ABSTRACT

Recent interest in commercial exploitation of gyrfalcons within the Northwest Territories has elevated the need for information on the status and population parameters of gyrfalcons. Studies were initiated in 1982. About 188 hours of helicopter time was expended surveying potential nesting habitat in Kitikmeot and Baffin Regions and to a small extent in Keewatin Region. Surveys were conducted during late June/early July (late incubation/early brooding). Density of territorial pairs ranged from 1 pair/277 km^2 to 1 pair/1,456 km^2, with an average of 1 pair/474 km^2 over all areas. Average indicated clutch size was 2.9 eggs, and average potential production of young measured during late incubation/early brooding was 2.0 young/pair for 35 pairs observed. It was concluded that density and population was normal for a healthy falcon population. Nest site characteristics and colour phases are discussed. Nesting observations of common ravens, peregrine falcons, rough-legged hawks and golden eagles are reported. Recommendations for future studies are made.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Prior to 1980, little legitimate interest in commercial or private harvest of falcons was known within the Northwest Territories (N.W.T.). As a consequence, the Government of the N.W.T. (GNWT) had not developed a policy or regulations pertaining specifically to the harvest of birds of prey. In 1980, requests were received from individuals in North America and abroad interested in capturing or purchasing gyrfalcons (Falco rusticolus) commercially. These requests were denied.

On 10 July 1981, the Kitikmeot Inuit Association applied to the Wildlife Service for permits to take 400 gyrfalcons from the wild for commercial purposes. The Executive Committee of the GNWT decided to allow an experimental harvest of up to 50 birds. A capture attempt was undertaken near Spence Bay from 18-26 September 1981. No gyrfalcons were caught and only one was observed.

In response to the increasing public interest and concern in exploiting the raptor resource, the Wildlife Service initiated baseline studies of birds of prey in the Kitikmeot, Baffin and Keewatin Regions in spring 1982. This report is the first of a series of annual reports on these studies. Previous to the study reported here, no extensive surveys specifically designed for nesting gyrfalcons had been conducted in the N.W.T. Since the 1960's however, the Canadian Wildlife Service has maintained records on nests they have encountered or had reported to them during work on other species in the N.W.T. (R. Fyfe, Canadian Wildlife Service Files, Edmonton). The Yukon Department of

Renewable Resources has conducted extensive surveys and research of gyrfalcons in the Yukon from the mid-1970's to the present. Many of the findings in the Yukon may prove to be pertinent to at least part of the N.W.T. It is expected that results of ongoing studies reported here will be utilized in the development of policy and regulations concerning raptors in the N.W.T. in future years.

The goal of the study was to become familiar with raptor survey techniques and with conditions and problems characteristic of work with raptor populations in the Canadian Arctic. The primary objectives of the first year of study were to survey sample areas in the Kitikmeot and Baffin Regions for active gyrfalcon nests to determine 1) density of nests, 2) timing of nesting during the 1982 season, 3) production of young in areas censused, 4) characteristics of nesting habitat, and 5) colour phase ratios of adults in the two regions. Secondary objectives included gathering information on nesting activity of rough-legged hawks (Buteo lagopus), golden eagles (Aquila chrysaetos), peregrine falcons (Falco peregrinus tundrius) and common raven (Corvus corax).

METHODS

We selected sample areas subjectively using primarily three criteria. The areas had to be 1) within the known range of gyrfalcons, 2) near an aircraft fuel source, and 3) within the regions which might be expected to support a harvest of gyrfalcons. Consequently, surveys were conducted from the arctic settlements of Cambridge Bay, Spence Bay, and Pelly Bay in the Kitikmeot Region, Repulse Bay in the Keewatin Region and Frobisher Bay, Lake Harbour, and Cape Dorset in the Baffin Region (Fig. 1). Since only a small area in the Keewatin Region was surveyed, the term Kitikmeot Region, as used in this report, includes areas in both the Kitikmeot and Keewatin Regions.

All surveys in the Kitikmeot Region were conducted in what Porsild and Cody (1979) termed the 4th phytogeographic province, except for the Victoria Island surveys. Although southern Victoria Island was not considered in that treatise, the survey areas were considered to be within the broad definition of the 4th province. Vegetation in South Baffin has apparently not been classified, but Porsild (1964) lists the flora for the island.

Surveys were conducted using a Bell 206B helicopter on skids (Kitikmeot) or pontoons (Baffin) carrying a pilot and two observers. We attempted to examine all cliff faces within an area. This often led to an erratic flight path and as a result, some cliffs were undoubtedly missed.

Usually one slow pass along a cliff allowed a thorough assessment of the presence of raptors or nests to the degree possible from a helicopter. Occasionally however, two or more

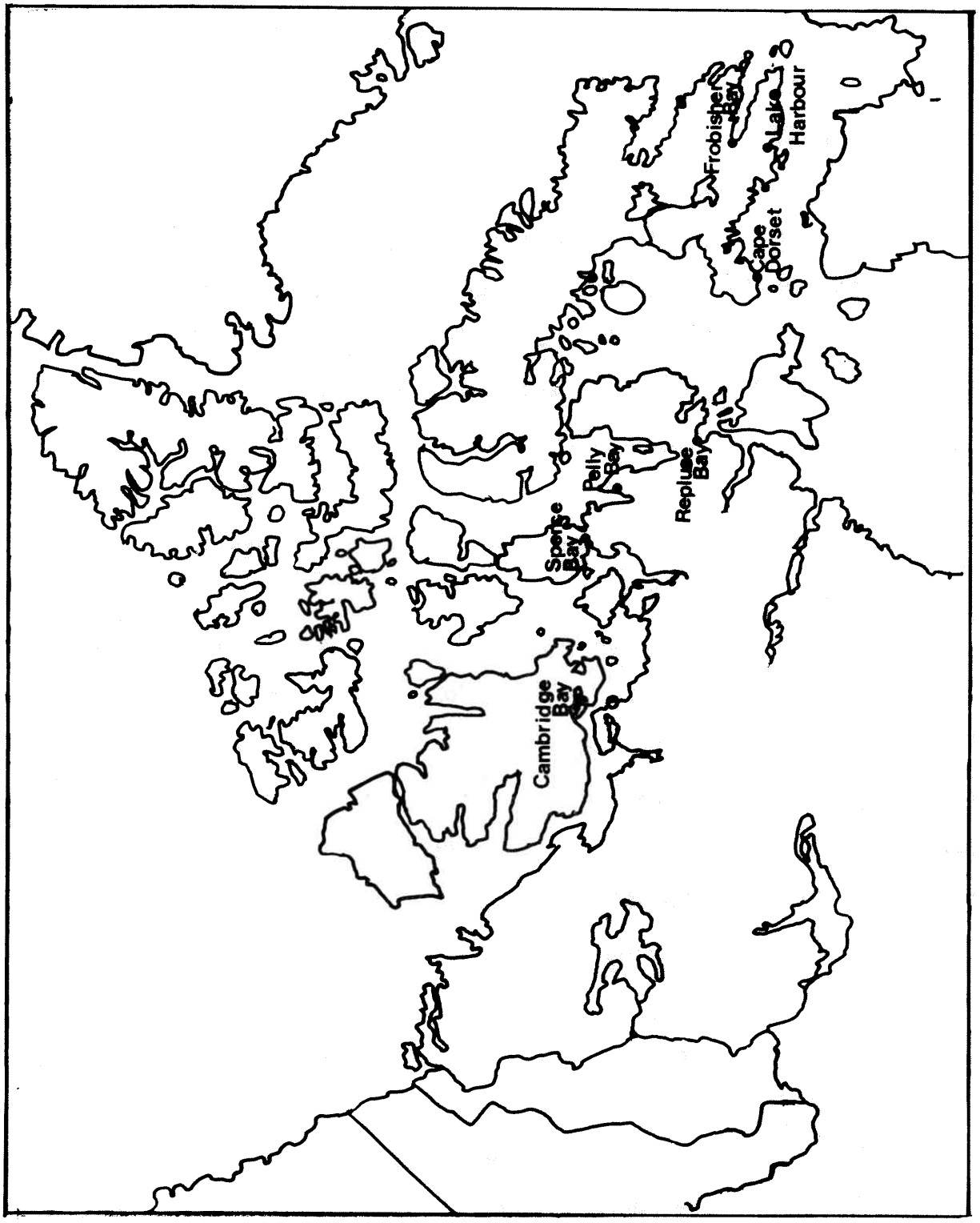


Figure 1. Map of Northwest Territories showing communities from which surveys were conducted.

