

NATIONAL PARK SERVICE

ALASKA REGION

ANCHORAGE

PRELIMINARY INVESTIGATIONS FOR THE DEVELOPMENT OF A LONG-TERM
MONITORING PROGRAM FOR GOLDEN EAGLES (Aquila chrysaetos) NESTING IN
DENALI NATIONAL PARK AND PRESERVE, ALASKA

BY: CAROL L. McINTYRE, BIOLOGICAL TECHNICIAN
RESEARCH AND RESOURCE MANAGEMENT
DENALI NATIONAL PARK AND PRESERVE
BOX 9 DENALI PARK, ALASKA, 99755

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INTRODUCTION

This project was started in 1987 as part of the Denali Raptor Nest Inventory Project to collect baseline information on the breeding biology of Golden Eagles (Aquila chrysaetos) in the eastern portion of Denali National Park and Preserve.

GOAL

To provide the information necessary for the development of a long-term monitoring program for breeding golden eagles in Denali National Park and Preserve.

OBJECTIVES

The primary objectives of this study are:

1. locate golden eagle breeding territories,
2. determine occupancy rates, nesting success, and productivity rates,
3. document breeding phenology,
4. document food habits,
5. document nest site characteristics,
6. investigate migration routes and wintering areas.

STUDY AREA

This project is being conducted in the eastern portion of Denali National Park and Preserve. The boundaries of the study area are the George Parks Highway, the crest of the Alaska Range, an imaginary line from Jeffery's Dome due north, and the northern boundary of the former Mount McKinley National Park, an area of approximately 5,500 square kilometers, (Figure 1). For a more detailed description of the study area refer to McIntyre et al. 1988.

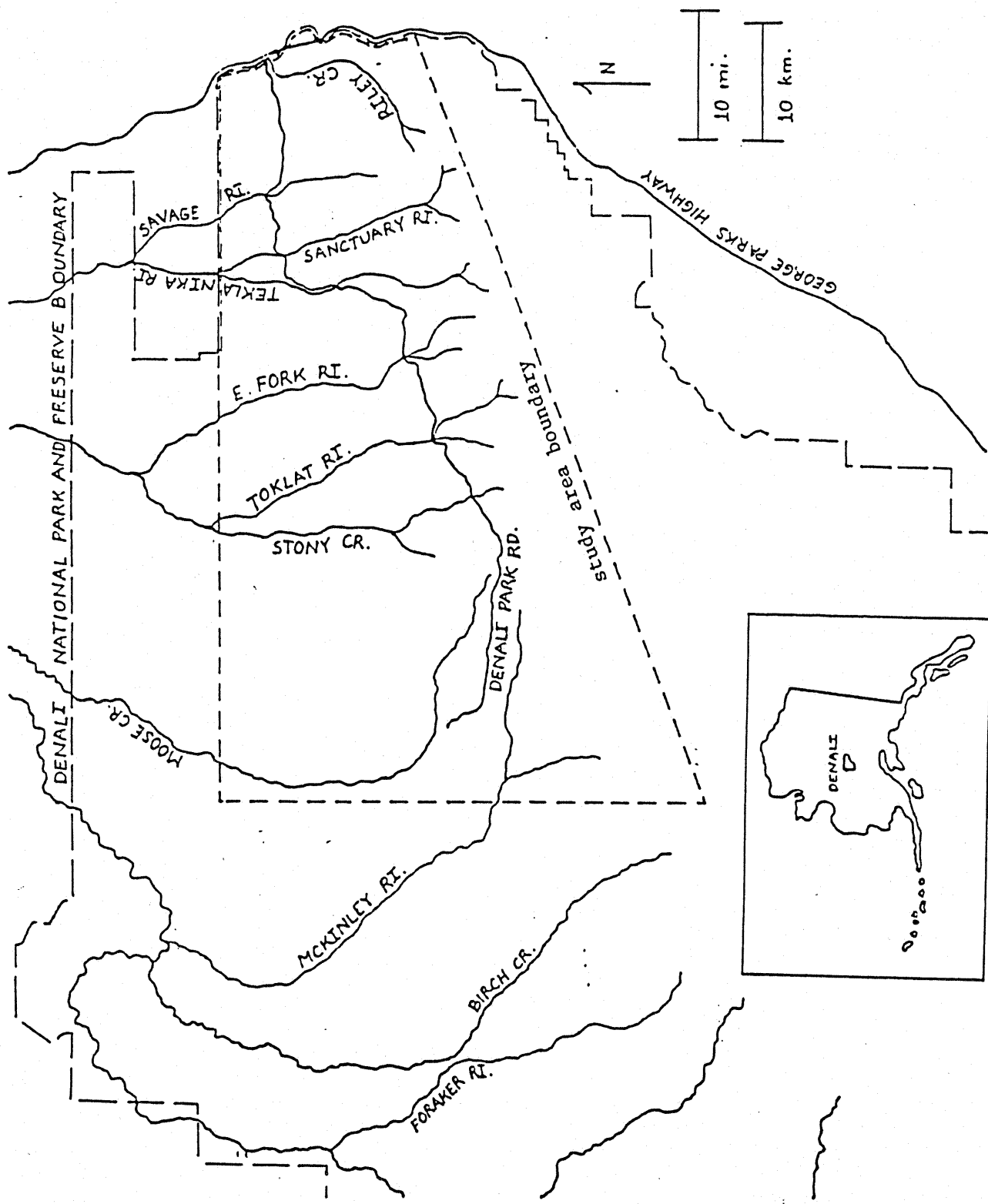


Figure 1. Study area, eastern portion of Denali National Park and Preserve, Alaska.

METHODS

Field work commenced on 1 March 1988 and ended on 26 August 1988. All breeding activity and nest site characteristic information was recorded on Alaska Raptor Observation and Nest Record Cards (refer to Britten and McIntyre, 1988). Nest locations were plotted on U.S. Geological Survey 1:63,360 and 1:250,000 topographical maps. All information was entered into the Denali Raptor Nest Inventory.

Terminology used to describe breeding territory status follows Postupalsky (1974, 1981, pers. comm.) and Steenhoff (1987) (Appendix 1). A breeding territory is defined as an area containing one or more nests within the range of one pair of mated birds. A breeding territory was considered to be occupied if one or two birds showing territorial behavior were observed. A breeding territory was considered to be occupied-breeding if it contained a nest where eggs were laid. Evidence of eggs included adults observed in an incubating posture in the nest, eggs in the nest, young in the nest, or fresh eggshells in the nest. An occupied nest is defined as a nest where eggs were laid. A breeding territory was considered to be occupied-breeding unknown if no evidence of egg-laying was found but the breeding territory was occupied by one or two territorial birds. A nest was considered successful if at least one young was raised to at least 80% of its fledgling age (Steenhoff 1987) and no subsequent information documented mortality of the fledgling before leaving the nest after that time. A nest was considered unsuccessful if no young were raised to fledgling age.

Aerial and Ground Surveys

Aerial and ground surveys were used throughout the field season to locate breeding territories, determine occupancy of breeding territories, count the number of incubating adults early in the breeding season, monitor breeding activities throughout the breeding season, and count the number of fledglings later in the breeding season.

An aerial survey was conducted on 21 April 1988 to observe breeding activities at known breeding territories to determine dates of egg-laying. Aerial surveys were conducted on 10 May and 11 May 1988 to count the number of occupied breeding territories and occupied nests throughout the study area. All known breeding territories located in the study area were observed during the 10 May and 11 May 1988 aerial surveys. All aerial surveys were conducted by two experienced observers from a Bell 206 B Jet Ranger Helicopter.

Dates to conduct the 10 May and 11 May 1988 surveys were determined by using breeding phenology data reported for golden eagles in Denali in 1987 (Britten and McIntyre 1988), by observations of breeding activities recorded on the 21 April 1988 aerial survey, and by ground observations made in March and April 1988. This survey was conducted at a time when most breeding birds should have completed their clutches and prior to the time of egg-hatching, and before a significant number of nest failures occurred (Fraser et al. 1983, Steenhoff 1987).

