trees were within 45 m of rivers and were located in either open needleleaf forest (white spruce) or open mixed forest (spruce-birch, spruce-poplar) (Viereck et al. 1982).

Other Raptors

Raptor species other than those already discussed are present within the study area but cannot be accurately surveyed by river or aerial surveys due to preferences for non-riparian (or nonedge) nesting habitats, well concealed nests and in some instances relatively unobstrusive behavior. Some incidental observations of these other raptor species are described as an indication of their distributions.

Merlin

The merlin is a rare to locally common breeder in southwestern Alaska. Merlins were seen occasionally throughout the study area, in both the upper and lower Kuskokwim drainages and on certain study rivers west of the Yukon. Lone adults were seen along the Kisaralik, Chiroskey, Tuluksak, and Kuskokwim Rivers and Quicksilver Creek, and a defending pair was seen along the Golsovia River harrying a golden eagle. A pair along the Yukon River near Russian Mission defended a hillside area of poplar and white spruce that contained an empty stick nest, apparently built by sharp-shinned hawks. (Mindell and Craighead 1981). White and Boyce (1978) found a merlin ground nest on a burned over hillside along the Anvik River. During extensive work in the Tuluksak River valley, Weir (pers. comm.) found seven merlin nesting territories with an annual occupation of 50% to 70%, fairly evenly spaced at 2.5 to 3.0 km

intervals. Two Tuluksak River nests found were scrapes in leaf litter on the ground in dense paper birch and alder thickets. Additional merlin sightings by Weir were from the Salmon River (Kilbuck Mountains) and Kagati Lake (Kanektok River headwaters).

Prey remains from a perch site in the Yukon River merlin territory represented two black-capped chickadees, one yellow-rumped warbler and one *Catharus* sp. thrush. Elsewhere in the study area, single merlins were seen chasing a robin and a varied thrush.

Northern Harrier

Northern harriers ranged throughout the study area and were more commonly seen in wet tundra areas bordering portions of survey rivers west of the Yukon than in boreal habitats in the Kuskokwim drainage. Northern harriers were common on the Golsovia River where sightings were made at five locations spaced evenly along the 50 km of river surveyed. Northern harriers were seen in three different areas along the 35 surveyed kilometers of the Chiroskey River, and at two sites along the lower 22 km of the South River. Northern harriers defended strongly at three sites along the Golsovia and two sites along both the Chiroskey and South Rivers. Defended sites ranged up to 200 m from rivers, although all were within the floodplain. The seven defended sites were characterized by low shrub tundra and wet tundra. Two of the sites also included a scattering of white spruce and poplar. Additional sightings are from St. Marys, Otter Creek, North River, McGrath and three sites along the Kuskokwim in the Oskawalik to Aniak section. Apparent breeding northern harriers are reported from the Tuluksak and Salmon Rivers by Weir (pers. comm.). The present surveys suggest that northern harriers are uncommon to locally common breeders within southwestern Alaska. Large numbers of northern harriers seen during spring migration in the Copper River Delta (Islieb in Kessel and Gibson, 1978) near Yakutat (Swem 1982), along the Glenn Highway (R. Dittrick pers. comm.), and observations of my own in regions of the western Yukon Territory suggest a somewhat greater abundance within Alaska than previously reported.

Sharp-shinned Hawk and Goshawk

Sharp-shinned hawks and goshawks are generally forest dwellers and appear to be common to uncommon throughout southwestern Alaska within the taiga. Detailed nesting densities and relative abundances within the study area are little known for these two *Accipiter* species. Sharp-shinned hawks were seen during the breeding season along the Kuskokwim, East Fork George and Yukon Rivers. Clarke (1982) found that sharp-shinned hawk nest sites in the Fairbanks vicinity were in heterogenous taiga dominated by small deciduous trees with actual nests placed in conifers.

Active goshawk nests were found along the Tuluksak, Kuskokwim, Kisaralik and Old Woman Rivers. Goshawks showed nesting preference for deciduous tree stands, and deciduous trees in the Fairbanks area (McGowan 1975). I found five goshawk nests in tall riparian deciduous tree stands. Two nests were in aspen trees and three were in balsam poplar.

Great-horned Owl

Great-horned owls, the most abundant owl and apparently one of the most abundant raptor species along the study rivers, were seen at 32 different sites, including 11 nests or fledgling groups. Great-horned owl locations were scattered throughout all wooded regions of the study area along the following rivers: Kuskokwim, Chiroskey, Otter Creek, South, Oskawalik, Tuluksak, North, Takotna, Stony, Yukon, Sheep Creek (near Farewell) and Tatlawiksuk.

On the Kuskokwim River (n = 2 pair) and Sheep Creek (n = 1), great-horned owls nested on parasitic growths (mistletoe) in white spruce trees. A great-horned owl pair in the Tuluksak River valley has nested on a platform inside an abandoned gold dredge during at least eight years (first located by Weir). The dredge is also used as a sheltered winter roost site. Weir reports four breeding territories in the Tuluksak vicinity spaced regularly at approximately 5.4 km intervals.