passes were made to confirm or reject certain sightings. Also, when extra tall (over 30 m) cliff faces were encountered, additional passes were made at different heights along the cliff face. The technique was to fly at elevations varying from 200 to 600 m above ground level (agl), depending on ground relief, along a roughly predetermined flight path. When outcrops were located, a lower, slower approach was exercised and a close surveillance of the cliff was made, at speeds of about 100 kilometers per hour (kph). A second, slower approach of about 50 kph was made if a gyrfalcon, a nest site, patch of orange lichens (Xantheria elegans), or some notable excrement stain (guano wash) was observed.

When an active gyrfalcon eyrie was located, polaroid and/or 35 mm slides were taken of the site for future relocation of nests. The number and colour phases of adults and the numbers of eggs or number and age of young were recorded if they could be observed without endangering the contents of the nest or helicopter. The helicopter was then landed and we approached the nest cliff on the ground. The heights of the cliff and of the eyrie were estimated visually. Further observation of adults or young were recorded. Two nests were climbed into in the Kitikmeot Region and several eyries were entered in the Baffin Region.

Opportunistic sightings of gyrfalcons not associated with nests were recorded, as were rough-legged hawks, golden eagles, peregrine falcons, ravens and active and inactive nests of these species.

Each survey flight from a settlement was given an unique number and the flight path of the helicopter traced on 1:250,000

topographic maps. All the observations of raptors and nest sites along the flight path were assigned sequential numbers, and the numbers plotted on the maps.

Maps detailing nest site locations are on file in the N.W.T. Wildlife Service headquarters office in Yellowknife. Site locations will not be published due to concerns regarding security and disturbance of falcon nests.

Surveys were conducted in the Kitikmeot and Keewatin Regions from 14 June to 4 July 1982 and in the Baffin Region from 23-30 June 1982. A total of 123 hours of helicopter time were utilized for surveys (Table 1), with an additional 65 hours of ferry time.

Table 1. The number of hours flown by helicopter in each area and region during the 1982 raptor survey in the N.W.T.

Survey area	Survey time (hr)	Ferry time (hr)	Total hours
Kitikmeot Region			
Cambridge Bay (CB)	30.0		
Spence Bay (SB)	25.8		
Pelly Bay (PB)	16.6		
Repulse Bay (RB)	13.9		
Total	86.3	36.9	123.2
Baffin Region			
Frobisher Bay (FB)	12.3		
Lake Harbour (LH)	10.5		
Cape Dorset (CD)	14.0		
Total	36.8	27.9	64.7
Grand Total	123.1	64.8	187.9

RESULTS AND DISCUSSION

Study Area

Cambridge Bay

The Cambridge Bay survey area was clearly good raptor habitat. Cliffs and bluffs with suitable nesting sites were common, both along coasts and dispersed inland throughout rolling hills which were generally covered in vegetation. Willows were common and often a meter high indicating the area had high potential as prey habitat. Ptarmigan (*Lagopus* spp.) and arctic ground squirrels (*Spermophilus parryi*), primary prey species of gyrfalcons, appeared to be common.

Cliffs varied in height and substrate, often encircling a bluff, thereby providing a wide range of nest sites with varying aspect. Golden eagle and rough-legged hawk stick nests were seen frequently, thus providing options for nesting falcons.

Spence Bay

The area north of Spence Bay seemed more typical of most high arctic regions than of the low arctic of the Cambridge Bay area. Vegetation cover was generally lower, with poorer quality ptarmigan and ground squirrel habitat. Cliffs in the eastern portion were abundant, with a more rugged terrain than characterized the western portion of the area. In the west, tall clay river banks were observed with low rolling hills hosting more vegetation than did the bleak eastern terrain. Ptarmigan and

arctic hare (Lepus arcticus) were occasionally observed. Based on frequency of observations of raptors and raptor prey, and availability of nest sites, the Spence Bay area appeared to be poor to moderate quality raptor habitat.

South and east of Spence Bay cliffs were lower, less rugged and less common. Vegetation appeared more prevalent as in the area northwest of Spence Bay. Foraging habitat here was also of poor to medium quality.

Pelly Bay

Cliffs were generally common in the Pelly Bay area, although some areas with widely ranging relief had steeply rounded hills as opposed to cliffs. Vegetative cover on the plateaus, river valleys and hills appeared extensive although willows were generally quite low. Pockets of good quality raptor habitat existed, interspersed with areas of low to medium quality.

Few prey species such as ptarmigan and hares were observed. Southeast of Pelly Bay nest sites were abundant and to the southwest, sites were fairly common. West of Pelly Bay, nesting cliffs were infrequent while north of the community, cliffs were fairly common. Raptor numbers were low.

Repulse Bay

High cliffs became prevalent as distance to the north and east of Repulse Bay increased. Coastal habitat near Repulse Bay was poor, but increased in quality to the east. Cliffs were abundant

in the interior north of Repulse Bay. Vegetative cover was fairly well developed in interior areas although relatively few ptarmigan and hares were observed. Raptor numbers were low.

Frobisher Bay

The interior, north of Frobisher Bay was gently undulating with an absence of major rock outcrops, and appeared to be poorly vegetated and supporting a relatively low density of waterfowl and ptarmigan. Both the interior areas east and west of Frobisher Bay were hilly and rocky with an apparent abundance of rock outcrops. The area was again poorly vegetated and appeared to support low densities of both ptarmigan and waterfowl. The coastlines around Frobisher Bay and Ward Inlet were rugged and rocky, and with an abundance of potential nesting cliffs. Raptors were present in low numbers.

Lake Harbour

The interior east, and to some extent south, of Lake Harbour was dotted with lakes, an abundance of outcrops appeared to support a relatively high density of waterfowl and gulls. Two major rivers drained the interior south and east of Lake Harbour, both fairly wide valleys supporting a cover of riparian willows and birch. Both areas presumably supported a resident population of ptarmigan. West of Lake Harbour was an area hilly and rocky, dotted with lakes but poorly vegetated. Rock outcrops were also less abundant in the western interior, compared to the east. The

coastal area was rocky and rich in sea cliffs and outcrops. However, the eastern coastline appeared much more productive in the way of vegetation, waterfowl and seabirds. Raptors were present in the Lake Harbour area in good numbers.

Cape Dorset

The Cape Dorset area showed less relief than either Frobisher Bay or Lake Harbour. Much of the interior was a tundra habitat dotted with lakes and ponds; poorly drained habitat that supported an abundance of waterfowl. Potential nesting cliffs however, were abundant around these interior lowlands. The coastal area was irregular and rugged; sea cliffs were common and seabirds, particularly gulls and guillemots were abundant. Raptors were common.

Gyrfalcons

Density and Distribution

In the Kitikmeot Region, density of active gyrfalcon territories averaged 1/584 km^2 compared to 1/370 km^2 in the Baffin Region, for an overall density of 1/474 km^2 (Table 2). Densities by settlement sample areas ranged from 1 pair/277 km^2 to 1 pair/1456 km^2. One subsample of a survey area averaged 1 pair/181 km^2.