Aerial surveys were conducted on 8 July, 10 July, 11 July, and 12 July 1988 to determine nesting success and to count the number of nestlings at each occupied nest. These surveys were conducted by one or two experienced observers from a Bell 206 B Jet Ranger Helicopter. Nest visits were also conducted during this period.

An aerial survey was conducted on 28 July 1988 to determine final breeding results at all known breeding territories. This survey was conducted by one experienced observer from a Bell 206 B Jet Ranger Helicopter. This survey was conducted when most nestlings had reached 80% of their fledgling age and before the time the fledglings actually leave the nest (Steenhoff 1987).

Ground surveys were conducted between 1 March and 26 August 1988. These surveys were used to locate breeding pairs, monitor breeding activities, and locate new nests and breeding territories.

Nest Visits and Prey Collection

Nests were visited between 6 July through 20 July 1988 to collect prey remains and band nestlings. Nestlings were banded on the right leg with USFWS aluminum leg bands, photographed, and measured.

All inedible prey remains and pellets found in and near nests were collected during the nest visits. Edible prey remains were recorded and left in the nest. Prey remains were identified by comparing them with known prey remain specimens collected at Denali in 1987. Only a preliminary analysis of large, easily identifiable prey remains was conducted. Samples of fresh plant materials found in the nests were collected and identified.

Aircraft Comparison Flight

See Appendix 3.

Recommendations made by Fyfe and Olendorff (1976) were followed during all aerial and ground surveys and all nest visits and observations to minimize disturbance at nests. During all aerial surveys, except for the Super Cub comparison flight, each nest was normally flown by once to minimize disturbance to the birds. When using the helicopter to access breeding territories for nest visits, the helicopter landed at least 500 meters away from the nest, usually out of sight of the nest.

RESULTS AND DISCUSSION

Productivity, Nesting Success, and Occupancy

In 1988, 59 occupied-breeding territories were located in the study area (Figure 2). Breeding status was determined at 51 occupied-breeding territories and final breeding status was determined at 49 occupied-breeding territories (Table 1).

Thirty-nine pairs of golden eagles (76.5 %) had successful breeding results in 1988. Productivity was 1.52 young per successful nest, 1.20 young per occupied breeding territory with known outcome, and 1.0 young per occupied breeding territory (Table 2). Nest failures were recorded at 10 occupied breeding territories (19.6 %). Final breeding status could not be determined at 2 occupied breeding territories (3.9 %).

Productivity and nesting success for golden eagles in Denali during 1987 and 1988 was similar (Table 2). Productivity estimates from 1987 and 1988 are similar to productivity reported from the Porcupine River, Alaska during 1979 - 1982 (Ritchie and Curatolo 1982), and from the Snake River Birds of Prey Area, Idaho, during 1970-1978 (U.S. Dept. Interior, B.L.M. 1979). The percentage of birds with successful breeding attempts at Denali from 1987 (82%) and 1988 (76.5%) is somewhat higher than successful breeding attempts recorded at the Snake River Birds of Prey Area, Idaho, during 1970 - 1978 (pooled mean of 65.9%) (U.S. Dept. Interior, B.L.M. 1979).

The number of young that fledged per individual nest was somewhat different in 1988 than in 1987. In 1987, 22 nests produced 1 fledgling, 8 nests produced 2 fledglings, and 2 nests produced 3 fledglings. In 1988, 19 nests produced 1 fledgling, 22 nests produced 2 fledglings, and 0 nests produced three fledglings. One nest in 1988 contained 2 fledglings and one dead nestling.

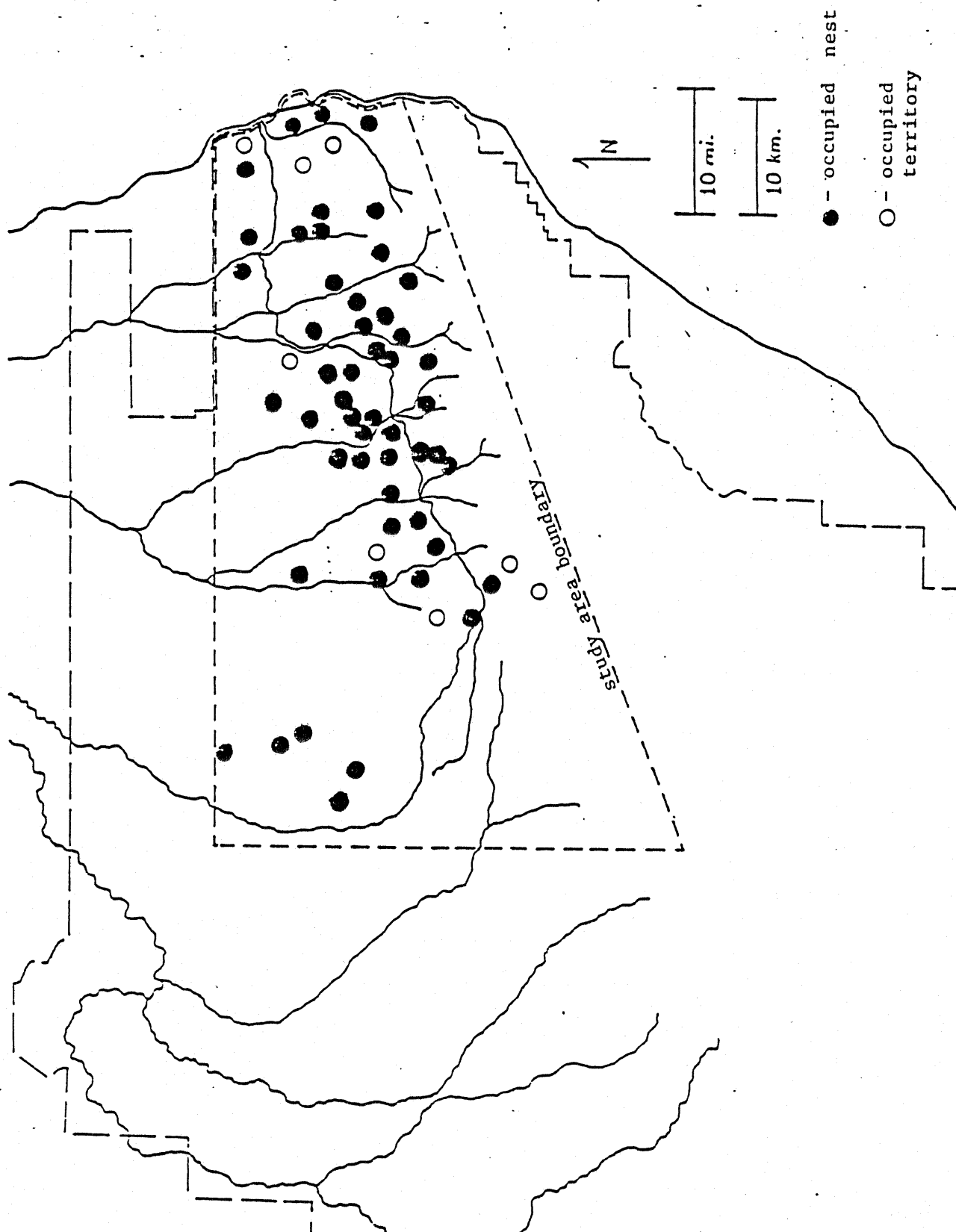


Figure 2. Occupied golden eagle breeding territories, 1938, Denali National Park and Preserve, Alaska.

Table 1. Results of golden eagle breeding at occupied breeding territories, 1988, Denali National Park and Preserve, Alaska.

