kiggavik Uranium Project

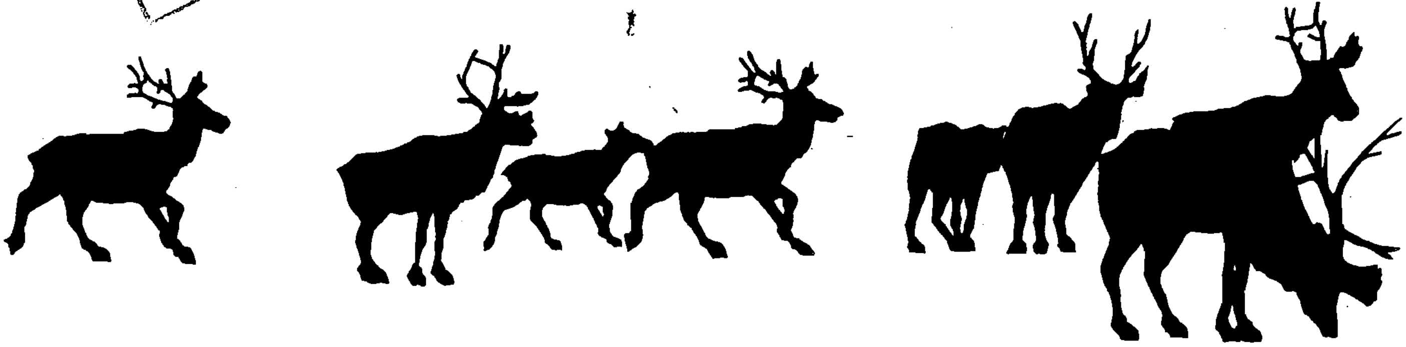
Baker Lake Northwest Territories Canada

Environmental Assessment

Prepared by Beak Consultants Limited

Supporting Document No. 3

Terrestrial Wildlife



Urangesellschaft Canada Limited

Toronto, Ontario Canada
January 1990

SUPPORTING DOCUMENT NO. 3

THE TERRESTRIAL WILDLIFE RESOURCE DESCRIPTION: KIGGAVIK URANIUM FACILITY, BAKER LAKE, NORTHWEST TERRITORIES

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1.0 SUMMARY

People living in the Keewatin Region of the Northwest Territories are dependent on terrestrial wildlife resources for food and for supporting renewable resources such as tourism. Urangesellschaft Canada Limited has made a conscious effort to protect these resources by proposing development of the Kiggavik uranium facility in such a way as to minimize effects on the wildlife community.

The local and regional wildlife populations are discussed in the following report. Caribou are perhaps the most significant species in the area, with the Beverly and Kaminuriak herds dominant in the general area of the Kiggavik project. Only a few individuals have been observed in the immediate area of the proposed site development. Migration routes and calving grounds are generally hundreds of kilometres to the northwest (for the Beverly herd) and southeast (for the Kaminuriak herd) from the project site. The nearest point of contact occurs about 40 km west of the proposed project site, where two water crossings are near the proposed limestone quarry north of Aberdeen Lake. These crossings have not been used to any extent since 1960, and human activity at this quarry occurs after the migrations.

Other large mammals such as the muskox and grizzly bear were rarely observed in the proposed site development areas during the decade or so of study. No rare or endangered mammals were found in the area of proposed site development. Small mammal populations (i.e., sik-sik and hare) were generally low in the immediate area of the proposed development, and so will not likely undergo significant change, especially since suitable habitats are found extensively throughout the area.

The most commonly occurring bird species in the proposed development area were lapland longspurs, ptarmigans, horned larks, herring gulls, oldsquaws, dunlins, golden plovers, Baird's sandpipers, Arctic terns and Canada geese. Also present were the rough-legged hawk, short-eared owl, gyrfalcon, snowy owl and peregrine falcon. Only the peregrine falcon is a rare/endangered species, which has been observed in the southeast end of Skinny Lake. Project development plans are to avoid this area. A pumphouse at Skinny Lake is more than 2 km away from the falcon nest and the winter road from Baker Lake to the project site is also some distance from the nest. All other species are also not likely to be significantly affected by the project development activities. A detailed assessment of potential effects is given in Section 3.0 of the Impact Assessment (BEAK, 1989).

2.0 INTRODUCTION

People living in the Keewatin Region of the Northwest Territories are dependent on terrestrial wildlife resources for food and for supporting renewable resources such as tourism. Urangesellschaft Canada Limited has made a conscious effort to protect these resources by proposing development of the Kiggavik uranium facility in such a way as to minimize effects on the terrestrial wildlife community.

The Kiggavik site is situated about 75 km west of Baker Lake. Besides the mine and mill, residential compounds and other infrastructures associated with a mining facility, there will also be (Figure 2.1):

- a winter road from Baker Lake to the Kiggavik site;
- a winter road from the Kiggavik site to a limestone deposit north of Aberdeen Lake;
- an airstrip west of Pointer Lake; and
- a docksite near Baker Lake.

Urangesellschaft, in association with the Baker Lake Hunters and Trappers Association, and the Fish and Wildlife Service (N.W.T.), has been carrying out terrestrial wildlife studies in the Kiggavik and surrounding areas since 1978. Four major areas have been intensively studied:

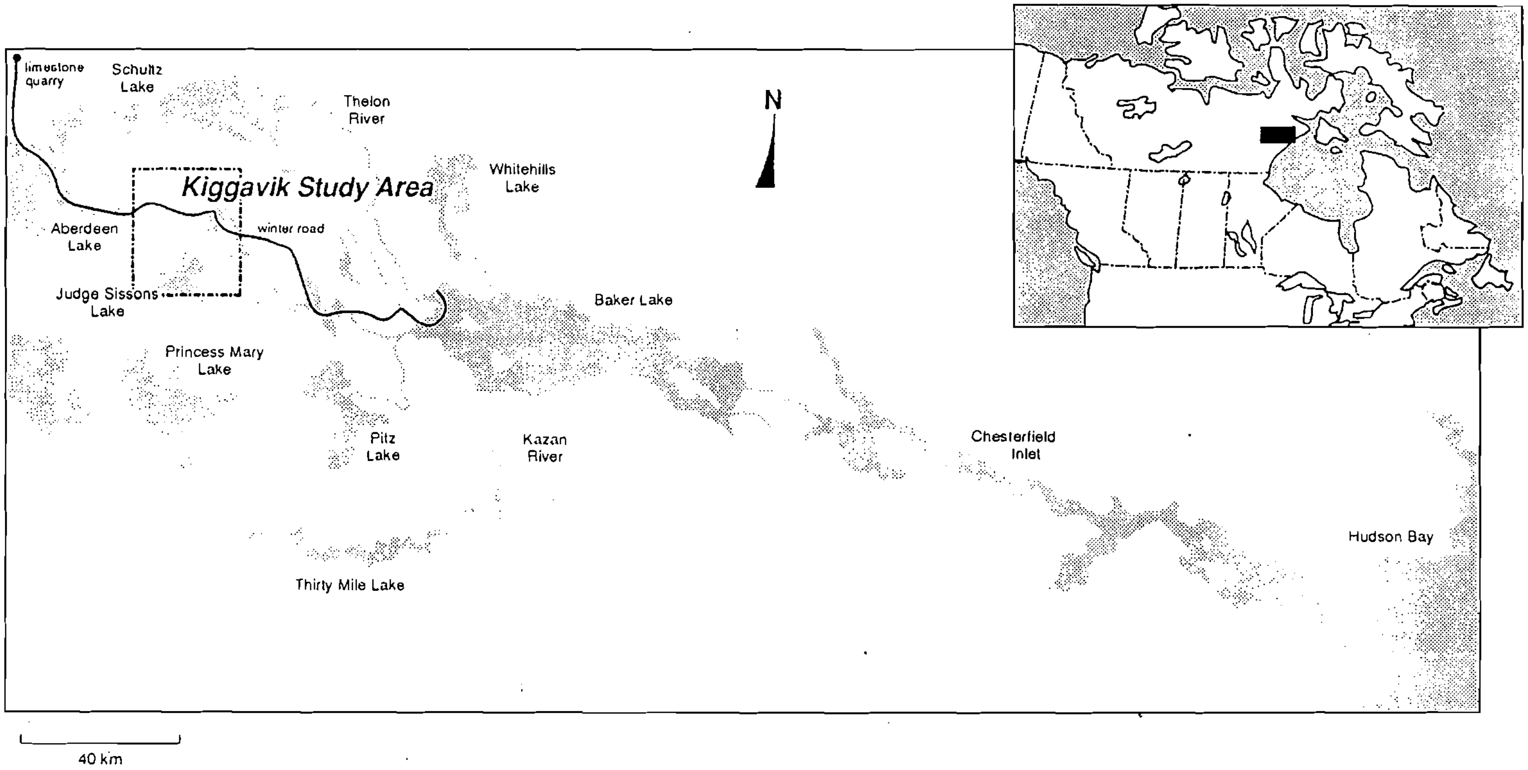
- the Sissons Lake area (containing the Kiggavik site);
- the Schultz Lake area;
- the Sandhills Lake area; and
- the Marjorie Lake area.

Within each of these four general areas, a number of ecological studies were carried out. Only those relating to the terrestrial wildlife community will be mentioned. The following surveys were carried out within each area:

- present caribou usage;
- past caribou usage (using fecal pellet-group counts);
- caribou behavioural responses to various disturbances (e.g., helicopters, canoe, incidental obstacles such as tents, etc.);

figure 2.1

District of Keewatin, Northwest Territories



- small mammal abundances, habitats and general characteristics (e.g., weights, sex, etc.); and
- avifauna (raptor) population levels, nesting sites and reactions to various disturbances.

The information from the site-specific Urangesellschaft studies has been supplemented by more regional data to give an overall picture of terrestrial wildlife resources in the central Keewatin. Additional regional information is summarized from:

- results of studies and monitoring programs relating to the migratory routes, calving areas and water crossings of the major caribou herds in the area;
- bird populations through the Chesterfield Inlet, Pitz-Baker Lowlands and Beverly/Aberdeen Lakes area; and
- wildlife populations in the Thelon, Queen Maud and McCormick sanctuaries.

The relationship between these local and regional areas and their terrestrial wildlife populations to the proposed Kiggavik site and infrastructures will be evaluated in the following report. The local and regional terrestrial wildlife resource is also presented.

3.0 CARIBOU RESOURCES

The Native people of the Baker Lake area are known as the Caribou Inuit. Caribou hunting is probably more important to Baker Lake Inuit than to any other settlement because seals, walrus, whales and geese, important foods in other Inuit settlements, are relatively scarce or rare (IDS, 1978). The major wildlife concern relevant to the proposed Kiggavik project has always related to the potential effects on caribou. For this reason, the caribou have been emphasized in this and previous wildlife studies in the area.

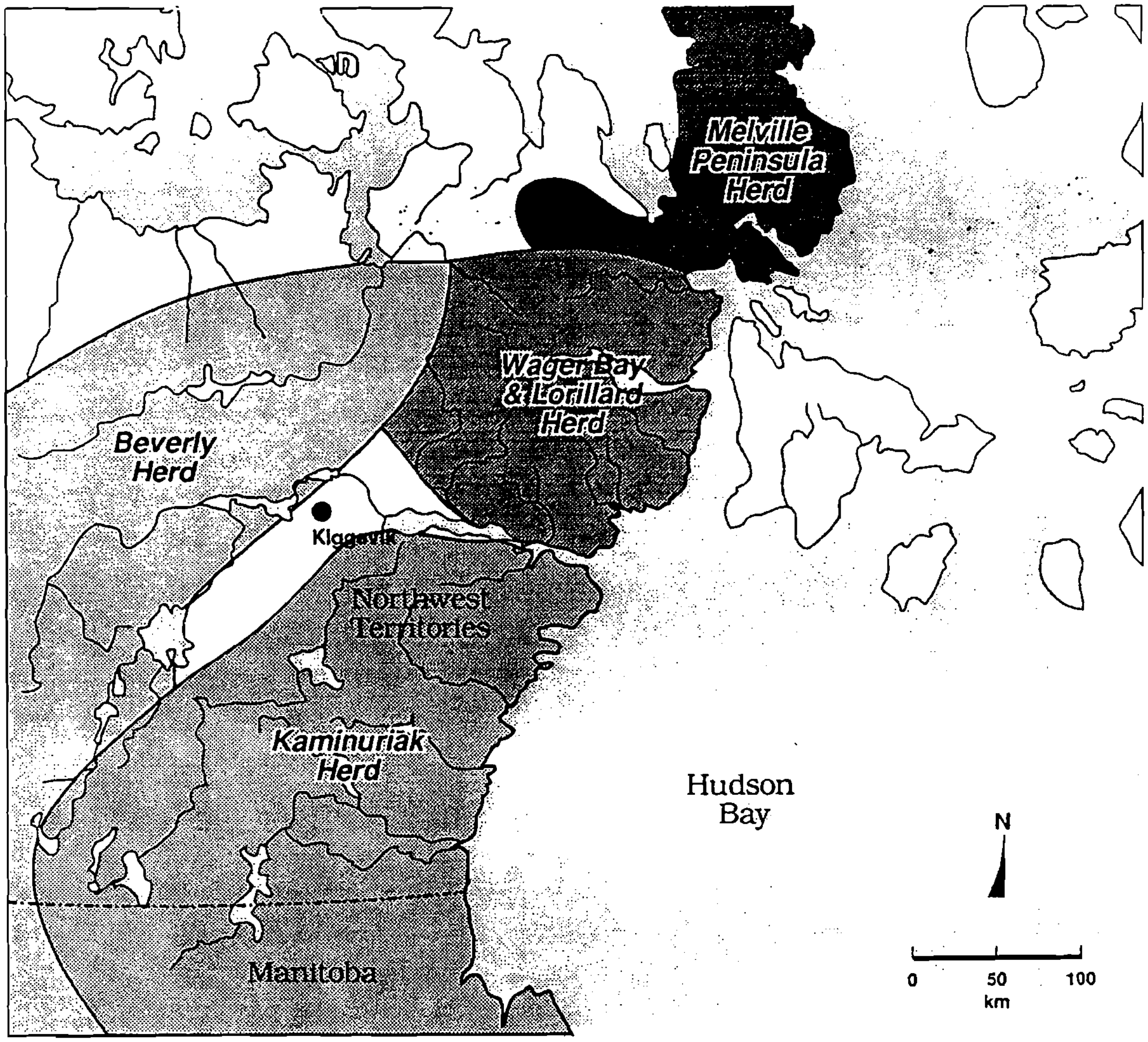
A number of different caribou herds are present throughout the N.W.T. (Figure 3.1). The two major barren-ground caribou (Rangifer tarandus groenlandicus) populations in the Baker Lake area are the Beverly herd and the Kaminuriak herd. The annual distribution and life histories of these populations are well documented (Heard et al., 1987). The locations of calving grounds for these two herds, for example, have been documented since 1957 (Figure 3.2). Total calving ground areas occupied by the Beverly and Kaminuriak herds since 1957 are listed in Table 3.1. Mean annual calving areas are approximately the same for each herd (i.e., 5,101 km^2 for Beverly and 5,718 km^2 for Kaminuriak). The caribou of these herds are a valuable resource from a variety of perspectives. For example, more than 10,000 people currently live on or near the range of the two herds and rely on the caribou for food and clothing (Beverly and Kaminuriak Caribou Management Board, 1987). Approximately 19,000 caribou are harvested from these two herds each year. Each harvested caribou represents a replacement value of approximately $800.00, or $15 million per year for the two herds. Apart from economic factors, the use of caribou is important to the culture and traditional lifestyle of native people. This importance cannot be fully evaluated using traditional analytical tools of measuring economic value because the caribou confer considerable benefits and strengths upon life in native communities (Beverly and Kaminuriak Caribou Management Board, 1987). Social, cultural and economic importances of the caribou and other wildlife to the Baker Lake Caribou Inuit are discussed in a separate BEAK report (Supporting Document No. 10).

Barren-ground caribou populations exhibit a complex annual nomadic cycle, characterized by major migratory movements extending over hundreds of kilometres within their range (Jakimchuk, 1979). Spring migration and summer movements are

figure 3.1

Distribution of the major caribou herds

in the eastern Keewatin District of the Northwest Territories (after Calef, 1978)



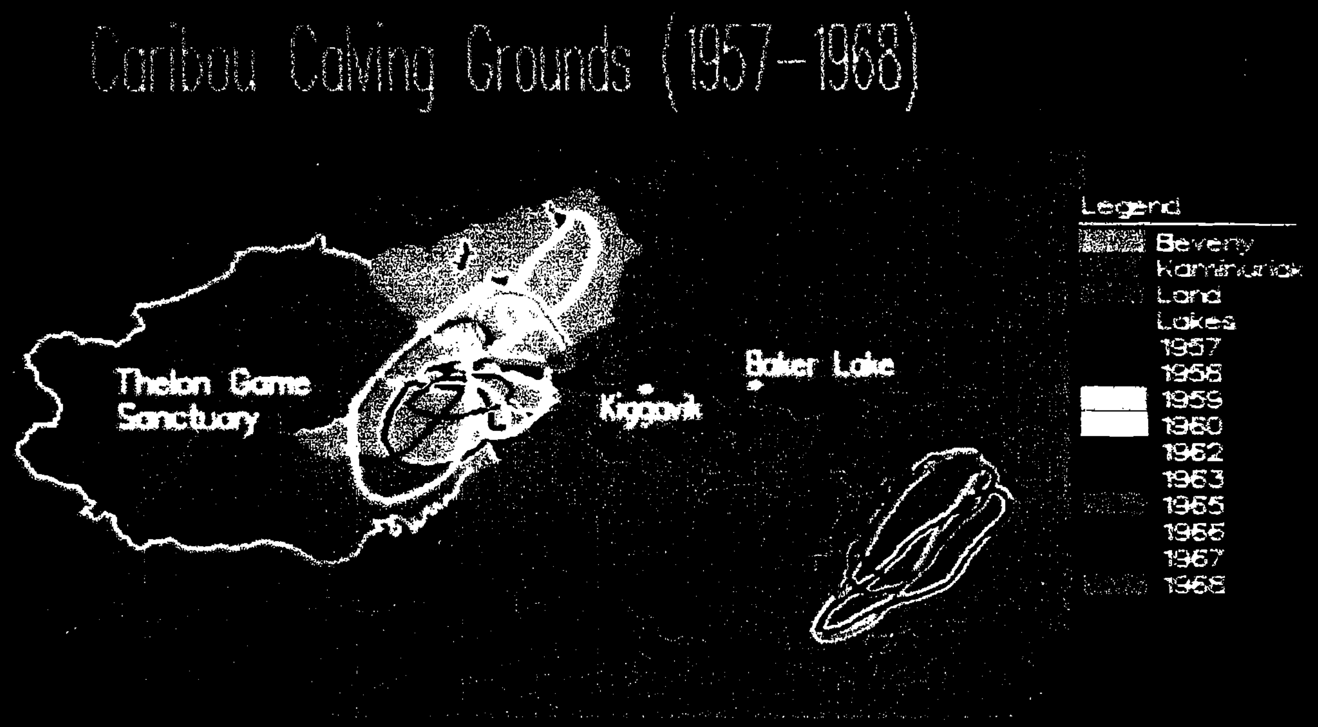

Caribou Calving Grounds (1957–1968)
Thelon Game Sanctuary
Kiggavik
Baker Lake
Legend
Beverly
Kaminuriak
Land
Lakes
1957
1958
1959
1960
1962
1963
1965
1966
1967
1968

Figure 3.2(a)

Caribou Calving Grounds (1970–1974)

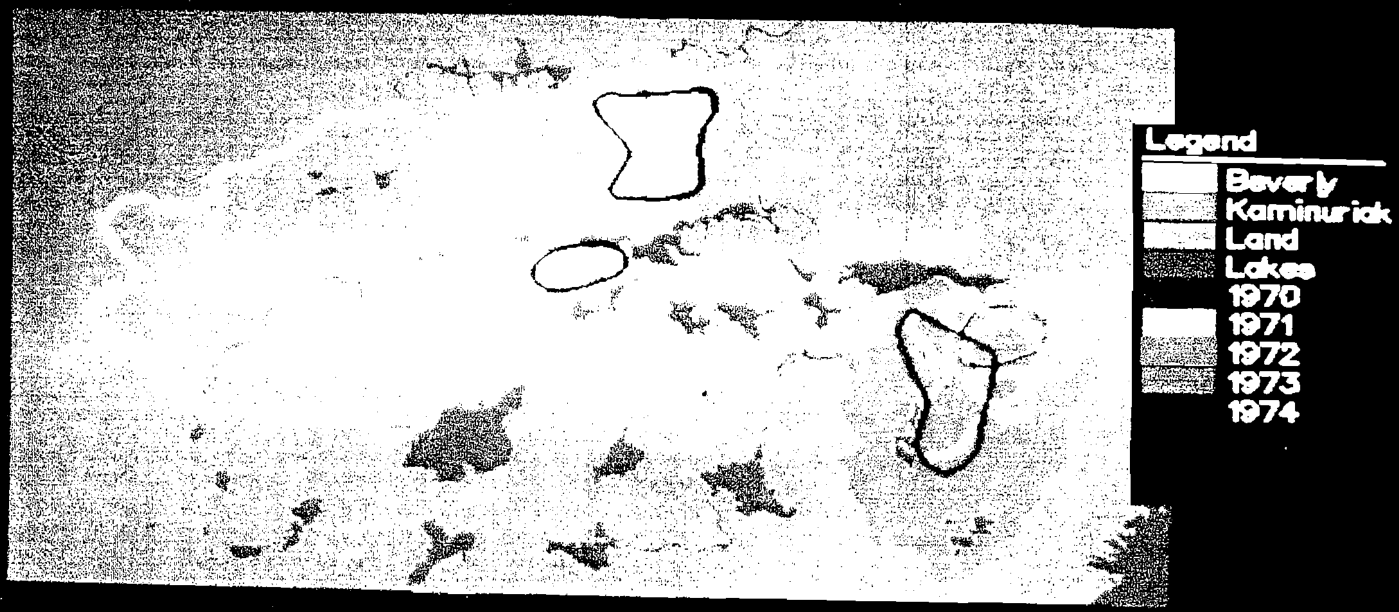


Figure 3.2(b)

Caribou Calving Grounds (1976-1981)