Hawk Owl

Hawk owls were seen at eight different sites on the Selatna, Tatlawiksuk Oskawalik, Nunsatuk, Kuskokwim, Stuyahok and Yukon Rivers. On the Kuskokwim in 1980, a brood of three was found in a stick nest in a balsam poplar snag. Ravens had fledged young from the same nest in 1979. In 1982, a hawk owl pair along the Nunsatuk River, a Kuskokwim tributary, nested in the hollow at the tip of a 6 m tall balsam poplar stub. The Kuskokwim River nest tree was in an open (less than 60% canopy cover) stand of poplar trees separated from the river by a 35 m wide belt of tall willows and alder. The Nunsatuk nest was 45 m from the river in a closed (greater than 60% canopy cover) mixed deciduous-conifer forest. A family group with two recently fledged young were located in an extensive burned area on the Oskawalik River. Additional hawk owl sightings occurred in or adjacent to burned areas elsewhere on the Oskawalik, along the Stuyahok, and at two sites near Farewell. Outside the study area, two burn-associated nests have been reported by Meehan and Ritchie (1982) near Fairbanks. Fires may benefit hawk owls by rejuvenating small mammal habitat and providing more open areas suitable to hunting from a perch; however, no data are presently available to test this idea.

American Kestrel

American kestrels are rare in the study area (possibly casual) and are strikingly less common than in portions of central and southeast Alaska. Only three sightings of American kestrels were made during the present study. A male and female were seen 6 km apart on the Golsovia River. They probably represent at least one breeding attempt, although no nest was found, as a passing great-horned owl provoked strong defense from the female. A single adult male was seen along the Yukon River one km from the Dalton Highway bridge during June 1981. Individuals have been reported from Cape Pierce and near Platinum in August and September, respectively (Weir, D., M. Peterson and M. Dick, "Birds of the Kilbuck and Ahklun Mountains and nearby islands," Ms. in review). Actual nesting is likely but has apparently not yet been reported in the study area.

American kestrels are generally adaptable and successful in areas of moderate human activity. In parts of central and southcentral Alaska they may be seen more frequently near such disturbance areas as roads, railroads, or powerline right-of-ways, and small towns than in undisturbed regions west of Denali National Park.

Boreal Owl

Nesting boreal owls were seen at Stony River and two locations in McGrath. Boreal owls were heard calling along the Oskawalik and Nunsatuk Rivers. Boreal owls are inconspicuous birds that frequent forested habitats, and as such are likely more common in the study area than the low encounter rate suggests.

Short-eared Owl

A short-eared owl was seen near Gibralter Point on the Kuskokwim River in June 1979. Another was seen chasing passerines and American golden plovers by the McGrath airstrip during late May, 1982. Weir reports one sighting from the Kanektok River.

Great Gray Owl

A territorial pair of great gray owls was found near the confluence of the Kuskokwim and Tatlawiksuk Rivers. One adult (apparently hunting) moved between perch sites at the edge of an abandoned cabin clearing and back into a dense stand of paper birch. A molted great gray owl tail feather was found along the Yukon River near Anvik. Weir reports two different nest sites along the Tuluksak River and sightings along the Kisaralik and Eek Rivers.

Impacts, Protection and Recommendation

Land Use Impacts

Health and size of raptor populations depend upon availability and quality of suitable habitat. Where various land use activities alter vegetation structure and composition or increase disturbances, raptors and their prey will likely be affected. Land use activities in southwestern Alaska are limited compared to those in more populated regions of North America; however, activities are concentrated in certain areas and will probably increase in the future.

Mining can cause extensive environmental change through removal of vegetation, creation of tailing piles and spoil banks, and alteration of stream flow and water quality. Large scale mining efforts occur within the study area at Nyac, Flat, and in the Goodnews Bay vicinity, with smaller scale mining and mineral exploration operations scattered elsewhere. Timber cutting for house logs and use by small sawmills to supply local needs also occur on a small scale. Disturbances and development related to human habitation are centered around villages and include local vegetation clearing and house construction, limited road construction, and aircraft and boat traffic. Excluding the immediate vicinity of villages, recreational use is light during most of the year.

Existing Protection Measures

All raptorial bird species are federally protected from persecution under the Migratory Bird Treaty Act, expanded for their inclusion in 1972. Shooting of raptors is punishable by fine and/or imprisonment, excluding snowy owls which remain legal quarry for subsistence hunters in some portions of Alaska. Under the Bald and Golden Eagle Act (16 U.S. C. 668-668d), protection for these two species extends to their nests, eggs, and nesting substrate. The Endangered Species Act of 1973 as amended (16 U.S.C. 1531 et seq.) affords protection to threatened or endangered animal species and to habitat deemed "critical" to their survival. However, designation of critical habitats is a controversial problem. The goal of this act is to facilitate population increases and eventually remove species from the threatened or endangered list. BLM Manual Section 6840, pursuant to the Endangered Species Act, provides management directives and, along with the Federal Land Policy and Management Act of 1976, mandates conservation of wildlife and its habitats on public lands (see Olendorff and Zeedyk 1978).

A recovery plan emphasizing specific disturbance restrictions has been developed for peregrine falcons (*Falco peregrinus anatum* and *F. p. tundrius* by the USFWS and the Alaska Peregrine Falcon Recovery Team (U.S. Fish and Wildlife Service 1982). The restrictions require that within one mile of peregrine falcon nest sites: aircraft remain 1,500 feet (450 m) above nest level between 15 April and 31 August, all ground level activity not on existing thoroughfares be prohibited between 15 April and 3 August, and that habitat alterations or construction of permanent facilities be prohibited. Within two miles of peregrine falcon nest sites, permanent facilities with high noise levels, sustained human activity, or that alter limited high quality habitat are prohibited. High noise levels from nonpermanent facilities between 15 April and 31 August are also prohibited. Within 15 miles of nest sites alteration of "limited high quality habitat" which could significantly reduce prey availability is prohibited. Wetlands are of particular concern.

