REPRODUCTIVE SUCCESS OF PEREGRINE FALCONS AND OTHER RAPTORS AT WAGER BAY AND MELVILLE PENINSULA NORTHWEST TERRITORIES

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ABSTRACT.—The Wager Bay area in northeastern Keewatin was surveyed for nests of raptorial birds during late July and August in 1976 and 1977, and the southwestern part of Melville Peninsula was also surveyed in August 1977. These surveys established Wager Bay and Melville Peninsula as the most productive nesting areas known for the endangered Peregrine Falcon (*Falco peregrinus tundrius*). More Peregrine Falcon sites producing young were located at Wager Bay than are known to exist in any other area of the North American Arctic. The production of young Peregrine Falcons at Wager Bay in 1976 and 1977 exceeded that of any area surveyed during the 1975 North American Peregrine Falcon Survey. In 1976 we located 14 nest sites occupied by Peregrine Falcons, 5 sites occupied by Gyrfalcons (*Falco rusticolus*), 11 sites occupied by Rough-legged Hawks (*Buteo lagopus*), and 1 nest site of a Golden Eagle (*Aquila chrysaetos*). In 1977, 27 Peregrine Falcon sites, 5 Gyrfalcon sites, 2 Rough-legged Hawk sites, and 1 eagle site were located. In 1977, Peregrine Falcons reoccupied at least 54%, and possibly as many as 91%, of the nesting territories occupied in 1976. Of the 13 peregrine sites visited in 1976, 85% produced young; young/occupied site averaged 2.08, and young/successful nest averaged 2.45. In 1977, 84% of the 22 visited sites produced young; young/occupied site averaged 2.21, and young/successful nest averaged 2.95. The Peregrine Falcon sites did not differ significantly between years in percent successful sites, young/occupied site, or young/successful nest. There was no correlation between the number of young Peregrine Falcons produced at nest sites in 1976 and the number produced at the same sites in 1977. The nests that had been visited in 1976 produced 2.16 young/successful nest in 1977, as compared with 3.3 young/successful nest among the nests not previously visited. This difference was significant.

Fifteen occupied Peregrine Falcon sites were located on Melville Peninsula, at least 10 of which produced young. The average number of young/successful nest was 2.6. The Peregrine Falcon populations at Wager Bay and Melville Peninsula did not differ significantly in either number of young/successful nest or in mean distance between occupied sites. Both the Wager Bay and the Melville Peninsula Peregrine Falcon populations are considered to be undepleted populations. A total of 30 Peregrine Falcon chicks from 11 nests were banded at Wager Bay and 6 chicks from 3 nests on Melville Peninsula. One of the banded birds was later captured on North Padre Island, Texas. *Received 21 December 1978, accepted 11 May 1979.*

RECENT surveys of known nesting areas of the Peregrine Falcon (*Falco peregrinus*) in northern Canada and Alaska have shown that both occupancy of nest sites and productivity have declined in many areas (Fyfe et al. 1976). Several populations of the arctic peregrine had declined to such an extent that Newton (1976) commented, "the entire *F. p. tundrius* population is now well into decline."

Unfortunately, little was known about the Peregrine Falcon populations of Keewatin district in the Northwest Territories, especially in the northeastern areas. During July and August of 1976 we conducted a survey of nesting raptors at Wager Bay. This survey revealed a highly productive population of Peregrine Falcons. In 1977 the surveys were intensified at Wager Bay and expanded to include Melville Peninsula.