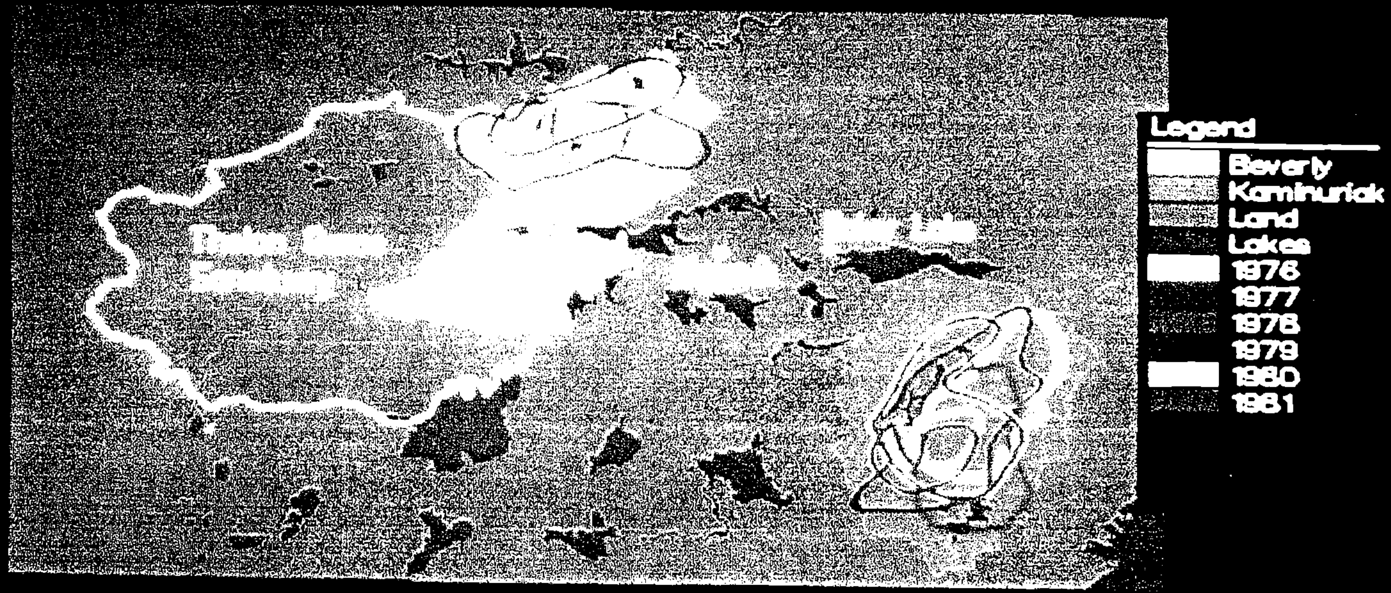


Figure 3.2(c)

Caribou Calving Grounds (1982-1987)

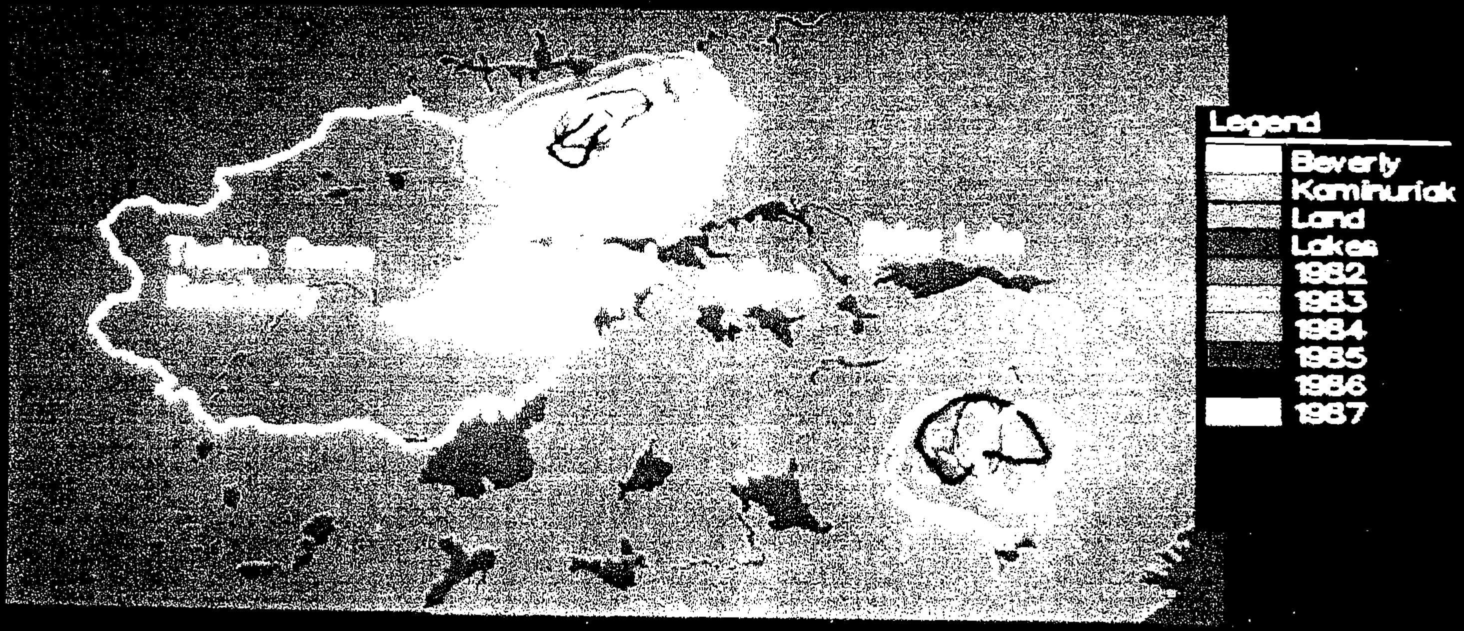


Figure 3.2(d)

TABLE 3.1: TOTAL CALVING GROUND AREA OCCUPIED BY THE BEVERLY AND KAMINURIAK CARIBOU HERDS IN THE EASTERN KEEWATIN, N.W.T.

	Beverly (km^2)	Kaminuriak (km^2)
1957	4,232	
1958	6,330	
1959	11,409	
1960	5,815	
1961		
1962	1,877	
1963		4,968
1964		
1965	3,091	
1966		6,367
1967		4,895
1968		6,477
1969		
1970		2,466
1971	4,012	7,581
1972		5,189
1973		3,165
1974	7,765	5,852
1975		
1976		7,876
1977		12,145
1978	2,650	9,017
1979	8,796	9,569
1980	2,613	1,987
1981	5,152	2,797
1982	5,704	994
1983	5,410	12,292
1984	9,422	7,876
1985	1,877	1,656
1986	810	3,643
1987	4,858	3,275
TOTAL	91,823	120,087
Mean	5,101.28	5,718.48
Range	11,409-810	12,292-994

major, directed, columnar movements; other movements, such as those occurring during winter, August dispersal and early fall are more casual drifting between ranges.

Caribou herds tend to expand their range when populations are high, and limit their distribution at lower population levels (Kelsall, 1968). Use of winter range is highly variable and largely dependent on snow conditions such as depth, density and hardness (Jakimchuk, 1979). The annual cycle is characterized by the following periods:

- winter range,
- spring migration,
- calving,
- post-calving movements,
- summer movements,
- August dispersal, and
- fall migration.

Movements tend to be localized and more extensive in early winter than late winter (Miller, 1976). Major and fairly rapid migration to the calving grounds occur in spring, with caribou generally reaching the tree line in full migration around early May (Parker, 1972). Pregnant females and yearlings reach calving grounds up to one month earlier than bulls (Jakimchuk et al., 1974). Calving generally takes place in the first two weeks of June, and is chronologically consistent (Jakimchuk, 1979). Following calving, cows and calves move towards areas of post-calving aggregation, forming large groups. Post-calving aggregates are generally formed by early July (Jakimchuk, 1979). Summer movements generally occur by mid-July, and follow the general routes of spring migration toward the tree line (Kelsall, 1968). As summer movements proceed, larger groups break up and spread widely over summer ranges. Caribou are generally widely distributed on the tundra toward the tree line by mid-August. Fall migrations are variable, but generally involve a drifting toward winter ranges (Jakimchuk, 1979).

In summary, barren-ground caribou movements are seasonally variable, but consistent in terms of:

- the timing and location of calving,
- the formation of post-calving aggregations, and
- summer movements.

3.1 The Beverly Herd

3.1.1 Range

The range of the Beverly herd generally lies east of the Slave River between Great Slave Lake and Lake Athabasca and from northeast Alberta and Saskatchewan in a northeast direction to Back River (Figure 3.1). Winter range of the herd lies south of Great Slave Lake and generally north of Lake Athabasca. The range can extend into northern Saskatchewan and into extreme northeast Alberta. Components of the herd have been noted to winter on the tundra, and Interdisciplinary Systems Ltd. (1978) mapped tundra wintering areas north and south of Aberdeen Lake.

The herd traditionally occupies two winter areas (Banfield, 1980):

- south of Christie Bay, Great Slave Lake and the lower Taltson River valley as far as Lake Nonacho; and
- along the northern shore of Lake Athabasca and south from Stoney Rapids as far as Cree Lake, Black Lake and Wollaston Lake.

3.1.2 Seasonal Movements

3.1.2.1 Spring Migration

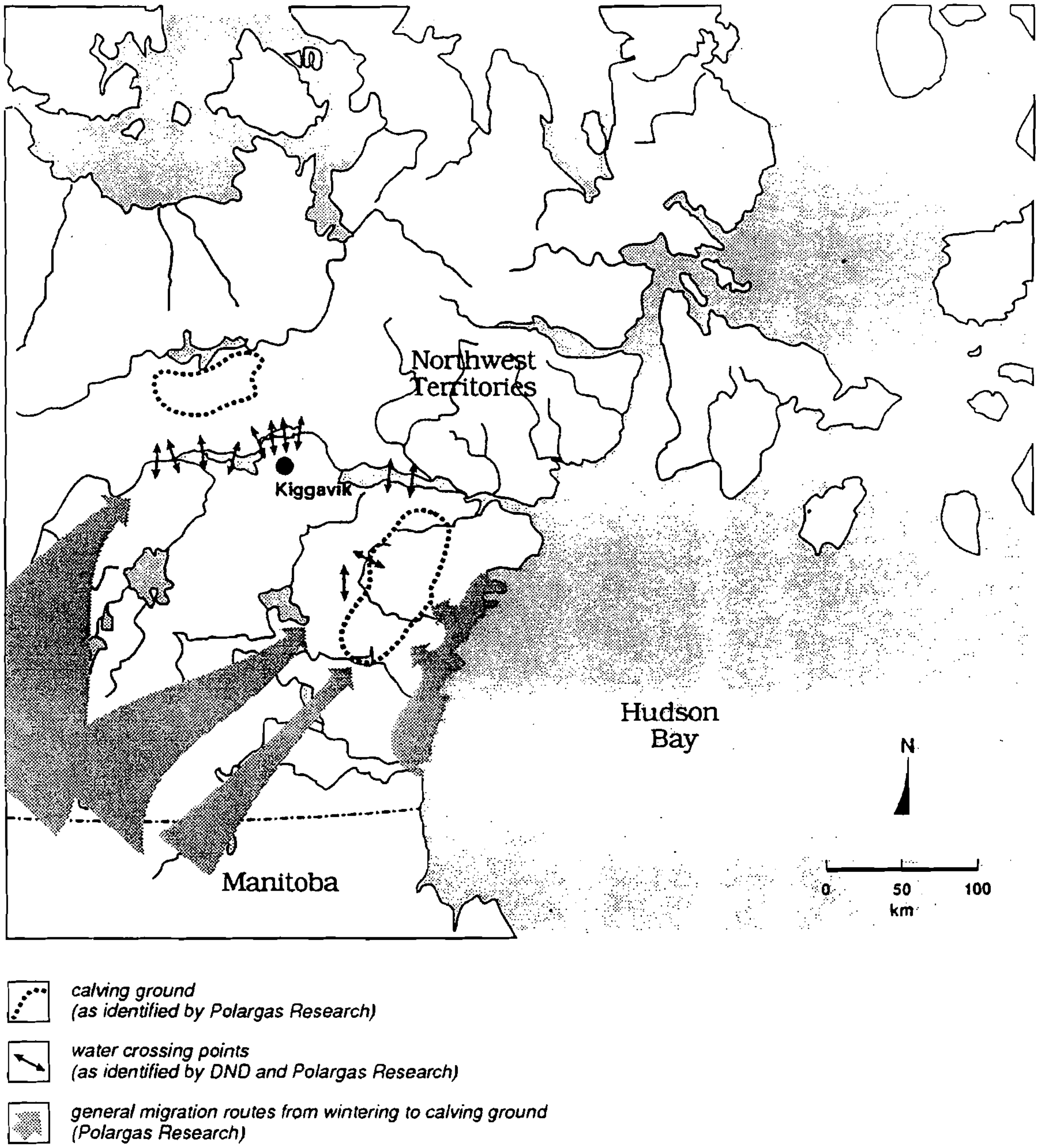
Migration routes used by Beverly barren-ground caribou to reach their calving grounds in 1978 are shown in Figure 3.3. Caribou cows ordinarily reach the treeline during the first or second week of May (Kelsall, 1968), and migrate into the caribou protection area (calving grounds) via the Thelon Game Sanctuary by early-to-mid June (Fleck and Gunn, 1982).

3.1.2.2 Calving Grounds

Calving grounds are located north and south of Beverly and Aberdeen Lakes over an area ranging between 810 km^2 and 11,409 km^2 (Table 3.1). Calving ground areas occupied by the herd over the last 30 years are shown in Figure 3.2. By early July, the Beverly caribou have typically left the calving grounds and moved into the post-calving areas in the Thelon Game Sanctuary (Ogilvie, 1987).

figure 3.3

Migration routes and calving grounds
for the Beverly and Kaminuriak herds



Four major range types are found on the northern portion of the Beverly calving grounds (Table 3.2): lichen upland, dwarf shrub, meadow, and rock/sand barrens. The amount of time spent by the caribou on each range in different activities is given in Table 3.3.

3.1.2.3 Post-Calving Movements

The dispersal of cows and calves from the Beverly calving ground generally occurs to the west and southwest (Figure 3.4). The departure of major concentrations of cows and calves from the protection area generally occurs in early July (Mychasiw, 1984). The location of post-calving areas, as defined by Darby (1978), is also shown in Figure 3.4. This figure is important and indicates that Kiggavik and Baker Lake are located in a former eastern post-calving area for the Beverly Herd. This area has not been used much since about 1960 (Banfield, pers. comm., 1989).

3.1.2.4 Summer Distribution and Movements

Summer movements generally tend towards the treeline, and follow the same corridor as the spring migration (Jakimchuk, 1979). The width of the migration expands as it moves towards the treeline (Kelsall, 1968).

3.1.3 Water Crossings

During summer migration, water bodies can be major obstacles to caribou movements. Caribou tend to follow natural geographic features, which causes them to concentrate at traditional crossing points (Williams and Gunn, 1982). A number of designated water crossings are utilized by the Beverly herd (Figure 3.3). A summary of observations in the literature of designated water crossings (1904-1978) are listed in Tables 3.4 and 3.5 for the Beverly herd. The designated water crossings, based on frequency of use, in decreasing order of current use patterns are Nos. 22-26, 19-21, 27 and 13-18 (Williams and Gunn, 1982).

Two designated crossings (No. 17 and 18) occur about 40 km west of the proposed project site, both near the east end of Aberdeen Lake (Williams and Gunn, 1982). Crossing No. 17 is the narrows between Aberdeen Lake and Qamanaarjuk Lake. Crossing No. 18 is the eastern narrows in Aberdeen Lake caused by a large northwest-southeast running

TABLE 3.2: RANGE TYPES AND THEIR CHARACTERISTICS ON THE BEVERLY CALVING GROUND (Source: Jingfors et al., 1982)

Range Type	Regime	Key Features	Dominant Plant Species
Rock/Sand Barrens	xeric	o low cover of vegetation o dominant % cover of exposed bedrock, coarse boulder, till or pure sand	Pogonatum dentatum
Lichen Upland (I)*	xeric to dry-mesic	o dominant cover of fruticose lichens o upland site including slopes of eskers, drumlins and coarse well-drained till plateaus	Cornicularia divergens Alectoria ochroleuca Cetraria nivalis C. cucullata
Dwarf Shrub (II, IV)	mesic	o dominant shrub plant cover; sites include the base of slopes, draws and some gently sloping uplands	Betula glandulosa Salix arctophila S. planifolia
Meadow	wet-mesic to hydric	o often pure stands of sedges o sites adjacent to permanent waterbodies following local drainage patterns	Carex aquatilis C. rostrata C. rariflora Eriophorum spp.

* The Roman numerals refer to the closest physiognomic types described by Fleck and Gunn (1982, Table 11). Rock/sand barrens were not included in their description.

TABLE 3.3: COMPARISON OF THE MEAN PROPORTION OF TIME SPENT BY CARIBOU IN DIFFERENT ACTIVITIES, BEVERLY CALVING GROUND, 1981 AND 1982 (Source: Urangesellschaft Canada Limited)

		% Time 1981			% Time 1982			
Class	Activity	$\bar{x}$	SD	n^1	$\bar{x}$	SD	n^1	t-statistic^2
Calving								
Cow	Bedded	32.8	12.1	20	34.8	16.0	28	-0.4720
	Foraging	49.4	11.9	20	50.3	14.5	28	-0.2231
	Standing	4.8	2.6	20	5.0	2.4	28	-0.2763
	Walking	12.4	6.8	20	9.6	7.0	28	1.3551
	Trotting	0.5	0.9	20	0.2	0.5	28	-
	Galloping	0.6	0.3	20	0.0	0.1	28	-
Calf	Bedded	58.5	21.0	20	50.4	21.2	27	1.3010
	Foraging	16.3	13.1	20	14.0	9.9	27	0.6729
	Standing	13.5	21.1	20	18.3	18.6	27	-0.8326
	Walking	11.0	7.8	20	14.9	13.2	27	-1.1883
	Trotting	0.6	0.8	20	1.9	2.5	27	-
	Galloping	0.3	0.5	20	0.6	1.3	27	-
Post-Calving								
Cow	Bedded	39.7	15.7	26	48.3	21.7	23	-1.6151
	Foraging	47.5	13.7	26	37.8	17.1	23	2.2171*
	Standing	4.3	2.1	26	2.7	2.7	23	2.3153*
	Walking	7.8	4.6	26	10.6	16.8	23	-0.8363
	Trotting	0.6	1.0	26	0.5	1.4	23	-
	Galloping	0.2	0.9	26	0.1	0.5	23	-
Calf	Bedded	66.0	11.7	26	69.1	21.3	22	-0.6291
	Foraging	16.0	6.0	26	11.2	6.9	22	2.5635*
	Standing	5.2	3.3	26	4.9	4.6	22	0.1919
	Walking	10.3	5.8	26	12.0	14.5	22	-0.5360
	Trotting	1.8	2.0	26	1.9	3.3	22	-
	Galloping	0.8	1.3	26	0.9	1.9	22	-
Combined								
Cow	Bedded	36.9	14.6	45	40.9	19.8	50	1.1103
	Foraging	48.1	12.9	45	44.6	16.8	50	-1.1294
	Standing	4.4	2.3	45	3.9	2.8	50	-0.9448
	Walking	9.9	6.1	45	10.1	12.3	50	-0.0987
	Trotting	0.6	1.0	45	0.4	1.0	50	-
	Galloping	0.2	0.7	45	0.1	0.3	50	-

TABLE 3.3: COMPARISON OF THE MEAN PROPORTION OF TIME SPENT BY CARIBOU IN DIFFERENT ACTIVITIES, BEVERLY CALVING GROUND, 1981 AND 1982 (Source: Urangesellschaft Canada Limited)

		% Time 1981			% Time 1982			
Class	Activity	$\bar{x}$	SD	n[1]	$\bar{x}$	SD	n[1]	t-statistic[2]
Calf	Bedded	62.7	16.8	45	58.7	23.0	48	0.9524
	Foraging	16.1	9.7	45	12.7	8.7	48	-1.7816
	Standing	8.7	14.7	45	12.3	15.6	48	-1.1436
	Walking	10.7	6.7	45	13.6	13.7	48	-1.2831
	Trotting	1.3	1.7	45	1.9	2.8	48	-1.2390
	Galloping	0.6	1.1	45	0.7	1.6	48	-

[1] Number of observer team days.

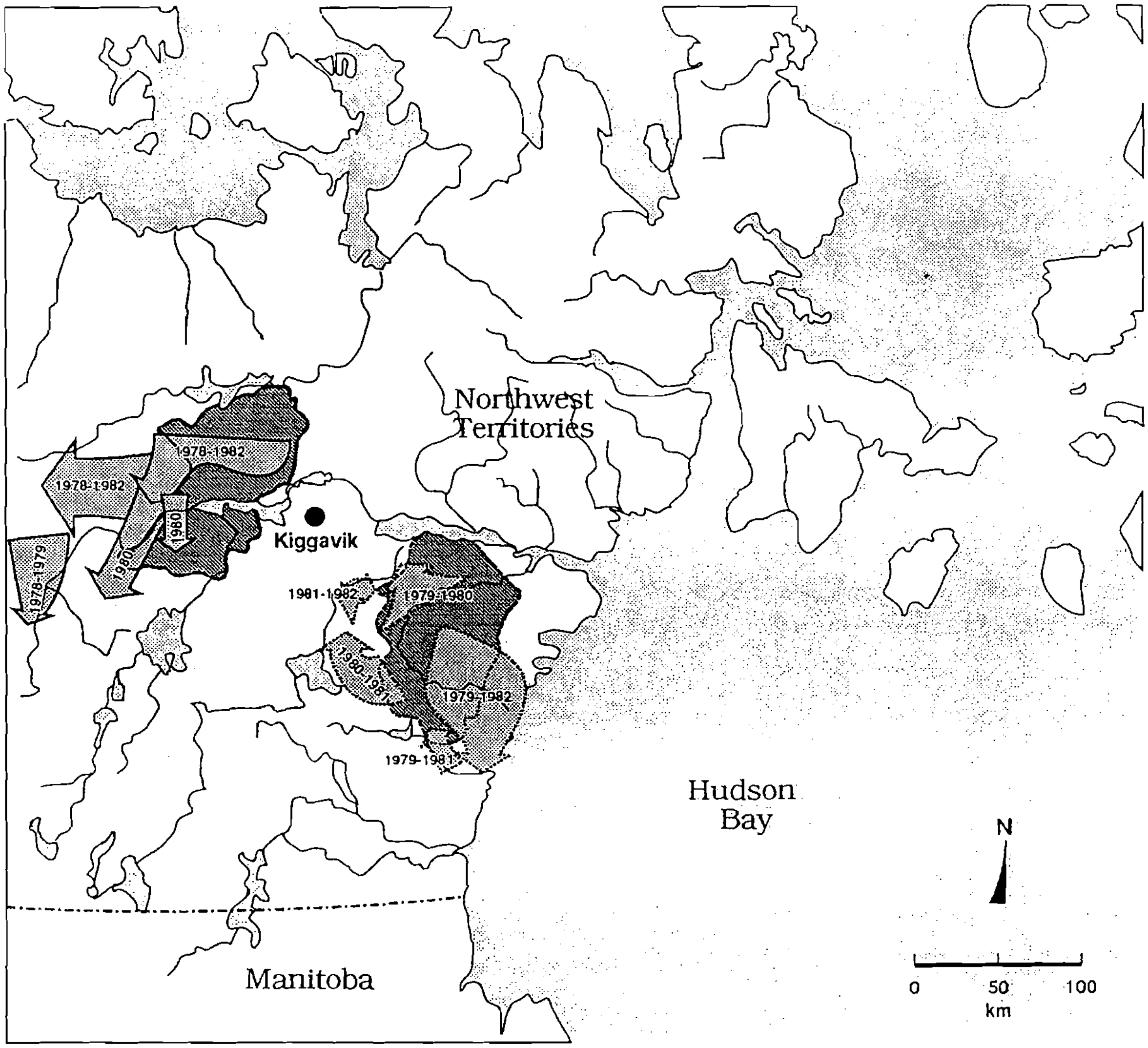
[2] t-statistic calculation based on assumption of unknown but assumed equal population variance (Dunn and Clark, 1974: 58).