Proposed Protection Measures

In addition to insuring compliance with the Endangered Species Act, BLM Manual Section 6840 recognizes the need to provide special consideration in land use planning to species considered sensitive by state wildlife agencies and BLM state offices. Sensitive species are described in BLM Manual Section 6840 as those " . . . having populations consistently small and widely dispersed such that any appre-

ciable reduction in numbers, habitat availability, or habitat condition might lead toward extinction." Sensitive status is generally assigned to avert, through habitat protection or management, a later need for threatened or endangered status. At the time of writing, neither the Alaska Department of Fish and Game nor the BLM Alaska State Office has a listing of animal species considered sensitive. Three raptor species present in the southwestern Alaska study area are suggested for consideration for sensitive status: the gyrfalcon, merlin and great gray owl.

Granting of sensitive status by Federal or State agencies entails a commitment to habitat protection or management. That commitment holds until population increases or further surveys show that population levels are high enough to warrant removal of sensitive status. The three species of raptors proposed for consideration as sensitive breed within the study area at low densities and have demonstrated susceptibility to human impacts. They have either experienced known population declines elsewhere in North America (merlin) or occur at low density throughout their range (gyrfalcon, merlin, great gray owl). More detailed abundance information is particularly needed for great gray owls and merlins. Swainson's hawks may occur rarely within the study area; however, since most of Alaska is peripheral to the Swainson's hawk present range it would not be an appropriate candidate for sensitive status in Alaska.

Rapid development and subsequent habitat alteration within Alaska necessitate some guidelines which can be used by land management agencies to protect raptor nesting areas of value. Thus, suggested disturbance restrictions for the proposed candidate sensitive species and three other raptor species of concern are given in Table 12. Osprey, bald and golden eagles are included in Table 12 because they also breed at low density in the study area and have experienced major population declines elsewhere in their respective ranges. These three species are not presently proposed as candidates for sensitive status as they are relatively more abundant in North America. The nest site restrictions are similar to those adopted by an Alaskan interagency team for protection of gyrfalcons, rough-legged hawks, and other nonendangered raptors during and after construction of oil and gas pipeline rights-of-way (Lou Pamplin pers. comm., see Olendorff and Zeedyk 1978). Facilities constructed and used outside the sensitive time period, such as trapper shelters, are generally not detrimental to breeding raptors. The sensitive time periods described in Table 12 span the nesting period from site selection and egg laying to departure of young during most years. Peak sensitivity of raptors to disturbance is generally prior to and during egg laying and incubation (Call 1978). The nest site restrictions should be reevaluated and possibly changed when more information is available concerning disturbance effects.

Recognizing habitat protection as one of the most important factors in maintaining viable raptor populations, Voous (1977) suggests that habitats of relatively common and stable raptor species also receive protection and management consideration. Voous further recommends an ecosystems approach including protection of large areas or reserves in each ecosystem where raptors still occur in large numbers and diversity. Accordingly, active nests of all raptors, even those lacking special status, should be protected from physical human disturbances and potentially disturbing activities should be discouraged within at least 30 m of nests. Two regions with relatively dense raptor populations within southwestern Alaska that would benefit from an ecosystems protection approach are the Kuskokwim River between Sterling Landing and Aniak and the upper Kisaralik River drainage between Gold Creek and Clear Creek.

Specific raptor management techniques and their applications have been reviewed by Olendorff et al. (1980), and it is beyond the scope of this report to provide management plans. Some measures to benefit raptors within the study area, however, do bear mentioning. Where mining is prevalent, attempts should be made to promote revegetation of cleared areas including tailings piles. In logging areas, 30 m to 50 m wide strips of timber should be left bordering rivers, and restricted cutting should leave at least two dominant trees per acre in a belt 40 m to 80 m distant from rivers. Woodcutters should be encouraged to leave snags where possible. Creating or enhancing nest ledges for

peregrine falcons may prove worthwhile, especially where unsuccessful pairs have been seen or where rough-legged hawk nests without protective rock overhangs have been used. Land exchanges to acquire and protect endangered species nesting sites or areas of raptor nesting concentration also should be considered.

Topics for Further Study

The emphasis of this study has been on riparian breeding raptors. Most other Alaska raptor surveys also have been either riparian or coastal, due to the lack of roads and general difficulty of gaining access to many areas. Peregrine falcons have received the vast majority of past survey efforts in interior Alaska, since most survey funding has been specifically for endangered species. Thus, there is a great need to learn more about the lesser studied species, and to survey nonriparian areas in greater detail. Much remains to be learned about habitat requirements, relative abundances and diversity of species within different types of habitat, and the basic ecology of populations. Which species populations normally fluctuate in this northern environment, which do not, and to what extent? What effects do various habitat alterations have? Mining and fire effects are especially pertinent concerns for the BLM in southwestern Alaska. This information would be valuable in preserving and monitoring populations of species that are considered by many (see Curry-Lindahl 1977) to be indicators of balanced ecoystems and environmental quality.

Summary

Surveys for nesting raptors (avian order Falconiformes) were conducted by boat along 16 rivers in southwestern Alaska north of the Alaska Peninsula during 1979 and 1980. The Kuskokwim River McGrath to Aniak section was surveyed annually from 1979 through 1982. Limited additional surveys were made by helicopter. Survey rivers were selected on the basis of being within areas of BLM jurisdiction and having potential for cliff nesting raptors.

Principle findings are:

1. Peregrine falcon pairs were found at seven different sites within the Kuskokwim River drainage and lone defending adults were seen at four additional locations.

2. Consistent reoccupation of known peregrine falcon nesting sites within the study area and increasing numbers of pairs on the Kuskokwim in 1981 and 1982 reflect the general rebuilding trend for interior Alaska breeding peregrines.