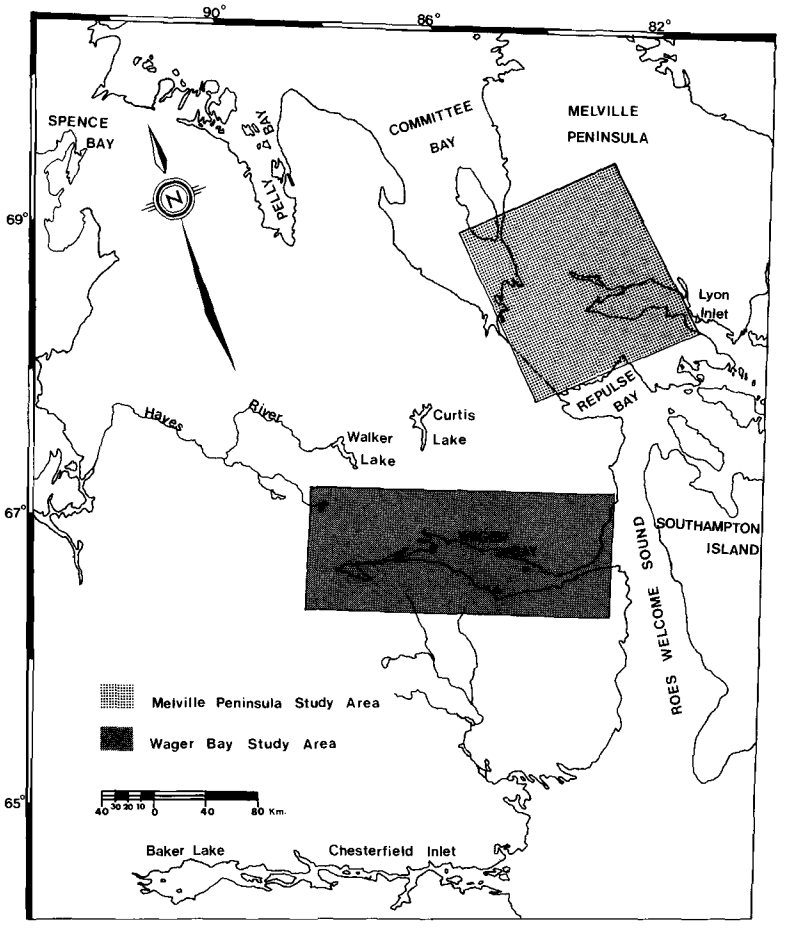

Fig. 1. Map of northeastern Keewatin showing the areas searched for raptor nests at Wager Bay and on Melville Peninsula.

Methods

The study area.—The area searched for raptor nests around Wager Bay included the shorelines of Wager Bay, Brown Lake, Ford Lake, and the shores of adjacent rivers and lakes within 15–30 km of these water bodies (Fig. 1). On Melville Peninsula, we searched the southwestern section, concentrating mostly on river valleys and cliffs overlooking large lakes (Fig. 1). The coastal cliffs were not searched. Some areas of Melville Peninsula featured miles of almost continuous deep river gorges. Rocky hills and sea cliffs (elevations up to 580 m), rock outcrops, and cliffs along the rivers that occur throughout both study areas provide innumerable ledges suitable for nesting by raptors.

The tundra habitats in both areas range from wet lowland areas dotted with lakes, ponds, and standing water to well-drained upland sites. Potential prey species include small mammals, passerine birds, and larger birds.

Survey techniques.—Because the Wager Bay area had not previously been searched for raptors, we had no prior knowledge of nest sites or of suitable nesting habitat. Therefore, during the initial survey in 1976, we concentrated our searches along the shores of Wager Bay, Brown Lake, Ford Lake, and along lakes and rivers where 1:250,000 topographic maps showed cliffs or broken relief. We searched by flying close to cliffs and outcrops and looking for nests, flushed birds, or excrement stains on the rock. Most of the searching at Wager Bay was done from a Cessna 185, but from 8 to 10 August 1977 we

TABLE 1. Site characteristics and productivity of Peregrine Falcon eyries at Wager Bay, Northwest Territories.

Site[a]	Description	Nest type	Number of young		Number of eggs		Nearest site occupied in 1977	Distance to nearest site (km) in 1977
			1976	1977	1976	1977		
P_1	Sea-cliff	Rock ledge	0	3	1	0	P_{5A}	6.4
P_2	Cliff on river	Rock ledge	4	1	0	1	P_{12}	5.6
P_3	Cliff above lake	Grassy ledge	4	*	0	*	P_8	–
P_{3A}	Outcrop near stream	Large stick nest	–	3	–	0	P_{11A}	8.5
P_4	Cliff above lake	Rock ledge	3–4	*	–	*	P_{10}	–
P_5	Sea-cliff	Rock ledge	2	*	1	*	P_1	–
P_{5A}	Cliff near sea	Stick nest	–	0[b]	–	3	P_{23}	3.2
P_6	Cliff near sea	Stick nest	1	*	1	*	P_7	14.5
P_7	Cliff near sea	Grassy ledge	2	0[c]	0	0	P_9	–
P_8	Outcrop near sea	Stick nest	3	*	0	*	P_{11}	–
P_9	Sea-cliff	Undetermined	0	2+[d]	0	–	P_{10}	3.6
P_{10}	Sea-cliff	Grassy ledge	1[d]	2[d]	0	–	P_9	3.6
P_{11}	Cliff near pond	Undetermined	2–3[d]	*[e]	–	0	P_{11}	–
P_{11A}	Cirque-like cliff	Grassy ledge	3	1	0	0	P_2	5.6
P_{12}	Outcrop near pond	Rock ledge	3	1	0	0	P_2	5.6
P_{13}	Outcrop near lake	Stick nest	2[d]	4	0	0	P_{31}	14.5
P_{14}	Cliff above lake	Grassy ledge	unknown	*[e]	?	*	?	–
P_{15}	Cliff on river	Rock ledge	unknown	4	?	0	P_{16}	7.2
P_{16}	Cliff on pond	Grassy ledge	unknown	3	?	0	P_{17}	3.22
P_{17}	Cliff near pond	Stick nest	unknown	2	?	0	P_{16}	3.22
P_{18}	Cliff on small stream	Undetermined	unknown	–	?	–	P_{17}	10.46
P_{19}	Cliff near large lake	Undetermined	unknown	–	?	–	P_{20}	9.25
P_{20}	Cliff on stream	Stick nest	unknown	3	?	0	P_{21}	4.83
P_{21}	Cliff above river	Grassy ledge	unknown	4	?	0	P_{20}	4.83
P_{22}	Cliff on stream	Stick nest	unknown	4	?	0	P_{21}	4.83
P_{23}	In deep canyon	Grassy ledge	unknown	4	?	0	P_{5A}	3.22
P_{24}	In deep canyon	Undetermined	unknown	–	?	–	P_{27}	8.05
P_{25}	Cliff near sea	Stick nest	unknown	2	?	0	P_{25}	4.02
P_{26}	Cliff near river	Undetermined	unknown	–	?	–	P_{30}	12.47
P_{27}	Cliff near sea	Grassy ledge	unknown	2	?	0	P_{25}	4.02
P_{28}	Outcrop near sea	Undetermined	unknown	4[d]	?	–	P_{29}	19.31
P_{29}	Outcrop near lake	Grassy ledge	unknown	0	?	0	P_{28}	19.31
P_{30}	Outcrop near lake	Grassy ledge	unknown	3[d]	?	–	P_{26}	12.47
P_{31}	Outcrop near stream	Undetermined	unknown	–	?	–	P_{13}	14.48