Regional densities of active territories reported in the literature have varied from 1/259 km^2 in 2590 km^2 in the north central Yukon (Nelson 1978) to 1/2900-3867 km^2 in east central

Table 2. Areas surveyed, number of gyrfalcon territories, and density of territories by survey area and region in 1982.

Survey area	Area surveyed (km^2)	Number of active territories	Density of territories (km^2 territory)
Kitikmeot Region			
CB	3004	10	300
SB	3724	4	931
PB	1456	1	1456
RB	1742	2	871
Total	9926	17	584
Baffin Region			
FB	2050	3	683
LH	1661	7	237
CD	2952	8	369
Total	6663	18	370
Sum of all areas	16,589	35	474

Yukon (Hayes and Mossop 1981). Roseneau (1972) documented densities of 1 pair/200 km^2 in sections of his 44,000 km^2 study area on the Seward Peninsula, Alaska where the regional density averaged 1 pair/917 km^2. Thus high densities on carefully selected study areas in this study compare favourably with those found in other geographic areas.

Although a high average density of 1 pair/474 km^2 in this study was determined, it must be noted that the areas surveyed were selected on the basis of appropriate cliff habitat predicted from examinations of topographic maps. Thus, the density of active territories we found cannot be extrapolated, for example, to the entire range of the gyrfalcon in the Northwest Territories. Any attempt to do so would vastly overestimate population size.

In any aerial survey it is probable that observer bias affects the results. During the 1982 surveys, the 3 principle observers were Norman Barichello*, Ron Graf**, and the writer. Barichello, who conducted the Baffin Region Surveys and part of the Kitikmeot Region Surveys had extensive experience surveying raptors in the Yukon Territory. Graf and the writer, who had conducted most of the Kitikmeot Region survey, had no prior experience specific to raptor surveys. No attempt was made to ground truth the accuracy of observations so the degree of error remains unknown. Data presented on many of the raptors and nesting densities however, represent minimum figures for the raptor surveys.

---

* - Department of Renewable Resources, Government of Yukon Territory, Whitehorse, Yukon Territory, Y1A 2C6

** - N.W.T. Wildlife Service, Yellowknife, N.W.T.

Chronology

The age of nestlings was estimated for young in 9 nests in the Central Arctic and in 7 nests in the Baffin Region. Four nests in Baffin contained eggs only. The timing of egg laying, hatching and fledging was determined for the two regions by back dating (Table 3). The incubation period of gyrfalcons is 35 days (Cade and Weaver 1976:42, Platt and Tull 1977:66) and was assumed to begin the day after the first egg was laid. Hatch date was estimated by back dating using the estimated age of eyases on the date they were found. Fledging period was assumed to be 47 days, as averaged from Jenkins (1974:12) and Cade (1960:205).

Most nests located contained small young, indicating egg laying must have occurred during mid May. It was apparent that gyrfalcons in the Kitikmeot and Baffin Regions either generally nested considerably later than in most other areas which have been studied to date, that nesting was delayed due to effects of the retarded spring weather (persistent cold and snow cover affecting prey availability, energetics of reproduction or other variables) or that both factors were true to some extent (Table 4). Future studies should determine which of these conditions applied.

Productivity

In the Kitikmeot Region 15 nests containing eggs and/or young were observed. Two pairs of falcons were observed loosely associated with cliffs but apparently were unproductive. In Baffin, 12 active nests and 6 unproductive pairs were located.

Table 3. Phenology of gyrfalcon nests located in the Canadian Arctic during the 1982 raptor survey.

Region	Nest number	Initiation of egg laying	Hatch	Fledging	Date located
Kitikmeot					
	CB 5(81)[a]	>13 May	>17 June	> 3 August	17 June
	6(123)	26 May	1 July	17 August	3 July
	7(133)	15 May	20 June	6 August	3 July
	7(153)	25 May	1 July	17 August	3 July
	8(167)	15 May	20 June	6 August	4 July
	8(187)	15 May	20 June	6 August	4 July
	8(190)	15 May	20 June	6 August	4 July
	SB 1(15)	15 May	20 June	6 August	21 June
	RB 2(31)	15 May	20 June	6 August	30 June
	3(35)	11 May	16 June	2 August	1 July
Average dates		>17 May	>22 June	> 8 August	
Baffin					
	LH 5(12)	9 May	26 June	12 August	26 June
	6(13)	10 May	16 June	31 July	26 June
	7(23)	12 May	19 June	5 August	26 June
	8(5)	17 May	19 June	5 August	27 June
	CD 11(31)	20 May	22 June	8 August	28 June
	12(5)	23 May	29 June	15 August	29 June
	13(19)	24 May	26 June	12 August	29 June
	FB 2(9)[a]	>21 May	>25 June	>11 August	24 June
	3(8)[a]	>21 May	>25 June	>11 August	24 June
	CD 13(6)[a]	>26 May	>30 June	>16 August	29 June
	13(22)[a]	>26 May	>30 June	>16 August	29 June
Average dates		>19 May	>24 June	>10 August	

a Nest with eggs only. Latest possible laying date was estimated as 35 days before the nest was located.

Table 4. A comparison of the nesting chronology of gyrfalcons from selected references with that of the Kitikmeot and Baffin Regions during 1982[a].

Location	Initiation of egg laying	Hatch	Fledge	Reference
South Kitikmeot and South Baffin	>18 May	>23 June	>9 August	This study (1982)
Ellesmere Island	23 May	27 June	15 August	Muir (1973)
N.E. Greenland	10 May	18 June	5 August	Fletcher and Webby (1977)
Thelon River, N.W.T.	8 May	12 June	29 July	Kuyt (1980)
Northern Alaska	22 April	1 June	20 July	Cade (1960)
Seward Peninsula, Alaska	25 April	1 June	20 July	Roseneau (1972)
Kola Peninsula, Russia	15 April	21 May	7 July	Kishchinskii (1957)
Dempster Highway Yukon Territory	5 April	19 May	7 July	Nelson (1978)

a Medians were calculated if references gave ranges of dates only.

Productivity, as measured during late incubation and the early nestling period, was 2.7 eggs and/or young per active nest and 2.1 per pair observed (Table 5). Maximum clutch size observed was 4 eggs.

These figures are comparable to those reported for a north central Yukon gyrfalcon population measured during the second half of the nestling phase. Nelson (1978) observed 2.63 young per pair with known production and 2.2+ young per known pair. On the north slope, Yukon Territory, Mossop (1980) found production of fledglings varied from 2.7 to 3.4 per productive nest with an average of 3.1 ± 0.3 young (my calculation) over 7 years. Ptarmigan numbers were considered high throughout the 7 year period. This level of productivity was considerably higher than that observed during this study.

Cade (1960) measured 1.3 to 3.0 young per productive nest over several years in northern Alaska. He speculated that starvation of young occurred during years of low prey abundance, resulting in a higher incidence of nestling mortality. Ratcliffe (1980) observed a 29% reduction from the egg stage to fledglings for peregrine falcons. Peregrine falcons and red-necked falcons (Falco chicquera) exhibited reductions of 10% (Pruett-Jones et al. 1981) and 21% (Osborne 1981), respectively, between hatching and fledging. Although the relative abundance of prey was unknown in this study, it is likely that some egg and nestling mortality took place prior to fledging beyond that which was observed.

During our surveys, we recorded 2 dead young and 2 addled eggs, all in different nests, indicating some mortality in the

Table 5. Productivity of gyrfalcons measured during late incubation and early nestling stages, 1982, in the Kitikmeot and Baffin Regions.