3. Average brood size from 14 peregrine nests was 2.7.

4. Of 562 individuals identified from peregrine prey remains on the middle and lower Yukon River, waterfowl and grebes accounted for 36.92% of the total by weight, followed by shorebirds at 22.32%, passerine birds at 16.12%, jaegers, gulls and terns as a group at 14.26%, mammals at 5.46% and woodpeckers and kingfishers at 3.8 percent.

5. Red-tailed hawks, common to abundant in the Kuskokwim drainage where a four year total of 107 nest sites were found, were uncommon to rare west of the Yukon River.

6. Close groupings of red-tailed hawk nests were often found along certain river sections bordered by large unoccupied sections of similar appearing habitat on each end.

7. Average distance between 35 red-tailed hawk nest sites found along the Kuskokwim River in 1981 was 9.6 km, and inter-nest distances within nest groupings were as low as 1.7 km (n = 3 nests).

8. Average brood size from 21 red-tailed hawk nests was 2.16.

9. Rough-legged hawks occurred throughout the study area but were restricted in local distribution by availability of cliff nesting sites.

10. Number of rough-legged hawk pairs along a 160 km section of the Kuskokwim River increased from 9 to 11 to 15 during 1979, 1980 and 1981, respectively, and numbered

15 again in 1982. The three year increase was accompanied by increasing average brood sizes and more uneaten prey items stocked in nests and may have reflected general increases in prey species abundance.

11. Sixty-five percent of 83 rough-legged hawk prey individuals identified from pellets or remains were voles, 28% were birds (14% Tetraonidae, 14% passerines), 2% were arctic ground squirrels, 2% were snowshoe hare, and 2% were red squirrels.

12. Rough-legged and red-tailed hawks were both attracted to riparian nest sites, shared several prey resources, and adjacent pairs of the two species were seen with overlapping territories during the breeing season.

13. Observed relative stability of nesting red-tailed hawk populations compared to rough legged hawk populations suggested different use of the available prey resource by the two species.

14. Gyrfalcons, golden eagles and osprey were widespread but generally uncommon breeders within the study area. Local high densities of gyrfalcons and golden eagles were found in a few areas.

15. Additional species observed in the study area were: merlin, marsh hawk, sharp-shinned hawk, goshawk, great-horned owl, hawk owl, American kestrel, boreal owl, short-eared owl and great gray owl.

16. Three species are proposed as candidate sensitive species: the merlin, gyrfalcon and great gray owl.

17. Proposed nest site disturbance restrictions for use by land managers are displayed for six species (Table 12).

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Appendix 1

Dates and Put-in Locations for Raptor Surveys Conducted by Boat in Southwestern Alaska.

Rivers	Survey Dates	Put-In Location	
Selatna	6/8 – 14/79	62°26'40"N	155°26'30"W
Tatlawiksuk	6/15 – 18/79 7/5/80	62°07'31"N	155°31'00"W Mouth
Cheeneetnuk	6/25 – 7/1/79	62°05'06"N	154°58'45"W
Kuskokwim	7/2 –7/79 7/3 – 9/80 6/15 – 7/15/81 5/21 – 7/15/82		McGrath McGrath McGrath McGrath
Golsovia	7/2 – 11/79	36°15'12"N	161°16'10"W
Chiroskey	7/16 – 18/79	36°39'50"N	160°26'20"W
Otter Creek	7/18 – 19/79	63°16'20"N	160°36'40"W
Canyon Creek	7/19/79	63°16'00"N	160°46'20"W
South	7/25 – 27/79	63°33'10"N	160°46'20"W
E. Fork George	7/31 – 8/2/79	62°11'16'N	156°57'43"W
Stuyahok	6/8 – 12/80	62°06'01"N	156°57'43"W
Gagaryah	6/17 – 20/80	61°51'05"N	154°47'42"W
Oskawalik	6/21 – 23/80	61°35'53"N	157°41'36"W
Tuluksak	7/15/80	61°02'16"N	159°56'06"W
Old Woman	7/26 – 27/80	63°41'36"N	159°48'36"W
North	7/28 – 31/80	62°24"31"N	159°56'28"W

Appendix 2

List of Nonraptorial Birds Seen

List of nonraptorial birds seen on survey rivers and in two other areas (surrounding 10 km radius). C=Common (seen frequently); U=Uncommon (seen occasionally); *=active nest or young seen; Blank=not seen; +=sighting made prior to 20 May, likely migrant. This appendix is simply a list of species observed rather than a comprehensive check-list for the river areas. Searches were not made for all species present, and more time was spent observing and hiking in some areas than in others.

BIRD SPECIES	OBSERVATION RIVERS AND AREAS						
	FAREWELL AREA	KUSKOKWIM	SELATNA	TATLAWIKSUK	CHEENEETNUK	GAGARYAH	E. FK. GEORGE
Common loon		U					
Arctic loon		U					
Red-throated loon		U	U	U	U		
Red-necked grebe		U					
Horned grebe	U*						
Tundra swan		U*					
Canada goose		C*	C*	C*	C*	U*	C*
White-fronted goose		C	C*	U	U*		C*
Snow goose		U+					
Mallard		U	U	U			C*
Pintail		U	U				U
Northern shoveler		C					
American wigeon		C	U	C			

OSKAWALIK		U	U	U	
NYAC AREA	U	U	U	U	
KISARALIK				U	
STUYAHOK		C*	U	C	C
OTTER CREEK		C*		U*	
CANYON CREEK					
CHIROSKEY				U	
OLD WOMAN		U*			
NORTH					
SOUTH					
GOLSOVIA	C			U	U

Appendix 2. Cont'd.