[a] Sites P_1–P_{14} were first located in 1976; sites P_{15}–P_{31} were located in 1977.
[b] One large downy chick found dead below the nest.
[c] White down feathers observed in nest—parents vociferous.
[d] Young had already left the nest.
[e] Nest occupied by Gyrfalcon in 1977.
*Nest not occupied by Peregrine Falcons in 1977.

searched with a Bell 206 helicopter, and on Melville Peninsula a Hughes 500 helicopter was used. When stains were observed on a cliff, we flew past the cliff several times to locate any nests. When a nest was observed, we attempted to count eggs or young. We also attempted to identify the species of all raptors observed. All sightings of possible nest sites and confirmed occupied nests were mapped.

In 1977 we concentrated first on revisiting all occupied and potential nest sites located in 1976. When a site occupied by Peregrine Falcons in 1976 was found unoccupied in 1977, we searched the surrounding area looking for alternate sites. Thereafter, we expanded our searches to areas unsurveyed during 1976. The procedure used on Melville Peninsula was the same as that used at Wager Bay in 1976 because we had no prior knowledge of nest sites on Melville Peninsula.

Surveys at Wager Bay were conducted from 23 July to 30 August in 1976 and 18 July to 28 August in 1977. Our survey of Melville Peninsula was conducted from 15 to 17 August 1977.

Where possible, we later visited suspected nest sites on foot to confirm occupancy, to locate the nest and describe the site, to count numbers of eggs and young, to determine the developmental stage of the young, and to collect any addled eggs for analysis of egg shell thickness and pesticide residue. Eggs were sent to the Canadian Wildlife Service for analysis.

Banding.—When possible, Peregrine Falcon nestlings were banded with a numbered metal band (size 7A) on one leg and a black plastic band with white numbering (using a code of two numbers and one letter) on the other leg. The young falcons were banded after they had reached the large downy stage, and most were partially feathered.

Results

Number, location, and site characteristics of Peregrine Falcon eyries.—In 1976 we located 14 eyries occupied by Peregrine Falcons at Wager Bay and 27 occupied eyries in 1977. Ten of the occupied eyries in 1977 were at or near sites occupied in 1976, and 17 were previously unknown. Occupied sites averaged 8.0 km apart (range 3.2–19.3 km). Twenty-four of the nest cliffs were above or near lakes, streams, or the sea (Table 1). Nests averaged a distance of 5.8 km from the major water bodies of Wager Bay, Ford Lake, and Brown Lake. Eighteen nests were less than 4 km from these water bodies, and only 4 were more than 15 km from them.

We located 15 occupied Peregrine Falcon nests on southern Melville Peninsula (Table 2). Twelve of these nests were on cliffs above lakes. The occupied sites averaged 9.2 km apart (range 4.8–12.9 km), if nests MP_1 and MP_5 on the periphery of the study area are excluded.

Of the peregrine nests observed on Melville Peninsula, 70% were on ledges without apparent nest material. The other 30% were in old stick nests of other species. At Wager Bay, 32% of the peregrine nests observed were in stick nests, and the remainder were on ledges without apparent nest material. Thus, the Wager Bay and Melville Peninsula populations are virtually identical in their use of nest types.