Area	Number of territorial pairs	Number of productive pairs	Number of nests where # egg/young known	Number of: eggs/young	$\bar{x}$ indicated clutch	Number potential young/active nest	Number potential young/pair
CB	10	9	8	4/18	2.75	2.75	2.48
SB	4	4	2	1/4	2.50	2.50	2.50
PB	1	0	-	-	-	-	0
RB	2	2	2	0/6[a]	3.00	2.50	2.50
Kitikmeot	17	15	12	5/28[a]	2.75	2.67	2.36
FB	3	2	2	5/0	2.50	2.50	1.67
LH	7	4	4	3[b]/10	3.25	3.00	1.71
CD	8	5	5	9[b]/6[a]	3.00	2.60	1.63
Baffin	18	11	11	17[c]/16[a]	3.00	2.73	1.67
Grand total	35	26	23	22[c]/44[d]	2.87	2.70	2.00

a 1 dead young
b 1 egg addled
c 2 eggs addled
d 2 dead young

nest was occurring. At least six of the 27 active nests still contained eggs only, and an additional four nests contained eggs and small young. Thus, there was a substantial amount of time prior to fledging during which significant mortality could have occurred. Assuming an average of 15% mortality between the time of location of the nest and fledging of young (see Pruett-Jones et al. 1981, Osborne 1981 and Ratcliffe 1980), 1.79 young/pair or 2.32 young/active nest observed fledged in the areas surveyed. Thus, production was considered low to moderate relative to areas studied by other workers as discussed above. Factors influencing productivity may have included a late spring and low prey abundance in some areas.

Success of pairs at maintaining viable eggs or young to the late incubation/early brooding stage varied among areas from 0 to 100% (Table 6). Gyrfalcons in the Kitikmeot Region were more successful (88%) than in the Baffin Region (61%) to that stage of reproduction (Table 6).

Nest Site Characteristics

Most gyrfalcon nests (60%) were in stick nests of common ravens, rough-legged hawks or golden eagles (Table 7). In the Baffin Region, where golden eagles were not present, the majority of gyrfalcons nested in raven nests. Gyrfalcons distributed their nests more evenly amongst raven, golden eagle and rough-legged hawk stick nests in the Kitikmeot Region. About 40% of nests were on ledges in both regions.

Table 6. Success of known gyrfalcon pairs at incubating eggs and raising young to the late incubation/early brooding stages in the Kitikmeot and Baffin Regions, 1982.

Area	Number of known sites active in 1982	Number of nests with eggs or young	% of sites successful to late incubation/early brooding
Kitikmeot Region			
CB	10	9	90
SB	4	4	100
PB	1	0	0
RB	2	2	100
Total	17	15	88
Baffin Region			
FB	3	2	67
LH	7	4	57
CD	8	5	63
Total	18	11	61
All areas	35	26	74

Table 7. Nest site characteristics of gyrfalcon nests located in the Kitikmeot and Baffin Regions in 1982.

Area	Site #	Type	Aspect	% Overhang	Cliff Ht. (m)	Nest Ht. (m)
CB	4(53)[a]	-	SW	-	50	-
	4(71)	SN(R)[b]	NW	100	50	47
	5(78)	L[c]	E	100	70	48
	5(81)	SN[d]	N	100	20	10
	6(123)	SN(E)[e]	E	90	30	18
	7(133)	L	S	100	20	7
	7(153)	SN	-	100	-	-
	8(167)	L	W	70	20	12
	8(87)	SN(R)	W	100	25	15
	8(190)	SN(E)	W	100	36	23
SB	1(15)	-	SE	60	20	17
	3(52)	-	SSE	75	45	25
	3(66)	L	WSW	100	30	20
	1(121)	L	SE	100	45	30
PB	3(40)[a]	-	E	-	35	-
RB	2(32)	SN	S	-	-	-
	3(35)	SN(R)	SW	100	10	8
FB	2(9)	L	W	0	-	-
	3(8)	SN(R)	SW	50	-	-
	3(13)[a]	SN(R)	W	100	-	-
LH	5( )	SN(R)	NE	100	-	-
	6(13)	SN(R)	E	100	40	-
	6(14)[a]	SN(R)	NE	100	-	-
	7(1)[a]	SN(RL)[f]	SW	100	-	-
	7(23)	SN(R)	E	100	15	13
	8(5)	L	S	100	-	-
	9(3)[a]	SN(RL)	E	100	-	-

Table 7. continued

Area	Site #	Type	Aspect	% Overhang	Cliff Ht. (m)	Nest Ht. (m)
CD	11(31)	L	S	100	-	-
	12(1)[a]	L	S	100	-	-
	12(3)[a]	SN(R)	NW	100	-	-
	12(5)	L	S	100	-	-
	12(6)[a]	SN(R)	W	100	-	-
	13(6)	L	SW	10-20	-	-
	13(17)	SN(R)	E	100	-	-
	13(22)	L	SW	100	90	5

a Unproductive
b SN(R) = Raven stick nest
c L = Ledge
d SN = Sticknest - probably rough-legged hawk
e SN(E) = Golden eagle stick nest
f SN(RL) - Rough-legged hawk stick nest

Gyrfalcons occupying ledges and eagle nests were the most successful, followed by those in raven nests then rough-legged hawk nests (Table 8). Small sample sizes of eagle and rough-legged hawk sites used by gyrfalcons however, precluded a rigorous analysis of these relationships. Eagles and ravens nest early in the year, similar to gyrfalcons. Possibly nest site requirements between the species at least are more similar than those of rough-legged hawks which nest after the weather has ameliorated to a considerable degree.

Gyrfalcons typically chose nest sites with large overhangs (Table 7), averaging about 90% covered by overhanging rock. The height of nesting cliffs varied widely, but averaged 36.2 m (± 20.3, n=32). Height of nests on cliffs averaged 19.9 m (± 13.2, n=15).

Gyrfalcons appeared to avoid north facing cliffs for nesting (Figs. 2-4). In the Kitikmeot Region, nests had an east to south to west aspect (Fig. 2) while in Baffin they were east or south to west orientated. Combining the regions, only 14.3% of all nests had a northwest to northeast aspect while only 8.7% of all productive nests had a similar aspect. Although based on small sample size the use of southerly facing cliffs and the lower reproductive success of gyrfalcons using northerly facing cliffs (Fig. 4) suggests there is a selective advantage to those falcons nesting on cliffs with southerly aspects. Cade (1960), Platt (1976), and others have discussed the need of snow free sites for this early nesting species. Large overhangs and southerly aspects would promote this condition. Local variations in aspect may be

Table 8. Success by nest type for 30 gyrfalcon nests located during the 1982 survey in Kitikmeot and Baffin Regions (abbreviations as in Table 7).

	Productive nests				Unproductive nests			
Area	SN(R)	SN(RL)	SN(E)	L	SN(R)	SN(RL)	SN(E)	L
Kitikmeot	2	2	2	5	1	1	0	0
Baffin	5	0	-	6	4	2	-	0
Total	7	2	2	11	5	3	0	0
Percent of nests	58	40	100	100	42	60	0	0