Nest Num.	General Location	Num. Adults	Eggs Laid?	Num. Nestl.	Num. Fledgl.	Breeding Territory Status	Breeding Result
0122	Trestle Cr.	2	?	?	?	O-BU	Unknown
0113	McKinley Vil.	2	y	0	0	O-B	Unsuccessful
0303	Carlo Creek	2	y	2	2	O-B	Successful
0009	Spofford Tek.	2	?	?	?	O-BU	Unknown
0007	Igloo Mt.	2	y	2	2	O-B	Successful
0001	Triple Lakes	2	y	1	1	O-B	Successful
0135	Jenny Creek	2	y	2	2	O-B	Successful
0141	Savage R. S.	2	y	1	1	O-B	Successful
0026	Savage R. N.	2	y	2	2	O-B	Successful
0039	Sanctuary Tom	2	y	1	2	O-B	Successful
0150	Calico Cr.	2	y	0	0	O-B	Unsuccessful
0160	Teklanika Br.	2	y	1	1	O-B	Successful
0032	Cathedral East	2	y	1	1	O-B	Successful
0011	Cathedral Pond	2	y	1	?	O-B	Unknown
0165	Teklanika Hill	2	y	1	1	O-B	Successful
0180	Big Cr. Lower	2	y	2	2	O-B	Successful
0192	East Fork Br.	2	y	0	0	O-B	Unsuccessful
0146	Double Mt.	2	y	2	2	O-B	Successful
0078	Savage R. E.	2	y	0	0	O-B	Unsuccessful
0181	Sushana Ridge	2	y	0	0	O-B	Unsuccessful
0188	Wyoming Hills	2	y	2	2	O-B	Successful
0328	Cabin Div. L.	2	y	1	1	O-B	Successful
0329	East Fork Spur	2	y	2	2	O-B	Successful
0060	Marmot Rock	2	y	1	1	O-B	Successful
	Castle Rock E.	2	?	?	?	O-BU	Unknown
0326	Tributary Cr.	2	y	1	1	O-B	Successful
0003	Rock Creek	2	y	0	0	O-B	Unsuccessful
0033	Savage Canyon	2	y	1	1	O-B	Successful
0173	Big Creek Up.	2	y	1	1	O-B	Successful
0183	Jumper	2	y	0	0	O-B	Unsuccessful
0250	Cabin Div. U.	2	y	0	0	O-B	Unsuccessful
0331	Toklat R.C.	2	y	0	0	O-B	Unsuccessful
0332	Three-young	2	y	2	2	O-B	Successful
0207	Stony/Boundary	2	y	2	2	O-B	Successful
0021	Bald Mt.	2	y	1	1	O-B	Successful
0050	East Fork Sad.	2	y	2	1	O-B	Successful
0205	Hill 4599	2	?	?	?	O-BU	Unknown
0019	Eielson Curve	2	y	1	1	O-B	Successful
0220	Red Mt.	1	?	?	?	O-BU	Unknown
0306	Riley Cr. Up.	2	y	1	1	O-B	Successful
0036	Little Cr.	2	?	?	?	O-BU	Unknown
0311	Dble. Mt. Pass	2	y	1	1	O-B	Successful
0020	Stony 20	2	y	2	2	O-B	Successful
0321	Glacier Cr.	2	y	0	0	O-B	Unsuccessful

Table 1. Results of golden eagle breeding at occupied breeding territories, (cont'd) 1988, Denali National Park and Preserve, Alaska.

Nest Num.	General Location	Num. Adults	Eggs Laid?	Num. Nestl.	Num. Fledgl.	Breeding Territory Status	Breeding Results
0300	Glenn Cr.	2	y	2	2	O-B	Successful
0320	Clearwater	2	y	3	2	O-B	Successful
0298	Little Caribou	2	y	2	2	O-B	Successful
0067	Bergh Lake	2	y	2	2	O-B	Successful
0309	Refuge Valley	2	y	1	1	O-B	Successful
0169	East Fork Cl.	2	y	2	2	O-B	Successful
0209	Boundary Cr.	1	?	?	?	O-BU	Unknown
	Riley Creek	2	?	?	?	O-BU	Unknown
0157	E.Branch Tok.	2	y	1	1	O-B	Successful
0200	Highway Pass	2	y	?	?	O-B	Unknown
0330	Polychrome P.	2	y	2	2	O-B	Successful
0307	Fang Mt.	2	y	2	2	O-B	Successful
0154	East Fork Op.	2	y	1	1	O-B	Successful
0204	Sheldon Lake	2	y	2	2	O-B	Successful
0319	Moonlight Cr.	2	y	1	1	O-B	Successful

O-B = Occupied-Breeding

O-BU= Occupied-Breeding Unknown

Table 2. Golden eagle reproductive success, 1987 - 1988, Denali National Park and Preserve, Alaska.

	1987	1988
Occupied-breeding territories	52	59
Pairs-breeding	39	51
Pairs-breeding status unknown	13	8
Pairs-apparently not breeding	0	0
Territories with one adult	0	2
Occupied-breeding territories with known outcome	39	49
Successful nests	32	39
Unsuccessful nests	7	10
Nests with unknown breeding results	0	2
Nests with 1 fledged young	22	19
Nests with 2 fledged young	8	20
Nests with 3 fledged young	2	0
Total number of fledged young	44	59
Fledged young/successful nest	1.37	1.51
Fledged young/occupied-breeding territory with known breeding outcome	1.13	1.20
Fledged young/occupied-breeding territory	.85	1.00

The number of pairs whose breeding status (whether they laid eggs) could not be determined dropped from 13 pairs in 1987 to 8 pairs in 1988. This decrease probably results from the ability to determine the breeding status of more pairs earlier in the breeding season in 1988 than in 1987. Aerial surveys conducted on 10 May and 11 May 1988 and ground surveys conducted in April and May 1988 allowed observers to determine breeding status at 46 breeding territories by 11 May 1988. In 1987 many breeding territories were not discovered until much later in the breeding cycle and breeding attempts by birds whose nesting effort had failed prior to discovery of the nest could not be determined. Field work in 1987 did not start until 5 May 1987 and aerial surveys to locate breeding territories in 1987 were not conducted until the first week of June 1987.

Determination of the number of occupied breeding territories, the number of territorial pairs, the number of pairs that laid eggs, and the number of young raised to fledgling age yields a good measure of productivity relative to population size (Brown in Postupalsky 1981). Conducting early season and late season surveys allow a comparison between the number of occupied territories with the number of golden eagles that had a successful breeding attempt (Postupalsky 1974, 1981, Fraser et al. 1984, and Steenhoff 1987). Comparison of productivity information allow comparisons of golden eagle populations among different areas and different years (Steenhoff 1987).

Thirty-seven of the same breeding territories were occupied in both 1987 and 1988 (Table 3). Fourteen breeding territories that were occupied in 1987 were not occupied in 1988 and 21 breeding territories that were occupied in 1988 were not occupied in 1987. Seven new breeding territories were located in 1988. Of the 37 breeding territories that were occupied in both 1987 and 1988, 15 pairs had successful breeding results in both years and 3 pairs had unsuccessful breeding results in both years. During 1987 and 1988 all breeding golden eagles were recorded as adults.

Table 3. Breeding status and breeding results at golden eagle breeding territories occupied in both 1987 and 1988, Denali National Park and Preserve, Alaska.