Nesting success and productivity of Peregrine Falcons at Wager Bay.—Overall, the production of Peregrine Falcons during 1976 was remarkably similar to that during 1977. The percentage of successful nests of Peregrine Falcons (defined as those occupied eyries having living young at the time of our visit), number of young/occupied site, and the number of young/successful nest did not differ significantly between 1976 and 1977 in the Wager Bay area (Table 3).

Nest sites that we had visited in 1976, however, produced fewer young on the average in 1977 than did those sites that we first discovered in 1977 (Table 4). If sites P_{3A}, P_{5A}, and P_{11A} are excluded from the sample of nest sites visited in 1976, then there is a significantly ($P < 0.025$) higher number of young/successful nest at sites first discovered in 1977 than at those sites first visited in 1976. If sites P_{3A}, P_{5A}, and P_{11A} are included in the sample of sites visited in 1976, then the difference in young/successful nest is less, but still approaches significance ($0.05 < P < 0.1$). The

TABLE 2. Site characteristics and productivity of Peregrine Falcon eyries on southern Melville Peninsula, 1977.

Site	Site description	Nest type	Number of young	Number of eggs	Nearest site	Distance to nearest site (km)
MP_1	Cliff above small pond	Grassy ledge	3	–	MP_5	30.2
MP_2	Cliff above lake	Grassy ledge	3	–	MP_4	12.9
MP_3	Cliff on river	Ledge	3[a]	–	MP_4	11.3
MP_4	Cliff on lake	Grassy ledge	1[a]	2	MP_3	11.3
MP_5	Cliff on lake	Grassy ledge	2	–	MP_1	30.2
MP_6	Low cliff above small stream	Undetermined	?	?	MP_7	8.8
MP_7	Cliff on lake	Undetermined	?	?	MP_6	8.8
MP_8	Cliff on lake	Undetermined	?	?	MP_9	12.1
MP_9	Cliff on lake	On rock ledge	2[a]	–	MP_8	12.1
MP_{10}	Cliff on lake	Stick nest	3[a]	–	MP_9	5.6
MP_{11}	Cliff on lake	Stick nest	2[a]	–	MP_{10}	4.8
MP_{12}	Cliff on lake	Undetermined	?	?	MP_{11}	6.4
MP_{13}	Cliff on lake	Undetermined	?	?	MP_{10}	5.6
MP_{14}	Cliff on lake	Grassy ledge	3[a]	–	MP_{15}	9.6
MP_{15}	Cliff near lake and river	stick nest	4[a]	–	MP_{14}	9.6

[a] Nest checked from helicopter only.

difference in young/occupied site between the latter two samples was not significant, nor was the percentage of successful nests.

Reoccupancy and productivity of previously occupied sites.—Of the 14 sites occupied by Peregrine Falcons in 1976, at least seven were reoccupied in 1977 (Table 4). One nest (P_4) was not checked, and another (P_6) was checked only from the air. Gyrfalcons occupied two of the 1976 peregrine eyries (P_{11} and P_{14}). Three nests (P_{3A}, P_{5A}, and P_{11A}) at locations close to sites occupied in 1976 could be considered alternates. These three alternate sites averaged 2.4 km from the site previously occupied. The average distance between apparent alternate sites is approximately 30% of the average distance between occupied sites and less than the minimum distance recorded between any two simultaneously occupied sites, suggesting that relocation by these three pairs did occur.

From these data we calculated a minimum and maximum reoccupancy rate for the Wager Bay population. The maximum reoccupancy rate possible was 91% (10 of 11 nests). In making this calculation, we assumed that sites P_4, P_6, and P_{14} were

TABLE 3. Comparison of reproductive success of Peregrine Falcons at Wager Bay, Northwest Territories in 1976 and 1977.

Year	Occupied nests	Percent successful[a]	Young/ occupied site	Young + eggs/ occupied site	Young/ successful nest
1976	14	85 (11/13)	2.08 (27/13)	2.31 (30/13)	2.45 (27/11)
1977	27	84 (18/22)	2.21 (53/24)	2.42 (58/24)	2.94 (53/18)
Statistical comparison between years		$\chi^2 = 0.045$ df = 1 $P > 0.75$	$t = 0.254$ df = 35 $P > 0.5$	$t = 0.338$ df = 35 $P > 0.5$	$t = 1.22$ df = 27 $P > 0.1$

[a] Reproductive success not determined for one nest in 1976 or for five nests in 1977.

TABLE 4. Comparison of reproductive success in 1977 at previously visited Peregrine Falcon nest sites and previously unvisited sites.