BIRD SPECIES	OBSERVATION RIVERS AND AREAS						
	FAREWELL AREA	KUSKOKWIM	SELATNA	TATLAWIKSUK	CHEENEETNUK	GAGARYAH	E. FK. GEORGE
Green-winged teal	U	C	C	C			C*
Scaup sp.	C	C					U
Common goldeneye		C	U		U		C
Harlequin duck		U	U	C	C	U	C*
Common eider							
Surf scoter		C					U
White-winged scoter		U					
Common merganser		C	U	U	C		
Red-breasted merganser		C	C	C	C	C	C
Spruce grouse		C			U		
Ruffed grouse		C					
Willow ptarmigan	U						
Sharp-tailed grouse	U						
Sandhill crane	U	C					
American golden plover		C					
Semipalmated plover		C*	C*	C	U	C*	U
Whimbrel		U					
Hudsonian godwit		U					
Solitary sandpiper		C					U
Spotted sandpiper		C*	C	C	C*	C	C
Lesser yellowlegs		C	U	U	U	U	C

OSKAWALIK	NYAC AREA	KISARALIK	STUYAHOK	OTTER CREEK	CANYON CREEK	CHIROSKEY	OLD WOMAN	NORTH	SOUTH	GOLSOVIA
U	C*	U	C	C	C*		C*			C*
	U	U								
U	U*	C	C	U*	C	C*	C*	C*	C*	C*
										C
U		U								
C	U	C	C	C	C	C*	C*	C*	C*	C*
	C									U
		C								
										C
U*	U		U							
								C		
C	U	C	C	C	C	C	C*	C*	C*	C
U	U		C			C	C		U	U

Appendix 2. Cont'd

BIRD SPECIES	OBSERVATION RIVERS AND AREAS						
	FAREWELL AREA	KUSKOKWIM	SELATNA	TATLAWIKSUK	CHEENEETNUK	GAGARYAH	E. FK. GEORGE
Least sandpiper		U					
Pectoral sandpiper				C	U		
Sanderling							
Western sandpiper							
Black turnstone		U+					
Northern phalarope							
Common snipe		C*	U	C	C		
Long-billed dowitcher		U					
Parasitic jaeger							
Long-tailed jaeger	C	U					
Glaucous gull		U					
Glaucous-winged gull[1]		C		U		U	
Herring gull [1]		U		U			
Mew gull		C		U			U
Bonaparte's gull		U					
Arctic tern		C	U	U		U	
Common murre							
Hummingbird sp.							
Belted kingfisher		C*	U	U			C
Hairy woodpecker		U					
Common flicker	U						

[1]Hybridization by large gull species made specific identification difficult

	OSKAWALIK	NYAC AREA	KISARALIK	STUYAHOK	OTTER CREEK	CANYON CREEK	CHIROSKEY	OLD WOMAN	NORTH	SOUTH	GOLSOVIA
											U
				U							
		U	U								
	C*	C	C	C*							C
				U							
											C
											C
					C	C*	U	C		C	C
		C	C	C*	C*			U	C*		C*
				C*							
		C*	C	C*				C	C		C
											U
		U									
		U*				C	C	U		C	U
											U

Appendix 2. Cont'd.

BIRD SPECIES	OBSERVATION RIVERS AND AREAS						
	FAREWELL AREA	KUSKOKWIM	SELATNA	TATLAWIKSUK	CHEENEETNUK	GAGARYAH	E. FK. GEORGE
Northern 3-toed woodpecker		U					
Say's phoebe							
Alder flycatcher		C	C	C	C		C
Olive-sided flycatcher	U			U			
Horned lark							
Cliff swallow		C*	C*	C*	C*		
Violet-green swallow		C	C*	C	C*	C	
Tree swallow	C	C	C	C	C	C	
Bank swallow		C*	C*	C*	C*		C*
Gray jay		C	U	U	C*	U	C
Black-billed magpie							
Common raven	C*	C*	C*	C*			
Black-capped chickadee	U	U	U				C
Boreal chickadee		U			U	C	
Dipper					U*	C*	
Robin	C	U		U	U		C
Varied thrush	C	C		C*	C	U	
Hermit thrush		U					
Swainson's thrush	C	C		C	C	C	
Gray-cheeked thrush	C	C			C	C	
Arctic warbler							

OSKAWALIK	NYAC AREA	KISARALIK	STUYAHOK	OTTER CREEK	CANYON CREEK	CHIROSKEY	OLD WOMAN	NORTH	SOUTH	GOLSOVIA
						U				
		C*		U	C			U	C	C*
C										C
						U				
		U*								
C*	U*	C*		C*	C*			C*		C*
U	C						C*	C		
U	C*	C	C							
U*			U*	C*	C*	C*				
	C*		C	C	C	C	C	U	C	C
		U*								
		C								
	C	U			C*				C	
	C		C		C	C				
	U	C*		C*				U*		
	C	C*		C		C	U			
C	C	C	C			C	U			
	U					C			U	
U	C						U			
U	C	C	C				C*		C	
	C									

Appendix 2 Cont'd.