General Location	No. Adults		Same Nest	Eggs Laid?		Successful Breeding?		No. Fledl.	
	1987	1988		1987	1988	1987	1988	1987	1988
Trestle Cr.	2	2	N	Y	?	Y	?	1	?
McKinley Vil.	2	2	Y	Y	Y	N	N	0	0
Carlo Creek	2	2	N	Y	Y	Y	Y	1	2
Spofford Tek.	2	2	?	?	?	?	?	?	?
Igloo Mt.	2	2	N	Y	Y	N	Y	0	2
Jenny Creek	2	2	N	?	Y	N	Y	0	2
Savage Riv. S.	2	2	Y	Y	Y	Y	Y	1	1
Savage Riv. N.	2	2	N	Y	Y	Y	Y	2	2
Sanctuary Tom	2	2	Y	Y	Y	Y	Y	1	1
Calico Creek	2	2	N	Y	Y	Y	N	1	0
Teklanika Br.	2	2	N	Y	Y	Y	Y	1	1
Cathedral E.	2	2	N	Y	Y	Y	Y	2	1
Cathedral Pond	2	2	N	Y	Y	Y	?	1	?
Teklanika Hill	2	2	N	Y	Y	Y	Y	1	1
Big Creek L.	2	2	?	?	Y	?	Y	?	2
East Fork Br.	2	2	Y	Y	Y	Y	N	2	0
Rock Creek	2	2	N	Y	Y	Y	N	1	0
Savage Canyon	2	2	Y	Y	Y	N	Y	0	1
Big Creek U.	2	2	Y	Y	Y	Y	Y	1	1
Jumper	2	2	Y	Y	Y	Y	N	2	0
Cabin Div. Up.	2	2	Y	Y	Y	Y	N	2	0
Toklat R.C.	2	2	N	Y	Y	N	N	0	0
Three-young	2	2	N	Y	Y	Y	Y	3	2
Stony/Boundary	2	2	N	Y	Y	Y	Y	2	2
Bald Mt.	2	2	Y	Y	Y	Y	Y	1	1
East Fork Sad.	2	2	N	Y	Y	Y	Y	2	1
Hill 4599	2	2	?	Y	?	Y	?	1	?
Eielson Curve	2	2	N	?	Y	?	Y	?	1
Red Mt.	1	1	?	?	?	?	?	?	?
Bergh Lake	2	2	N	?	Y	?	Y	?	2
Refuge Valley	2	2	N	Y	Y	Y	Y	1	1
East Fork Up.	2	2	Y	Y	Y	Y	Y	1	2
Boundary Cr.	2	1	?	Y	?	Y	?	1	?
Riley Creek	1	2	?	?	?	?	?	?	?
E. Branch Tok.	2	2	Y	Y	Y	Y	Y	1	1
E. Fork Op.	1	2	N	?	Y	?	Y	?	1
Sheldon Lake	2	2	Y	Y	Y	Y	Y	2	2

Aerial and Ground Surveys

Results of the number of breeding territories located by aerial surveys and ground surveys are summarized in Appendix 2. All aerial surveys, except for the comparison flight experiment, were conducted from a Bell 206 B Jet Ranger Helicopter. Aerial surveys were a practical and economical way to locate breeding pairs, count incubating adults, count nestlings, count fledglings and locate new breeding territories in the study area. It should be noted that several times during the aerial surveys conducted on 10 and 11 May 1988 the helicopter landed near several breeding territories to allow the observers to search for occupied nests from the ground.

The amount of time used to conduct each aerial survey is summarized in Appendix 2. This information is made available to help others when planning future aerial surveys for breeding golden eagles in Denali.

Ground surveys were useful for monitoring breeding activities throughout the breeding cycle. In March and early April ground surveys were used exclusively to monitor breeding activities at known breeding territories in the eastern portion of the study area. Later in the season ground surveys were used to search areas where aerial observations of nests was difficult due to terrain features or turbulence, and in areas where little aerial reconnaissance had been conducted.

Nest Visits

Eighteen nests were entered and 24 nestlings were banded (Table 4). Ages of nestlings on the banding date were estimated by comparing photographs, measurements, and notes on development of flight feathers and contour feathers (body, head, and throat), with information on nestling development provided by Ellis (1979), Mathieu (1985), and Nakajyo et al. (1983).

Table 4. Golden eagle nestling banding information, 1988, Denali National Park and Preserve, Alaska.

Nest Num.	General Location	Banding Date	Num. Nestlings	Est. Age at Banding	Band Number
0011	Cathedral Ponds	07/07/88	1	42 days	629-27651
0141	Savage River S.	07/08/88	1	45 days	629-27652
0306	Riley Cr. Up.	07/08/88	1	37 days	629-27653
0135	Jenny Cr.	07/08/88	2	45 days	629-27654
				43 days	629-27656
0328	Cabin Div. L.	07/10/88	1	43 days	629-27657
0020	Stony 20	07/10/88	2	47 days	629-27658
				49 days	629-27659
0207	Stony/Boundary	07/10/88	2	56 days	629-27660
				50 days	629-27661
0050	East Fork Sad.	07/10/88	1	44 days	629-27662
0307	Fang Mt.	07/11/88	2	35 days	629-27663
				37 days	629-27664
0039	Sanctuary Tom	07/11/88	1	49 days	629-27665
0311	Double Mt. Pass	07/11/88	1	34 days	629-27666
0165	Teklanika Hill	07/11/88	1	44 days	629-27667
0169	East Fork Up.	07/12/88	2	32 days	629-27668
				40 days	629-27669
0173	Big Creek Up.	07/12/88	1	38 days	629-27670
0320	Clearwater	07/12/88	2	48 days	629-27671
				44 days	629-27672
0319	Moonlight	07/12/88	1	50 days	629-27673
0033	Savage Canyon	07/13/88	1	42 days	629-27674
0001	Triple Lakes	07/13/88	1	48 days	629-27675

Prey Collection and Analysis

Prey collections were made at 17 nests where nestlings were banded and prey remains were recorded at 6 nests that were visited but not entered. Only one collection of prey at each nest was made in 1988.

Ten prey taxa were identified in 1988 including: Hoary Marmot (Marmota caligata), Arctic Ground Squirrel (Citellus parryi), Spruce Grouse (Canachites canadensis), Willow Ptarmigan (Lagopus lagopus), Rock Ptarmigan (L. mutus), White-tailed Ptarmigan (L. leucurus), Black-billed Magpie (Pica pica), Dall Sheep (Ovis dalli), Northern Red Squirrel (Tamiasciurus hudsonicus), and Gray Jay (Perisoreus canadensis). Remains of one passerine bird species was also noted. The absence of Snowshoe Hare (Lepus americanus) remains was noted this year.

Ptarmigan remains, adults and chicks, were found in 13 nests and ground squirrel remains were found in 12 nests (nine fresh ground squirrels were observed in one nest). Dall sheep lamb remains were observed in two nests. It is not known whether the lambs were killed by the eagles or found as carrion.

Results of preliminary analysis of prey remains collected in 1987 and 1988 are similar to results of contents of golden eagle pellets collected and analysed by Murie (1944). Murie found arctic ground squirrel remains in 544 of 632 pellets (86%) that he collected and analyzed over 3 years. Ritchie and Curatolo (1982) also found a large number of arctic ground squirrel remains in golden eagle nests along the Porcupine River, Alaska.

Information on food habits at present is very limited for several reasons. First, only a preliminary analysis of remains has been conducted. Only large pieces of prey remains have been examined and identified. Second, prey remains are only collected once or twice during the season and only at a limited number of nests (10 in 1987, 18 in 1988). Third, smaller prey remains may be overlooked during collections and may be underestimated when determining prey preference. Forth, female golden eagles will remove many of the prey items from the nest

between prey collections (Gordon 1955). Fifth, the prey remains found in nests may not reflect the food preference of adult birds (Brown 1969).

Several food habit analysis techniques may be incorporated into this study in 1989 to achieve a better understanding of the food habits of golden eagles. The first involves conducting a thorough analysis of all prey remains and pellets collected at each nest. The second involves making systematic prey remains collections at a selected number of nests throughout the breeding cycle. The third will utilize direct observations and time-lapse photographs of prey deliveries at nests.

The abundance and availability of prey in relationship to nesting success and productivity rates should also be addressed at Denali in future years. Tjernberg (1983) found that breeding may be influenced by prey abundance early in spring just before egg-laying in a resident population of golden eagles in northern Sweden. Information concerning prey abundance, prey availability, and prey delivery rate may be important when looking at productivity rates collected over long periods of time and determining reasons why productivity rates may differ among years.

Breeding Phenology

Egg-laying and egg-hatching dates were estimated by back-dating using estimates of nestling ages on the banding date, using 45 days as the length of incubation (Nice in Steenhoff 1987). Fledgling dates were estimated using 64 days as the fledgling age (BLM unpublished information in Steenhoff 1987).