* Significant difference (p = 0.05).

figure 3.4

Post-calving movements from 1978 to 1982

for the Beverly and Kaminuriak herds



▨ *Kaminuriak caribou protection area*

▨ *Beverly caribou protection area*

▨ *post-calving movements for the Kaminuriak caribou*

▨ *post-calving movements for the Beverly caribou*

TABLE 3.4: SUMMARY OF OBSERVATIONS IN THE LITERATURE OF DESIGNATED WATER CROSSINGS (1904-1978), N.W.T. (Source: Williams and Gunn, 1982)

Water Crossing No.	Observation Date	Sign	Author and Date
1-3	August 1967		F.L. Miller, pers. comm.
3	July 1945	carcasses, trails	Manning (1948)
4 and 5	July 1954	2	Loughrey (1955)
4 and 5	July-August 1966	2	Parker (1972)
4 and 5	July-August 1967	2	Parker (1972)
4 and 5	July-August 1968	2	Parker (1972)
4 and 5	July 1970	caribou trails	F.L. Miller, pers. comm.
6	July-August 1966	2	Parker (1972)
7	July-August 1967	2	Parker (1972)
7	July-August 1968	2	Parker (1972)
8	July 1969	post-calving aggregation seen	Parker (1972)
10	not specified	traditional hunting area	Birket-Smith (1929)
12	not specified	traditional hunting area	Birket-Smith (1929)
12	August 1945	trails on shore	Manning (1948)
12	August 1944	reported crossing	Manning (1948)
13,14,15, 17	unspecified	archaeological hunting site	Harp (1961)
13,14	unspecified		hunters in IDS (1978)
15	August 1904	hunting activity	Hanbury (1904)
15,16,17			hunters in IDS (1978)
16	July 1959	reported crossing to south	McEwan (1960)
15,16			hunters in Welland (1976)
15,16			hunters in Stager (1977)
17	July 1973	signs of recent crossing	Hawkins (1973)
18			hunters in IDS (1978)
19,20		archaeological hunting sites	Harp (1961)
19	August 1951	caribou drowning	Kelsall (1953)
19	August 1956	hunting camp	Loughrey (1956)
19,20	June-July 1960	caribou moving south	hunters in Welland (1976)
19,20			hunters in Stager (1977)

TABLE 3.5: SUMMARY OF OBSERVATIONS OF USE OF WATER CROSSINGS DURING THE CARIBOU MONITORING PROGRAM (1978-1981), N.W.T. (Source: Williams and Gunn, 1982)

Water Crossing No.	Observation Date	Sign	Author and Date
2	1980	trails	this report
3	1980	trails	this report
4	June-July 1978	caribou moving north	Cooper (1981)
4	July 1980	heavy trails	this report
5	Spring (?) 1980	heavy trails	Cooper (1981)
7	June-July 1978	caribou moving south	Darby (1978)
7	1980	trails	this report
8	July 1980	trails	Cooper (1981)
8	July 1980	few caribou	this report
9	July 1979	caribou moving northwest	Neigo in Darby (1980)
10	1980	trails	this report
12	May 1981	caribou moving south	C. Gates, pers. comm.
13-17	July 1980	few trails	this report
15	July 1980	few caribou	Cooper (1981)
19	July 1980	few caribou	this report
20	1980	few caribou	this report
21	1980	few caribou	this report
22	June-July 1978	caribou moving northwest	Darby (1978)
22	July-August 1979	caribou moving south	Darby (1980)
22	July 1980	caribou moving south	Cooper (1981)
22	July 1980	few trails	this report
23	July 1978	caribou moving north	Darby (1978)
23	July-August 1979	caribou moving south	Darby (1980)
23	July 1980	heavy trails	this report
24	July 1978	caribou moving south	Darby (1978)
24	July 1980	trails	Cooper (1981)
25	July 1978	caribou moving south	Darby (1978)
25	July 1979	caribou moving south	Darby (1980)
25	July 1980	caribou moving south	Cooper (1981)
25	July 1981	caribou moving south	A. Gunn field notes
26	July 1980	caribou moving south	Cooper (1981)
26	July 1981	caribou moving south	A. Gunn field notes

peninsula jutting from the south shore. These crossings were used prehistorically at the turn of the century, 1939-1940 (Banfield, 1980) and 1959. Neither crossing has been used to any extent since 1960 (Jakimchuk, 1979; Ogilvie, 1987). The herd begins its dispersal from the summer range during August, slowly migrating back to the winter range by October.

3.1.4 Beverly Herd Populations and Distributions

Estimates of herd size based on GNWT Renewable Resource surveys of the calving grounds in 1988 suggested a total population of between 120,000 and 260,000, with a best estimate of about 190,000 caribou. Optimum herd size based on user demand and ability of the habitat to support caribou is estimated to be 300,000 animals. Crisis herd size is considered to be 150,000 (Beverly and Kaminuriak Caribou Management Board, 1987).

Monitoring programs were carried out by Urangesellschaft Canada Limited from 1978 to 1980 to document caribou usage in the local and regional area surrounding the Kiggavik site. Four areas were chosen for investigation, each of which is characterized by important phases in the annual distribution of the Beverly herd (Figure 3.5). The Marjorie Lake and Sandhill areas are within the "primary calving and post-calving aggregation" area of the Beverly herd, and the Sissons Lake and Schultz Lake areas are within an area of "potential calving and post-calving aggregation". The Kiggavik site is located within the Sissons Lake study area. The other three areas are a great distance from the Kiggavik site, but are discussed to give a regional context.

Caribou usage at each site was estimated using a pellet-group counting technique. This method has been used extensively both for estimating numbers and distribution of big game animals for defining habitat preference. The numbers of caribou observed within a 15 km radius of each site during the 1978 to 1980 field seasons are summarized in Table 3.6. Mean weekly caribou use and total caribou days were greater in the Sissons Lake area in 1980 than in 1979, but close to the 1978 records. Schultz Lake saw higher numbers of caribou in 1980 than in the last two years, and Marjorie Lake sightings were down slightly in 1980 from 1979. With the exception of Schultz Lake for 1978, mean weekly caribou days are lower in the Sissons Lake area than for any of the other areas. These data suggest minimal caribou occupation of the Sissons Lake area relative to the other areas.

figure 3.5

1979 environmental study areas in Baker Lake region

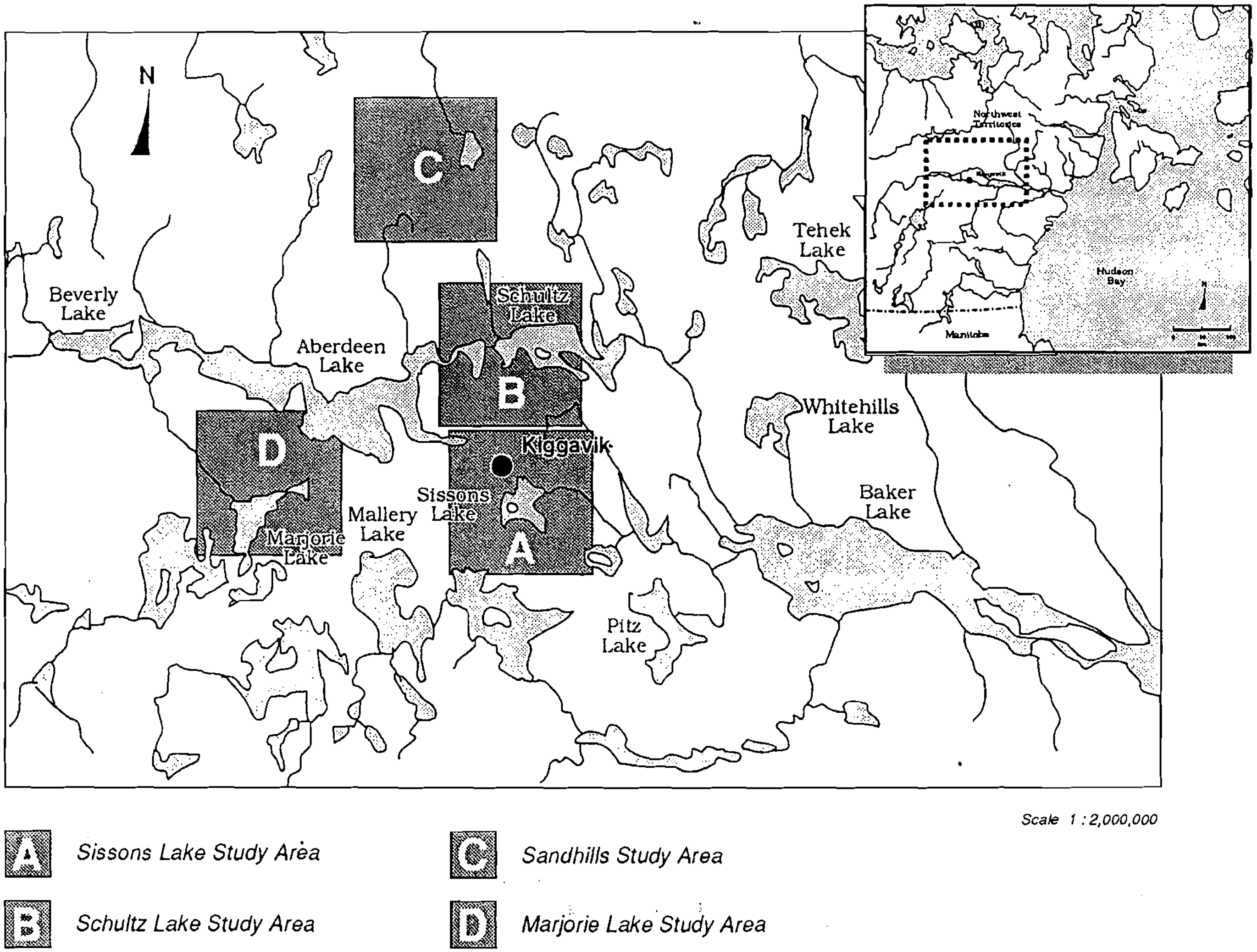


TABLE 3.6: SUMMARY OF CARIBOU OBSERVATIONS
(This information is useful as an index of usage, not absolute numbers of caribou) (Source: Urangesellschaft Canada Limited)

Location	No. of Weeks	Mean Weekly Caribou Use ± 1 S.D.	Total Caribou Days	Male: Female*
1980				
Sissons Lake	12	8.6±	103	8:1
Schultz Lake	9	16.8±	151	1.3:1
Marjorie Lake	12	14.6±	175	4.3:1
1979				
Sissons Lake	11	3.8±3.8	42	14:1
Schultz Lake	10	4.2±5.5	52	1:1.6
Sandhills	10	952.3±716.9	10,000**	1:24
Marjorie Lake	11	17.0±23.8	187	32:1
1978				
Sissons Lake	13	8.5±13.5	110	12:1
Schultz Lake	11	3.8±17.9	42	9:1
Sandhills	9	32.9±41.4	296	1:9.8

* Ratio refers only to adult animals. The solitary yearlings and calves, the unsexed animals and the groups of caribou are not included in this ratio.

** This figure represents the estimated total number of caribou observed, not caribou days.

Table 3.7 compares the number of caribou days per year per ha, estimated by the pellet-group counts, for each area between 1978 and 1980.

The Sissons Lake Area

The Sissons Lake area had a high pellet-group count per hectare, probably because of the physiography of the area. The escarpment in this area provides late-lying snow beds and an upland exposed position which both act to reduce insect harassment. Extensive wetlands in the area also provide a good food supply with the sedge meadows. According to the pellet-group counts, the Sissons Lake area had greater caribou usage than the other areas. This may be explained by the fact that a group of bulls wandered into the Sissons study area and followed the Urangesellschaft biologists during the sampling periods (Dr. Banfield, pers. comm.). As a result, these data may represent elevated caribou use of the area above normal levels.

Observations made by the BEAK study team since 1986, and many years of government study, have shown that Beverly caribou migrations and calving areas are well beyond the Kiggavik boundaries. Some individuals of the herd do wander through Kiggavik during the off-season periods (i.e., late spring and summer) for reasons mentioned above. The fact that there is such a high variability of caribou use in this area (and the others) suggests these areas are used randomly and, therefore, are not vital to the caribou in the area.

The Sandhills Area

Caribou activity has been documented in the area between 1957 to 1978 (Darby, 1978). Up to 1974, this site was well within the observed calving grounds of the Beverly herd (Moshenko, 1974). During the summer of 1978, however, biologists employed by Urangesellschaft did not observe any calving or post-calving activity in the area. A relatively large number (about 10,000) of caribou were seen between 18-27 June 1979, but most were females and calves. By the end of June 1979, most caribou had left the Sandhills area. The mean estimate of pellet-groups/ha for the Sandhills site is 28.8±20, which is considerably less than the Kiggavik estimate, but greater than counts at other sites (Table 3.7).

TABLE 3.7: SUMMARY OF CARIBOU PELLET COUNTS AND THE RESULTING CARIBOU DAY ESTIMATES
(Source: Urangesellschaft Canada Limited)

	Total Area Sampled (m^2)	No. of Transects	Pellet Groups/ Hectare[1]	Estimated Caribou Days[2]	
				5	8
1980 Data					
Sissons Lake	123,010	15	16.4±13.0	0.11±	0.07±
Marjorie Lake	87,748	16	6.7±5.3	0.04±	0.03±
Schultz Lake	64,200	9	9.27±6.0	0.06±	0.04±
1979 Data[3]					
Sandhills	36,800	14	28.8±20.1	0.18±	0.12±
Sissons Lake	4,000	4	120.5±67.5	1.16±	0.48±
Marjorie Lake	28,800	18	8.7±6.1	0.05±	0.03±
Schultz Lake (total)	36,910	20	45.7±?		
(north of crossing	13,600	8	12.5±19.4	0.08±	0.05±
Shultz Lake Island	3,810	8	30.1±35.4	0.19±	0.12±
crossing peninsula)	19,500	4	3.1±1.7	0.02±	0.01
1978 Data[3]					
Sissons Lake	19,026	9	57.71±43.45	0.37±	0.23±
Schultz Lake (crossing peninsula)	121,980	9	6.72±4.17	0.04±	0.03±

[1] Mean estimate of pellet groups present on claim area per hectare ± S.D.

[2] Estimated caribou days per year per hectare when pellet group durability is five and eight years.

[3] 1979 and 1978 caribou day calculations have been corrected from the original calculation where one pellet group was considered to equal one defecation, rather than 2.6 groups per defecation.

The Marjorie Lake Area

The use of this site by the Beverly herd for calving is not as clearly established as is the Sandhills site. Although no calving was reported on the site beween 1957 to 1978, McEwen (1960, 1962) reported calving occurring about 20 km west of the site. Urangesellschaft biologists also did not observe calving in 1979 or 1980, although 187 caribou were seen from 16 June to 30 August 1979, and 175 for the same period in 1980. The estimated mean number of pellet-groups per ha is 6.7±5.3, representing limited caribou use (Kelsall, 1957).

The Schultz Lake Area

This area is situated adjacent to a caribou crossing (DIAND, 1979 Caribou Protection Map). The use of this crossing by caribou is not well-documented, although data collected in 1979 and 1980 by Urangesellschaft biologists revealed no significant numbers of caribou used it. The N.W.T. Wildlife Service also reported that the crossing was not used by cows and calves, or any significant number of bulls, during the spring of 1979 (Darby, 1979).

3.2 The Kaminuriak Herd

3.2.1 Range

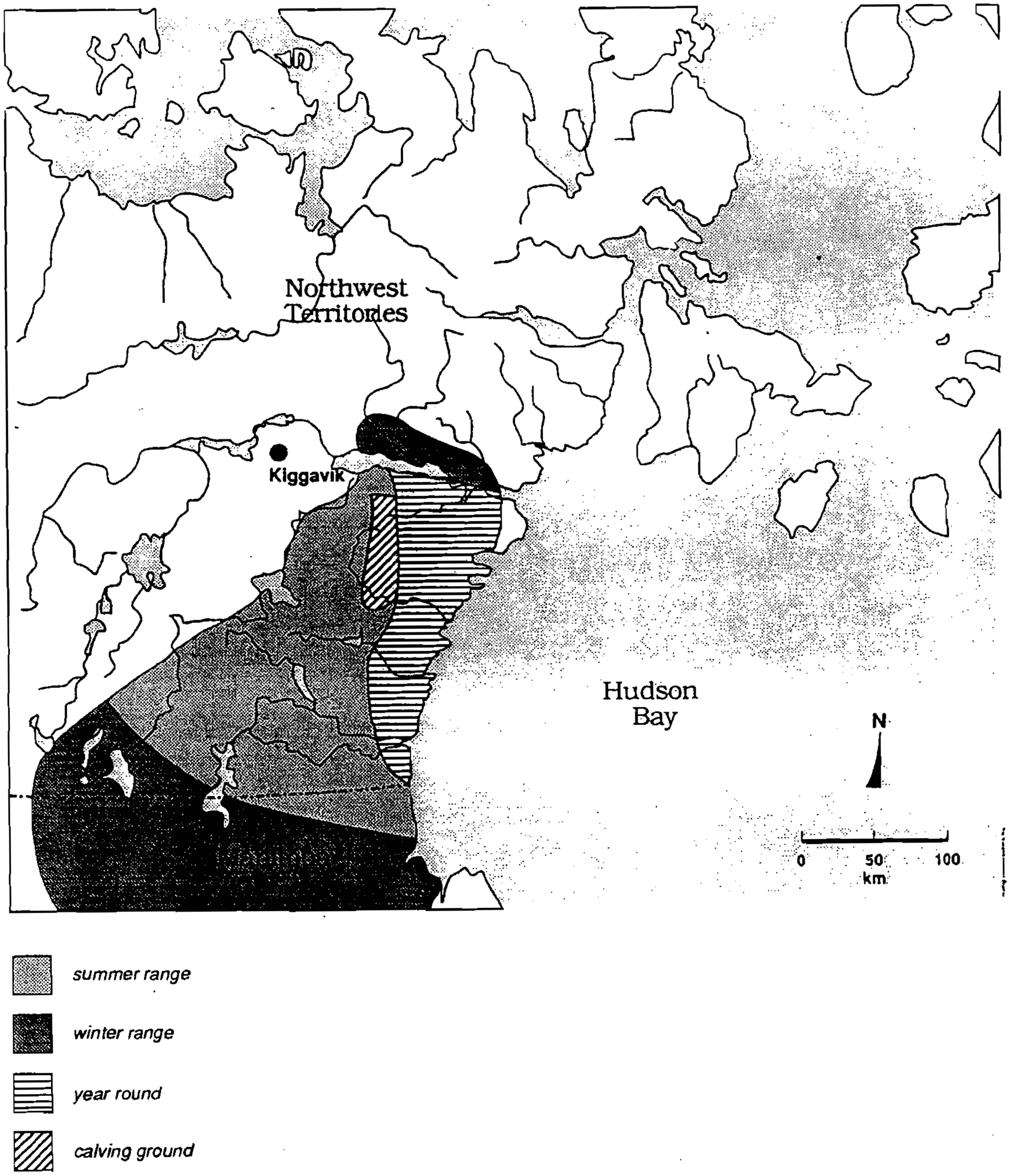
The general range of the Kaminuriak herd includes southeastern Keewatin, as far north as the Chesterfield Inlet area, northern Manitoba and northeastern Saskatchewan (Figure 3.1). Historical observations of the herd date from the 17th century (Banfield and Jakimchuk, 1980).

Traditionally, the Kaminuriak herd has used winter ranges in the Taiga of northern Manitoba and northeastern Saskatchewan, although frequent wintering on the tundra near Arviat has been observed (Jakimchuk, 1979). Since 1973, the herd altered these long-established patterns and has wintered on the tundra north and east of Baker Lake and in the Arviat area (Figure 3.6) (Fischer et al., 1977).

figure 3.6

General range and calving ground

Kaminuriak herd (after Jakimchuk, 1979))



3.2.2 Seasonal Movements

3.2.2.1 Spring Migration

Spring migration generally commences in the first week of May, and is preceded by premigratory concentration in late April (Parker, 1972). Groups of adult males, yearlings and non-calving females typically follow pregnant cows along similar, but broader, corridors up to a month later (Jakimchuk, 1979). Major routes are from the Taiga winter range area northeast towards Kaminuriak Lake (Figure 3.6), for that part of the herd in and near the Taiga, and to Kaminuriak Lake from the north and east, for those that winter north in the Baker Lake-Chesterfield Inlet area. Arrival on the calving grounds typically occurs in early June.

3.2.2.2 Calving Grounds

Since 1978, the calving grounds have been in the general area of Kaminuriak Lake with the exception of 1982, when cows calved between Ferguson Lake and Kaminuriak Lake (Ogilvie, 1987) (Figure 3.6). Calving typically occurs in early-to-mid June of each year (Parker, 1972). In general, post-calving aggregations are distributed south of Baker Lake and east of the Kazan River. In 1987, Ogilvie (1987) reported that from the time of calving until early July, cow-calf caribou slowly converged upon the area surrounding Happotiyik Lake. During July dispersal, mixing of the cow-calf and yearling-bull components of the herd have occurred. A large concentration (up to 50,000 animals) typically occurs along the Hudson Bay coast between the Maguse and Wallace Rivers. Other smaller groups occur at various locations within the caribou protection area.

3.2.2.3 Post-Calving Movements

Following calving, cows and calves generally move towards the northern end of the calving ground, forming numerous post-calving aggregations by the end of June (Jakimchuk, 1979). Post-calving aggregations are generally distributed to the south of Baker Lake and to the east of the Kazan River.

3.2.2.4 Summer Distribution and Movements

The mid-summer migration commences about mid-July with movements south on either side of Kaminuriak Lake to three late summering areas (Jakimchuk, 1979):

- central area - between Nejanilini and Sealhole Lakes,
- eastern area - Arviat south to Hyde Lake, and
- western area - west side of Nueltin Lake.

The mid-summer migration usually terminates by mid-August.

3.2.2.5 Fall Migration

In late September, movement commences towards the rutting area (between Edehon and South Henik Lake), and the autumn migration to winter ranges begins in late October or early November (Jakimchuk, 1979).