BIRD SPECIES	OBSERVATION RIVERS AND AREAS						
	FAREWELL AREA	KUSKOKWIM	SELATNA	TATLAWIKSUK	CHEENEETNUK	GAGARYAH	E. FK. GEORGE
Ruby-crowned kinglet	U	U					
Water pipit		C					
Yellow wagtail							
Bohemian waxwing		U	U	C	C	U	
Northern shrike							C
Orange-crowned warbler		U					
Yellow warbler		C	C	C	C		
Yellow-rumped warbler	C	C	C	C	C	C	C
Blackpoll warbler		U			U	U	
Northern waterthrush		C	C	C	C	C	C
Wilson's warbler		C	C		C		
Rusty blackbird		U	C	C	C		C
Gray-crowned rosy finch					U		
Common redpoll		C	C	C	U		
White-winged crossbill		U					
Savannah sparrow	C*	C*					
Tree sparrow							
Dark-eyed junco	C	C			U	U	U
White-crowned sparrow	C*	C	C	C	C		
Fox sparrow		C	C*	C			U
Golden-crowned sparrow							

OSKAWALIK	NYAC AREA	KISARALIK	STUYAHOK	OTTER CREEK	CANYON CREEK	CHIROSKEY	OLD WOMAN	NORTH	SOUTH	GOLSOVIA
									U	
U		U							C*	
U										
	U	C	C	C	C					C
U			C			C	U			
	U*		U							
C	C	C	C	C	C	C	C		C	C
U	C	C	C		C	C				C
	U		C*						C	
	U	U	C	C						C
	U	C*								C
	C	C	C*							C
	U		C			C	C	U	C	C
	C	C*	U		C	C				C
		U	C							
	C	C*								

Appendix 2. Cont'd.

BIRD SPECIES	OBSERVATION RIVERS AND AREAS						
	FAREWELL AREA	KUSKOKWIM	SELATNA	TATLAWIKSUK	CHEENEETNUK	GAGARYAH	E. FK. GEORGE
Lapland longspur		U			U		
Snow bunting							

		OSKAWALIK
		NYAC AREA
U	C	KISARALIK
		STUYAHOK
		OTTER CREEK
		CANYON CREEK
		CHIROSKEY
		OLD WOMAN
		NORTH
		SOUTH
	C	GOLSOVIA

Appendix 3

Common and Scientific Names of Birds, Mammals, Fish and Plants Mentioned in this Study.

Birds

Common loon, *Gavia immer*
Arctic loon, *Gavia arctica*
Red-throated loon, *Gavia stellata*
Red-necked grebe, *Podiceps grisegena*
Horned grebe, *Podiceps auritus*
Tundra swan, *Cygnus columbianus*
Canada goose, *Branta canadensis*
White-fronted goose, *Anser albifrons*
Mallard, *Anas platyrhynchos*
Pintail, *Anas acuta*
Northern shoveler, *Anas clypeata*
American wigeon, *Anas americana*
Scaup sp., *Aytha* sp.
Green-winged teal, *Anas crecca*
Common goldeneye, *Bucephala clangula*
Harlequin duck, *Histrionicus histrionicus*
Common eider, *Somateria mollissima*
Surf scoter, *Melanitta perspicillata*
White-winged scoter, *Melanitta fusca*
Common merganser, *Mergus merganser*
Red-breasted merganser, *Mergus serrator*
Goshawk, *Accipiter gentilis*
Northern harrier, *Circus cyaneus*
Rough-legged hawk, *Buteo lagopus*
Red-tailed hawk, *Buteo jamaicensis*
Golden eagle, *Aquila chrysaetos*
Bald eagle, *Haliaeetus leucocephalus*
Osprey, *Pandion haliaetus*
Gyrfalcon, *Falco rusticolus*
Peregrine falcon, *Falco peregrinus*
Merlin, *Falco columbarius*
American kestrel, *Falco sparverius*
Spruce grouse, *Dendragapus canadensis*
Sharp-tailed grouse, Tympanuchus phasianellus
Sharp-tailed grouse, *Tympanuchus phasianellus*
Willow ptarmigan, *Lagopus lagopus*
Rock ptarmigan, *Lagopus mutus*
Sandhill crane, *Grus canadensis*
American golden plover, *Pluvialis dominica*
Semipalmated plover, *Charadrius semipalmatus*
Whimbrel, *Numenius phaeopus*
Hudsonian godwit, *Limosa haemastica*
Solitary sandpiper, *Tringa solitaria*
Spotted sandpiper, *Actitis macularia*
Greater yellowlegs, *Tringa melanoleuca*
Lesser yellowlegs, *Tringa flavipes*
Least sandpiper, *Calidris minutilla*
Pectoral sandpiper, *Calidris melanotos*
Sanderling, *Calidris alba*
Western sandpiper, *Calidris mauri*
Red-necked phalarope, *Phalaropus lobatus*
Common snipe, *Gallinago gallinago*
Long-billed dowitcher, *Limnodromus scolopaceus*
Parasitic jaeger, *Stercorarius parasiticus*
Glaucous-winged gull, *Larus glaucescens*
Herring gull, *Larus argentatus*
Mew gull, *Larus canus*
Bonaparte's gull, *Larus philadelphia*
Sabine's gull, *Xema sabini*
Arctic tern, *Sterna paradisaea*
Common murre, *Uria aalge*
Great horned owl, *Bubo virginianus*
Snowy owl, *Nyctea scandiaca*
Great gray owl, *Strix nebulosa*
Short-eared owl, *Asio flammeus*
Hawk owl, *Surnia ulula*
Boreal owl, *Aegolius funereus*
Belted kingfisher, *Ceryle alcyon*
Hairy woodpecker, *Picoides villosus*
Common flicker, *Colaptes auratus*
Northern three-toed woodpecker, *Picoides tridactylus*
Say's phoebe, *Sayornis saya*
Alder flycatcher, *Empidonax alnorum*
Olive-sided flycatcher, *Contopus borealis*
Horned lark, *Eremophila alpestris*
Cliff swallow, *Hirundo pyrrhonota*
Violet-green swallow, *Tachycineta thalassina*
Tree swallow, *Tachycineta bicolor*
Bank swallow, *Riparia riparia*
Gray jay, *Perisoreus canadensis*
Common raven, *Corvus corax*
Black-capped chickadee, *Parus atricapillus*
Boreal chickadee, *Parus hudsonicus*
Dipper, *Cinclus mexicanus*
Robin, *Turdus migratorius*
Varied thrush, *Ixoreus naevius*
Hermit thrush, *Catharus guttatus*
Swainson's thrush, *Catharus ustulatus*
Gray-cheeked thrush, *Catharus minimus*
Arctic warbler, *Phylloscopus borealis*
Water pipit, *Anthus spinoletta*
Yellow wagtail, *Motacilla flava*
Bohemian waxwing, *Bombycilla garrulus*
Northern shrike, *Lanius excubitor*
Orange-crowned warbler, *Vermivora celata*
Yellow warbler, *Dendroica petechia*
Yellow-rumped warbler, *Dendroica coronata*
Blackpoll warbler, *Dendroica striata*