In 1988 egg-laying occurred from 2 April through 28 April, egg-hatching occurred from 17 May through 12 June, and fledgling occurred from 20 July through 15 August. Breeding phenology in 1987 and 1988 was similar (Table 5). Breeding phenology information reported for golden eagles breeding along the Porcupine River, Alaska, in 1981, (Ritchie and Curatolo 1982) and in northern Sweden during 1975 - 1980 (Tjerberg 1983), is very similar to breeding phenology recorded at Denali in 1987 and 1988.

Table 5. Golden eagle breeding phenology, 1987 and 1988, Denali National Park and Preserve, Alaska.

	1987	1988
Egg-laying:	Range= 28 March - 8 May (n=15, mean= 12 April)	2 April - 28 April (n=24, mean = 14 April)
Egg Hatching:	Range= 12 May - 23 June (n=15, mean = 27 May)	17 May - 12 June (n=24, mean = 29 May)
Fledging:	Range= 20 July - 24 August (n=13, mean = 3 August)	20 July - 15 August (n=24, mean = 1 August)

The first pair of golden eagles recorded in 1988 were observed near a nest 8 miles NE of the eastern portion of the study area on 13 March 1988. Several other pairs were noted near known breeding territories in late March.

Nest Situation, Aspect, and Elevation

The first golden eagle tree nest in the Denali area was discovered on 13 March 1988 in a large White Spruce (Picea alba) on a west facing bank of the Nenana River, near Ferry, Alaska (approximately 8 miles NE of the eastern boundary of the study area). All other known golden eagle nests in the study area are located on cliffs or rock outcrops. Tree nests may be very uncommon in the study due to the abundance of nesting cliffs and rock outcrops and the lack of suitable nesting trees. No golden eagle nests have been found on the ground in the study area.

In 1988, 66% of all occupied nests faced in a southerly (SE, S, SW) direction and 25% of all occupied nests faced in a northerly direction (NW,N,NE) (Table 6). This is somewhat different than nest aspects of occupied nests in 1987 when 46% of the nests faced in a southerly direction and 37% of the nests faced in a northerly direction.

Occupied nests ranged in elevation from 762 m to 1372 m above sea level (ASL), with a mean elevation of 1125 m ASL (SD= 142 m, N= 51) (Table 6).

Alternate nests are associated with most occupied nests in the study area.

Table 6. Elevation and aspect for occupied golden eagle nests, 1988, Denali National Park and Preserve, Alaska.

Nest Number	General Location	Nest Elevation (meters above sea level)	Nest Aspect
0330	Polychrome P.	1219	S
0157	East Branch Toklat	1341	N
0154	East Fork Open	1189	SW
0001	Triple Lakes	762	S
0003	Rock Creek	853	W
0303	Carlo Creek	1067	SE
0113	McKinley Village	1036	E
0309	Refuge Valley	1158	S
0307	Fang Mt.	1372	N
0306	Riley Creek Upper	1158	S
0150	Calico Creek	1289	S
0146	Double Mt.	1341	NW
0141	Savage River South	1250	S
0135	Jenny Creek	1341	SE
0078	Savage River East	1158	SE
0039	Sanctuary Tom	1128	S
0026	Savage River North	1219	SW
0326	Tributary Creek	1067	NW
0328	Cabin Divide Lower	1006	NW
0329	East Fork Spur	1036	S
0311	Double Mt. Pass	1067	SW
0250	Cabin Divide Upper	1036	NE
0192	East Fork Bridge	1036	S
0188	Wyoming Hills	914	N
0183	Jumper	1250	E
0181	Sushana Ridge	1067	N
0180	Big Creek Lower	914	W
0173	Big Creek Upper	1128	N
0169	East Fork Closed	1219	NE
0165	Teklanika Hill	1067	S
0160	Teklanika Bridge	1006	S
0060	Marmot Rock	1097	SE
0050	East Fork Saddle	1128	S
0032	Cathedral East	1219	SE
0011	Cathedral Ponds	1219	S
0007	Igloo Mt.	1372	S
0033	Savage Canyon	1158	NE
0019	Eielson Curve	1097	NE
0020	Stony 20	1006	SE
0021	Bald Mt.	1189	SW
0067	Bergh Lake	1097	SW
0331	Toklat Road Camp	1097	S
0200	Highway Pass	1372	SE

Table 6. Elevation and nest aspect for occupied golden eagle nests, 1988,
(cont'd) Denali National Park and Preserve, Alaska.

Nest Num.	General Location	Nest Elevation (meters above sea level)	Nest Aspect
0204	Sheldon Lake	884	SE
0207	Stony/Boundary	1067	SW
0332	Three Young	1372	S
0319	Moonlight Creek	1067	S
0320	Clearwater Creek	1189	SE
0321	Glacier Creek	914	SE
0300	Glenn Creek	1067	SE
0298	Little Caribou Creek	1067	NW

Density

Density of occupied breeding territories was 93 km/occupied breeding territory in 1988 compared with 107 km/occupied breeding territory in 1987. This difference results from the increased number of occupied breeding territories found in 1988. Density of breeding pairs was 108 km /breeding pair in 1988 and 141 km /breeding pair in 1987 (Table 7).

Densities recorded for golden eagles in Denali in both 1987 and 1988 are comparable to densities reported for golden eagles breeding in the southern Yukon Territory (Yukon Department of Renewable Resources 1982), the Snake River Birds of Prey Area, Idaho (U.S. Department of the Interior 1979, in Phillips et al. 1984), and in West Norway (Bergo 1984).

Vegetation Found in Nests

Fresh vegetation consisting of stems, leaves, twigs, and sticks was found in all nests that were visited. At least 17 vascular plant species from 10 families were noted (Table 8). Vegetation may be brought to nests for nest adornment, nest sanitation, nest advertisement, or nest structure enforcement (Newton 1979).

Aircraft Comparison Flight

Results of the aircraft comparison flight are summarized in Appendix 3.

Table 7. Golden eagle nesting density, 1987 - 1988, Denali National Park and Preserve, Alaska.

	1987	1988
Occupied territories	52	59
Breeding Pairs	39	51
Maximum area/occupied territory	106 sq. km.	93 sq. km.
Maximum area/breeding pair	141 sq. km.	108 sq. km.

Table 8. Fresh vegetation noted in occupied golden eagle nests, 1988, Denali National Park and Preserve, Alaska.

Nest Number	General Location	Plant Species Noted in Nest (Family)
0141	Savage Ri. S.	<u>Salix</u> sp? (Salicaceae), <u>Betula</u> sp? (Betulaceae)
0135	Jenny Cr.	<u>Salix</u> sp?, <u>Betula</u> sp?
0328	Cabin Div. L.	<u>Betula</u> sp?, <u>Dryas octopetala</u> (Rosaceae)
0020	Stony 20	<u>Dryas octopetala</u> , <u>Shepardia canadensis</u> (Elegnaceae)
0207	Stony/Bound.	<u>Picea</u> sp? (Picea)
0050	E.Fork Sad.	<u>Epilobium</u> sp? (Onagraceae), <u>Shepardia canadensis</u> , <u>Ledum palustre</u> (Ericaceae), <u>Dryas octopetala</u>
0307	Fang Mt.	<u>Cassiope tetragona</u> (Compositae), <u>Salix</u> sp?, <u>Betula</u> sp?, <u>Dryas octopetala</u>
0039	Sanctuary Tom	<u>Shepardia canadensis</u> , <u>Cassiope tetragona</u> , <u>Juniperus communis</u> (Cupressaceae)
0311	Double Mt. P.	<u>Dryas octopetala</u> , <u>Cassiope tetragona</u> , <u>Empetrum nigra</u> (Empetraceae)
0165	Teklanika Hill	<u>Shepardia canadensis</u>
0160	Teklanika Br.	<u>Potentilla fruticosa</u> (Rosaceae), <u>Juniperus communis</u> , <u>Betula</u> sp?
0169	East Fork Cl.	<u>Salix</u> sp?, <u>Dryas octopetala</u> , <u>Cassiope tetragona</u>
0320	Clearwater	<u>Salix</u> sp?, <u>Vaccinium</u> sp? (Ericaceae), <u>Cassiope tetragona</u>
0319	Moonlight Cr.	<u>Picea glauca</u> (Pinus), <u>Alnus</u> sp? (Betulaceae), <u>Salix</u> sp?
0033	Savage Canyon	<u>Alnus</u> sp?, <u>Salix</u> sp?, <u>Betula glandulosa</u> , <u>Arnica</u> sp? (Compositae), <u>Salix</u> sp?, <u>Cassiope tetragona</u>
0001	Triple Lakes	<u>Cassiope tetragona</u> , <u>Loiseleuria procumbens</u> (Ericaceae), <u>Picea glauca</u>

Interactions with other nesting bird species

An interesting observation was made this year concerning nesting Say's Phoebes (Sayornis saya) and nesting golden eagles. Say's phoebes were found nesting very close to the 18 golden eagle nests that were visited in 1988. It may be that the phoebes benefit from the associated insect fauna around the eagle nests. It would be interesting to examine this relationship to determine if this was just a casual observation or if a commensalist nesting relationship occurs between nesting raptors and Say's phoebes.