3.2.3 Water Crossings

During the summer migration, a number of water crossings occur at several major sites in the lower Kazan River between Thirty Mile Lake and Baker Lake (Jakimchuk, 1979). A major crossing at the east end of Baker Lake in the Christopher and Bowell Islands area is used by that portion of the herd wintering in the area north of Baker Lake (Inter-Disciplinary Systems Ltd., 1978).

3.2.4 Kaminuriak Herd Populations and Distributions

Estimates of herd size based on GNWT Renewable Resource surveys on the calving grounds in 1988 indicated a population of between 150,000 and 300,000, with the best estimate at 220,000 animals. This represented a significant increase in herd size from the 1970s when population estimates were as low as 30,700 (Thompson et al., 1978). Optimum and crisis herd size is similar to that for the Beverly herd.

3.3 Disturbance and Caribou Behaviour

Traditional calving grounds of migratory barren-ground caribou are of great importance because during the first days of the newborn calf's life the cow and calf form a strong attachment to each other (Gunn, 1983). Calving and post-calving are also times when critical early growth of calves occurs, which will subsequently influence their chances of survival (Gunn et al., 1983). Responses to human activities that could reduce foraging and disrupt the continuing formation and strengthening of the mother-young bond during the sensitive calving and post-calving periods may be detrimental to calf survival and to the long-term well-being of the caribou population (Gunn et al., 1983).

Concerns have been raised about the consequences of human activities on cows and calves on their traditional calving grounds. In 1978, the Federal Department of Indian Affairs and Northern Development (DIAND) developed and implemented the "Caribou Protection Measures", to restrict land use activities just before and during the calving and post-calving periods of the Beverly and Kaminuriak herds (15 May to 31 July).

Early efforts to anticipate the consequences for caribou and reindeer of increased human activity in the north were directed at assessing the reaction of these animals to harassment by low-flying aircraft. This potential problem was outlined because of the accelerated oil and gas exploratory activity involving low-level aircraft flights over the Arctic. In addition, there was also concern that normal movement patterns may be affected because of petroleum exploration and development activities. Consequently, several investigations were carried out on the reaction of caribou to above-ground pipelines, highways and highway traffic, compressor station sounds and related activities (Klein, 1980). As a result of these studies, a considerable body of knowledge on the reaction of Rangifer to obstruction and disturbances has now been accumulated.

3.3.1 Aircraft Disturbance

Several separate studies have been carried out on the effects of aircraft disturbance and harassment on caribou (Klein, 1973; Calef et al., 1976; Miller and Gunn, 1979; Jakimchuk, 1980). There is a general agreement in the literature that distance from the aircraft is the most important factor influencing the degree of response. Shank (1979) summarized findings of a number of studies and found a rapid decline of the severity of the response

TABLE 3.8: PRE- AND POST-DISTURBANCE ACTIVITY BUDGETS OF CARIBOU[1] CALCULATED AS MEAN PROPORTIONS AND EXPRESSED AS PERCENTAGES OF TIME SPENT IN EACH ACTIVITY, BEVERLY CALVING GROUND, 1982 (Source: Gunn et al., 1983)

		Pre-disturbance			Post-disturbance		
Class	Activity	$\bar{x}^2$	SD	n^3	$\bar{x}$	SD	n
Cow	Bedded	44.3	8.1	7	46.6	18.1	7
	Foraging	47.2	7.8	7	39.7	10.2	7
	Standing	3.0	2.5	7	2.5	3.1	7
	Walking	5.3	3.7	7	11.1	13.7	7
	Trotting	0.1	0.2	7	0.1	0.2	7
	Galloping	0.0	0.0	7	0.0	0.0	7
Calf	Bedded	73.5	9.6	7	64.2	24.4	7
	Foraging	6.6	6.2	7	15.5	7.5	7
	Standing	3.3	2.3	7	2.5	2.0	7
	Walking	5.8	4.8	7	15.4	17.9	7
	Trotting	0.6	0.7	7	1.9	2.6	7
	Galloping	0.1	0.2	7	0.5	0.8	7

[1] Observations of the same caribou group during pre- and post-disturbance.

[2] Mean proportion of time (expressed as a percentage) spent in each activity.

[3] Number of observer team days.

with distances of up to about 80 m, and less of a relationship above 80 m. He also noted that winter is the season of greatest sensitivity, followed by calving periods. Summer and fall are the least critical seasons; groups with calves react more than groups without, and large groups respond more severely to aircraft than small groups (Jakimchuk, 1980). Helicopters are generally more disturbing to the caribou than fixed-wing aircraft.

Gunn et al. (1983) carried out a study to assess the effect of helicopter landings on the Beverly herd. The pre- and post-disturbance activity budgets of caribou are listed in Table 3.8. The standard deviations for the mean activity budgets of the cows and calves during post-disturbance were generally higher than during pre-disturbance, suggesting greater variation in the activity proportion of cows were walking, trotting or galloping during post-disturbance as during pre-disturbance.

The proportions of caribou observed on the different range types were more variable during post-disturbance than pre-disturbance (Table 3.9). The largest proportion of bedded caribou was on Meadow during pre-disturbance, but was on Lichen Upland during post-disturbance. The greatest proportion of caribou foraging was observed on Meadow both before and after the helicopter landings.

3.3.2 Noise

Considerable variations in response of caribou to noise are reported in the literature, depending on associated activity, time of year and the nature of the noise emission (Jakimchuk, 1980). Observations have been made in nature of caribou responses to blasting, gunshots and sonic booms. De Vos (1960) reported temporary cessation of feeding and investigative behaviour by caribou exposed to noise from a 30.30 rifle at a distance of half a mile. Kelsall (1968) observed caribou migrating in apparent disregard of incessant shooting. Bergerud (1974) found that the sound of trains, cars, chain saws and dynamite blasts produced no visible responses by caribou. Russell (1977) reported that seismic blasting of 3 to 6 km does not appear to produce a reaction by caribou. In fact, Urquhart (1970) reported that the greatest concentration of caribou remained in an area where seismic activity was most concentrated. The level of response of individual and groups of caribou to rifle shots, as observed by biologists for UG in 1980, is listed in Table 3.10.

TABLE 3.9: RANGE USE BY CARIBOU[1] PRE- AND POST-DISTURBANCE, CALCULATED AS MEAN PROPORTIONS AND EXPRESSED AS PERCENTAGES OF CARIBOU OBSERVED BEDDED OR FORAGING ON EACH RANGE TYPE, BEVERLY CALVING GROUND, 1982 (Source: Gunn et al., 1983)

		Pre-disturbance			Post-disturbance		
Range Type	Activity	$\bar{x}$	SD	n[2]	$\bar{x}$	SD	n
Lichen Upland	Bedded	32.0	30.5	7	46.5	39.1	7
	Foraging	24.9	24.6	7	37.9	40.5	7
Dwarf Shrub	Bedded	8.4	12.9	7	12.0	19.7	7
	Foraging	6.9	9.3	7	11.4	21.9	7
Meadow	Bedded	55.5	31.3	7	41.4	40.6	7
	Foraging	67.6	28.6	7	50.8	36.8	7

[1] Observations of the same caribou group during pre- and post-disturbance.

[2] Number of observer team days.

TABLE 3.10: LEVELS OF RESPONSE OF INDIVIDUAL AND GROUPS OF CARIBOU TO RIFLE SHOTS (level of insect activity is included)
(Source: Urangesellschaft Canada Limited)

No. of Caribou	Sex/Age	Level of Response	Level of Insect Activity
5	yearling	low	nil
1	yearling	moderate	nil
1	yearling	severe	moderate
1	calf	severe	nil

It should be noted that there are several instances where caribou exhibit learned behaviour, such as an attraction to noise from chain saws in order to feed on arboreal lichens from felled trees (Herbison, 1973).

3.3.3 Human Presence, Activities and Structure

Three major categories of human-related stimuli, as defined by Jakimchuk (1980), are:

- structures encountered by caribou, but which do not threaten them (i.e., presence of buildings, machinery, etc.);
- structures associated with motion or human activity (i.e., vehicles, towns); and
- hunting.

The presence of stationary objects, such as machinery, alone does not appear to induce avoidance reactions by caribou. Jakimchuk et al. (1974) observed caribou within a few feet of oil storage tanks in the northern Yukon.

Cameron and Whitten (1979) argue that human activities, rather than structures, appear to be the cause of avoidance reactions by caribou. As Miller and Gunn (1977) pointed out, caribou responded more to people on the ground than to helicopter overflights. Biologists for UG, for example, found that, at an observer distance of less than 50 m, caribou ran or trotted away during 50% of the observations (Tables 3.11 and 3.12).

A considerable volume of literature is available dealing with the effects of hunting on caribou avoidance (Shank, 1979). Barren-ground caribou display greatest reactions to hunting activity (i.e., snow machines, human presence) while on winter range, and are less responsive when hunting takes place during migratory periods (Jakimchuk, 1980). Spring migrations are not readily affected by hunting activity (Jakimchuk et al., 1984).

3.3.4 Access Roads

Since 1971, a number of field studies has been carried out on the effects of transportation corridors and associated activities on caribou movements, distribution and behaviour (Tracy, 1977; Cameron and Whitten, 1978; Roby, 1978). The increased

TABLE 3.11: LEVELS OF RESPONSE OF SOLITARY CARIBOU TO MOVING OR STATIONARY OBSERVERS AND HUNTERS
(the distance (in metres) between the caribou and the disturbance which triggered the most severe response is included)
(Source: Urangesellschaft Canada Limited)

Sex/Age Class	Distance (m)	Level of Response				Totals
		Maint.	Low	Mod.	Sev.	
Bull	0-20	0	1	2	4	7
	21-50	1	0	4	3	8
	51-100	0	1	2	2	5
	100	3	3	2	0	8
	Unknown	0	0	2	2	4
	TOTAL	4	5	12	11	32
Cow	0-20	0	0	1	0	1
	21-50	0	0	1	1	2
	51-100	0	0	2	1	3
	100	0	0	0	0	0
	Unknown	0	0	2	1	3
	TOTAL	0	0	6	3	9
Yearling	0-20	0	0	4	2	6
	21-50	1	0	1	4	6
	51-100	0	0	0	0	0
	100	1	0	1	2	4
	Unknown	1	1	1	2	5
	TOTAL	3	1	7	10	21
GRAND TOTAL		7	6	26	24	63

TABLE 3.12: LEVELS OF RESPONSE OF GROUPS OF CARIBOU TO MOVING OR STATIONARY OBSERVERS AND HUNTERS
(the distance (in metres) between the caribou and the disturbance which triggered the most severe response is included)
(Source: Urangesellschaft Canada Limited)

Group Size Class	Distance (m)	Level of Response				Totals
		Maint.	Low	Mod.	Sev.	
2-5	0-20	0	0	0	1	1
	21-50	0	0	1	3	4
	51-100	0	0	1	0	1
	100	1	0	1	1	3
	Unknown	0	0	1	3	4
	TOTAL	1	0	4	8	13
6-20	0-20	0	0	0	0	0
	21-50	0	0	1	0	1
	51-100	0	0	0	1	1
	100	0	0	0	1	1
	Unknown	0	0	1	0	1
	TOTAL	0	0	2	2	4
20	0-20	0	0	0	0	0
	21-50	0	0	1	1	2
	51-100	0	0	0	0	0
	100	0	0	2	0	2
	Unknown	0	0	1	1	2
	TOTAL	0	0	4	2	6
GRAND TOTAL		1	0	10	12	23

attention in caribou-transportation corridor relations results because highways may transect the entire range of a caribou population (Jakimchuk, 1980). This is in contrast to the localized (camp/town) or transitory (i.e., aircraft disturbance) stimuli presented by other disturbances.

Several barren-ground caribou herds interact well with much-travelled highways in Alaska. The Nelchina and Fortymile herds have co-existed with highways for over 30 years (LeResche, 1975). Tracy (1977) studied the effects of highway disturbance on small bands of the McKinley herd on summer range, and found that caribou crossed the road fairly readily, but with caution. Eventually, the caribou became habituated to the road and non-abrupt traffic patterns. In studies of a small population of 25 to 30 animals of mountain caribou, Johnson (1976) found no evidence that Highway No. 3 in British Columbia modified caribou movements in the winter months. In fact, despite illegal shooting and vehicle mortality, the population has continued to cross the highway at traditional locations since its construction (Johnson and Todd, 1977).

3.3.5 Summary

Some conflicting observations appear in the literature, and there are genetic differences in behaviour exhibited between populations of <u>Rangifer</u>. For the most part, however, when variations in environmental conditions are considered, similar patterns exist in the reaction of caribou to obstructions and related disturbances associated with northern development. These can be summarized as follows (Klein, 1980):

- Roads, railroads, pipelines, powerlines, artificial or altered water courses or other man-made linear features can, independent of other human activities, block, delay or deflect the movements of caribou. Highways or railroad beds elevated substantially above the surrounding terrain present both physical and visual barriers to caribou. Deep construction cuts and associated obstacles such as snow fences or steep snow berms have similar effects. In open terrain, roads or railroads are visible from a great distance. As a result, approaching animals may react to them sooner and thereby be delayed longer in their movements than when approaching such features in forested terrain. The road or railroad surfaces may also cause deflection of moving animals either because of their reluctance to walk on it or, particularly in winter, it offers an easy surface to travel on.

- The level and type of vehicular traffic and other human activities associated with roads, railroads and other man-made features are major factors influencing the reaction of caribou. There is generally greater caribou alarm (and avoidance) to traffic and other human activities than to the constructed feature themselves. The greater the vehicle, and the greater the frequency of traffic, the greater the disturbance to caribou. The sounds associated with traffic appear to accentuate the alarm reaction, although sound in itself appears to be readily adapted to.
- Caribou react to obstructions and associated disturbances differently in relation to the season of the year. During spring and summer, for example, females accompanied by young show stronger avoidance of obstructions than during the winter. During summer, insect harassment levels are high and caribou seem to be less responsive to other disturbances.
- There are pronounced differences in response to obstructions in relation to sex and age of the animals involved and to group size. Adult males generally appear to be more adaptable to man-made features and show less alarm to highway traffic and other human activities than females with young. Generally, the larger the group, the greater the likelihood of avoidance reaction or deflection when confronting obstructions.
- Caribou more readily adapt or habituate to obstructions and associated disturbances if they are resident in the area of the obstruction rather than being present seasonally or during migration.

3.4 Caribou Habitats

Habitat selection by caribou appears to depend on two inter-related factors (Thompson et al., 1978):

- seasonal food preferences, and
- food availability.

In winter, caribou tend to avoid low-lying areas where snow collects and becomes wind-packed. Instead, they concentrate in more upland exposed areas. The caribou's winter diet is largely composed of lichens, with shrubs, sedges and other green plant material being important additions (Thompson et al., 1978). In their investigations for the Polar Gas Environmental Program, Thompson et al. (1978) found the most heavily used winter vegetation communities, in order of abundance, to be:

- lichen steppes,
- lichen heath tundra,
- dwarf shrub-lichen tundra, and
- dwarf shrub-sedge tundra.

All are typically found in upland sites that can be more easily exposed by the caribou.

In summer, caribou increase their consumption of green vegetation, primarily sedges. Thompson et al. (1978) reported that tussock tundra and, to a lesser degree, dwarf shrub-lichen tundra communities were of importance. The use of sedge meadows and other areas of sedge growth may be restricted in summer because of:

- the problem of insect harassment (Kelsall, 1968), and
- the high water levels, or the high proportion of standing dead material and mosses (White et al., 1975).

Lichens form an important portion of the caribou's summer diet. The dwarf shrub-lichen association is utilized much because it provides lichen, along with good cover of Eriophorum, Betula and Salix, and because it generally grows in more windy, insect-free upland areas (Thompson et al., 1978).

4.0 SMALL MAMMAL COMMUNITIES

Many of the small-mammal studies were carried out in 1979 and 1980 by Urangesellschaft Canada Limited. For these studies, small mammals were defined as those insectivores and rodents having a mean body weight of less than 100 g.

Sixty-seven livetrap captures were made of small mammals in the vicinity of the Kiggavik camp during the 1979 field season (Figure 4.1). The four major species in decreasing order of abundance were:

- red-backed vole (Clethrionomys rutilus),
- brown lemming (Lemmus sibiricus),
- Greenland collared lemming (Dicrostonys torquatus), and
- meadow vole (Microtus pennsylvanicus).

The masked shrew (Sorex cinereus) was expected (because their range includes Keewatin (Banfield, 1974)), but none were captured.

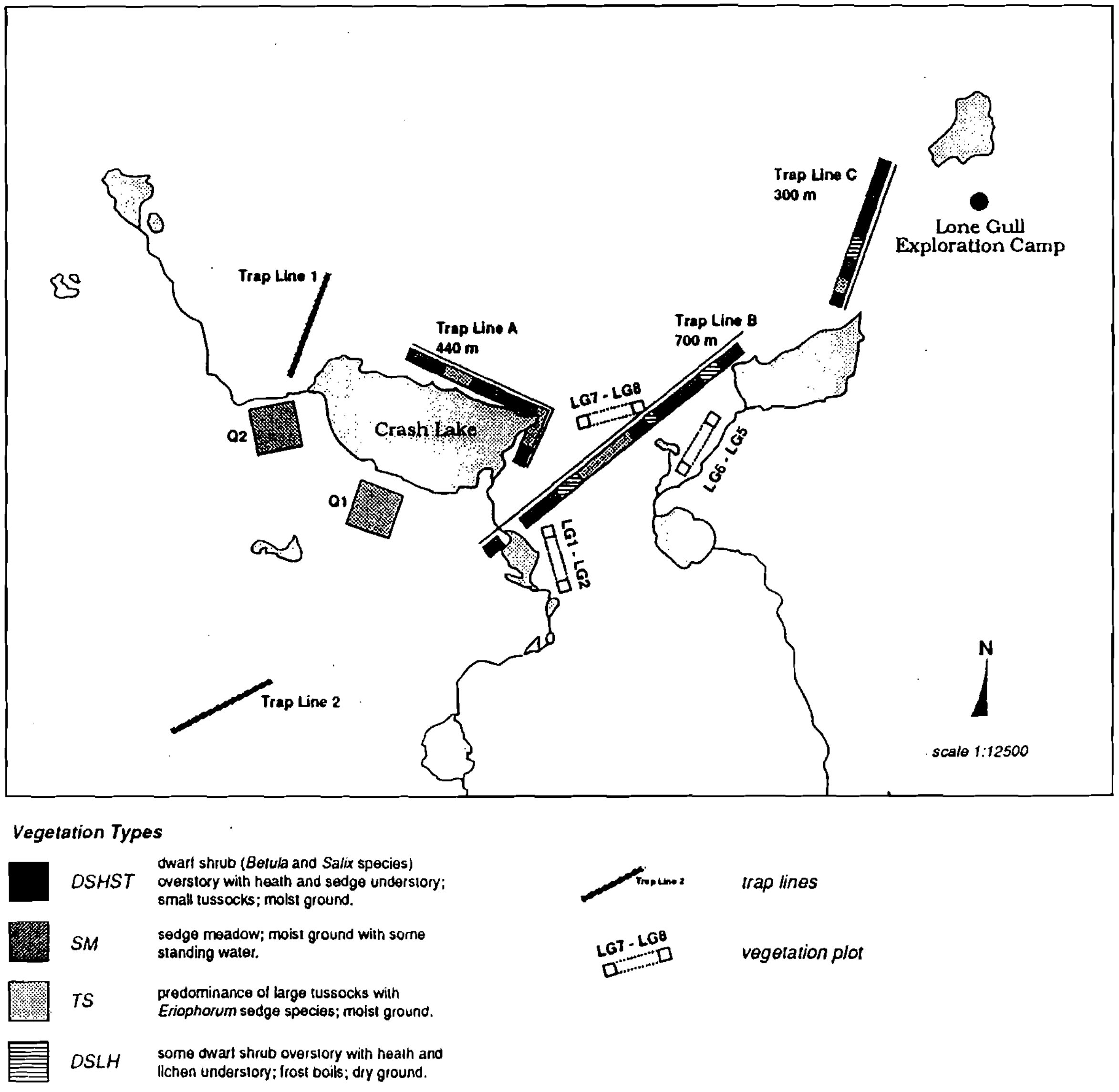
The number of species found within the four main habitats are summarized in Figure 4.2. The red-backed voles are the most abundant small mammal in two of the four documented habitats:

- the dwarf shrub overstory, heath-sedge understory, small tussocks, moist ground (DSHST), and
- the dwarf shrub overstory, heath-lichen understory, frost boils, dry ground (DSLH).