Northern waterthrush, *Seiurus noveboracensis*
Wilson's warbler, *Wilsonia pusilla*
Rusty blackbird, *Euphagus carolinus*
Gray-crowned rosy finch, *Leucosticte arctoa*
Common redpoll, *Carduelis flammea*
White-winged crossbill, *Loxia leucoptera*
Savannah sparrow, *Passerculus sandwichensis*
Tree sparrow, *Spizella arborea*
Dark-eyed junco, *Junco hyemalis*
White-crowned sparrow, *Zonotrichia leucophrys*
Fox sparrow, *Passerella iliaca*
Golden-crowned sparrow, *Zonotrichia atricapilla*
Lapland longspur, *Calcarius lapponicus*

Mammals

Red-backed vole, *Clethrionomys rutilus*
Black bear, *Ursus americanus*
Red squirrel, *Tamiasciurus hudsonicus*
Arctic ground squirrel, *Citellus undulatus*
Snowshoe hare, *Lepus americanus*

Fish

Arctic grayling, *Thymallus arcticus*

Plants

White spruce, *Picea glauca*
Black spruce, *Picea mariana*
Quaking aspen, *Populus tremuloides*
Balsam poplar, *Populus balsamifera*
Paper birch, *Betula papyrifera*
Dwarf arctic birch, *Betula nana*
Labrador tea, *Ledum palustre*
Wild rose, *Rosa acicularis*
Bluejoint, *Calamagrostis canadensis*
Cotton grass, *Eriophorum* sp.
Horsetail, *Equisetum* sp.
Fireweed, *Epilobium* sp.
Willow, *Salix* sp.
Thinleaf alder, *Alnum tenuifolia*
Alder, *Alnum* sp.
Mountain cranberry, *Vaccinium vitis-idaea*
Cranberry, *Vaccinium* sp.

Appendix 4

Study River Descriptions.

River	Topography and Geology[1]	Riparian Vegetation[2]	Travel Conditions
Selatna	The river flows through low rolling hills. In its upper reaches the river flows S of a 329 m tall hill consisting of tightly folded Mesozoic age rocks with gray-wacke, argillite, conglomerate, and greenstone flows. Steep banks cut into hill producing rock slides and a few low cliffs.	Mixed conifer and deciduous forests predominate, with white spruce and balsam poplar being the most common tree species. The understory consists mostly of willow, alder, wild rose and other shrubs.	Two large log jams would have made navigation farther than 16 km upriver impossible.
Tatlawiksuk	The river flows through a wide, flat valley and has cut a few scattered cliffs and steep banks into several large hills that are 360 m – 390 m in elevation.	Mixed conifer and deciduous forests predominate. The lower river portion is surrounded by muskeg-bog areas.	During June 1979, the lower 32 km of river could have been traveled in a motor-boat with a 0.35 m draft.
Cheeneetnuk	The river heads in the Limestone Mts. with many cliffs occurring along the river and on nearby mountain sides. 24 km from its mouth, the river leaves the foothills and meanders through a flat valley.	Mixed conifer and deciduous forests predominate. Alpine herbaceous tundra is present in adjacent mountains and black spruce stands and bogs are common along the lower section of the river.	During 1979, upriver travel in motorboat with a 0.35 m. draft would have been re-stricted by shallow water farther than 24 km from the mouth.
Kuskokwim	From McGrath to Devil's Elbow the river valley is 3 - 13 km wide with few cliffs. Below Devil's Elbow the river cuts across the Kuskokwim Mountains in a gorge 30 - 120 m deep. Exposed cliffs are sedimentary and com-posed mostly of siltstone, lime-stone and conglomerate.	Mixed conifer and deciduous forests predominate.	Generally, navigable by motorboats and barges with a draft of 1-2 meters.
Golsovia	The river cuts through sandstone and shales of Cretaceous Age, overlain by interbedded qua-ternary lava flows and ash deposits. The basalt lava cap on either side of the river provides nesting sites for raptors.	Riparian vegetation is mostly willow and alder with some balsam poplar, white spruce and black spruce stands. Non-riparian vegetation is generally shrub tundra and tussock trundra.	Frequent rock-choked areas make floating this river impractical for most of the season.