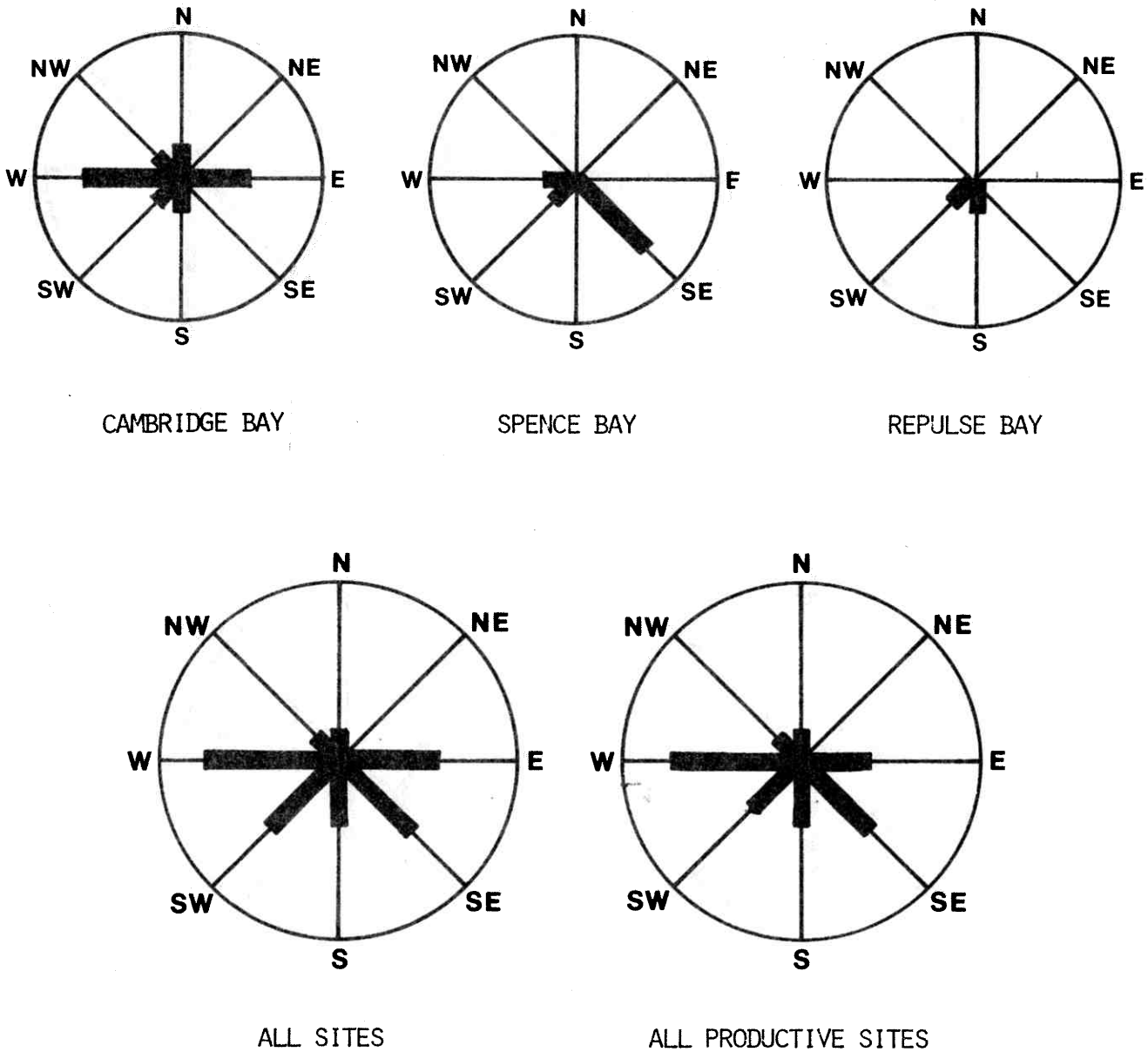
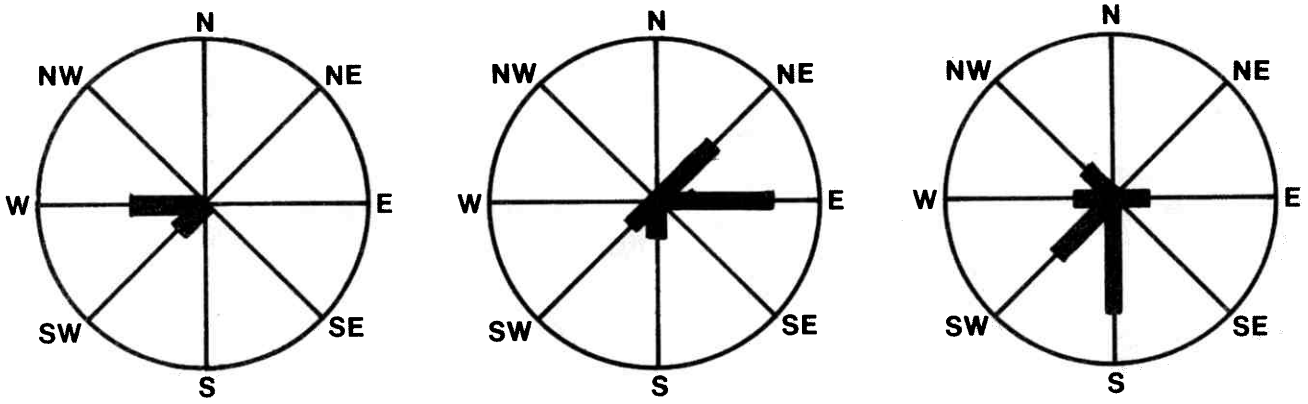


Figure 2. Aspect of gyrfalcon nest sites in the Kitikmeot Region in 1982.



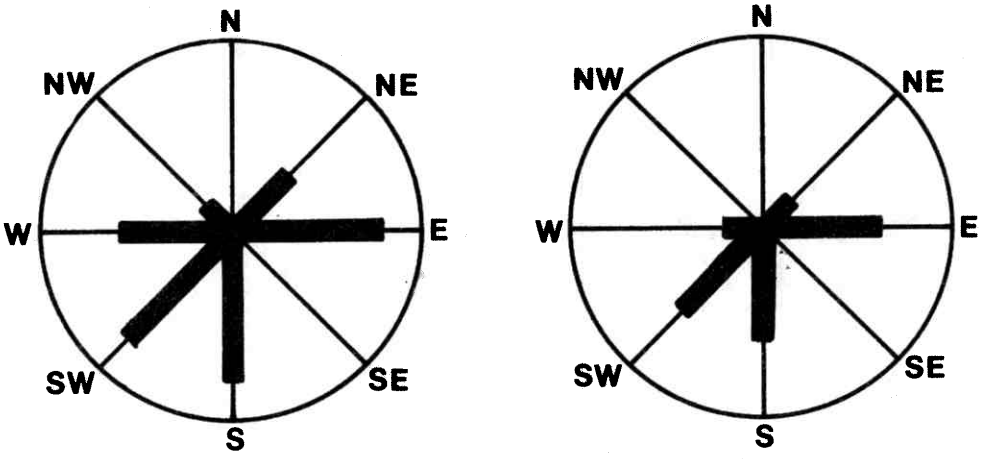
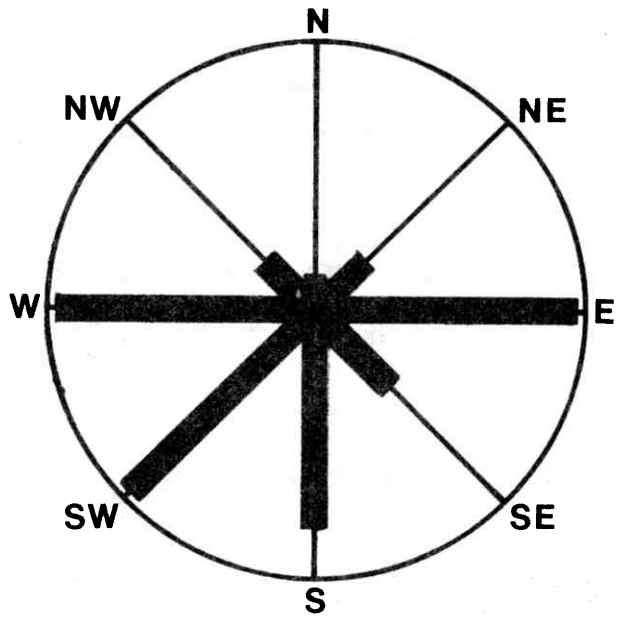
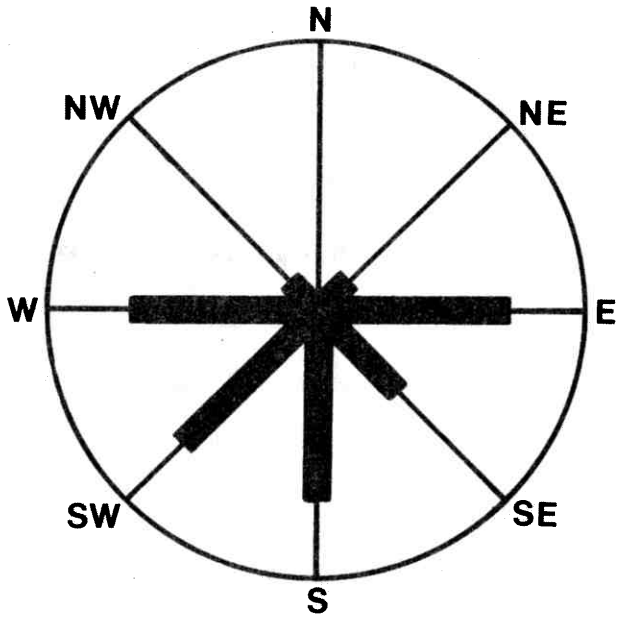