The Greenland collared lemming was captured most frequently in DSHST, and was the most common member of sedge meadow (SM). Ranges of brown and collared lemmings overlap, but occupy different niches. Brown lemmings were trapped in only two habitats: TS (large tussocks with sedges, moist ground) and DSHST. Most of the captures were in the TS, and they were the most abundant small mammal in that habitat. The Greenland collared lemming, in contrast, prefers the DSHST, and is dominant in SM.

figure 4.1

Locations of small mammal trap lines and vegetation plot sites near the Kiggavik site



Vegetation Types

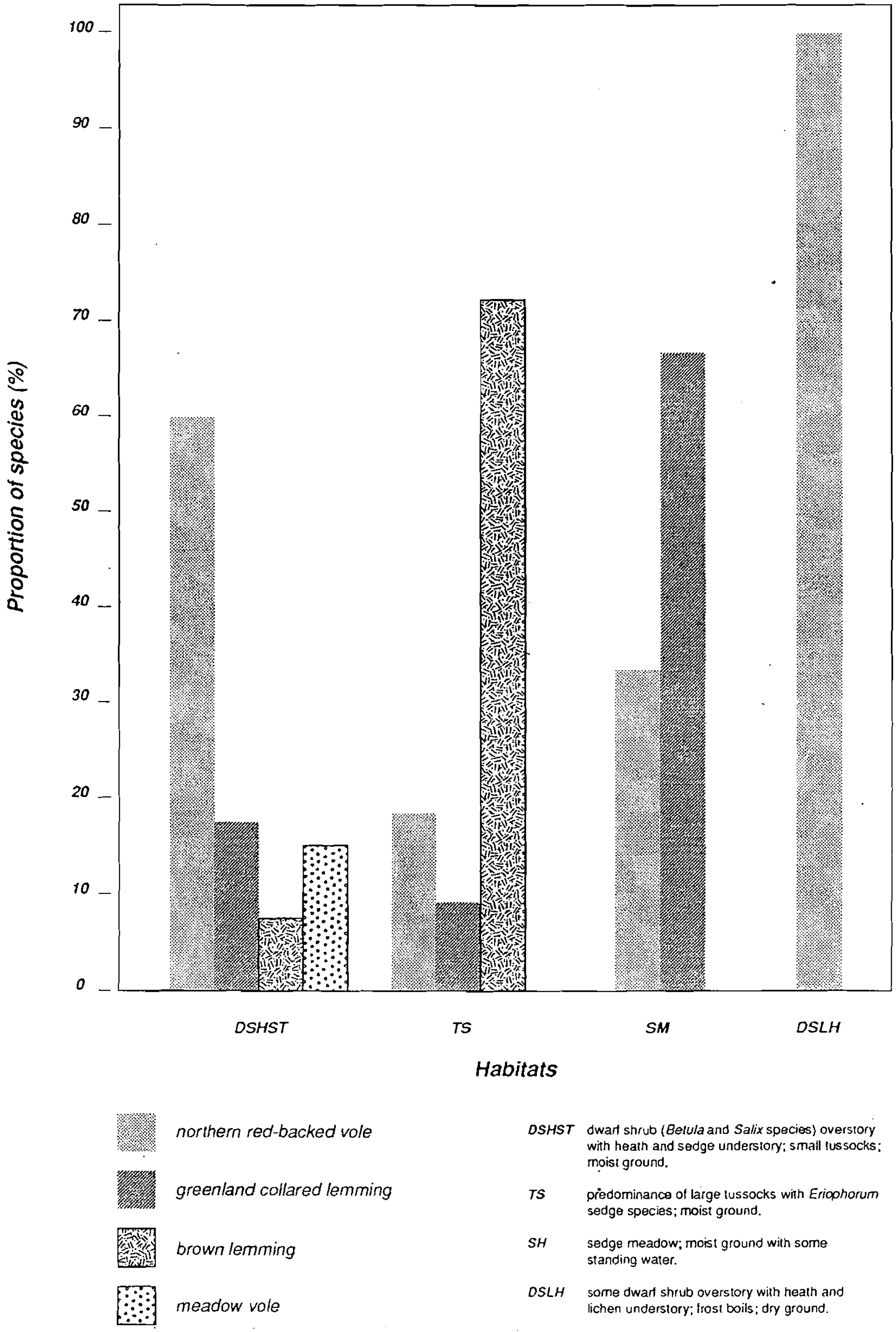
■	*DSHST*	dwarf shrub (*Betula* and *Salix* species) overstory with heath and sedge understory; small tussocks; moist ground.
▩	*SM*	sedge meadow; moist ground with some standing water.
▒	*TS*	predominance of large tussocks with *Eriophorum* sedge species; moist ground.
▤	*DSLH*	some dwarf shrub overstory with heath and lichen understory; frost boils; dry ground.

trap lines

vegetation plot

figure 4.2

Proportion of species within habitats



DSHST	dwarf shrub (*Betula* and *Salix* species) overstory with heath and sedge understory; small tussocks; moist ground.
TS	predominance of large tussocks with *Eriophorum* sedge species; moist ground.
SH	sedge meadow; moist ground with some standing water.
DSLH	some dwarf shrub overstory with heath and lichen understory; frost boils; dry ground.

In summary:

- DSHST is the most used habitat;
- DSHST is the only habitat in which all four species were trapped;
- meadow voles were only captured in DSHST; and
- red-backed voles were the most wide-ranging species, being trapped, in varying proportions, in all four habitats.

For the 1980 field season, two quadrants (80 x 80 m) of small mammal traps were set up approximately 1 km west of the Kiggavik camp (Figure 4.1). Population density estimates for the four major species are listed in Table 4.1. The results from both quadrants suggest that population densities of small mammals near the Kiggavik camp is low.

Small mammals respond differently to various disturbances. Carnivores, such as fox and wolf, are not likely to venture into camps, and so will probably be locally displaced through Kiggavik activities. The smaller mammal populations, such as lemmings, will likely increase in project development areas because of the more restricted access of predators.

TABLE 4.1: INDICES (no./1,000 trap nights) OF ABUNDANCE OF SMALL MAMMALS AT THE KIGGAVIK STUDY SITE
(number of trap nights in parentheses)
(Source: Urangesellschaft Canada Limited)

	1979				1980			
	June	July	Aug	Mean	June	July	Aug	Mean
<u>Clethionomys rutilus</u>	8.9	18.9	6.7	11.5	-	6.2	4.4	3.5
<u>Lemmus sibivicus</u>	21.1	-	-	7.0	15.4	9.3	2.6	9.1
<u>Dicrostanyx torquatus</u>	3.3	8.9	-	4.1	3.1	-	2.6	1.9
<u>Microtus pennsylvanicus</u>	1.1	3.3	2.2	2.2	-	3.1	0.9	1.3
TOTAL	34.4 (900)	31.1 (900)	8.9 (900)		18.5 (324)	18.6 (324)	10.5 (1144)	

5.0 OTHER MAMMALS

Observations of "other mammals" in the vicinity of the Kiggavik site were made by Urangesellschaft Canada Limited. Other mammals refers to those species equal in size or larger than the Arctic ground squirrel (Spermophilus parryii). Caribou are discussed in Section 3.0 of this document, and small mammals in Section 4.0.

A list of "other mammals" sighted in the Kiggavik regional area is given below. A summary of these sightings is listed in Table 5.1, and habitat preferences and diets for these species are given in Table 5.2.

Other Mammals Sighted in the Kiggavik Area

- Snowshoe hare (Lepus americanus),
- Arctic hare (Lepus arcticus),
- Arctic ground squirrel (Sermophilus parryii),
- Wolf (Canis lupus),
- Arctic fox (Alopex lagopus),
- Barren-ground grizzly bear (Ursus arctos),
- Ermine (Mustela erminea),
- Moose (Aleces alces), and
- Muskox (Ovibos moschatus).

Many of the large mammals sighted in the Kiggavik and surrounding areas are relatively uncommon-to-rare in abundance. Isolated individuals may wander through the Kiggavik site, but not regularly or in large numbers. The majority of these small and large mammals tend to avoid populated areas or where human presence is obvious. Populations as a whole will not likely be affected by Kiggavik development activities, although the small number of individuals that would have wandered into the area probably will not continue to do so.

As part of the Keewatin Region Economic Base Study Update by Kivalliq Consulting, Management and Training Services Ltd., wildlife maps were prepared to delimit the southern extent of muskox and polar bear habitats (Figure 5.1). The Kiggavik site is located at the southern limit of muskox range, and is not near any polar bear habitats.

TABLE 5.1: SUMMARY OF 'OTHER MAMMAL' SIGHTINGS AND STATUS DURING THE 1979 SEASON (Source: Urangesellschaft Canada Limited)

	Mammal	Abundance	Location Sighted	Date of Sighting
1.	Snowshoe hare	rare	Marjorie Lake	27 July (1)
2.	Arctic hare	uncommon	Marjorie Lake	27 July (1)
3.	Arctic ground squirrel	common	Marjorie Lake	27 July (1)
4.	Wolf	uncommon	Sandhills	18 June (1), 19 June (1)
	Wolf	uncommon	Marjorie Lake	20 July (1), 12, 13 August (ad. and pups), 15 August (1 ad. and 6 pups) 24 August (1 pup) Total = 6 sightings
5.	Arctic fox	uncommon	Kiggavik Site	21 August (1), 25 August (1)
	Arctic fox	uncommon	Sandhills	19 June (1), 06 August (1)
	Arctic fox	uncommon	Marjorie Lake	17 July (1), 11 August (pups) Total = 6 sightings
6.	Barren-ground grizzly bear	uncommon	Sandhills	07 July (1), 12 (2), 19 (1), 25 (1), 27 (1)
	Barren-ground grizzly bear	uncommon	Marjorie Lake	28 June (1), 26 July (1 ad. and 2 2 cubs) Total = 7 sightings
7.	Ermine	uncommon	Marjorie Lake	
8.	Moose	rare	Marjorie Lake	13 July (1), 17 July (1)
9.	Muskox	rare	Sissons Lake (near Pointer Lake)	14 August (1)

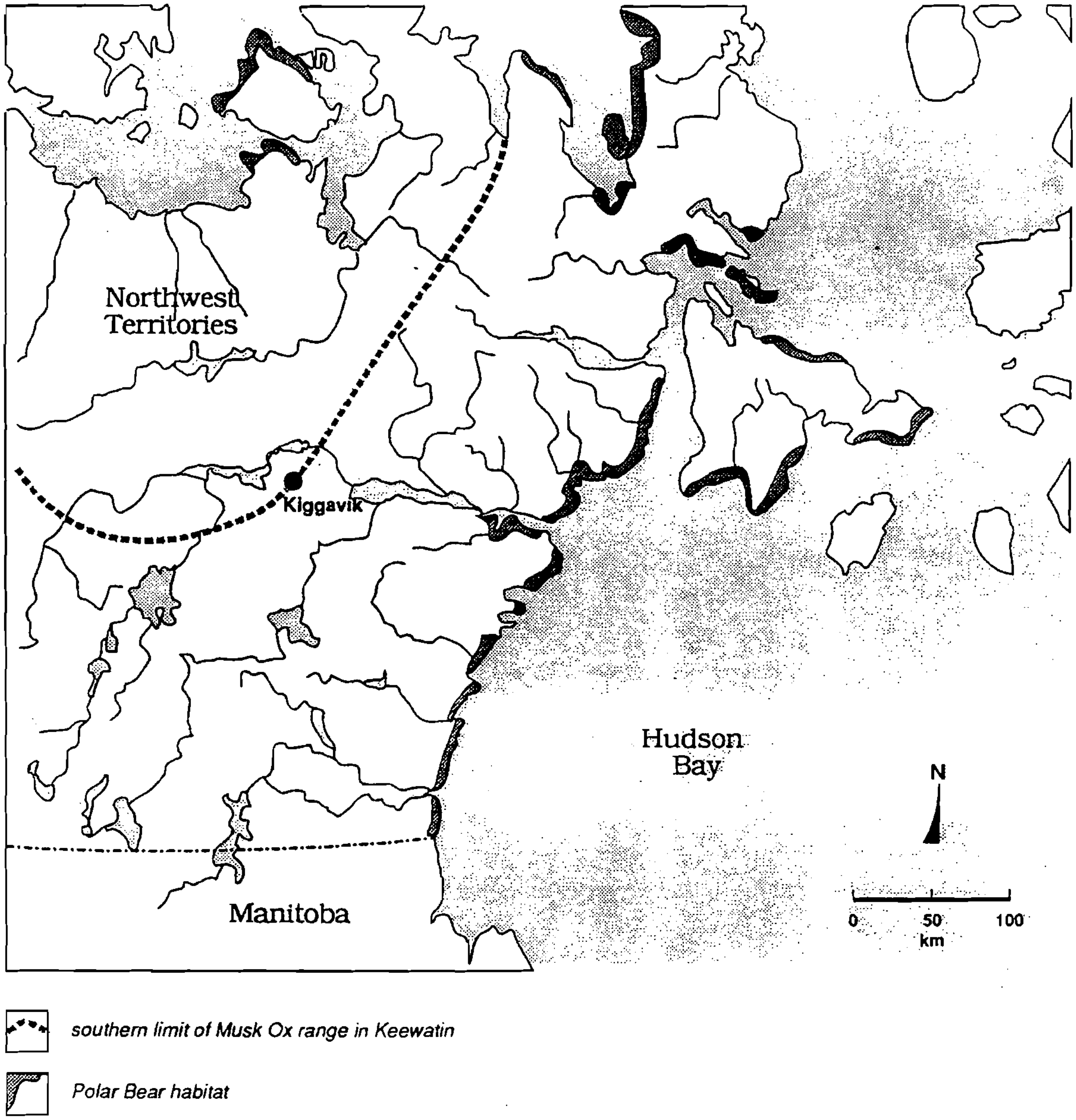
TABLE 5.2: HABITAT PREFERENCES AND DIET OF 'OTHER WILDLIFE' (source is Banfield (1974) unless otherwise noted)

Species	Habitat	Diet
Arctic Hare (Lepus arcticus)	Frequents rough hillsides where blown snowfree. In summer, will use lowlands.	Willow twigs and roots, crowberry, green summer grasses and sedges, forbs.
Arctic Ground Squirrel (Spermophilus parryii)	Eskers, moraines, river banks, lakeshores, sandbanks - where good drainage and a deep active layer for burrows.	Leaves, seeds, fruit, stems, flowers and roots of many grasses, forbs and woody species (mushrooms, grasses, sedges, heaths, etc.).
Red-backed Vole (Clethrionomys rutilus)	Usually near shrubby growths of alders, willows, birches. Also rock fields, rock talus.	Leaves, buds, twigs and fruit of shrubs. Also forbs, occasionally heaths.
Brown Lemming (Lemmus sibiricus)	Summer: wet tundra, preferably grass and/or sedge growth. Winter: wet meadows, rock talus, under crests of ridges (under snow banks).	Primarily grass and sedge shoots; less so forbs and bark of willow and birch in winter.
Collared Lemming (Dicrostonyx torquatus)	Summer: higher, drier, rockier tundra than brown lemming. Depends on moisture. Winter: lower sedge meadows with deep snow.	Summer: sedges, grasses, berries. Winter: buds, twigs and bark of willow.
Meadow Vole (Microtus pennsylvanicus)	Wet meadows preferred, or any grassland-type habitat.	Predominantly grasses and sedges; less so forbs.
Wolf (Canis lupus)	Wide-ranging, no special habitat requirements. Very mobile. Forest-tundra ecotone is a preferred denning area for wolves that depend on migrating caribou (Kelsall, 1968).	Primarily big game, on tundra - caribou (muskox), some small game.
Arctic Fox (Alopex lagopus)	Dens in light sandy soils in river banks, eskers, small hillocks. Occasionally rock alus or rock field.	Lemmings and voles the major item. Also ground squirrels, Arctic hare, ptarmigan.
Grizzly Bear (Ursus arctos)	Wide-ranging in summer. Retreat to treeline to den in winter (MacPherson et al., 1959).	Omnivorous: largely vegetarian - grasses, sedges, roots, berries. Also ground squirrels, caribou.
Ermine (Mustela erminea)	Likes cover, rock talus.	Small mammals.
Muskox (Ovibos moschatus)	Summer: river valleys and lakeshores, meadows rich in willows, heath and grasses. Winter: hilltops, slopes, plateaus where snowfree.	Summer: willows, sedges, rushes, grasses, horsetails, forbs. Winter: primarily browse - heaths, willow, birch.

figure 5.1

Range of muskox and polar bear habitat

in the eastern Keewatin District, Northwest Territories
(from Kivallig Consulting, 1985)



5.1 Bears and Human Conflict

Grizzly Bears occupy large home ranges and are found throughout the study area on occasions and in low densities. Polar bears have not been reported this far inland.

Two types of potential impact can occur with bears. Bears accommodate human disturbance quite well and, in fact, will treat human encampments as a source of food if they smell or have access to garbage, stored food, fish, etc. This can result in bear-human encounters and a safety hazard to both species. The other type of impact is through the loss of habitat either directly to the developmental infrastructure or through human disturbances restricting bear access to this habitat.

The Kiggavik development area is relatively small in size. During winter road use, vehicles will provide a protective environment. There will be a high level of machinery and human activities in the camp area, as well as in nearby areas of mining, waste rock and tailings disposal. Most of these activities will tend to exclude bears from the area rather than attract them; in fact, the more noise and disturbance, the less likely will be the chance for bear-human encounters.

Human interaction with bears can be a serious concern. Several human-bear encounters have resulted from Urangesellschaft's exploration activities. One such incident occurred at the Sandhills Lake site, where two bears wandered into the camp (Banfield, 1987). To date, there have been no serious results.

Grizzly Bears can take an aggressive reaction, especially if startled or with cubs in attendance. However, it should be emphasized that only two grizzly-caused deaths have been recorded in the N.W.T. in recent history. Grizzly Bear attacks occur most frequently when the bear is startled or has a history of finding human sources of food (Herrero, 1985).

The GNWT Department of Renewable Resources has both reviewed the literature on human-bear encounters and conducted studies to determine the most successful deterrent systems. This was summarized by Stenhouse (1983) and Stenhouse and Cattet (1984) from which the following is extracted. References can be found in the second source document cited.

Man's increasing utilization of previously undisturbed bear habitat has resulted in an increase in the number of serious man/bear conflicts. Many of these conflicts result in human injury and/or the destruction of property. While it is not known what percentage of man/bear encounters result in the death of a bear, it must be recognized that bears which cannot be chased away (deterred) are usually shot.

With an increase in industrial exploration and development (e.g., oil and gas, and mining), and other forms of human activity (e.g., scientific research, tourism, etc.) in the NWT, more man/bear encounters can be expected, and indeed are occurring. It is important to emphasize that northern industrial exploration and development is not responsible for all problem bear kills; many problem bears are killed by residents of the NWT. Therefore, it is important to realize that all human activities occurring in bear habitat will have an impact on bear populations.

It is well recognized that man/bear confrontations can result in damage to property and/or serious injury or death to man; however, little emphasis has been placed on the effects of problem bear "mortalities" on resident bear populations in the NWT.

Man/bear conflicts can occur for a variety of reasons; many of which are not fully understood by biologists. It is known that bears are attracted to human habitations by food, garbage, and associated odours. Many conflict situations can be avoided or reduced through more efficient handling of food, garbage and other waste materials. Once bears have found a nutrient-rich food source (e.g., garbage), they are often reluctant to leave. If and when they do leave, they may make regular return visits to the site in search of food.

In addition to being attracted by food, bears will investigate any novel stimulus in their environment. This behavioural trait has been termed curiosity, but the exact cause of this behaviour is unknown. Bears attracted by novel stimuli can inflict major damage to equipment and machines and jeopardize the safety of personnel working in the area. Encounters between bears and humans often result in economic loss to a company working in bear habitat. There are circumstances in which workers will have to stop work until the bear(s) have been driven from the work site. In addition, there are many individuals who will want to observe or photograph the intruding bear irrespective of the possible danger. Accordingly, it is important that workers be trained and provided with basic knowledge which will allow them to respond to a bear's presence in an appropriate and safe manner. This approach would reduce danger to personnel and potentially reduce the number of bears destroyed in defense of life or property. Training programs are available through the GNWT Department of Renewable Resources (Matthews, pers comm., 1988).

In the NWT, application of proper camp and work-site procedures can be used to reduce the occurrence of man/bear conflicts. Despite the implementation of proper camp procedures, there will be cases in which bears will enter human installations and encounter people. These encounters cannot be avoided and must be dealt with effectively.

Problem bears have been exposed to a number of management techniques across North America. The most common technique is bear relocation. Most programs have been implemented to relocate problem Grizzly and Black Bears, and have made use of existing roads for the transportation of bears. The lack of an extensive road system in the NWT reduces the applicability of problem bear relocation programs.

Electrified fence systems have been used to protect apiaries and construction camps from intruding Black and Grizzly Bears. Fencing requirements are site specific and must be designed accordingly. A complete review of the use of electrified fences to deter bears is outlined by Herrero (1983).

In addition to these common management techniques, research on food aversion paradigms has been conducted but has proven ineffective in deterring bears from a food source.

In most cases where people have had to deal with problem bears, a number of common deterrent techniques have typically been used (e.g., firing warning shots, cracker shells, airhorns, chasing the bear by snowmobile or helicopter). Unfortunately, in most cases these techniques have been ineffective. Once these common techniques fail, and the bear remains a threat to life and property, the animal is killed as a last resort.

In the research conducted by Stenhouse and Cattet (1983) a variety of bear deterrents were tested on Polar Bears attracted to bait. Plastic bullets, sirens, flares and the sounds of barking dogs were generally less than effective and bear responses unpredictable. The most effective deterrent (which worked on all but 1 of 123 bears tested) was a 38 mm multipurpose riot gun with rubber bullets. It not only chased bears from the food source but was felt to result in a "punishment" which could deter future visits to the area. Although Polar Bears are not found in the Kiggavik area, this method would work equally well with less aggressive Grizzly Bears and is definitely preferred to killing the bear.

Mitigation to avoid human-bear interactions generally takes three forms of action in a hierarchical order:

1. avoidance of any action which will attract bears to the area (or as a corollary conducting activities that will disturb bears and remove them from the area);
2. training workers on how to work safely in bear country and how to best avoid or react to an encounter; and
3. destruction or removal of nuissance bears.

6.0 BIRD POPULATIONS

6.1 The Kiggavik Site Area

The most intensive surveys of bird populations in the Kiggavik site area were carried out by Urangesellschaft Canada Limited in the late 1970s to the early 1980s. Transects were used to evaluate bird communities in the area. Approximately half of the experimental transect through the Kiggavik site area ran along a low ridge covered predominantly with dwarf shrub-heath and dwarf shrub-sedge communities. The remainder extended through sedge meadow and sedge heath in a low area alongside two lakes.

Table 6.1 summarizes avifauna species recorded along the surveyed transect in 1979 and 1980. Mean breeding densities per km and per 100 ha were 2.8 and 47.2 birds, respectively. The most commonly occurring species were:

- lapland longspurs,
- ptarmigans,
- horned larks,
- herring gulls,
- oldsquaws,
- dunlins,
- golden plovers,
- Baird's sandpipers,
- Arctic terns, and
- Canada geese.

Five species of raptors were observed. These were, in order of abundance:

- rough-legged hawk (Buteo lagopus),
- peregrine falcon (Falco peregrinus),
- short-eared owl (Asio flammeus),
- gyrfalcon (Falco rusticolus), and
- snowy owl (Nyctea scandiaca).

TABLE 6.1: SUMMARY OF BIRDS OBSERVED ALONG TRANSECTS DURING THE 1979 AND 1980 STUDIES BY URANGESELLSCHAFT IN THE KIGGAVIK AREA (Source: Urangesellschaft Canada Limited)

		1980		1979	
Common Name	Scientific Name	On	Off	On	Off
Arctic Loon	Gavia arctica	-	x	x	-
Canada Goose	Branta canadensis	-	x	x	x
Snow Goose	Chen caerulescens	-	-	x	-
Oldsquaw	Clangula hyemalis	x	x	x	x
Greater Scaup	Aythya marila	-	x	-	-
Rough-legged Hawk	Buteo lagopus	x	x	x	x
Rock Ptarmigan	Lagopus mutus	x	x	-	-
Willow Ptarmigan	Lagopus lagopus	-	-	x	-
Sandhill Crane	Grus canadensis	x	x	x	x
Golden Plover	Pluvialis dominica	x	x	x	x
Pectoral Sandpiper	Calidris melanotos	x	-	-	x
Least Sandpiper	Calidris minutilla	-	-	x	-
Baird's Sandpiper	Calidris bairdii	x	-	-	-
Dunlin	Calidris alpina	x	-	-	-
Long-tailed Jaeger	Stereorarius longicandus	x	x	x	x
Parasitic Jaeger	Stercorarius parasiticus	x	x	-	-
Herring Gull	Larus argentatus				
Glacous Gull	Larus hyperboreus	-	-	x	x
Arctic Tern	Sterna paradisaes	-	-	-	
Short-eared Owl	Asio flammeus	-	x	-	-
Snowy Owl	Nyctea scandiaca	-	-	-	x
Horned Lark	Eremophila alpestris	x	x	x	x
Water Pipit	Anthus spinoletta	x	x	x	x
Savannah Sparrow	Passerculus sandwichensis	x	-	x	x
Tree Sparrow	Spizella arborea			x	-
Lapland Longspur	Calcarius lapponicus	x	x	x	x
Black-bellied Plover	Pluvialis squatarola	x	-		
Redpoll	Carduelis flammed	x	-		
Peregrine Falcon	Falco peregrinus	x	x		

The peregrine falcon was generally uncommon throughout the area as a whole. No peregrine falcons were observed in the immediate Kiggavik development area, probably due to the absence of good nesting sites in the low relief terrain, typical of the area. One active nest was observed in 1988 on the escarpment to the east of the south end of Skinny Lake, about 2 km from where the water supply pumphouse is proposed to be located.