Chiroskey	The river runs to the west of and parallel to a long north-south ridge which ends in a section of exposed cliff where the river meets the Unalakleet River valley. This cliff consists of graywacke and is the only major cliff on the river.	Alder and willow are predominate along the banks. The flood plains contain scattered stands of white spruce, balsam poplar, black spruce, in addition to areas of shrub and tussock tundra.	During July 1979,the river was not navigable by motorboat.
Otter Creek and Canyon Creek	Otter Creek runs through an alluvial valley of silt, sand and gravel, with several rock outcroppings along the river. Canyon Creek runs through an area that experienced a great deal of faulting. Within 15 km of the Anvik confluence the Creek has cut a narrow canyon 6 m – 12 m deep on the south side with high cliffs of conglomeritic rock on the north.	Both creeks have extensive willow and alder riparian communities. The surrounding country has all been burned over within the past 20 years.	Because of low water levels, neither Otter nor Canyon Creek would have been navigable by small motorboat during July, 1979.
South River	The river originates in the Nulato Hills and cuts through the Shaktoolik formation group producing many cliffs of graywacke, shale, grit and conglomerate rocks.	The river flood plain contains stands of white spruce and balsam poplar with some paper birch. The river section closest to the mouth is surrounded by sedge-grass and tussock tundra.	Low water levels, frequent boulder courses, fallen trees and log jams, would make motorized navigation further than 5 km upriver from the mouth difficult. During July 1979, water depth was not sufficient to float a small raft.
East Fork George River and George River	The river valley is wide and flat, although along the lower section there are hills 180 m tall with cliffs in a few scattered locations.	The river cuts through a relatively tall and dense white spruce forest, mixed locally with birch or balsam poplar.	The George River and East Fork George are seasonally navigable by small motorized craft.
Stuyahok River	The river vally is wide and flat. Volcanic rock underlies the entire upper river area; however rock is exposed in only a few places. One cliff suitable for nesting raptors is present.	Mixed conifer and deciduous forests predominate. Tundra and black spruce bogs occur farther from the river.	During June 1980 the Stuyahok could have been traveled up river to an area 10 km downstream from the Stuyahok Mine in a boat with a .35 m draft.

Gagaryah River	The upper portion of the river flows through mountains of Paleozoic age graywacke, sandstones and shale. Cliffs occur regularly although many are 0.5 km or more distant from the river.	Mixed conifer and deciduous forests predominate. Black spruce bogs are common near the mouth.	Due to rock-choked areas and low water levels, the Gagaryah would have been navigable by a .35 draft boat less than 20 km upstream.
Oskawalik River	The river flows through mountains of Mesozoic age sedimentary rocks with cliffs composed of siltstone, limestone and conglomerate, and ranging in height from 20 m – 75 meters.	Mixed conifer and deciduous forests predominate. Large burn areas are characterized by dead black spruce spikes and a lush growth of shrubs and herbaceous plants.	Travel upriver in a .35 m draft boat would have been possible at least up to the put-in spot, 7 km north of Henderson Mountain.
Tuluksak River	The river portion above Granite Creek has several scliffs, 15 m – 27 m tall, of interbedded siltstone and graywacke. Foothills in the Nyac area are mostly sedimentary and higher mountain ridges are often granitic with frequent outcrops. Tailing piles average 7 m – 12 m in height and vary from 10 m to 1 km in length.	Vegetation in undisturbed areas is mostly mixed stands of white spruce and balsam poplar. In areas dredged for gold, volunteer willow and alders occur along the tailings and are interspersed with open mixed conifer and deciduous forest.	The short section covered was too shallow for small motorboats although there were no difficulties with the raft.
Old Woman River	The river crosses several faults and cuts through Shaktoolik formation slopes of graywacke, shale, grit and conglomerate, exposing cliffs at irregular intervals.	Mixed conifer and deciduous forests predominate.	Old Woman River could have been traveled in a .35 m draft boat for at least 10 km upstream from the mouth. The river was not floatable by raft further than 38 km (air distance) upstream.
North River	The river cuts through steep to rolling hills of metamorphosed sedimentary rock. For its upper half the river runs intermittently through narrow steep-walled canyons 15 m – 30 m in height.	Mixed conifer and deciduous forests predominate.	Due to narrow chutes and small rapids, motorized upriver travel would be restricted after 56 kilometers.

[1]Technical information for this section was gathered from Selkregg (1975) and observations.

[2]Vegetation types are used as described in Viereck and Dyrness (1980).

Appendix 5

1983 Status

Peregrine falcon observations on the Kuskokwim River in 1983 were (see Table 1): a lone adult a K1, a brood of two young at K2, a brood of four young at K3, on unsuccessful pair at K4, a brood of three young at K5, and an unsuccessful pair, including a brown plumaged female, at K6. A brood of three young peregrines were found at T1, and H1 was unoccupied. One young peregrine was found at L1, a lake associated site, and one young was found at L4, a new site.

On the Kuskokwim River in 1983 there were 14 rough-legged hawk nests, with 12 occurring between Red Devil and the Oskawalik River. The average brood size was 2.21 (n=14).

BLM-ALASKA TECHNICAL PUBLICATIONS

In 1977 we began publication of reports to make available to appropriate audiences the results of BLM-sponsored studies, symposia, and administrative practices that could be applied in public land management.

Most of the reports published to date have been intended to facilitate the application of research and study results and to communicate with the scientific community. Our purpose has been to improve multiple-use management of the public lands. There is also a wealth of resource management information derived from management experience and observation, rather than scientific studies. That information will be published through a series of Resources Management Notes.

One of our earlier reports dealt with raptors in Alaska.

White, C.M. and Boyce, D. A. A profile of various rivers and their raptor populations in western Alaska in 1977. BLM-Alaska Technical Report 1. 77 pp. 1978. (NTIS Accession No. PB-284965)

This report is out of print and no longer available from BLM. Copies may be purchased in either paper or microfiche from the National Technical Information Service (NTIS), Springfield, Virginia 22151.