Sample	Number of sites occupied	Percent of occupied sites successful		Young/ occupied site[a]	Young/successful nest	
		Assuming alternates[a]	No alternates[b]		Assuming alternates	No alternates
Previously visited in 1976	10	80 (8/10)	85.7 (6/7)	2.0 (20/10)	2.5 (20/8)	2.16 (13/6)
Discovered in 1977	14	71.4 (10/14)	70.6 (12/17)	2.36 (33/14)	3.3 (33/10)	3.33 (40/12)
Statistical comparison of visited vs. unvisited sites		$\chi^2 = 0.229$ df = 1 $P > 0.5$	$\chi^2 = 0.605$ df = 1 $P > 0.1$	$t = 0.535$ df = 22 $P > 0.5$	$t = 1.68$ df = 16 $0.1 > P > 0.05$	$t = 2.54$ df = 16 $P < 0.025$

[a] Assumes that sites 3A, 5A, and 11A are alternates to sites 3, 5, and 11.
[b] Assumes that sites 3A, 5A, and 11A are new sites.

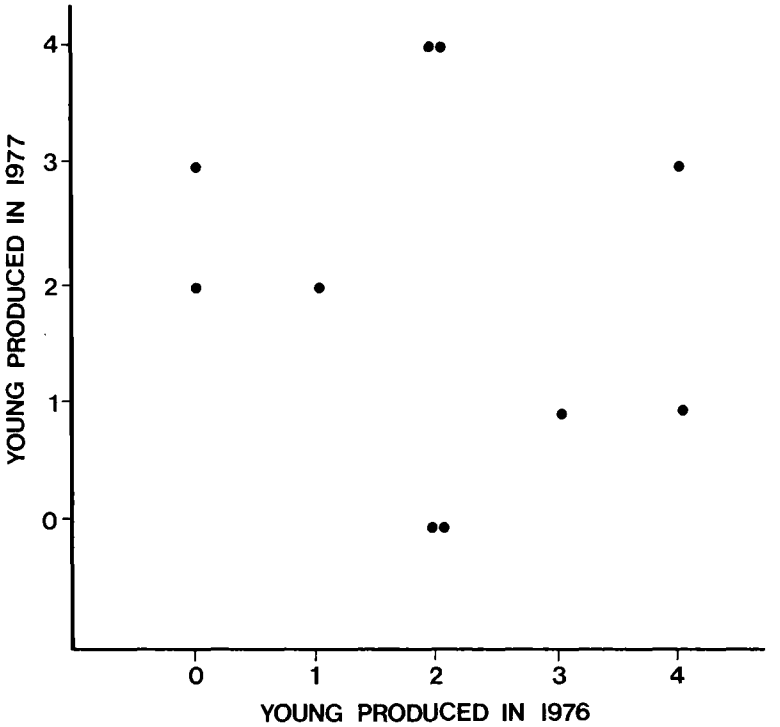

Fig. 2. Lack of correlation between number of young produced at 10 Peregrine Falcon sites at Wager Bay, 1976 and 1977.

not adequately checked and therefore that alternates to these sites might have been occupied although we did not locate them, and we assumed that sites P_{3A}, P_{5A}, and P_{11A} were alternates to sites P_3, P_5, and P_{11}, respectively. The minimum reoccupancy rate was calculated to be 54% (7 of 13 nests). In this calculation, only P_4 (the unchecked site) was excluded from the sample, and we assumed that P_3, P_5, P_6, P_8, P_{11}, and P_{14} were unoccupied (i.e. we assumed that no alternates existed).

Assuming that sites P_{3A}, P_{5A}, and P_{11A} are alternate sites, we can compare productivity at sites visited in both 1976 and 1977. In 1976, 85% (11/13) of all occupied sites checked produced young; in 1977, 80% (8 of 10) were successful.

The number of young/occupied site averaged 2.08 (27/13) in 1976 and 2.0 (20/10) in 1977. The number of young/successful nest averaged 2.45 (27/11) in 1976 and 2.5 (20/8) in 1977. None of these differences between years was significant (Table 4). No significant correlation existed ($r^2 = 0.032$) between the number of young Peregrine Falcons produced at a given site in 1976 and the number produced in 1977 at the same site (Fig. 2).

Nesting success and productivity of Peregrine Falcons on Melville Peninsula.— Of the 15 occupied sites that we located on Melville Peninsula, 10 were known to have produced young in 1977. As all the sites were visited in mid-August when young might have already left the nest, however, and as several of the sites were checked only by helicopter, it is likely that some of the remaining five nests also produced young that we did not observe. The 10 known successful sites produced 26 young, an average of 2.6/successful nest (Table 2).

The Wager Bay and Melville Peninsula Peregrine Falcon populations are similar in both site spacing and in productivity. The distance between nests did not differ significantly between the populations ($t = 0.725$, df = 38, $P > 0.4$), nor did the number of young/successful nest ($t = 0.884$, df = 26, $P > 0.2$).