Figure 3. Aspect of gyrfalcon nest sites in the Baffin Region in 1982.



ALL SITES IN KITIKMEOT AND BAFFIN REGIONS



ALL PRODUCTIVE SITES IN
KITIKMEOT AND BAFFIN REGIONS

Figure 4. Aspect of gyrfalcon nest sites in the Kitikmeot and Baffin Regions in 1982.

expected in relationship to local prevailing wind directions (Platt 1976). Although the availability of potential nest sites on northern orientated cliffs was not examined quantiatively searches of these cliffs suggested they existed in similar frequencies to those of southern aspect.

Numbers and Colour Phases of Gyrfalcons

Of the 59 gyrfalcons recorded (Table 9), 30 were in the Kitikmeot Region, with 21 falcons associated with nests and 6 with unproductive sites. Three incidental sightings of individuals apparently not associated with nests were made. In the Baffin Region, 29 birds were seen; 20 associated with nests and 6 with unproductive territories. One dead adult falcon was observed at an active site occupied by 2 adults, and an additional three sightings of individuals were noted.

Colour phase of adult birds was categorized as white or grey, although some grey phase birds were more brown than grey. Colour phase was discerned for 58 of the 59 birds, for an overall ratio of 47 white to 11 grey or 4.3:1 (Table 9). There was a slight trend from west to east, with percentages of white phase falcons increasing from 77% in the Kitikmeot Region to 86% in the Baffin Region.

Common Ravens

A total of 49 raven nests not occupied by gyrfalcons were located in the Baffin and Kitikmeot regions. Nests had aspects

Table 9. Numbers and colour phases of gyrfalcons observed in Kitikmeot and Baffin Regions in 1982.

Area	Numbers at nests	At unproductive territories	Incidental sightings	Colour phase ratio (W:G)
Kitikmeot Region				
CB	8W[a], 4G[b]	2G	2G, 1W	1.4:1
SB	7W	2W	-	1:0
PB	-	2W	-	1:0
RB	2W	-	-	1:0
Total	17W, 4G	4W, 2G	2W, 1G	3.3:1
Baffin Region				
FB	3W	-	2W, 1G	5:1
LH	6W, 2G	6W	-	6:1
CD	7W, 1G	-	1U[c]	7:1
Total	16W, 3G	6W	2W, 1G, 1U	6:1
Grand total	33W, 7G	10W, 2G	4W, 2G, 1U	4.3:1

a W = white phase

b G = grey phase

c U = unknown colour phase

Table 10. Common raven nest site characteristics and production in the Kitikmeot and Baffin Regions, 1982 (excluding raven nests occupied by gyrfalcons).

Area	Site	Aspect	% Overhang	No. young	Date
CB	1(15)	NE	100	5	14 June
	6(99)	-	-	4+	3 July
	8(160)	-	-	4	4 July
	9(215)	-	-	4+	
	8(167)	W	100	2+	
SB	2(46)	-	-	1+	23 June
	3(49)	-	-	1+	23 June
	8(130)	-	-	3+	26 June
	8(132)	NW	100	2+	26 June
	8(133)	SE	100	-	26 June
PB	9(139)	E	100	1+	26 June
	3(43)	-	100	3	28 June
	4(66)	-	-	3+	28 June
RB	1(19)*	SW	100	3+	30 June
	3(45)	E	100	3+	1 July
	4(50)*	SW	100	1+	1 July
FB	1(2)*	ESE	100	2+	23 June
	3(4)*	W	100	3	24 June
	3(10)*	W	30-80	3	24 June
	3(13)	-	100	-	24 June
	4(5)	-	-	1+	25 June
	4(7)*	S	100	3	25 June
	5(4)	-	-	1+	25 June
	5(9)	-	-	-	25 June
	5(11)	E	100	-	25 June
LH	7(3)	W	100	3	26 June
	7(4)	SE	100	-	26 June
	7(10)	S	100	3	26 June
	7(20)	S	100	3	26 June
	7(21)	SE	-	3	26 June
	7(22)	E	100	4	--
	7(24)	SW	100	1+	26 June
	8(1)	E	100	3	27 June
	9(1)	SE	100	3	27 June

Table 10 continued

Area	Site	Aspect	% Overhang	No. young	Date
CD	11(28)	SW	100	1	28 June
	11(29)	-	-	-	28 June
	11(41)	-	-	2+	28 June
	11(45)	-	-	-	28 June
	12(6)*	NW	100	-	29 June
	13(2)*	SW	100	-	29 June
	13(24)	E	100	2	29 June
	13(26)	S	100	1+	29 June
	14(7)	W	100	2	30 June
	14(10)*	S	100	-	30 June
	14(12)	W	100	2	30 June
	14(18)		100	2+	30 June
	15(11)	-	-	-	30 June
	15(15)	S	100	-	30 June
	15(27)*	SW	100	-	30 June

* Likely gyrfalcon site.

from east to south to west, with only three of the 32 where aspect was recorded having northerly orientations (Table 10, Fig. 3). All raven nests were well protected from above with rock overhangs generally projecting over the entire nest.

Thirty-four of the 49 nests (69%) contained young, with an average of 2.47+ young per successful nest (Table 11). Some pairs fledged young before nests were located. Fewer nests were observed in the Kitikmeot Region than in the Baffin Region, but ravens in the Kitikmeot Region were slightly more productive. Ravens may play an important role in the ecology of gyrfalcons in the Canadian Arctic both by providing nest sites for falcons and by competing for nest sites (Cade 1960). Of 32 raven nests where aspect was recorded, only 9.3% were facing northwesterly to northeasterly, similar to the 14.3% observed in gyrfalcons. Ravens likewise selected sites with large overhangs providing extraordinary protection from the elements.

Tundra Peregrine Falcons

During the surveys, 26 active peregrine falcon nests were observed and confirmed, with another 27 nests implicated through observations of territorial peregrines (usually a pair) at what appeared to be good potential nesting cliffs (Table 12). Since the objective of the surveys was to locate gyrfalcon nests, observations of territorial peregrines were not pursued to confirm nesting activity. Since observations were interpreted conservatively, it is likely that the number of peregrine falcons observed (Table 12) represented many more than the 53 nests (26 confirmed, 17 implicated) recorded.

Table 11. Production at active common raven nests in 1982[a].

Area	No. of productive nests	No. of young	No. of young/nest
Kitikmeot	15	40+	2.67+
Baffin	19	44+	2.32+
Total	34	84	2.47+

a Some flying young were observed in the vicinity of nest sites, indicating fledging had already occurred. This would cause an underestimate of total young produced and number of productive nests.