Golden eagles were found nesting at 3 locations in 1988 where Gyrfalcons (Falco rusticolus) were recorded breeding in previous years (McIntyre et al. 1988). At two locations in 1988, golden eagles and gyrfalcons were breeding less than 1 km away from each other. Golden eagles and gyrfalcons have been known to alternate breeding at the same nests in different years in Denali (McIntyre et al. 1988).

The first pair of breeding Peregrine Falcons (Falco peregrinus anatum) recorded within the boundaries of Denali National Park and Preserve was found on 29 July 1988. This pair was located incidentally while searching for golden eagle nests from a Bell 206 B Jet Ranger Helicopter. The eyrie was located in a small pothole on a large granite rock outcrop approximately 4 km north of Chilchukabena Lake. The eyrie contained two nestling approximately 40 days old.

CONCLUSIONS

1. A significant concentration of breeding golden eagles is located in the eastern portion of Denali National Park and Preserve. At present this is the largest concentration of breeding golden eagles known in Alaska.
2. This study provides natural resource managers and biologists with methods to determine annual productivity, occupancy rates, breeding phenology, and food habits of golden eagles. This information will be useful in developing a long-term monitoring program for golden eagle breeding in Denali. Methods used in this study should be applicable to similar projects in other areas in Alaska.
3. Aerial surveys conducted during the early breeding cycle to determine the number of pairs that laid eggs and the number of territorial pairs and during the late breeding cycle to determine the number of fledged young provides information on nesting success and productivity rates.
4. Breeding phenology information collected in 1987 and early breeding season observations in 1988 allowed researchers to determine optimum dates to conduct aerial surveys to count the number of pairs of golden eagles with eggs.
5. Observations made at nests throughout the breeding cycle allowed researchers to determine optimum dates to conduct aerial surveys to count the number of fledglings at successful nests.
6. Productivity in 1987 and 1988 averaged 1.45 young/ successful nest and .91 young/ occupied breeding territory and is similar to productivity reported for golden eagles breeding in Idaho (U.S. Dept. Interior, B.L.M. 1979), northern interior Alaska (Ritchie and Curatolo 1982), Sweden (Tjernberg 1983), and Finland (Sulkava 1984).
7. Nesting success was 78% in 1987 and 76% in 1988.

8. Twenty-four nestlings were banded at eighteen nests in 1988. No band recoveries have been reported.
10. Preliminary analysis of prey remains indicates that arctic ground squirrel and ptarmigan make up a large part of the prey brought to nestlings by breeding golden eagles.
11. Breeding phenology information collected in both years indicates that egg-laying occurs from late March (28 March) through April (28 April), egg-hatching occurs from mid-May (12 May) through late June (23 June), and fledging occurs from mid-July (20 July) through late August (24 August).
12. Density of breeding golden eagles in Daniel in 1987 and 1988 is comparable to densities recorded for breeding golden eagles in other geographic locations.
13. All but one golden eagle nest in or near the study area are located on cliffs or rock outcrops. One golden eagle nest was located in a tree outside the study area.
14. Occupied nests in both 1987 and 1988 were found between 762 meters ASL and 1372 meters ASL, with a average elevation of 1117 meters ASL.
15. Forty-six percent of all occupied nests faced in a southerly direction in 1987 and 66% of all occupied nests faced in a southerly direction in 1988.

RECOMMENDATIONS

1. Continue to collect information on occupancy, nesting success, and productivity using aerial and ground survey methods. At least 2 aerial surveys should be conducted each year (Postupalsky 1974) to maintain consistency in information collected concerning breeding activities of golden eagles in Denali. The first survey should be conducted early in the breeding season to locate incubating birds and territorial pairs. The second survey should be conducted late in the breeding cycle to determine the number of successful breeding attempts and to count fledglings.
2. Continue to search for golden eagle nest structures and breeding territories in the study area. Although many nest structures and breeding territories have been located in the study area, it can not be assumed that all structures and territories have been located. Future aerial and ground surveys should be conducted in the Riley Creek drainage, the upper Sushana River drainage, the Wyoming Hills area, the Kantishna Hills area, the lower Stony Creek drainage, the Thorofare River drainage, and the Glacier Creek drainage.
3. Determine accuracy and precision of ground and aerial surveys, and in estimating annual productivity rates. Sampling and measurement error associated with locating nests and documenting breeding activities at nests and breeding territories should be identified (Grier et al. 1981) (Fraser et al. 1984), (Steenhoff 1987) and addressed.
4. Document migration and wintering areas using satellite telemetry or other methods such as color-markers. Although Boeker and Ray (1971) and Spofford (1964) report that golden eagles that breed in arctic and subarctic areas of North America probably winter in the southwestern United States and upland Mexico, there has been little research conducted to actually prove this theory.

Golden eagles can be influenced by many factors once they leave the boundaries of Denali. Some of these factors, such as reduction in seasonal food supplies,

loss of wintering habitat, and human persecution, may affect breeding performance, productivity, and population structure (Phillips 1986). It is essential that wintering areas of arctic and subarctic golden eagles are documented in order to identify threats these birds could be facing during migration and wintering periods.

Satellite telemetry could provide answers to the questions concerning wintering areas and migration paths. Use of color-markers, such as patagial markers, could also provide information on migration routes and wintering locations.

4. Expand present prey study to include complete analysis of prey remains and pellets collected at occupied nests, multiple prey collections at selected nests, and direct observations of prey deliveries at nests. Simultaneous populations studies conducted on common prey species of golden eagles, such as arctic ground squirrels and ptarmigan (willow, white-tailed, and rock), could provide information on relationships of prey abundance and availability to nesting success and productivity.
5. Determine how annual local weather conditions, such as late springs or heavy winter snowfall, may influence golden eagle breeding success and productivity.
6. Utilize radio-telemetry or color-marking to determine movements, home-range, nest site fidelity, dispersal, pair relationships, mate fidelity, and recruitment.
7. Expand search efforts to include areas outside the study area. Little information is available concerning golden eagles nesting south of the Alaska Range and north of the Alaska Range west of Peter's Glacier. Efforts to conduct nest searches in these areas would be dependent upon yearly funding and personnel availability.
8. Determine if residues of pesticides or other contaminants are present in golden eagle eggs.

PUBLICATION INFORMATION

A poster, "Developing a Long-term Monitoring Project for Golden Eagles in Denali", was presented at the George Wright Society's Fifth Triennial Conference on Research in the National Parks and Equivalent Reserves. The presentation was awarded with a Best Poster Award.

An oral presentation was given on the "Breeding Biology of Golden Eagles in the Eastern Portion of Denali National Park and Preserve" at the Third Alaska Bird Conference and Workshop in March 1989.

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A. Breeding Territory Status

Unoccupied: a breeding territory where no bird showing an affinity for the territory during the breeding season was observed.

Occupancy unknown: a breeding territory where no bird showing an affinity for the breeding territory during the breeding season was observed, but investigators spent less than 3 hours at the territory during the incubation period.