6.2 Regional Bird Communities

A number of studies have been carried out on bird populations.regional to the Kiggavik project site. These include:

- bird populations in the Schultz Lake, Marjorie Lake and Sandhills areas (Urangesellschaft Canada Limited),
- bird populations in the Pitz-Baker Lowlands (McLaren and Holdsworth, 1978),
- waterfowl near Chesterfield Inlet (McLaren, 1978),
- peregrine falcon (Falco peregrinus) populations (Alliston and Patterson, 1978),
- migratory bird terrestrial habitats (McCormick and Adams, 1984),
- bird populations in the Thelon Game Sanctuary (Norment, 1985), and
- bird populations in the Queen Maud Gulf (Findlay and McCormick, 1984).

6.2.1 The Schultz Lake, Marjorie Lake and Sandhills Areas

Bird populations in the Schultz Lake, Marjorie Lake and Sandhills areas were documented in 1979 and 1980 by surveys along transects carried out by Urangesellschaft Canada Limited.

The Schultz Lake transect began in a low area of sedge meadow near several ponds, then continued through a drier upland of lichen heath, dwarf shrub-heath and dwarf shrub-sedge associations to the lakeshore and angled there to parallel the shoreline. Three breeding transects were run. Mean density indices were 1.2 birds per km and 20.8 per 100 ha (i.e., lower than at Kiggavik). Diversity was comparatively high, however, with ten species being recorded but only three on transect. These were the Arctic Loon, Least Sandpiper (with nest) and Lapland Longspur. Post-breeding density indices were low. Two active and two occupied peregrine falcon nests were found in the area. Six active rough-legged hawk nests were also observed.

Transects through the Marjorie Lake area passed over rocky outcrops that rose above surrounding lichen heath, dwarf shrub heath, dwarf shrub-sedge, Dryas saxifraga and tussock communities. The variety in topography was perhaps partly responsible for the high relative abundance of breeding species recorded from the transect: 12 were observed, six of these on transect. Mean breeding densities, for all species combined, were 2.8 birds per km and 45.8 per 100 ha. Four active and three occupied peregrine falcon nests were seen in the area. Fifteen active rough-legged hawk nests and one gyrfalcon nest were also observed.

Both a control and an experimental transect were set up at Sandhills. The control transect was over relatively flat terrain covered in lichens, heath, dwarf shrub and Dryas saxifraga, in approximately equal proportions in the drier sections, and tussocks in the lower wet areas. The experimental transect ran over gently rolling land, predominantly dry uplands. Vegetation cover over large stretches consisted of Dryas saxifraga and sedge-heath communities around frost boils. Tussocks and sedge meadows were found in lower wet sections.

Mean breeding densities on the experimental transect were high: three birds per km and 50 per 100 ha. Nine species were recorded, eight being on transect; Lapland longspur was again the most common breeder. Relatively few breeding species were noted on the control transect. Mean breeding densities were 2.1 per km and 35.4 per 100 ha.

6.2.2 Chesterfield Inlet

Four aerial fixed-wing surveys were flown along the coasts of Chesterfield Inlet between 28 July and 11 September 1977 (McLaren, 1978). The survey route extended from Finger Point, near the town of Chesterfield Inlet, along the south coast to Cross Bay. Density-indices of the birds observed on each of the four surveys are listed in Tables 6.2 to 6.5. On average, 87% of the total birds observed were waterfowl, averaging 11.4 birds/sq km overall, 14.5 for the south coast and 7.9 for the north coast of the Chesterfield Inlet. Most of the remainder of the birds were shorebirds (i.e., Arctic terns, herring gulls and jaegers).

TABLE 6.2: DENSITY-INDICES OF THE BIRDS MOST COMMONLY OBSERVED ALONG CHESTERFIELD INLET, NORTHWEST TERRITORIES (Source: McLaren, 1978)

	Density-Index (birds/sq km)			
	Sector of South Coast			
	Eastern	Central	Western	Overall
All Loons[1]	L 0.1	0.0	0.0	L 0.1
Canada Goose	0.1	0.0	0.0	L 0.1
Oldsquaw	0.9	1.1	7.1	2.4
Eiders[1]	0.7	0.8	0.0	0.6
Red-breasted Merganser	L 0.1	1.0	0.6	0.6
All Ducks[1]	2.0	2.9	7.9	3.8
All Waterfowl[1]	2.1	2.9	7.9	3.8
All Shorebirds[1]	0.0	0.3	0.1	0.2
All Jaegers[1]	1.1	0.0	0.0	0.4
All Gulls[1]	0.6	0.9	0.5	0.7
Arctic Tern	2.2	0.3	0.0	0.8
All Birds[1]	6.2	4.6	8.4	6.0

[1] Includes birds not identified to species.

L = less than.

TABLE 6.3: DENSITY-INDICES OF THE BIRDS MOST COMMONLY OBSERVED ALONG CHESTERFIELD INLET, 13-14 AUGUST 1977 (Source: McLaren, 1978)

	Density-Index (birds/sq km)								
	North Coast				South Coast				
	Eastern	Central	Western	Overall	Eastern	Central	Western	Overall	All Areas
Arctic Loon	0.0	0.0	0.0	0.0	0.1	0.1	0.0	L 0.1	L 0.1
Red-throated Loon	0.0	0.0	0.0	0.0	0.0	0.3	L 0.1	0.1	0.1
All Loons[1]	0.0	0.0	L 0.1	L 0.1	0.3	0.7	0.1	0.4	0.2
Canada Goose	0.0	1.6	0.9	1.0	0.0	2.9	5.7	3.3	2.3
Snow Goose	0.0	0.0	0.0	0.0	0.0	L 0.1	0.0	L 0.1	L 0.1
All Geese[1]	0.0	1.6	0.9	1.0	0.0	2.9	5.7	3.3	2.3
Pintail	0.0	0.0	0.0	0.0	0.2	0.0	0.3	0.2	0.1
Oldsquaw	1.3	6.9	2.3	4.0	1.7	14.6	4.1	7.3	5.9
Eiders[1]	9.7	2.0	0.0	2.2	8.5	2.9	0.7	3.4	2.9
Red-breasted Merganser	0.0	0.0	L 0.1	L 0.1	0.0	L 0.1	L 0.1	L 0.1	L 0.1
All Ducks[1]	11.0	10.1	2.3	5.2	11.1	17.5	5.5	11.1	9.2
All Waterfowl[1]	11.0	11.6	3.3	7.7	12.0	21.0	11.2	14.9	11.8
All Shorebirds[1]	0.6	3.1	0.1	1.4	0.1	1.2	2.4	1.4	1.4
All Gulls[1]	0.9	1.7	1.5	1.5	1.2	3.1	0.8	1.8	1.6
Arctic Tern	1.4	1.0	0.1	0.7	2.0	6.1	0.0	2.7	1.8
All Birds[1]	13.9	15.1	5.1	11.3	15.7	32.1	15.0	21.3	15.4

[1] Includes birds not identified to species.

L = less than.

TABLE 6.4: DENSITY-INDICES OF THE BIRDS MOST COMMONLY OBSERVED ALONG CHESTERFIELD INLET, 27-28 AUGUST 1977 (Source: McLaren, 1978)

	Density-Index (birds/sq km)								
	North Coast				South Coast				
	Eastern	Central	Western	Overall	Eastern	Central	Western	Overall	All Areas
Arctic Loon	L 0.1	0.0	0.0	L 0.1	L 0.1	0.0	0.0	L 0.1	L 0.1
Red-throated Loon	0.0	0.0	0.0	0.0	0.2	0.3	0.1	0.2	0.1
All Loons[1]	L 0.1	0.0	0.0	L 0.1	0.6	0.4	0.2	0.4	0.2
Whistling Swan	0.0	0.0	0.1	L 0.1	0.0	0.0	0.1	L 0.1	L 0.1
Canada Goose	0.3	0.4	0.9	0.6	L 0.1	1.1	2.7	1.6	1.1
Snow Goose	1.4	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.2
All Geese[1]	1.7	0.4	0.9	0.0	L 0.1	1.1	2.7	1.6	1.3
Pintail	0.0	0.4	0.0	0.2	0.0	0.0	0.0	0.0	0.1
Oldsquaw	1.5	10.5	2.3	5.1	9.4	17.0	5.6	10.3	8.0
Eiders[1]	0.6	1.0	0.1	0.6	6.5	1.8	2.0	3.0	1.9
Red-breasted Merganser	0.0	0.1	0.0	L 0.1	0.2	0.3	0.3	0.3	0.2
All Ducks[1]	2.1	12.1	2.5	5.9	16.3	19.2	7.9	13.6	10.1
All Waterfowl[1]	3.8	12.5	3.5	6.8	16.4	20.3	10.7	15.3	11.4
All Shorebirds[1]	0.0	L 0.1	L 0.1	L 0.1	2.4	1.3	L 0.1	1.0	0.6
All Jaegers[1]	0.0	0.0	L 0.1	L 0.1	0.1	L 0.1	0.8	0.4	0.2
All Gulls[1]	0.5	2.0	0.2	0.9	1.2	0.8	0.3	0.7	0.8
Arctic Tern	17.9	1.5	0.0	4.9	1.1	0.3	0.0	0.4	2.4
All Birds[1]	22.3	16.1	3.8	12.8	22.2	23.2	12.1	18.1	15.7

[1] Includes birds not identified to species.

L = less than.

TABLE 6.5: DENSITY-INDICES OF THE BIRDS MOST COMMONLY OBSERVED ALONG CHESTERFIELD INLET, 11 SEPTEMBER 1977 (Source: McLaren, 1978)

	Density-Index (birds/sq km)								
	North Coast				South Coast				
	Eastern	Central	Western	Overall	Eastern	Central	Western	Overall	All Areas
Arctic Loon	0.2	0.0	0.0	L 0.1	0.0	0.0	0.0	0.0	L 0.1
Red-throated Loon	0.1	L 0.1	0.0	L 0.1	L 0.1	L 0.1	0.0	L 0.1	L 0.1
All Loons[1]	0.6	0.1	0.0	0.2	L 0.1	L 0.1	0.0	L 0.1	0.1
Canada Goose	0.0	0.0	1.3	0.5	0.4	0.4	0.6	0.5	0.5
Pintail	0.0	0.2	0.0	0.1	0.3	0.0	0.0	0.1	0.1
Oldsquaw	1.7	12.6	5.0	6.9	5.3	10.8	14.8	11.3	9.3
Eiders[1]	2.5	1.0	0.1	1.0	2.0	0.3	0.2	0.6	0.8
Red-breasted Merganser	0.5	0.5	0.3	0.4	0.7	0.8	0.4	0.6	0.5
All Ducks[1]	5.4	14.6	5.4	8.8	8.5	12.2	15.3	12.7	10.9
All Waterfowl[1]	5.4	14.6	6.7	9.3	8.9	12.7	15.9	13.3	11.5
All Shorebirds[1]	0.0	0.1	0.4	0.2	0.0	1.1	0.0	0.4	0.3
All Gulls[1]	1.0	1.7	0.5	1.0	1.1	0.9	0.6	0.8	0.9
Black Guillemot	L 0.1	0.0	0.0	L 0.1	L 0.1	0.5	0.0	0.2	0.1
All Birds[1]	7.0	16.2	7.6	10.7	10.2	15.2	16.6	14.7	12.9

[1] Includes birds not identified to species.

L = less than.

Other birds encountered in the area included:

- common loons (Gavia immer),
- yellow-billed loons (Gavia adamsii),
- Arctic loons (Gavia artica),
- red-throated loons (Gavia stellata),
- whistling swans (Olor columbianus),
- Canada geese (Branta canadensis),
- brants (Branta bernicla),
- snow geese (Chen caerulescens),
- pintails (Anas acuta),
- scoters (Melanitta spp.),
- oldsquaws (Clangula hyemalis),
- eiders (Somateria spp.),
- red-breasted mergansers (Mergus serrator), and
- peregrine falcons (Falco peregrinus).

The most common species of waterfowl in the inlet appears to be oldsquaw, but large numbers of Canada geese also use the area in late August. Densities of oldsquaw recorded during three aerial surveys along the coast of Chesterfield Inlet are shown in Figure 6.1. The distribution of oldsquaw is listed in Table 6.6. Chesterfield Inlet is an important moulting area for oldsquaw. Numbers of oldsquaw in the inlet increase during the summer towards a peak in late August and early September. Several thousands of oldsquaw remain in Chesterfield Inlet until at least mid-September and possibly mid-October (McLaren, 1978). Densities of oldsquaw were consistently higher along the south coast of the inlet than along the north coast, probably because coastal waters along the south coast are considerably calmer than waters along the north coast.

Two distinct groups of Canadian geese occur in summer in Chesterfield Inlet. Nesting birds consist of individuals of the subspecies B. c. paruipes and B. c. hutchinsii (McLaren, 1978). Numbers of Canada geese that moult on Chesterfield Inlet are small in relation to numbers that moult on the interior rivers of Keewatin District. This is probably because:

- the premoult migration of Canada geese into Keewatin occurs from mid-June to early July (Pakulak, 1971). The ice in Chesterfield Inlet does not

figure 6.1

Densities of Oldsquaw Ducks

recorded during three aerial surveys along the coast of Chesterfield Inlet, July - September 1977. Values are numbers of Oldsquaw recorded per sq. km (from McLaren, 1978)

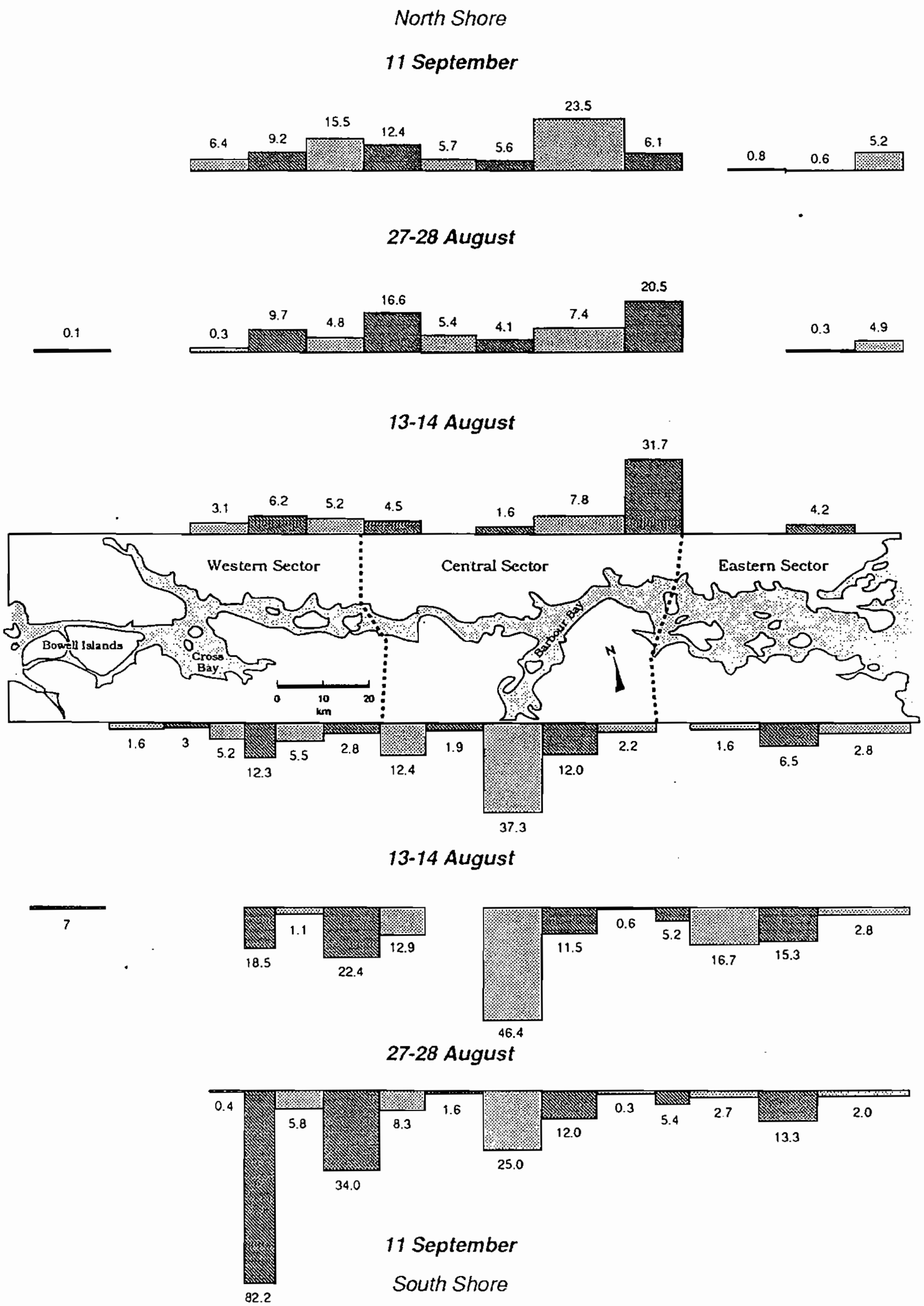


TABLE 6.6: DISTRIBUTION OF OLDSQUAW ALONG CHESTERFIELD INLET, 13 AUGUST TO 11 SEPTEMBER 1977 (Source: McLaren, 1978)

	13-14 August		27-28 August		11 September	
	No. Birds On (Off) Transect	No. Birds/ sq km	No. Birds On (Off) Transect	No. Birds/ sq km	No. Birds On (Off) Transect	No. Birds/ sq km
North Coast						
Eastern Sector	15 (3)	1.3	36	1.5	39 (5)	1.7
Central Sector	224	6.9	375 (75)	10.5	450 (107)	12.6
Western Sector	86 (7)	2.3	87 (24)	2.3	184 (5)	5.0
TOTAL	325 (10)	4.0	498 (99)	5.1	673 (117)	6.9
South Coast						
Eastern Sector	45 (31)	1.7	249 (186)	9.4	139 (136)	5.3
Central Sector	565 (459)	14.6	657 (741)	17.0	417 (234)	10.8
Western Sector	173 (29)	4.1	279 (279)	5.6	741 (131)	14.8
TOTAL	783 (519)	7.3	1,185 (1,206	10.3	1,297 (501)	11.3
TOTAL	1,108 (529)	5.9	1,683 (1,305)	8.0	1,970 (618)	9.3

become ice-free until mid-to-date July (Allen and Cudbird, 1971). Only small areas, if any, would initially be available for moulting geese (McLaren, 1978); and

- moulting Canada geese require sheltered waters and low shorelines with beaches and nearby meadows for feeding (Salomonsen, 1968). Because of the rugged terrain that characterizes both coasts of the inlet, these conditions are infrequently encountered (McLaren, 1978).

The Peregrine falcon is a rare and endangered raptor that nests locally in Keewatin District (McLaren et al., 1976). Two nests of falcons were found on the cliffs in the western sector of Chesterfield Inlet during breeding bird surveys in the Pitz Lake area (McLaren and Holdsworth, 1978). Much suitable nesting habitats for Peregrine falcons occur along most of Chesterfield Inlet (McLaren, 1978). Peregrines may, therefore, nest at several locations along the inlet besides those known.

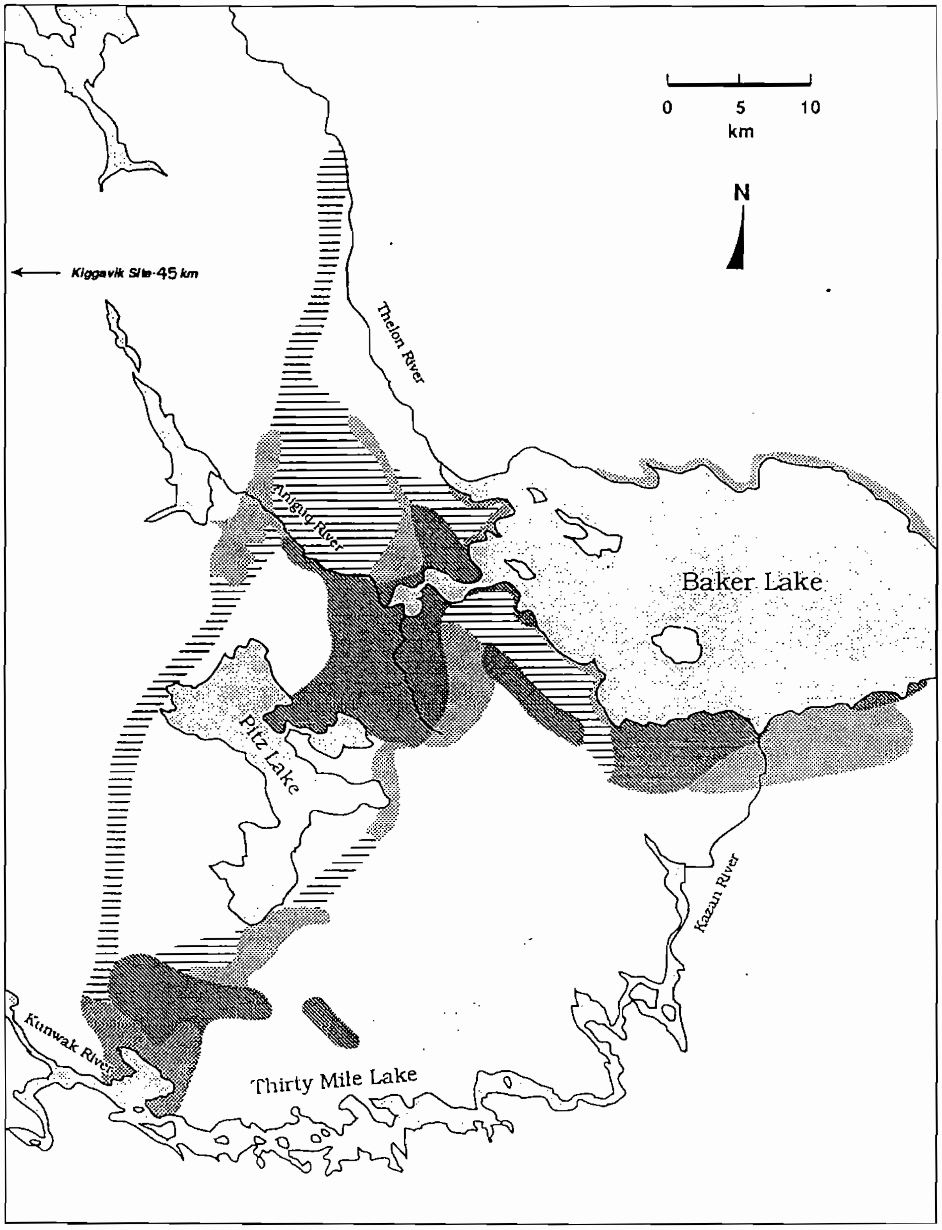
6.2.3 The Pitz-Baker Lowlands

McLaren and Holdsworth (1978) examined summer bird populations in the area between Pitz and Baker Lakes, a well-vegetated area (i.e., Pitz-Baker Lowlands) identified as important to migratory and nesting birds. Figure 6.2 shows the distribution of waterfowl and their densities observed during surveys conducted in 1977 in the Baker-Pitz Lakes area. The area north of the Aniguq River is characterized by widely-dispersed nesting birds and low population densities. Canada geese and red-breasted mergansers were the only waterfowl observed in this area (McLaren and Holdsworth, 1978).