The percentage of successful nests on Melville Peninsula appeared lower than at Wager Bay (66% vs. 84%). This is probably because sites on Melville Peninsula were visited later in the season and also were not checked as intensively as the sites at Wager Bay. Overall, the population characteristics of Peregrine Falcons nesting on Melville Peninsula and at Wager Bay appeared similar.

Observations of nest sites of other raptor species.—In 1976 we located 11 nest sites occupied by Rough-legged Hawks, 5 sites occupied by Gyrfalcons, and 1 site occupied by a pair of Golden Eagles.

In 1977, we located five occupied Gyrfalcon sites at Wager Bay. At one nest site, two young were observed and banded; at another, two fully fledged young were observed. Two of the Gyrfalcon sites had been occupied by Peregrine Falcons in 1976. On Melville Peninsula we located one Gyrfalcon site.

At Wager Bay we located only two Rough-legged Hawk nest sites in 1977, as compared with 11 sites in 1976. Neither of these sites successfully fledged young, although 1 nest initially had 2 eggs and the other 2 young. Seven occupied Rough-legged Hawk nests were located on Melville Peninsula. These nests produced an average of 2.3 young/nest, as compared with 3.0 young/successful nest among 6 Rough-legged Hawk nests visited at Wager Bay in 1976.

Our surveys were conducted at the optimal time for locating successful Peregrine Falcon and Rough-legged Hawk sites. Young of both species were present in the nests but had not yet fledged. The parents had been using perches for several weeks so excrement stains were highly visible. Conversely, young Gyrfalcons were fledged and flying at the time of our surveys and therefore likely to be away from the nest sites. Thus, our survey was probably less successful in locating Gyrfalcon sites than it would have been if conducted a month earlier.

Nests of all raptor species at Wager Bay and Melville Peninsula were located on cliffs or rock outcrops; none was on soil cutbanks. Rough-legged Hawks nested throughout the area, using rock outcrops away from bodies of water as well as cliffs on the sea, lakes, and streams. No Gyrfalcon nests were on sea cliffs. Rough-legged Hawks often used lower, less protected cliffs than did Peregrine Falcons. Most of the nests of all species, however, were on or near broad ledges, and the majority were accessible without a rope.

Banding and band recoveries.—Thirty Peregrine Falcon chicks from 11 nests were banded at Wager Bay, and 6 were banded from 3 nests on Melville Peninsula. One of the falcons banded on Melville Peninsula was live captured and released on North Padre Island, Texas on 17 October 1977 (H. Armbruster, Canadian Wildlife Service, pers. comm.).

Discussion

Productivity of Peregrine Falcons in northeastern Keewatin and Melville Peninsula.—The raptor studies conducted during 1976 and 1977 established Wager Bay and Melville Peninsula as the most productive nesting areas known for the rare and endangered tundra Peregrine Falcon. More producing peregrine falcon eyries are now known at Wager Bay than in any other area in the North American Arctic

TABLE 5. Occupancy and productivity of Peregrine Falcons in arctic North America.

Area[a]	Total known sites	Occupied1975	Number young produced	Number of sites producing
West Greenland	9	8	12	5
Ungava Coast	27	11	16	9
East Coast	5	0	0	0
Interior Barrens	16	1	3	1
Central Arctic Coast (NWT)	27	13	21	11
Horton River	15	5	9	3
Banks Island	14	7	18	6
North Slope (YT)	12	5	–	?
Northeast Alaska	28	3	–	2+
Colville River	46	12	–	?
TOTALS (1975)	199	65	79+	37+
Wager Bay (1976)	14	14	27+	11+
Wager Bay (1977)	31	27	53+	18+
Melville Peninsula (1977)	15	15	26+	10+
TOTALS (1977)	46	42	79+	28+

[a] Data from Fyfe et al. (1976).

(Table 5). The nests we visited at Wager Bay and Melville Peninsula produced as many young in 1977 as did all the Peregrine Falcon nests in the North American Arctic visited during the 1975 survey (Table 5). Moreover, large areas of northeastern Keewatin and Melville Peninsula have a combination of ideal nest sites (cliffs and outcrops near many lakes, ponds, and streams) and abundant passerine birds for prey, which makes these areas highly suitable for nesting Peregrine Falcons. We suspect that more nests remain to be discovered at Wager Bay and that the 15 sites located on Melville Peninsula represent only a small fraction of the nest sites there and on the Rae Isthmus. The entire area of northeastern Keewatin probably produces several hundred Peregrine Falcons each year. For example, Alliston and Patterson (1978) recently located 41 previously unknown eyries of Peregrine Falcons on Boothia Peninsula and Sumerset Island.