Occupied, non-breeding: a breeding territory where 2 birds showing an affinity for the breeding territory during the breeding season were observed but no eggs were laid. This category involves proving that no eggs were laid.

Occupied-breeding: an occupied breeding territory containing a nest where eggs were laid. Evidence of eggs includes young in nest, eggs or fresh eggshells in the nest, or adult(s) seen in incubating posture in the nest.

Occupied-unsuccessful breeding: an occupied breeding territory containing an occupied nest where eggs were laid but where no young fledged.

Occupied-successful breeding: an occupied breeding territory containing an occupied nest where eggs were laid and where young fledged.

Occupied-breeding status unknown: an occupied breeding territory where breeding status could not be determined.

B. Definitions

Breeding territory: an area that contains one or more nests with in the range of one pair of mated birds, and where no more than one pair, of the same species, has bred at one time in the same year.

Fledged young: young that have fledged from the nest, young who have reached at least 80% or more of their fledging age and subsequent observations do not show that the young was killed after this age.

Alternate nest: an unoccupied nest within the breeding territory of one pair of birds.

APPENDIX 2. Aerial Survey Information

Table 2A-1. Flight time used to conduct all aerial surveys for golden eagles, 1988, Denali National Park and Preserve, Alaska.

Date	Purpose	Aircraft	Total Flight Time
21 April 1988	Observe breeding activities at known breeding territories.	Be11 206 B Jet Ranger Helicopter	2.5 hours*
10 May - 11 May 1988	Determine occupancy at breeding territories and locate occupied golden eagle nests.	same	11.5 hours
8 July- 12 July 1988	Determine nesting success, count nestlings, and conduct nest visits.	same	14.0 hours
19 July 1988	Locate occupied nests and count nestlings.	Super Cub	4.3 hours
28 July 1988	Count fledglings at all occupied nests.	Be11 206 B Jet Ranger Helicopter	2.5 hours
29 July 1988	Survey areas to locate new nests and eagle breeding territories.	same	5.0 hours

*- survey terminated due to inclement weather.

Table 2A-2. Breeding activities observed during ground and aerial surveys, 1988, Denali National Park and Preserve, Alaska.

Nest	General	Num.	Location										
				GS-1	AS-1	GS-2	AS-2	GS-3	AS-3	GS-4	AS-4	GS-5	
0122	Trestle Cr.	TP	TP	TP	TP, I	1A	0	1A	TP, I	AE	2A	1A	1A
0113	McKinley Vtl.	0	0	0	I	I	I	TP, I	AE	2A	AE	2A	2A
0303	Carlo Creek	TP, I	TP, I	I	I	I	I	2N	2N	2N	2F	N	N
0009	Spofford Tek.	TP	TP	0	0	0	0	0	0	0	0	0	0
0007	Igloo Mt.	TP, I	I	I	I	I	I	1N	2N	2N	2F	2FY	2FY
0001	Triple Lakes	N	I	N	I	I	I	1N	1N	1N	1N	1FY	N
0135	Jenny Creek	N	I	N	I	I	I	2N	2N	N	2F	N	N
0141	Savage R. S.	N	I	N	I	I	I	1N	1N	N	1F	N	N
0026	Savage R. N.	N	I	N	I	I	I	2N	2N	N	2F	N	N
0039	Sanctuary Tom	N	I	N	I	I	I	1N	1N	N	1F	N	N
0150	Calico Creek	N	1E	N	N	N	N	1TA	1TA	N	0	N	N
0160	Teklanika Br.	1A	I	N	I	I	I	1N	1N	1N	1F	1FY	1FY
0032	Cathedral E.	N	I	I	I	I	I	1N	1N	1N	1F	1FY	1FY
0011	Cathedral P.	N	I	I	I	I	I	1N	1N	1N	1F	1FY	1FY
0165	Teklanika H.	N	NB	N	I	I	I	1N	1N	1N	1F	N	N
0180	Big Creek L.	N	I	N	I	I	I	2N	2N	N	2F	N	N
0192	E. Fork Br.	N	N	I	I	I	I	0	0	0	0	1A	1A
0146	Double Mt.	N	NB	N	I	I	I	2N	2N	2N	2F	N	N
0078	Savage R. E.	1A	N	1A	I	I	I	2A, EN	0	2A	0	2A	2A
0181	Sushana Ridge	N	N	N	I	I	I	0	0	N	0	N	N
0188	Wyoming Hills	N	N	N	I	I	I	2N	2N	N	2F	N	N
0328	Cabin Div, L.	N	N	N	I	I	I	1N	1N	N	1F	N	N
0329	East Fork Sp.	N	N	N	I	I	I	2N	2N	N	2F	N	N
0060	Marmot Rock	N	N	2A	I	I	I	1N	1N	1N	1F	1FY	1FY
0326	Tributary Cr.	N	N	N	TP	TP	TP	2N	1N	1N	1F	1FY	N
0003	Rock Creek	2A	2A	2A	I	I	I	2A-EN	0	0	0	N	N
0033	Savage Canyon	2A	N	2A	I	I	I	1N	1N	1N	1F	1FY	N
0173	Big Creek Up.	N	N	N	I	I	I	1N	1N	N	1F	N	N
0183	Juniper	N	N	N	I	I	I	EN	EN	N	EN	N	N
0250	Cabin Div. U.	N	N	N	I	I	I	EN	EN	N	EN	N	N
0331	Toklat R.C.	N	N	N	I-2SA	2A	2A	EN	EN	2A	EN	N	N
0332	Three-Young	N	N	N	I	I	I	2N	2N	2N	2F	N	N
0207	Stony/Bound.	N	N	N	I	I	I	2N	2N	N	2F	N	N
0021	Bald Mt.	N	N	N	I	I	I	1N	1N	1N	1F	1FY	N
0050	East Fk. Sad.	N	N	N	TP	TP	TP	2N	1N	1N	1F	1FY	N
0205	Hill 4599	N	N	N	TP	TP	TP	1A	1A	N	1F	N	N
0019	Eielson Curve	N	N	N	I	I	I	1N	1N	1N	1F	1FY	N
0220	Red Mt.	N	N	N	1A	1A	1A	0	N	N	0	N	N
0306	Riley Cr. Up.	N	N	N	I	I	I	1N	1N	N	1F	N	N
0036	Little Creek	N	N	N	2A	2A	2A	2A	2A	N	0	N	N
0311	Dbie. Mt. Ps.	N	N	N	I	I	I	1N	1N	N	1F	N	N
0020	Stony 20	N	N	N	I	I	I	2N	2N	N	2F	N	N

Table 2A-2. Breeding activities observed during ground and aerial surveys, 1988, (cont'd) Denali National Park and Preserve, Alaska.

Nest General	Num.	Location										
			GS-1	GS-2	GS-3	GS-4	GS-5	AS-1	AS-2	AS-3	AS-4	AS-5
0321	Glacier Cr.	N	N	N	I	N	0	N	N	0	N	N
0300	Glenn Cr.	N	N	N	I	N	2N	N	N	2F	N	N
0320	Clearwater	N	N	N	I	N	2N	N	N	2F	N	N
0298	Lt. Caribou	N	N	N	I	N	2N	N	N	2F	N	N
0067	Bergh Lake	N	N	N	I	N	2N	N	N	2F	N	2FY
0309	Refuge Valley	N	N	N	I	N	1N	N	N	2F	N	N
0169	East Fork Up.	N	N	N	I	N	2N	N	N	2F	N	N
0209	Boundary Cr.	N	N	N	1A,NB	N	0	N	N	0	N	N
	Riley Cr.	N	N	N	TP	N	0	N	N	0	N	N
0157	E. Fork Tok.	N	N	N	I	1N	1N	N	N	1F	N	N
0200	Highway Pass	N	N	N	I	0	1A	N	N	0	N	0
0330	Polychrome P.	N	N	N	I	2N	2N	N	N	2F	N	N
0307	Fang Mt.	N	N	N	N	2N	2N	N	N	2F	N	N
0154	E. Fork Op.	N	N	N	N	1N	1N	N	N	1F	N	1FY
0204	Sheldon Lake	N	N	N	N	2N	2N	N	N	2F	N	N
0319	Moonlight Cr.	N	N	N	N	1N	1N	N	N	1F	N	N

* = final status of this nestling could not be determined. It had fallen out of the nest in late June and was discovered to have several injuries. This breeding territory final result was termed unknown.