The Baker Lake shoreline was also surveyed by McLaren and Holdsworth (1978) as part of the Polar Gas study. Both numbers and densities of nesting, summering and migrating birds are higher along the southwest shore between the Thelon and Kazan Rivers than along either the north shore or the south shore east of the Kazan River. The shoreline of Baker Lake between the Thelon River and the Kazan River, including Qinguq Bay where the winter road is routed, is an important summering area for several species of birds, especially waterfowl. Nests of whistling swans, Canada geese, snow geese and sandhill cranes have been found within 200 m of this shoreline. In addition to individual nests along the shoreline, a colony of 40 snow goose nests was found at the mouth of the Kazan River (McLaren and Holdsworth, 1978). Arctic loons, red-throated loons, pintails, scaup, figure 6.2

Densities of Waterfowl

recorded during helicopter surveys over the Pitz - Baker Lake area 1-5 July, 1977



▩ *> 5.0 birds per / sq km*

▒ *1.0 - 5.0 birds / sq km*

▤ *< 1.0 birds / sq km*

oldsquaw, red-breasted mergansers, several species of shorebirds and jaegers also occur along the shore. This section of shoreline is also used as a staging area by migrating whistling swans, Canada geese and snow geese.

The north shore of Baker Lake is little used by birds (McLaren and Holdsworth, 1978). Flocks of Canada geese, some moulting, were found along the shore. Gulls were the only other birds observed during the Polar Gas survey. During the summer reconnaissance carried out during this survey, Sandhill cranes and numerous species of passerines were observed in the area. The habitat conditions associated with the stream and wetland in this location was a major contributing factor for this local species abundance.

The area around Baker Lake is known to provide excellent nesting habitats for gyrfalcons, rough-legged hawks and peregrine falcons (McLaren, 1978). A summary of the chronology of use of the northwestern Hudson Bay area by peregrine falcons is presented in Figure 6.3. These data suggest that, in the northwestern Hudson Bay area, the duration of use is shorter, the timing of activities is later, and the synchrony of nesting activities is greater than for Alaskan peregrines at similar latitudes (Alliston and Patterson, 1978). Three different types of cliff habitat are generally available to, and occupied by, peregrine falcons in the northwestern Hudson Bay area:

- escarpments,
- rock outcrops, and
- cliffs and embankments along rivers.

Almost half (46.5%) of the peregrine sites found were on escarpments, another one-third (34.9%) on rock outcrops and the remainder (19.6%) along rivers (Table 6.7; Alliston and Patterson, 1978).

6.2.4 The Beverly/Aberdeen Lakes Area

Bird populations in the Beverly and Aberdeen Lakes areas were studied by McCormick and Adams (1984) for the Canadian Wildlife Service. Species observed in this region include the Canada goose, white-fronted goose, the tundra swan, the lesser snow goose and the peregrine falcon.

figure 6.3

Chronology of use of breeding grounds by *F. p. Tundrius*
in northwestern Hudson Bay —
and northern Alaska ━

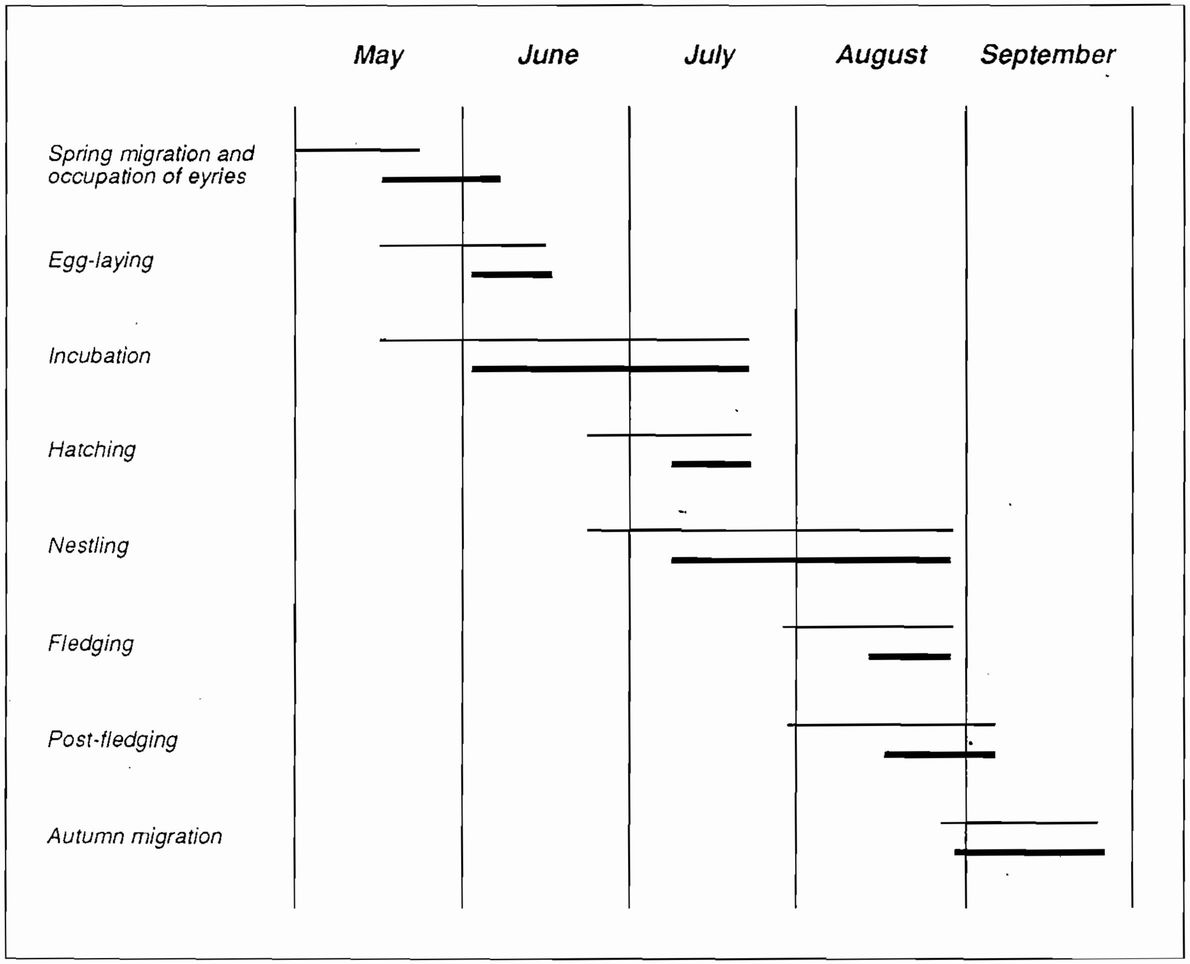


TABLE 6.7: NUMBERS OF PEREGRINE SITES FOUND IN DIFFERENT HABITAT TYPES IN VARIOUS SECTORS OF THE STUDY AREA, 1974-1977 (Source: Alliston and Patterson, 1978)

Habitat	Baker Lake	Northern Keewatin	Southern Boothia	Central Boothia	S. Somerset- N. Boothia	Central Somerset	Total	Percent
Escarpment:								
o Adjacent lowlands	0	10	5	1	0	0	16	37.2
o Other	0	1	0	0	0	3	4	9.3
Rock Outcrop	7	4	2	0	2	0	15	34.9
River:								
o Cliff	4	0	0	0	1	0	5	11.6
o Embankment	3	0	0	0	0	0	3	7.0
TOTAL	14	15	7	1	3	3	43	

The Thelon River and Beverly and Aberdeen Lakes are major moulting areas for non-breeding Canada geese from mid-continental breeding grounds (Sterling and Dzubin, 1967). Arrival in the area occurs about mid-June and moulting may begin by the end of June. More than 2,000 birds have been recorded on the Thelon River, and more than 3,000 geese were recorded in the Beverly/Aberdeen Lakes area (McCormick and Adams, 1984). White-fronted geese are known to breed in the Thelon River valley (Kuyt, 1962), and many flocks of moulting sub-adults have been reported between Beverly and Aberdeen Lakes (McCormick and Adams, 1984). Lesser snow goose nests have been observed to the western end of Aberdeen Lake and colonies were reported on islands in the Thelon River (McCormick and Adams, 1984).

6.2.5 Game Sanctuaries

Information regarding game sanctuaries in the central Keewatin is provided largely to outline that the Kiggavik project area is remote from these areas. The two main game sanctuaries in the regional area are the Thelon Game Sanctuary and the Queen Maud Gulf Bird Sanctuary. Their locations relative to the Kiggavik site is shown in Figure 6.4. Information regarding each sanctuary is discussed below.

6.2.5.1 The Thelon Game Sanctuary

A study was carried out on the fall and spring migrations, wintering birds and summer birds by Norment (1985) in the Thelon Game Sanctuary (TGS) from August 1977 to July 1978. The TGS is a 31,000 km^2 area in the central barrenlands, established in 1927 to protect the muskoxen (Ovibos moschatus).

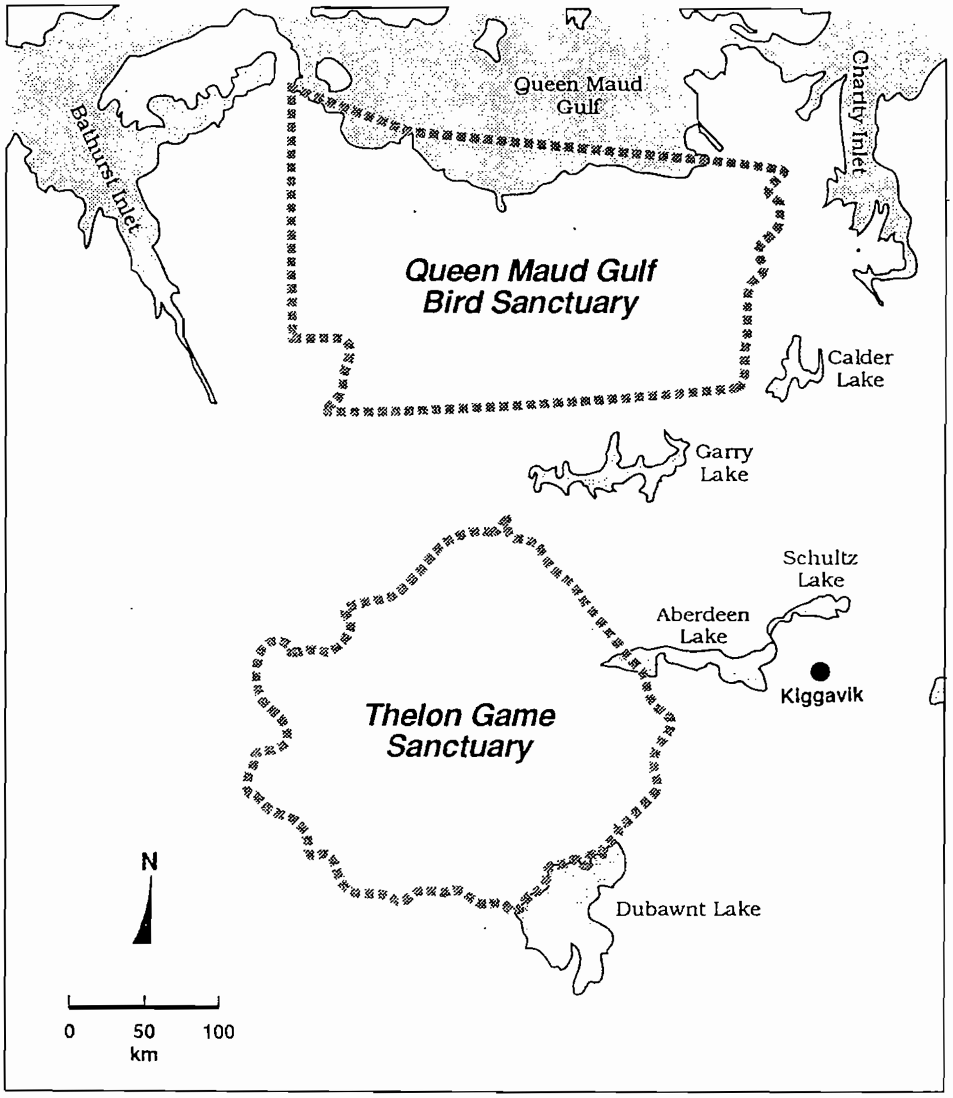
Observation periods were divided into four segments:

- fall (15 August to 31 October),
- winter (01 November to 30 April),
- spring (01 May to 15 June), and
- summer (16 June to 16 July).

These divisions were selected to correspond with weather patterns, timing of ice and snowmelt and deposition, and migration chronology (Norment, 1985). The seasonal

figure 6.4

Queen Maud Gulf and Thelon Sanctuary boundaries



summary of bird observations in the Thelon River area is presented in Table 6.8. The following summary is taken directly from Norment (1985).

A total of 44 species was observed in the fall of 1977. Some breeding species had already departed from the area prior to 15 August, but the last migrants did not leave until the end of October. Of the seven species observed during the winter, only willow ptarmigan, rock ptarmigan and gray jays were seen throughout the period. In the spring of 1978, 61 species were seen. Although some migrants arrived shortly after the beginning of thaw (i.e., 29 April), most species, dependent on aquatic or streamside habitats, did not arrive until open water appeared in late May. Sixty-nine species were observed during the summer of 1978. The earliest breeding species were the common raven and gyrfalcon. Most passerines appeared to fledge young during the second half of July.

6.2.5.2 The Queen Maud Gulf Bird Sanctuary

The Queen Maud Gulf Bird Sanctuary, at approximately 67°00'N and 100°30'W, is situated on the south shore of Queen Maud Gulf, and occurs at the junction of the Mackenzie, Franklin and Keewatin Districts (Findlay and McCormick, 1984). The sanctuary is the largest in Canada (McCormick and Sirois, pers. comm., 1988) and is managed to ensure the protection of rare or endangered species and migratory bird populations.

Sixty-one bird species, including 44 breeding species, have been recorded within the Queen Maud Gulf Bird Sanctuary (Table 6.9). The area is endowed with countless shallow lakes, streams and rivers which provide nesting habitat for numerous aquatic species (Findlay and McCormick, 1984). Grasses and sedges are abundant near lakes and rivers, providing excellent grazing areas for geese (Ryder, 1967, in Findlay and McCormick, 1984), while exposed bedrock throughout the area provides nesting habitat for raptors such as rough-legged hawk, gyrfalcon and peregrine falcon. The area supports high-Arctic species such as the hoary redpoll, white-rumped sandpiper and glacous gull, as well as low-Arctic species including the yellow-billed loon, sandhill crane and pomerine jaeger (Renaud et al., 1981, in Findlay and McCormick, 1984). The sanctuary also supports the largest variety of geese of any nesting area in North America (Barry, 1961, in Findlay and McCormick, 1984). The most dominant of these are the Lesser Snow Goose and the Ross' Goose.

TABLE 6.8: SEASONAL SUMMARY OF BIRD OBSERVATIONS, THELON RIVER AREA, NORTHWEST TERRITORIES, 15 AUGUST 1977 TO 16 JULY 1978 (fall = 15 August-31 October; winter = 01 November-30 April; spring = 01 May-15 June; summer = 16 June-16 July) (Source: Norment, 1985)

	Fall (39 d)		Winter (75 d)		Spring (39 d)		Summer (24 d)			
Species	F[1]	Max.[2]	F	Max.	F	Max.	F	Max.	Departure Date[3]	Arrival Date[4]
Red-throated Loon					2	2	3	2		10 June
Arctic Loon					4	8	8	8		07 June
Common Loon	2	1			1	1	1	1	07 October	11 June
Yellow-billed Loon	1	3			5	5	3	4	15 August	30 May
Tundra Swan*	7	5			11	20	10	15	07 October	20 May
Greater White-fronted Goose	2	10			9	150±	1	2	16 August	17 May
Snow Goose					9	2,000±	1	1		18 May
Ross' Goose					2	400±				30 May
Canada Goose	7	30			15	300±	6	400±	06 October	13 May
Green-winged Teal	1	2			3	1	7	12	24 September	10 June
American Black Duck							1	2		
Mallard	2	20			1	1	2	6	05 October	10 June
Northern Pintail	1	1			7	60	9	50	18 August	26 May
American Wigeon					4	4	5	8		07 June
Scaup	1	3			3	8	5	8	24 September	30 May
Oldsquaw	1	6			5	50	12	30	24 September	30 May
Surf Scoter							3	12		
White-winged Scoter					3	4	5	8		08 June
Common Goldeneye							1	1		
Common Merganser					2	3	5	15		03 June
Red-breasted Merganser*	6	30			7	8	14	30	05 October	30 May
Bald Eagle							1	1		
Northern Harrier	2	1			1	1	1	2	20 August	26 May
Northern Goshawk	2	1					1	1	05 October	
Rough-legged Hawk*	5	3			15	6	5	4	24 September	03 May
Golden Eagle	1	1					2	3	07 October	
Merlin					3	2				21 May
Peregrine Falcon*	9	3			7	3	2	2	21 September	18 May
Gyrfalcon*	3	3	3	2	5	2	2	3		
Willow Ptarmigan*	10	150±	41	20	26	20	15	10		
Rock Ptarmigan	2	6	10	10	2	10				
Sandhill Crane	3	20			15	50±	2	3	25 September	07 May
Lesser Golden Plover					3	15	3	4		03 June
Semipalmated Plover					5	4	3	2		28 May
Lesser Yellowlegs							4	6		28 June
Spotted Sandpiper							1	3		
Ruddy Turnstone							3	4		19 June
Sanderling	1	2					3	4	24 September	19 June
Semipalmated Sandpiper					8	10	4	10		30 May
Least Sandpiper					9	15	4	20		28 May
White-rumped Sandpiper					2	1	4	4		10 June
Baird's Sandpiper	1	3							18 August	
Pectoral Sandpiper	1	1							24 September	
Dunlin							1	2		20 June
Common Snipe	1	1			1	1	3	4	18 August	11 June
Red-necked Phalarope					1	1	5	100±		11 June
Red Phalarope					1	2	3	1		08 June
Parasitic Jaeger					5	2	3	10		31 May
Long-tailed Jaeger	1	2					5	3	15 August	19 June
Bonaparte's Gull							1	2		
Mew Gull					5	3	3	2		23 May
Herring Gull	7	10			11	10	12	30	07 October	06 May

TABLE 6.8: SEASONAL SUMMARY OF BIRD OBSERVATIONS, THELON RIVER AREA, NORTHWEST TERRITORIES, 15 AUGUST 1977 TO 16 JULY 1978 (fall = 15 August-31 October; winter = 01 November-30 April; spring = 01 May-15 June; summer = 16 June-16 July) (Source: Norment, 1985)

	Fall (39 d)		Winter (75 d)		Spring (39 d)		Summer (24 d)			
Species	F[1]	Max.[2]	F	Max.	F	Max.	F	Max.	Departure Date[3]	Arrival Date[4]
Arctic Tern	1	4					12	150±	18 August	20 June
Short-eared Owl*	1	2			5	1	2	3	23 September	30 May
Yellow-bellied Sapsucker	2	1							30 September	
Horned Lark*	1	1			6	50	4	6	19 August	14 May
Cliff Swallow*					4	2	8	100±		28 May
Barn Swallow					1	2				04 May
Gray Jay*	15	4	38	4	17	7	6	4		
Common Raven*	16	6	13	4	12	6	9	15		
Gray-cheeked Thrush*					9	6	13	4		01 June
American Robin*	13	25			16	20	18	10	13 October	13 May
Water Pipit*	1	1			1	2	2	1	03 September	14 June
Northern Shrike*	7	3			7	1	3	2	25 September	06 May
Yellow-rumped Warbler					7	3	3	6		31 May
Blackpoll Warbler					6	5	15	16		04 June
American Tree Sparrow*	9	22			14	10	18	25	25 September	19 May
Chipping Sparrow	1	1							18 August	
Savannah Sparrow					5	1	5	4		07 June
Fox Sparrow					1	1	1	1		29 May
White-crowned Sparrow*	3	5			11	5	16	7	03 September	21 May
Harris' Sparrow*	6	15			12	20	20	26	09 September	26 May
Dark-eyed Junco	4	4							31 October	
Lapland Longspur*	6	30			5	15	7	6	23 September	17 May
Snow Bunting	6	100±			8	100±			29 October	01 May
Rusty Blackbird*					8	5	6	24		21 May
Pine Grosbeak					2	1				26 May
White-winged Crossbill	1	6	28	30	3	4	10	5		
Redpoll	14	40	2	16						
Common Redpoll*					7	30	7	4		02 May
Hoary Redpoll*					12	4	9	6		12 May
TOTAL SPECIES	44		7		61		69			

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[1] F = number of days observed.

[2] Max. = maximum number of individuals observed on any one day.

[3] In fall of 1977.

[4] In spring of 1978.

* Species which bred in the TGS in 1977-1978 (eggs, nestlings or fledged young observed).