Fyfe (1969) considered Wager Bay and Melville Peninsula to be areas of "limited nesting" habitat (approximate breeding density of 1 pair/259 km^2). We calculate the breeding density at Wager Bay and Melville Peninsula at approximately 1 pair/50 km^2 (assuming that the area occupied by a pair equals the area of a circle of radius ½ the inter-nest distance). Fyfe considered a density of 1 pair/52 km^2 as "optimum nesting" habitat. Thus we must reclassify Wager Bay and Melville Peninsula as "optimum nesting" habitat, according to Fyfe's (1969) terminology.

Reproductive and population status of Peregrine Falcons at Wager Bay and Melville Peninsula.—The reproductive status of the Wager Bay and Melville Peninsula Peregrine Falcon populations cannot be assessed with certainty from our surveys, because we have no observations during the period of territory establishment or incubation. Pairs that fail to lay eggs or to hatch them successfully may abandon their eyries before July and August (Cade 1960), the period during which our surveys were conducted. If our surveys failed to detect such pairs, which nested but did not successfully hatch young, then our estimates of population density and site reoccupancy would be low, and our estimate of reproductive success rate for the overall population high. Of the 6 unsuccessful nests that we visited, 2 had unhatched eggs, 2 had dead young or evidence of young (e.g. white down feathers), and 2 had no sign of eggs or young. These findings suggest that our surveys were more likely to

find successful nests or those in which young were hatched than to find nests which failed early in the reproductive cycle. However, we believe that the number of unsuccessful nests missed is unlikely to be large, because the nest spacing was quite uniform and the nest density we observed was as high as has ever been reported for arctic Peregrine Falcons (Cade 1960, Fyfe 1969).

Many populations of arctic Peregrine Falcons appear to have declined in recent years (Fyfe et al. 1976). Unfortunately, there are no previous surveys with which to compare our findings at Wager Bay and Melville Peninsula. Thus, we have no direct evidence on the trend of these populations. If the Wager Bay and Melville Peninsula populations had declined significantly prior to our study, then previously these areas must have had nesting densities higher than in any other area of the Arctic previously studied. Only further surveys, preferably conducted during the entire nesting period, will confirm the trend of these populations.

Occupancy rates of Peregrine Falcons.—The problem of determining occupancy rates in Peregrine Falcon populations stems from the difficulty in differentiating between the use of alternate sites within a breeding territory and actual loss of a pair from a nesting territory. Fyfe et al. (1976) state that ". . . alternate nest sites, though most frequently found on the same cliff, in some instances have been recorded as far as 1.6 km from a previously used scrape." Without individually recognizable birds, the distinction between a new pair and a previously known pair using an alternate nest site is impossible to make with certainty. We believe that sites P_{3A}, P_{5A}, and P_{11A} should be considered alternates to sites P_3, P_5, and P_{11}, which were occupied by peregrines in 1976 but not in 1977 (Table 1). We feel that these sites are alternates because they are closer to the previously occupied sites than the minimum distance that we have observed between simultaneously occupied sites. Similarly, we cannot consider that the pairs of Peregrine Falcons that occupied sites P_{11} and P_{14} in 1976 were lost to the population in 1977 simply because Gyrfalcons usurped their nest sites; these displaced peregrines probably nested elsewhere. According to Beebe (1977), replacement of peregrines at nest sites by Gyrfalcons, which arrive and set up territories earlier than peregrines, is natural and common. Only site P_8 is considered to have actually been abandoned. Thus, we feel that the maximum re-occupancy rate (91%) calculated for 1977 is likely closer to the true situation for the Wager Bay population than is the minimum value (54%).

If the occupancy rate were 90%, it represents a much higher rate than that currently seen in other populations in the Canadian Arctic (Table 6). Because all the known peregrine sites at Wager Bay were discovered in either 1976 or 1977, however, occupancy rates there are perhaps not directly comparable to other areas where declines in occupancy rate have been measured over longer time spans.

Changes in productivity in Peregrine Falcon populations.—The productivity rate of the northeastern Keewatin peregrines was remarkably similar between years (Table 3) and between areas. The productivity/successful pair was higher than that observed in many areas of the Arctic in 1975 (Table 7) and was near the maximum that could be expected for the species (Hickey 1969).