Key:

N = no observations made at that territory during the survey period.
 TP = Territorial pair
 1TA = One territorial adult
 I = Incubating adult
 NB = Nest building
 1E = One egg
 1A = One adult
 2A = Two adults
 2SA = Two subadults
 EN = Empty Nest

1F = 1 fledgling
 2F = 2 fledgling
 1FY = 1 flying young
 2FY = 2 flying young
 0 = no birds or activities noted during observations.

1N = One nestling
 2N = Two nestlings
 AE = Added Eggs

Survey periods:
 Ground surveys

Aerial surveys

GS-1 = 1 March - 20 April 1988
 GS-2 = 22 April - 09 May 1988
 GS-3 = 12 May - 07 July 1988
 GS-4 = 13 July - 27 July 1988
 GS-5 = 29 July - 26 August 1988
 AS-1 = 21 April 1988
 AS-2 = 10 May and 11 May 1988
 AS-3 = 08 July - 12 July 1988 (nest visits)
 AS-4 = 28 July 1988

APPENDIX 3. Aircraft Comparison Flight - Methods and Results.

Methods

Use of aircraft to locate golden eagle nests and to observe breeding activities at nests has been shown to be a practical and economical method (Boeker 1970, Hickman 1972, Phillips et al. 1984). Aerial surveys, using helicopters and Super Cub aircraft, at Denali have been useful for locating golden eagle nests, for looking at large numbers of nests in one day over a large area, and for determining breeding status and success.

The cost difference between using a helicopter to conduct aerial surveys versus a Super Cub aircraft can be significant (\$400.00/hour for helicopter and \$120.00/hour for Super Cub). This difference could determine whether surveys are conducted or not in years of limited funding. Because of this cost factor and in order to determine differences in results of similar surveys conducted from different aircraft, an experiment was conducted to determine the efficiency of using a Super Cub aircraft with an experienced pilot and experienced observer to conduct an aerial survey to locate known occupied nests and to count the number of young located in each nest.

The comparison flight was conducted on 19 July 1988. Twenty-one nests, where the number of nestlings had been counted by an experienced observer from a Bell 206 B Jet Ranger Helicopter and then from the ground, were selected for the comparison flight experiment. The Super Cub flight was conducted by one experienced observer who had not seen any of the nests in 1988. The observer was provided with a 1:250,000 USGS topographic map marked with nest locations. The Super Cub observer was instructed to count the number of young at each nest, record the number of passes made by the Super Cub at each nest, and record the amount of time spent conducting the flight. The Super Cub observer had not seen any of the occupied nests in the 1988 breeding season.

The Super Cub flight was conducted within seven days of the helicopter flight and ground counts of nestlings.

Results and Discussion

The Super Cub observer found 19 of the 21 nests (90 %), and recorded the same number of young at each nest as the observer who conducted nestlings counts from the helicopter and on the ground (Table A3-1). Two nests could not be located by the Super Cub observer. The Super Cub flight used 4.8 hours of flight time. In all but one case the Super Cub observer needed to make at least two passes by each nest in order to count the young (Table A3-1).

These results indicate that using a Super Cub aircraft with an observer who is experienced in conducting aerial golden eagle surveys and who is familiar with the survey area may be an efficient and economical method to use to count the number of young at known nests to determine annual productivity. But, caution should be used when interpreting these results for several reasons. First, the Super Cub observer and the Super Cub pilot were both extremely familiar with the study area, and the observer has superior abilities when conducting any type of wildlife survey. Second, only 21 nests were selected for this experiment. These nests were not randomly selected and this may have biased the results. Future experiments like this should use randomly selected nests. Most of the nests selected for this experiment were located in areas where it was thought that the Super Cub observer would easily be able to find the nests. It should be noted that the 2 nests that were not located during the Super Cub flight were hard to observe from the helicopter even when the exact nest location was known by the observer. Many nests at Denali are located in narrow canyons or among rugged terrain which makes them very difficult to view from any aircraft. Maneuvering fixed-wing aircraft in some of the study area can be very difficult due to rugged terrain or severe weather conditions. Third, at most nests two or more fly-bys were required by the Super Cub to determine the number of young in the nest. To keep disturbance of breeding birds to a minimum during this study the number of nest fly-bys should be kept at a minimum. If fixed-wing aircraft were used exclusively for aerial survey for breeding golden eagles, disturbance at the nests could be increased if too many passes were made by each nest over the course of the breeding cycle. Fourth, the flights were not conducted on the same day and viewing conditions may have been different.

More information is needed before relying strictly on fixed-winged aircraft for conducting golden eagle surveys in Denali. Future experiments such as this one, conducted at different stages of the breeding cycle, should be designed and conducted in order to determine true differences between use of different aircraft to conduct golden eagle surveys in Denali.

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- Hickman, G.L. 1972. Aerial determination of golden eagle nesting status. J. Wildl. Manage. 36(4):1289-1292.
- Phillips, R.L., T.P. McEneaney, and A.E. Beske. 1984. Population densities of breeding golden eagles in Wyoming. Wildl. Soc. Bull. 12:269-273, 1984.

Table A3-1. Results of counting nestlings from helicopter and Super Cub aircraft with comparisons to ground-truthed nestling numbers, 1988, Denali National Park and Preserve, Alaska.

Nest Num.	General Location	Number of Young	Jet Ranger	G-T Super Cub	Jet Ranger	Number of Passes	Super Cub
0001	Triple Lakes	1	2	1	2	1	3
0303	Carlo Creek	1	2	2	1	2	2
0306	Riley Creek Up.	1	1	1	1	1	2
0135	Jenny Creek	2	2	2	1	1	3
0141	Savage Rl.S.	1	1	1	1	1	2
0026	Savage Rl. N.	2	2	2	2	2	3
0039	Sanctuary Tom	1	1	1	1	1	3
0307	Fang Mt.	2	2	2	2	2	3
0309	Refuge Valley	1	1	1	1	1	3
0146	Double Mt.	2	2	2	2	2	5
0160	Teklanika Br.	1	1	1	1	1	3
0311	Double Mt. P.	1	1	1	1	1	5
0165	Teklanika Hill	1	1	1	1	1	5
0032	Cathedral E.	1	1	1	1	1	5
0050	East Fork Sad.	1	1	1	1	1	4
0328	Cabin Div. L.	1	1	1	1	1	4
0332	Three-Young	2	2	2	2	2	2
0207	Stony/Branch	2	2	2	2	2	2
0020	Stony 20	2	2	2	2	2	2
0156	East Branch Toklat	1	1	1	1	1	1
0033	Savage Canyon	1	1	1	1	1	5

G-T = ground truthed, NF = nest not found.

APPENDIX 4. Information Concerning Golden Eagle Breeding Territories Located Outside the Study Area.

Ten golden eagle breeding territories have been located outside the study area within 10 km of the study area boundaries. Six of these territories are located outside the boundaries of Denali. Five breeding territories were occupied in 1988 (Table A4-1). The same two pairs were successful in raising young in both years.

Table A4-1. Results of golden eagle breeding at occupied territories located out of the study area and near Daniel National Park and Preserve, Alaska, 1988.

Nest Number	General Location	Num. Adults	Eggs Laid?	Num. Nestl.	Num. Fledgl.	Breeding Territory Status	Breeding Result
0335	Ferry	2	?	?	?	O-BU	Unknown
0336	Nenana Pinn.	2	?	?	?	O-BU	Unknown
0246	Moody Bridge	2	Y	2	2	OB	Successful
0248	Healy Creek	2	Y	1	1	OB	Successful
0243	Dragonfly	1	?	?	?	O-BU	Unknown

O-BU = Occupied-breeding unknown
OB = Occupied breeding