TABLE 6.9: CHECKLIST OF BIRDS OF QUEEN MAUD GULF BIRD SANCTUARY (Source: Findlay and McCormick, 1984)

Common Name	Scientific Name
Yellow-billed Loon	Gavia adamsii
Arctic Loon	Gavia arctica
Red-throated Loon	Gavia stellata
Sandhill Crane	Grus canadensis
Tundra Swan	Olor columbianus
Great White-fronted Goose	Anser albifrons
Snow Goose	Chen caerulescens
Ross' Goose	Chen rossii
Canada Goose	Branta canadensis
Brant	Branta bernicla
Green-winged Teal	Anas carolinensis
Northern Pintail	Anas acuta
Common Eider	Somateria mollissima
King Eider	Somateria spectabilis
White-winged Scoter	Melanitta deglandi
Oldsquaw	Clangula hyemalis
Red-breasted Merganser	Mergus serrator
Semipalmated Plover	Charadrius semipalmatus
Common Ringed Plover	Charadrius hiaticula
Black-bellied Plover	Squatarola squatarola
Lesser Golden Plover	Pluvialis dominica
Red-necked Phalarope	Lobipes lobipes
Red Phalarope	Phalaropus fulicarius
ruddy Turnstone	Arenaria interpres
Red Knot	Calidris canutus
Dunlin	Erolia alpina
Semipalmated Sandpiper	Ereunetes pusillus
Least Sandpiper	Erolia minutilla
White-rumped Sandpiper	Erolia fuscicollis
Baird's Sandpiper	Erolia bairdii
Pectoral Sandpiper	Erolia melanotos
Buff-breasted Sandpiper	Tryngites subruficollis
Pomarine Jaeger	Stercorarius pomarinus
Parasitic Jaeger	Stercorarius parasiticus
Long-tailed Jaeger	Stercorarius longicaudus
Herring Gull	Larus argentatus
Glaucous Gull	Larus hyperboreus
Sabine's Gull	Xema sabini
Arctic Tern	Sterna paradisaea
Dovekie	Plautus alle
Black Guillemot	Cepphus grylle

TABLE 6.9: CHECKLIST OF BIRDS OF QUEEN MAUD GULF BIRD SANCTUARY (Source: Findlay and McCormick, 1984)

Common Name	Scientific Name
Golden Eagle	Aquila crysaet
Rough-legged Hawk	Buteo lagopus
Merlin	Palco columbarius
Peregrine Falcon	Falco peregrinus
Gyrfalcon	Falco rusticolus
Willow Ptarmigan	Lagopus lagopus
Rock Ptarmigan	Lagopus mutus
Short-eared Owl	Asio flammeus
Snowy Owl	Nyctea scandiaca
Horned Lark	Eremophila alpestris
Barn Swallow	Hirundo rustica
Common Raven	Corvus corax
Brown Thrasher	Toxostoma rufum
Water Pipit	Anthus spinoletta
Savannah Sparrow	Passerculus sandwichensis
White-crowned Sparrow	Zonotrichia leucophrys
Lapland Longspur	Calcarius lapponicus
Snow Bunting	Plectrophenax nivalis
Hoary Redpoll	Acanthis bornemanni
Common Redpoll	Acanthis flammea

6.3 Comparison of Bird Populations in the Kiggavik Area Relative to Other Areas Within the Northwest Territories

To provide some reference for bird populations in Kiggavik (and Marjorie Lake, Shultz Lake and Sandhills) relative to other areas in the N.W.T., the data collected at the Kiggavik site is compared with findings of similar research undertaken for the Polar Gas Environmental Program. These studies, by McLaren and Holdsworth (1978) and McLaren et al. (1976) in the Keewatin, and Davis et al. (1974) on the Boothia Peninsula and Arctic islands, are three of very few standardized quantitative investigations of bird populations in these areas.

Fortunately, they are directly comparable with the Urangesellschaft data, as essentially identical transect techniques and analyses were used. Rather than comparing density-indices of individual transects, means were calculated from all applicable (tundra habitat) Polar Gas transects and compared with the means from Urangsellschaft's transects. All comparisons involve breeding populations, not post-breeding. Also compared are numbers of species. The results are presented in Table 6.10.

In comparison with the Polar Gas Keewatin data, the breeding season mean density-indices at the Urangesellschaft study sites are much lower. The three Polar Gas mean values from this region were 9.53 and 11.92 birds per 1,000 yards and 12.11 birds per km. These compare with mean values ranging from 1.25 to 3.0 birds per km for this study. Only the extremely low, individual transect values from Polar Gas, approach or fall within the range of density-indices found in Urangesellschaft's study area. Interestingly, more comparable results are obtained with the mean density-indices for the Boothia Peninsula and several high Arctic islands. The mean value for Prince of Wales Island transects, at 2.89 birds per 1,000 yards, comes the closest to the Urangesellschaft results.

Why breeding density-indices determined for the Urangesellschaft study should be comparable to those for sites some seven to eight degrees of latitude and 500 miles to the further north is unknown. Habitats and species are most similar in the Keewatin, yet Polar Gas density-indices for this area are much higher.

TABLE 6.10: SUMMARY OF POLAR GAS AND URANGESELLSCHAFT COMPARATIVE BREEDING TRANSECT DATA

Study	No. of Transects	Indices (no. of birds per 1,000 yards)	Range	Mean No. Spp. On-Transect	Range	Mean Total No. Species On-Transect	Mean Total No. Species On and Off Transect
POLAR GAS							
Davis et al. (1974)							
Boothia Peninsula	6	4.88	3.69-8.12	7.0	4-11	25	34
Prince of Wales Island	8	2.89	1.94-4.89	7.0	4-11		
Melville Island	4	0.38	0.0-1.02	1.5	0-3		
Somerset Island	1	1.03	-	4	-		
McLaren et al. (1976)							
South of Baker Lake	11	11.92	3.96-36.00	10.7	6-17	41	46
Rasmussen Basin Lowlands	16	9.53	1.99-22.65	8.6	3-14	27	31
McLaren and Holdsworth (1978)		(no. per km)					
Pitz Lake - Baker Lake	10	12.11	4.71-26.67	8.1	2-16	26	32
URANGESELLSCHAFT							
(breeding transects)							
Kiggavik Site - E*	3	2.8	2.0-4.0	3.0	2-4	5	6
Schultz Lake - E	3	1.2	0.5-2.25	2.0	1-3	3	10
Sandhills - E	4	3.0	2.25-3.75	3.5	2-6	8	9
Sandhills - C	2	2.1	1.75-2.5	2.5	1-4	4	6
Marjorie Lake - E	4	2.8	1.5-5.25	2.75	1-6	6	12
TOTAL	16	2.4	1.2-3.0	2.8	2.0-3.5	17	21

* E = experimental transect
C = control transect

Likely factors are the habitats and localities chosen for the Polar Gas transects. Despite these two parameters being apparently similar in the two studies, birds can often have a patchy distribution within a relatively uniform habitat. Because the area investigated for the Polar Gas Environmental Program was so large, the researchers conducting the study first selected those sites they considered likely to have the highest bird densities and, therefore, those that had the potential to be most affected by the proposed pipeline project. Perhaps these selected sites are not typical of the majority of the Keewatin and should not be expected to be comparable to the results of this study. McLaren and Holdsworth (1978) reported that "Densities at the former staging area (Site 264) and in the Pitz-Baker lowlands were as high or higher than anywhere else along the pipeline route in the tundra areas of the central Keewatin District surveyed by McLaren et al. (1976)". Perhaps the density-indices for Prince of Wales Island, which are comparable, likewise represent the most productive sites on that island.

An additional factor, restricted to those Keewatin transects south of Baker Lake, is the number of species. Several birds reach the northern limits of their range to the south of Baker Lake but within the Keewatin District; for example, green-winged teal (Anas crecca), American wigeon (Anas americana), greater scaup (Aythya marila), common snipe (Dapella gallinago), whimbrel (Numenius phaeopus) and spotted sandpiper (Actitis macularia). Some of these were recorded in Polar Gas studies but not at Urangesellschaft sites. They add not only to the species diversity but to the total number of individual birds as well.

The densities of breeding birds at the four Urangesellschaft study sites might also be expected to be somewhat reduced because of the habitat covered by the transects.

In the Pitz Lake-Baker Lake area, McLaren and Holdworth (1978) found there to be more species and individuals in the low-lying areas of shallow ponds, streams, lakes and sedge meadows. Passerines were the most abundant group observed in Urangesellschaft areas, due primarily to the very common Lapland longspur and less so to the horned lark and savannah sparrow.

Not only are the density-indices of breeding birds comparatively low, but so also are the numbers of breeding species (Table 6.10). The mean number of species detected on-transect at the Polar Gas Keewatin sites ranged from 8.1 to 8.6. Urangesellschaft figures were from three to six species. Only the lower species totals of individual Polar Gas transects fall within the range of the Urangesellschaft results. Mean numbers of species on the Boothia Peninsula and Arctic island Polar Gas transects are comparable to the Urangesellschaft study, ranging from 1.5 to 7, and the counts for individual transects include the range of values for the Urangesellschaft sites.

A total of 17 species were detected on-transect, plus an additional four off-transect from the Urangesellschaft transects. These totals are again significantly less than those presented in the three Polar Gas studies, even including those totals for the Boothia Peninsula and Arctic islands (altogether 34 species, with 25 on-transect).

7.0 WILDLIFE BASELINE CHEMISTRY

During the summer of 1989, two BEAK personnel collected a number of small animals for baseline chemical analyses. In total, five (5) sik sik, six (6) ptarmigan and two (2) hares were collected, along with two (2) caribou and one (1) wolf sample provided by the local RCMP and wildlife office, respectively. Heavy metal and uranium series analyses were carried out on the following samples from each animal:

- sik sik and ptarmigan: stomach contents, muscle, bone, carcass
- hare: stomach contents, muscle, bone
- caribou and wolf: muscle, bone

Chemical analyses of the above-mentioned samples were carried out by the Saskatchewan Research Council (SRC) in Saskatchewan. Analytical methods and QA/QC methods are discussed in Appendix 1. The results from these analyses are listed in Table 7.1. Heavy metal and radionuclide levels were generally low in all species, except for the stomach contents in the sik sik. These animals were all caught in the immediate vicinity of the exposed orebody at Main Zone. Soil uranium and radium levels in this area are 1,600 times and 24 times background values (Table 3.17 in Supporting Document No. 1).

There is generally little information on the contaminant load in terrestrial mammals from the Canadian Arctic (Wong, 1985). The relevant data available are listed in Table 7.1. Heavy metal levels reported in caribou muscle for this study are similar to those reported for tissue and liver from caribou collected in the Prince of Wales Island. Mercury levels in wolf muscle collected for this study are also similar to levels measured in muscle from wolf and Arctic fox from Victoria Island.

Chemical levels in the wildlife of the Kiggavik project are, therefore, low and similar to other Arctic areas.

TABLE 7.1: TRACE METAL AND RADIONUCLIDE CONCENTRATIONS (WET WEIGHT BASIS) IN WILDLIFE TISSUES FROM THE KIGGAVIK PROJECT AREA AND THE EASTERN KEEWATIN, 1989

	Wolf Muscle	Wolf Bone	Ptarmigan Muscle	Ptarmigan Bone	Ptarmigan SC	Ptarmigan Carcass	Hare Muscle	Hare Bone	Hare SC	Caribou Muscle	Caribou Bone	Sik-Sik Muscle	Sik-Sik Bone	Sik-Sik Carcass	Sik-Sik SC	Caribou Tissue[1]	Caribou Liver[1]	Wolf Muscle[2]	Wolf Muscle[2]	Arctic Fo Muscle[2]
Zinc (ug/g)	4.51E+01	1.04E+02	1.4E+01	8.17E+01	-	5.74E+01	1.9E+01	9.58E+01	-	3.61E+01	4.8E+01	2.81E+01	8.14E+01	2.70E+01	-	28.8	28.8	-	-	-
Cadmium (ug/g)	L 2E-02	L 4E-02	7.8E-02	6.3E-02	-	2.6E-01	L 1E-02	L 2E-02	-	L 1E-02	L 3E-02	6.2E-02	L 2E-02	1.1E-01	-	-	-	-	-	-
Cobalt (ug/g)	L 3E-01	L 8E-01	L 3E-01	L 4E-01	-	L 4E-01	L 2E-01	L 4E-01	-	L 3E-01	L 5E-01	L 2E-01	L 4E-01	L 3E-01	-	ND	0.76	-	-	-
Copper (ug/g)	2.8E+00	4E-01	2.74E+00	1.1E+00	-	4.46E+00	1.4E+00	8.7E-01	-	1.6E+00	5.3E-01	2.47E+00	7.3E-01	2.83E+00	-	5.19	17.2	-	-	-
Lead (ug/g)	2E-01	5E-01	6.8E+00	1.1E+00	-	1.4E+01	1.6E+01	7.0E-01	-	2E-01	4E-01	3.26E+00	4.4E-01	1.27E+01	-	2.80	3.0	-	-	-
Chromium (ug/g)	4.0E+00	2E+00	L 3E-01	4E-01	-	1E+00	L 2E-01	1E+00	-	L 3E-01	1E+00	L 2E-01	7E-01	8E-01	-	2.46	2.78	-	-	-
Nickel (ug/g)	6.7E+00	8E-01	L 3E-01	L 4E-01	-	1E+00	L 2E-01	4E-01	-	L 3E-01	L 5E-01	L 3E-01	4E-01	8E-01	-	0.20	ND	-	-	-
Mercury (ug/g)	1.2E-01	L 7.7E-03	2.4E-02	L 4.2E-03	-	1.1E-01	4.2E-02	8.7E-03	-	4.7E-02	L 5.3E-03	2.0E-02	5.5E-02	3.5E-02	-	-	-	0.051	0.24	0.31
Arsenic (ug/g)	L 2E-01	L 4E-01	L 1E-01	L 2E-01	-	8.5E-01	2.2E-01	L 2E-01	-	L 1E-01	L 3E-01	L 1E-01	L 2E-01	6.7E-01	-	-	-	-	-	-
Selenium (ug/g)	1.2E+00	L 4E-01	6.5E-01	2E-01	-	8.5E-01	2.2E-01	2E-01	-	7.8E-01	L 3E-01	4.9E-01	5.5E-01	5.4E-01	-	-	-	-	-	-
Uranium (ug/g)	L 5.0E-04	L 3.8E-02	1.8E-03	L 2.21E-02	5.20E+00	1.25E-01	5.79E-03	1.50E+00	5.03E-01	1.0E-03	2.09E-02	2.97E-01	2.84E+00	3.83E-01	7.75E+00	-	-	-	-	-
Th-230 (Bq/g)	L 5.0E-05	L 3.8E-03	L 8.9E-05	L 2.2E-03	4.53E-02	1.6E-03	L 1.7E-04	L 2.3E-03	6.27E-03	L 1.0E-04	L 2.1E-03	7.4E-04	1.3E-03	4.3E-04	2.92E-02	-	-	-	-	-
Ra-226 (Bq/g)	5.0E-05	1.13E-02	L 4.4E-05	2.2E-03	8.48E-02	2.6E-03	4.2E-04	2.34E-01	4.27E-03	5.2E-05	2.09E-02	1E-03	1.06E-02	3.48E-03	3.09E-02	-	-	-	-	-
Pb-210 (Bq/g)	1E-03	1.1E-01	9.7E-04	7.74E-02	1.42E-02	9E-03	1.08E-03	1.1E-01	1.38E-02	2.1E-03	4.2E-01	1E-03	2E-02	1E-02	9.0E-02	-	-	-	-	-
Po-210 (Bq/g)	5.3E-03	2.5E-02	-	-	-	5.1E-03	-	2.0E-02	-	-	8.9E-02	5E-04	4.7E-03	8E-03	-	-	-	-	-	-
Th-232 (Bq/g)	L 5.0E-05	L 3.8E-03	L 8.9E-05	L 2.2E-03	2.82E-02	5.1E-04	L 1.7E-04	L 2.3E-03	7.4E-04	L 1.0E-04	L 2.1E-03	L 1E-04	L 1.3E-03	L 4.3E-04	L 8.1E-04	-	-	-	-	-
Th-228 (Bq/g)	L 5.0E-05	L 3.8E-03	L 8.9E-05	2.2E-03	1.13E-02	5.1E-04	L 1.7E-04	L 2.3E-03	1.5E-03	L 1.0E-04	6.26E-03	L 1E-04	L 1.3E-03	L 4.3E-04	L 1.6E-03	-	-	-	-	-
Dry Solids (%)	33.4	77.0	26.1	42.1	77.8	42.5	22.2	43.5	22.4	26.1	52.6	24.7	36.3	27.0	16.9					

L = less than.

Notes:

Wolf - tissues from one animal, from Baker Lake traplines.
Ptarmigan - tissues from six animals (composite), Kiggavik site.
Hare - tissues from two animals (composite), Kiggavik site.
Sik-Sik - tissues from five animals (composite), Kiggavik site.
Caribou - tissues from one animal, from Baker Lake hunters.
Carcass - remainder after removal of muscle (flesh), bone and stomach content samples.
SC - stomach contents.

[1] From: Shaw and Gunn (1981). Samples from Prince of Wales Island.

2 From: Smith and Armstrong (1975). Samples from Victoria Island.

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APPENDIX 1

Analysis of Tissue Samples for Trace Metals and Radiochemicals: Methods and Analytical Quality Control

APPENDIX 1: ANALYSIS OF TISSUE SAMPLES FOR TRACE METALS AND RADIOCHEMICALS: METHODS AND ANALYTICAL QUALITY CONTROL

A.1 Trace Metal Analysis

The specimens of Arctic fauna analyzed for heavy metals and radionuclides are summarized in Table A1. All tissue samples were dried at 105°C before analysis. One gram of the dried tissue were digested at 110°C for at least 12 hours in 13 mL of nitric, sulphuric and perchloric acid (10:2:1) until only sulphuric acid remained. An additional 2 mL of HCl was added and the digestion was continued until the volume was brought down to 1 mL. The digestate was then made up to a volume of 25 mL in distilled deionized water. Analysis of zinc, cobalt, copper, chromium and nickel was performed by plasma emission (DCP Beckman Spectrospan V). Lead and cadmium were analyzed by graphite furnace atomic absorption spectrometry on a Zeeman corrected Perkin Elmer 3030Z. Mercury was analyzed by the method of cold vapour atomic absorption spectrometry on a Perkin Elmer 3030. Arsenic and selenium were analyzed by the method of hydride generation on a Perkin Elmer 2380 atomic absorption spectrophotometer.

A.2 Quality Control - Trace Metals

Analysis of the tissue samples at Beak Analytical Services (BAS) followed standard QA/QC protocols resembling those at the Ontario Ministry of the Environment. Calibration, precision and accuracy of each analytical run were controlled with calibration control standards, in-run duplicates and standard reference materials, respectively. The QC protocols followed and methods of calculating control limits are described in detail in Appendix 3 of Supporting Document 4.

Table A2 presents the results of analyzing the calibration control samples QCA, QCB during the analytical runs. All results fall within the statistically determined control limits. Table A3 presents the results of analyzing duplicate extractions of wolf bones and caribou flesh. All replicate differences are within acceptable levels of precision for this sample matrix. Table A3 also presents the results of analyzing an EPA standard reference material (Trace Metals in Fish 2174). Target values and published control limits (interlaboratory) are included on the table to indicate that an acceptable degree of accuracy was attained for each metal in the sample matrix.

TABLE A1: SUMMARY OF TISSUE SAMPLES ANALYZED FOR TRACE METALS AND RADIOCHEMICALS

Animal	Flesh	Bones	Carcass
Wolf	1	1	
Ptarmigan	1	1	1
Hare	1	1	
Caribou	1	1	
Sik-Sik	1	1	1

TABLE A2: CALIBRATION CONTROL SAMPLES ANALYZED WITH TISSUE SAMPLES

Parameter	QCA	QCB	A+B	Control Limits A+B	A-B	Control Limits A-B
Zn (mg/L)	8.09	1.95	10.04	9.40-10.18	6.14	5.50-6.28
Cd (ug/L)	3.86	1.016	4.876	4.29-5.67	2.844	2.26-3.63
Mn (mg/L)	3.97	0.923	4.89	4.73-5.22	3.047	2.76-3.25
Co (mg/L)	4.05	0.998	5.048	4.73-5.26	3.052	2.74-3.28
Cu (mg/L)	4.14	0.992	5.132	4.78-5.28	3.142	2.78-3.27
Fe (mg/L)	8.00	1.89	9.89	9.54-10.42	6.11	5.57-6.47
Pb (ug/L)	39.70	10.59	50.29	47.40-51.46	29.11	27.65-31.71
Cr (mg/L)	4.09	1.01	5.10	4.7-5.29	3.08	2.71-3.30
Ni (mg/L)	4.84	0.555	5.395	N/A	4.285	N/A
As (ug/L)	8.0	2.0	10.0	9.13-10.94	6.0	5.17-6.97
Se (ug/L)	8.1	2.0	10.1	9.09-11.14	6.1	5.09-7.14

TABLE A3: RESULTS OF REPLICATE PAIRS AND STANDARD REFERENCE MATERIAL ANALYZED WITH TISSUE SAMPLES

	Replicates		Reference Material[1]		
Parameter	Wolf Bones	Caribou Flesh	Analyzed Value	Target Value	Confidence Interval (95%)[2]
Zn (ug/g)	143/128	138/138	45.75	43.6	35.5-51.7
Co (ug/g)	L 1/L 1	L 1/L 1	0.25	-	-
Cu (ug/g)	0.5/0.5	6.0/6.0	1.5	2.21	0.93-3.49
Cr (ug/g)	2/3	L 1/2	1.5	0.58	0-1.34
Ni (ug/g)	1/1	L 1/L 1	1.1	0.54	0-110
Pb (ug/g)	1.0/0.4	0.6/0.6	0.417	0.26	0-0.62
As (ug/g)	L 0.5/L 1	L 0.5/L 1	-	-	-
Se (ug/g)	L 0.5/L 1	3.0/3.0	0.13	0.37	0-0.75

[1] EPA Trace Metals in Fish.

[2] Based on published interlaboratory data.

L = less than.

A.3 Radiochemical Analysis

Radiochemical analyses were performed by the Saskatchewan Research Council on the animal tissues (and one lichen) for Ra-226, Pb-210, Th-230, Th-232, Po-210 and total uranium. All analyses were performed on dried material and later recalculated on a wet weight basis. Samples for Ra-226 were first ashed then dissolved in nitric acid (1:1). The radium was removed from this solution by coprecipitation with lead sulphate. The lead sulphate was dissolved in alkaline EDTA and the radium coprecipitated as barium sulphate. The barium sulphate was filtered on a membrane filter, contacted with a zinc sulphide-mylar disc. Alpha disintegrations were counted on a bare-photomultiplier scintillation counter.

Samples for Pb-210 and Po-210 were wet ashed in nitric/perchloric acid. Pb-210 was determined from its daughter Bi-210 after allowing for a specified period of ingrowth. The Bi-210 was extracted with DDTC (diethylammonium diethyldithiocarbonate) from a 2M HCl solution. After evaporation, the organic extract was dissolved in nitric acid, diluted and BiOCl precipitated as the final counting form of Bi-210. The quantity of Bi-210 present was determined by beta counting with a low background counting system.

Po-210 was plated onto silver or nickel disks. The metal disks were then counted for Po-210 by alpha spectrometry. Thorium was separated from each sample by coprecipitation with barium sulphate after potassium pyrosulphate fusion. The barium sulphate was dissolved in a strongly alkaline solution of EDTA and the thorium was precipitated as a hydroxide with a 50 um cerium carrier. The precipitate was mounted on a 25 mm 0.2 micron membrane filter and its isotopes (Th-230, Th-232) were determined by alpha spectrometry using a surface barrier detector. Total uranium was determined on each sample by delayed neutron activation. Cs-137 was determined directly on the dried sample by gamma spectrometry on a NaI (Tl) detector.

A.4 Quality Control - Radiochemicals

Quality control samples analyzed at SRC consist of blind duplicates, spiked samples and blanks. All radiochemical procedures are calibrated and checked with NBS traceable standards. Results of the QC samples run at SRC were not submitted to us or available on request.

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