Table 12. Tundra peregrine falcon observations in the Kitikmeot and Baffin Regions, 1982.

Area	Number active nests	Number unconfirmed active nests	Number adults at nests as: Pairs	Singles	Number of birds not associated with nests as Pairs	Singles
CB	5	8	24	0	2	17
SB	4	5	6	5	0	15
PB	3	2	4	3	0	12
RB	1	3	6	0	0	7
Kitikmeot total	13	18	40	8	2	51
FB	1	0	2	0	2	3
LH	4	4	6	5	0	4
CD	8	5	10	8	0	2
Baffin total	13	9	18	13	2	9
Grand total	26	27	58	21	4	60

There were 143 peregrines observed throughout the survey compared to 59 gyrfalcons, giving a ratio of 2.4:1.0. This ratio is probably biased in favour of gyrfalcons, since the survey concentrated on locating gyrfalcons using the observers' interpretations of what constituted gyrfalcon habitat. The ratio of peregrines to gyrfalcons in the regions suggests that gyrfalcons are relatively more common in the Baffin Region (1.4:1.0) than in the Kitikmeot Region (3.4:1.0). This indication is also supported in an absolute sense by the density of gyrfalcon territories (Table 2) in Baffin (1/370 km^2) compared to Kitikmeot (1/584 km^2).

Density of peregrine falcon territories was estimated conservatively at 1/313 km^2 (53 nests/16,589 km^2). As with gyrfalcons, this estimate cannot be extrapolated throughout the range of the tundra peregrine falcon. Density of peregrine falcon territories were considerably less than found in the Wager Bay area (one occupied territory per 50 km^2 [Calef and Heard 1980]) and in Rankin Inlet (1 territory/8.5 km^2 [Gates 1982]).

Rough-legged Hawks

Of 304 rough-legged hawk nests 50 (16%) were active, but the proportion of active nests varied widely between survey areas (Table 13). In the Kitikmeot Region, the Spence Bay area had 20.5% active nests, considerably higher than other areas in the Region. In the Baffin Region, the proportion of active nests indicated extreme differences between areas, such as between Cape Dorset (42.6%) and Frobisher Bay (10.0%).

Table 13. Rough-legged hawk observations in the Kitikmeot and Baffin Regions, 1982.

Area	Number of nests active/inactive (% active)		Number of adults at nests as pairs	Number of adults at nests as singles	Number of adults not at nests as pairs	Number of adults not at nests as singles
CB	11/105	(9.4)	4	7	0	13
SB	9/35	(20.5)	0	9	1	10
PB	2/33	(5.7)	0	2	0	4
RB	4/28	(12.5)	0	4	0	4
Kitikmeot total	26/201	(11.5)	4	22	1	31
FB	1/91	(10.0)	0	1	2	8
LH	3/17	(15.0)	0	3	0	1
CD	20/27	(42.6)	2	19	0	17
Baffin total	24/53	(31.2)	2	23	2	26
Grand total	50/254	(16.4)	8	45	3	57

Hagen (1969) showed that numbers of rough-legged hawk nesting pairs varied annually in relation to microtine population levels. It is likely that food abundance varies regionally and can promote regional differences in rough-legged hawk populations (Newton 1979, Baker and Brooks 1981), such as observed in this study. No data on microtine populations were gathered during our surveys.

Although the proportion of nests that were active revealed large regional variations, the productivity of the areas did not always follow. When the number of active nests per unit area were examined (Table 14), it was concluded that in the Kitikmeot Region, the Cambridge Bay area was most productive for rough-legged hawks. Cape Dorset was still the most important area of the Baffin areas surveyed.

Golden Eagles

Golden eagles were only observed in the Kitikmeot Regions, with nesting recorded in the Cambridge Bay and Pelly Bay survey areas (Table 15). Nesting density was 1/231 km^2 and 1/291 km^2, respectively. Nests contained an average of 1.67 young, less than 3 weeks of age.

Golden eagle nest sites could be important to gyrfalcons in parts of the Kitikmeot Region. One observation in the Cambridge Bay area of a pair of gyrfalcons pursuing a pair of golden eagles away from the falcon nest confirmed the expectation that territorial interactions between the two species were occurring in that area.

Table 14. Density of active and total rough-legged hawk nests by area in the Kitikmeot and Baffin Regions, 1982.

Location	% of nests active	Density of active nests (km^2)	Total density of nests (km^2)
Kitikmeot Region			
CB	9.4	1/273	1/26
SB	20.5	1/414	1/85
PB	5.7	1/728	1/42
RB	12.5	1/436	1/54
Total	11.5	1/382	1/44
Baffin Region			
FB	10.0	1/2050	1/205
LH	15.0	1/554	1/83
CD	42.6	1/148	1/63
Total	31.2	1/278	1/87
All areas	16.4	1/332	1/55

Table 15. Golden eagle observations in the Kitikmeot and Baffin Regions, 1982.

Area	Number of nests	Number adults and sub-adults observed		Number nests where young counted	Total young	Average number of young per nest
		at nests	not at nests			
CB	13	14	19	8	14	1.75
SB	0	-	5	-	-	-
PB	5	6	1	1	1	1.00
RB	0	-	2	-	-	-
Kitikmeot total	18	20	27	9	15	1.67

Behaviour of Nesting Raptors

The behaviour of nesting raptors in relation to disturbance is known to vary according to their stage of reproduction when disturbed (Fyfe and Olendorff 1976). Similar observations were made during our surveys. In many cases, incubating peregrines, gyrfalcons and golden eagles did not leave their nest despite one to three close passes and hovering with the helicopter within 25 to 50 m of the nests. Single birds, presumably males, often flushed from nesting cliffs or adjacent cliffs as the helicopter approached, giving the observers an indication that a nest site could be nearby. Rough-legged hawks appeared to flush more readily from the helicopter than other raptors.

On four occasions, nests containing young were observed with no adult birds in the immediate vicinity. These nests, two belonging to golden eagles and two to gyrfalcons, had to be visited again to confirm species identification.

RECOMMENDATIONS

In the future, surveys should be timed to coincide more closely with the age of young falcons, to allow banding of young (preferably young should be 10 to 35 days, see Fyfe and Olendorff 1976). Based on information from 1982 surveys, this should ideally be between early and late July. Assuming however, that 1982 was a late spring, surveys should normally be conducted during early to mid-July in the Kitikmeot and Baffin Regions.

One implication of aerial surveys timed to allow banding of young, is that more unproductive pairs may be missed than if the surveys were conducted earlier. To compensate for this shortcoming, either ground surveys to count territorial pairs during early incubation on small selected sample areas or aerial surveys in spring should also be conducted (cf. Fraser et al. 1983).

To maximize efficiency of helicopter time, annual surveys for gyrfalcons should concentrate first on checking known and identified potential gyrfalcon, raven and eagle nest sites in the survey areas. Time permitting, the survey areas should then be expanded to include new habitat and increase our present sample size of gyrfalcon nest sites. Ideally, surveys of this design should continue for several years until a sufficient number of sites have been located in well distributed areas that will reflect true values of reproductive parameters for different regions within the range of nesting gyrfalcons in the N.W.T. Representative study areas should then be selected and monitored annually, with major surveys checking all known sites every 5 to 10 years.

In order to understand variation in production based on aerial surveys, it is necessary to have coincidental studies on the ground examining relationships between gyrfalcons and their environment. These studies should be conducted in at least two different parts of their range which are representative of these parts of their range. Surveys reported in this work indicated the ecology of gyrfalcons may vary considerably between areas where their range is sympatric with golden eagles versus where it is not.

SUMMARY

Extensive aerial surveys designed to locate nesting gyrfalcons, other raptors and ravens were conducted in the Kitikmeot and Baffin Regions in 1982. Density of active gyrfalcon territories ranged from 1/370 km^2 to 1/1,456 km^2 with an overall average of 1/474 km^2. There were 35 active territories located in the 16,589 km^2 surveyed.