Two aspects deserve additional comment. First, the lack of correlation in productivity between years at individual nest sites (Fig. 2) suggests that pesticide pollution is not the major factor affecting reproductive success. If pesticides must reach a threshold level before metabolism or behavior is altered enough to affect productivity, then one would expect some pairs to consistently produce well, while others would consistently produce poorly. Fyfe (pers. comm.) believes that this is why some

TABLE 6. Comparison of site occupancy by Peregrine Falcons at Wager Bay with other areas in the Canadian Arctic.[a]

Area	Sites checked	Sites occupied	Percent occupancy
Ungava Bay	25	9	44
Thelon River	13	1	8
Central Arctic Coast (NWT)	27	12	48
Horton River	15	5	33
North Slope (YT)	11	4	36
TOTAL	91	31	34
Wager Bay maximum[b]	11	10	91
Wager Bay minimum[b]	13	7	54

[a] Data from Fyfe et al. (1976).
[b] See text for explanation.

pairs keep producing normally while the overall productivity and occupancy of a population is declining. This was not observed at Wager Bay. Such an analysis assumes that pairs are occupying the same nest sites each year. Reoccupancy by the same pairs cannot be determined with certainty without individually recognizable birds.

Second, the observation that sites visited in 1976 produced significantly less in 1977 than did previously unvisited sites (Table 3) raises the distressing possibility that disturbance may produce delayed effects. We hope that this observation was due to chance, but future studies should address delayed effects. Grier (1969) detected no delayed effects on productivity of Bald Eagles (*Haliaeetus leucocephalus*) resulting from his having visited the nests. Platt (1977) presented evidence of delayed effects of disturbance on nesting in Gyrfalcons. Sites disturbed in one year appeared to be abandoned the following year.

Productivity of other raptors.—Gyrfalcons apparently occupied sites at about the same rate in 1976 and 1977. Our studies were conducted too late in the summer to determine the productivity of the Gyrfalcons. At Wager Bay, Rough-legged Hawks had a much lower occupancy rate in 1977 than in 1976 and, as far as we know, did not successfully produce young in 1977. Reproduction by Rough-legged Hawks varies from year to year, because their prey (microtine rodents) are cyclic. We had

TABLE 7. Comparison of productivity in arctic Peregrine Falcon populations.

Area	Year	Pair with young	Young/pair	Young/successful pair
Western Greenland	1972	7	2.30	2.60
	1973	9	2.60	2.70
	1974	5	3.00	3.00
	1975	5	2.00	2.40
Ungava Bay	1970	7	1.30	1.71
	1975	9	1.78	1.78
Thelon River	1970	3	2.00	2.67
	1975	1	3.00	3.00
Central Arctic Coast (NWT)	1975	11	1.75	1.91
Banks Island	1975	6	3.00	3.00
Horton River	1973	2	0.60	1.33
	1975	3	1.80	3.00
Wager Bay	1976	11	2.08	2.45
	1977	18	2.21	2.94
Melville Peninsula	1977	10	2.60	2.60

thought that Rough-legged Hawks at Wager Bay might be less variable in their rate of reproduction than populations in some other areas because arctic ground squirrels (*Citellus undulatus*) were abundant in the Wager Bay area and available as alternate prey. Although ground squirrels were brought to the nest by Rough-legged Hawks later in the season, however, these alone were apparently not sufficient to allow successful raising of young. Perhaps only juvenile squirrels, which emerge later, are vulnerable to attack by Rough-legged Hawks. It is noteworthy that Rough-legged Hawks on Melville Peninsula produced young in 1977 while those at Wager Bay did not. Thus reproductive failures were apparently not synchronous over these very large geographical areas.

Recommended Future Studies

The existence of more producing Peregrine Falcon pairs in the Wager Bay-Melville Peninsula than at any other known area in the Arctic makes the area ideal for long-term field studies of an apparently healthy population of arctic Peregrine Falcons. Long-term studies would be valuable in answering the following questions:

1. What is the degree of fidelity of male and female falcons to each other and to particular nesting territories?
2. Over how wide an area do young falcons produced in a given area disperse when establishing territories in following seasons?
3. Where do Peregrine Falcons from northeastern Keewatin winter, and by what routes do they migrate to and from these areas?
4. What levels of contaminants are being carried by Peregrine Falcons and their prey, and how do these affect reproduction and behavior?
5. What is the effect of human disturbance on falcon populations?

The answers to most of these questions require continuous monitoring of the population and its reproduction for several years, and the gradual accumulation of a substantial proportion of individually recognizable, marked birds in the population. From large numbers of visibly marked individuals, statistical information on pair fidelity, fidelity to nest sites, dispersal patterns of young, location of wintering areas, and migration routes could be collected. Continuous monitoring of the population would make it clear if some pairs consistently experienced reproductive failure, and if eggs of such pairs contain high levels of chemical contaminants. If high levels of contaminants were confirmed in the population, perhaps these could be correlated with the use of particular prey species or particular wintering areas. Finally, the Wager Bay-Melville Peninsula population is the only one in North America large enough to allow controlled studies of the effect of disturbance on Peregrine Falcons. Such studies are desirable in order to anticipate disturbance problems should the current proposal to make Wager Bay a National Park be carried out.

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