At the time of the surveys (late incubation/early brooding stages) there was an average of 1.7 (Baffin) to 2.4 (Kitikmeot) eggs and or young per productive pair of gyrfalcons. Timing of nesting was late compared to that of other studies. Due to their small size, no young were banded.

A majority of gyrfalcons seen were white phase birds, increasingly so towards the east. Nests were generally located on cliffs of east to south to west exposure and in the nests of other species (common ravens, golden eagles and rough-legged hawks).

Although some ravens had already fledged their young, 49 raven nests were still active with young (about 2.5 young per nest). Ravens were suspected of affecting gyrfalcon ecology by providing nest sites and by competing for nest sites. Similar to gyrfalcons (14.3%), only 9.3% of the raven nests had northwest to northeast aspects, indicating a high degree of selection was propably operating for east to south to west facing nesting cliffs.

One hundred forty-three peregrine falcons were observed, representing at least 26 active nests, and probably more than 53 nests. Density of active territories ranged from 1/370 km^2 in Baffin to 1/584 km^2 in Kitikmeot.

Over 16% of 304 rough-legged hawk nests were active, possibly reflecting a low in the microtine cycle. The degree of nesting activity varied locally, however, indicating probable variations in prey abundance.

In the Kitikmeot Region, 18 active golden eagle nests were observed containing an average of 1.67 young. Gyrfalcon use of unoccupied golden eagle nests was high, and production of young falcons was higher at golden eagle nests than at nests of other species. Use of similar nesting sites and prey, and similar characteristics of nesting by eagles and gyrfalcons of the Kitikmeot Region, reveal likely areas of competition between the two species.

It was recognized that to maximize return on survey effort, surveys should be conducted in early to late-July when young are of a sufficient size to be banded. Spring surveys on the ground should be carried out to determine the nesting population and to allow determination of productivity in concert with the July production surveys.

Surveys should be repeated and expanded to allow assessment of the population over time.

ACKNOWLEDGEMENTS

I would like to express considerable appreciation to Norman Barichello for his major contributions to this first intensive effort directed towards gyrfalcons in the N.W.T. Norman conducted the Baffin Region survey, after initiating the Kitikmeot Region survey to standardize our methods.

Ron Graf (NWT WS) did most of the planning for the 1982 work, assisted with the Kitikmeot Region survey and reviewed this report. I gratefully acknowledge his efforts. Doug Heard (NWT WS) provided a constructive review of the report - thanks Doug.

Surveys benefited significantly from the interest and contribution of Judy Donaldson and the Baffin Region Inuit Association in Frobisher Bay, Matthew Saviakjuk of Cape Dorset, and Seemega Aqpik, Graham Baird, Mike Ferguson, Alan Helmer and Pauloosie Kilabuk (NWT WS). Finally, I am grateful to Frank O'Connor (pilot/engineer), Geoff Goodyear (pilot) and Ken Drover (engineer) for their capable work in flying the helicopters safely and productively, and for their real interest and contributions to the success of the surveys.

LITERATURE CITED

Baker, J.A. and R.J. Brooks. 1981. Distribution patterns of raptors in relation to density of meadow voles. Condor 83: 42-47.

Cade, T.J. 1960. Ecology of the peregrine and gyrfalcon populations in Alaska. Univ. California Publ. in Zool. Vol. 63, No. 3. pp. 151-290.

Cade, T.J. and J.D. Weaver. 1976. Gyrfalcon X peregrine hybrids produced by artificial insemination. J. North Amer. Falconers' Assoc. 15: 42-47.

Calef, G.W. and D.C. Heard. 1980. Reproductive success of peregrine falcons and other raptors at Wager Bay and Melville Peninsula, N.W.T. N.W.T. Wildl. Serv. File Rep. No. 4. 33 pp.

Fletcher, D.J. and K. Webby. 1977. Observations on gyrfalcons Falco rusticolus in Northeast Greeland. Dask Orn. Fren. Tidsskr. (1977) 77: 29-35.

Fraser, I.D., L.D. Frenzel, J.E. Mathisen, F. Martin and M.E. Slouch. 1983. Scheduling bald eagle reproduction surveys. Wildl. Soc. Bull. 11(1): 13-16.

Fyfe, R.W. and R.R. Olendorff. 1976. Minimizing the dangers of nesting studies to raptors and other sensitive species. Can. Wildl. Serv. Occ. Paper No. 23. 17 pp.

Gates, C. 1982. A first report of the reproductive biology of peregrine falcons at Rankin Inlet, N.W.T. N.W.T. Wildl. Serv. unpubl. rep. 20 pp.

Hagen, Y. 1969. Norwegian studies on the reproduction of birds of prey and owls in relation to micro-rodent population fluctuations. Fauna 22: 73-126.

Hayes, R. and D.H. Mossop. 1981. Nesting raptor studies in the north Canol-Macmillan Pass development area. Yukon Wildl. Branch unpubl. rep. 45 pp.

Jenkins, M.A. 1974. Behaviour of gyrfalcon (Falco rusticolus) from hatching to fledging: A time-lapse photographic study. M.S. Thesis, August, 1974. Dept. of Zoology, Brigham Young University, Salt Lake City. 83 pp.

Kishchinskii, A.A. 1957. On the biology of the Gyr-Falcon (Falco gyrfalco gyrfalco) in the Kola Peninsula. Ornithology, No. 1. 1957 (USSR). 31 pp.

Kuyt, E. 1980. Distribution and breeding biology of raptors in the Thelon River area, Northwest Territories, 1957-1969. Can. Field-Nat. 94(2): 121-130.

Mossop, D. 1980. The Yukon Territory gyrfalcon harvest experiment (1974-79). Final Rep. Wildl. Branch, Yukon Government, Whitehorse. 25 pp.

Muir, D. 1973. A study of the breeding biology of Arctic Gyrfalcons. Can. Wildl. Serv. unpubl. rep. 58 pp.

Nelson, R.W. 1978. Gyrfalcon ecology and behaviour in the north central Yukon, 1978. World Wildl. Fund Gyrfalcon Proj. Prog. Rep. No. 1. 36 pp.

Newton, I. 1979. Population ecology of raptors. Buteo Books, Vermillion, S. Dakota. 399 pp.

Osborne, T.O. 1981. Ecology of the red-necked falcon (Falco chicquera) in Zambia, 1981. The British Ornith. Union, Vol. 123: 189-297.

Platt, J.B. 1976. Gyrfalcon nest site selection and winter activity in the western Canadian Arctic. Can. Field-Nat. 90(3): 338-345.

Platt, J. and C.E. Tull. 1977. A study of wintering and nesting gyrfalcons on the Yukon North Slope during 1975 with emphasis on their behaviour during experimental overflights by helicopter. Arctic Gas Biol. Rep. Ser. Vol. 35: 1-79.

Porsild, A.E. 1964. Illustrated flora of the Canadian Arctic Archipelago. Nat. Mus. Can. Bull. 146. Biol. Ser. No. 50. 216 pp.

Porsild, A.E. and W.J. Cody. 1979. Vascular plants of continental Northwest Territories, Canada. Nat. Mus. Nat. Sci., Ottawa. 667 pp.

Pruett-Jones, S.G., C.M. White and W.R. Devine. 1981. Breeding of the peregrine falcon in Victoria, Australia. Supplement, The Emu. 80: 253-269.

Ratcliffe, D. 1980. The peregrine falcon. Buteo Books, Vermillion, S. Dakota. 416 pp.

Roseneau, D.G. 1972. Summer distribution, numbers, and food habits of the gyrfalcon (Falco rusticolus L.) on the Seward Peninsula, Alaska. PhD. Thesis. Univ. of Alaska. 124 pp.