Progress Notes

Aussi disponible en français

No. 88, August 1978

Polar bears in the area of Jones Sound and Norwegian Bay

by H.P.L. Kiliaan[1], I. Stirling[1], and C.J. Jonkel[2]

Introduction

Studies of polar bears in the area of Jones Sound and Norwegian Bay were initiated by the Canadian Wildlife Service (CWS) in 1971 as part of a general study of polar bear population ecology in the eastern High Arctic. The objective here is to summarize all research knowledge and hunter kill data for the area of Jones Sound and Norwegian Bay. For a recent review of polar bear biology, research, and management in Canada see Stirling (1976).

Study area

We broadly defined the study area as Norwegian Bay east of 93°W and south of 79°N, Jones Sound, and northwestern Baffin Bay, and adjacent coastal areas of southern Ellesmere and northern Devon islands (Fig. 1). This area encompasses the hunting area of the Inuit from Grise Fiord and will be referred to as the Jones Sound–Norwegian Bay area.

Physiographically the area is composed of three main zones (Dunbar and Greenaway 1956). First, the eastern part of Devon Island and the southeastern part of Ellesmere Island, which comprise Precambrian highlands with peaks rising over 1200 m, and are for the most part ice-capped. Second, central Devon Island and southern Ellesmere Island, which are underlain by gently sloping sedimentary strata forming a plateau that rises over 600 m. On Ellesmere Island the plateau is more dissected, partly ice-capped, and slightly higher. Third, the Grinnell Peninsula on northwestern Devon Island, Graham Island, and the Bjorne Peninsula on western Ellesmere Island which are much lower, mainly below 300 m. A low pass (<300 m) exists between Baumann Fiord on the western side of Ellesmere Island and Makinson Inlet in the east. The coastline of the area, except for the Bjorne and Grinnell peninsulas and Graham Island, is prominent with continuous cliffs, 300 to 450 m high, and a number of long inlets. In the eastern part, numerous glaciers are actively calving icebergs into the bays.

Climatically the area experiences long, very cold winters and short, cool summers. The marked variation in solar radiation throughout the year is responsible for the extreme temperature range between winter and summer, and the continuous dark period in winter and daylight in summer. Mean daily temperatures range from about −30°C in February to about 5°C in July. Total precipitation is light (about 23 cm) with maxima as snow in the fall (September to November) and as rain in summer (July to August). Climatic data are from Craig Harbour, southern Ellesmere Island, where there is some amelioration of temperature extremes and slightly more precipitation than in the rest of the High Arctic, because of the proximity of the Northwater (Transport Canada 1970).

A great deal of variation in the patterns of ice formation and break-up occurs from year to year (Environment Canada 1964–1976). A virtually complete ice cover forms over the bays and sounds each winter. Some open water persists in Cardigan Strait and Hell Gate between northwestern Devon Island and southwestern Ellesmere Island, and in northern Baffin Bay (part of the Northwater). Break-up begins in late June to early July at the eastern and western ends of Jones Sound, adjacent to the open water areas which have persisted throughout the winter. Usually by the end of August only small areas of very open pack ice persist in Jones Sound and the southern part of Norwegian Bay. By early to mid-September ice begins to form in the bays, and by the end of October to early November most of the area is completely ice covered. Due to the influence of tides and winds, the ice remains in motion until March, then most leads disappear except for a few narrow ones between Coburg Island and northeastern Devon Island, and at the head of the Sound (Dunbar and Greenaway 1956).

The dominant sea currents flow south through Norwegian Bay and east through Jones Sound into Baffin Bay. Although the currents are generally weak, they maintain open water throughout the winter in Cardigan Strait and Hell Gate (Dunbar and Greenaway 1956, Collin 1963). A small branch of the southerly flowing current off the eastern coast of Ellesmere Island flows into the entrance of Jones Sound, carrying numerous icebergs, many of which become frozen into the annual ice cover of Jones Sound.

Materials and methods

Tagging programs

To determine quantitatively population size, discreteness, and seasonal movements, one must tag individual polar bears and recover the tags at a later date, either by recapture of the bears or tag returns from hunters. The techniques of immobilizing and tagging polar bears have been described by Jonkel (1967), Lentfer (1968), and Larsen (1971). We weighed, measured, and eartagged the immobilized bears, and tattooed them on both upper inner lips with the same number as that on the eartags. A premolar tooth was extracted for ageing from some but not all bears, and bears were examined for general physical condition. Table 1 lists the dates and areas covered during tagging studies done with the aid of helicopters. During tagging operations, if there was a choice, family groups were selected for tagging rather than single animals.

During spring tagging operations, we kept records of the number and direction of tracks and the distance in kilometers flown as an index of polar bear density. Feeding areas were identified from sightings of bears and seal kills. Seals killed

[1]CWS, Edmonton, Alberta T5J 1S6.
[2]Formerly of CWS, Ottawa, Ontario. Present address: School of Forestry, University of Montana, Missoula 59801.

Figure 1
Locations in Jones Sound–Norwegian Bay area

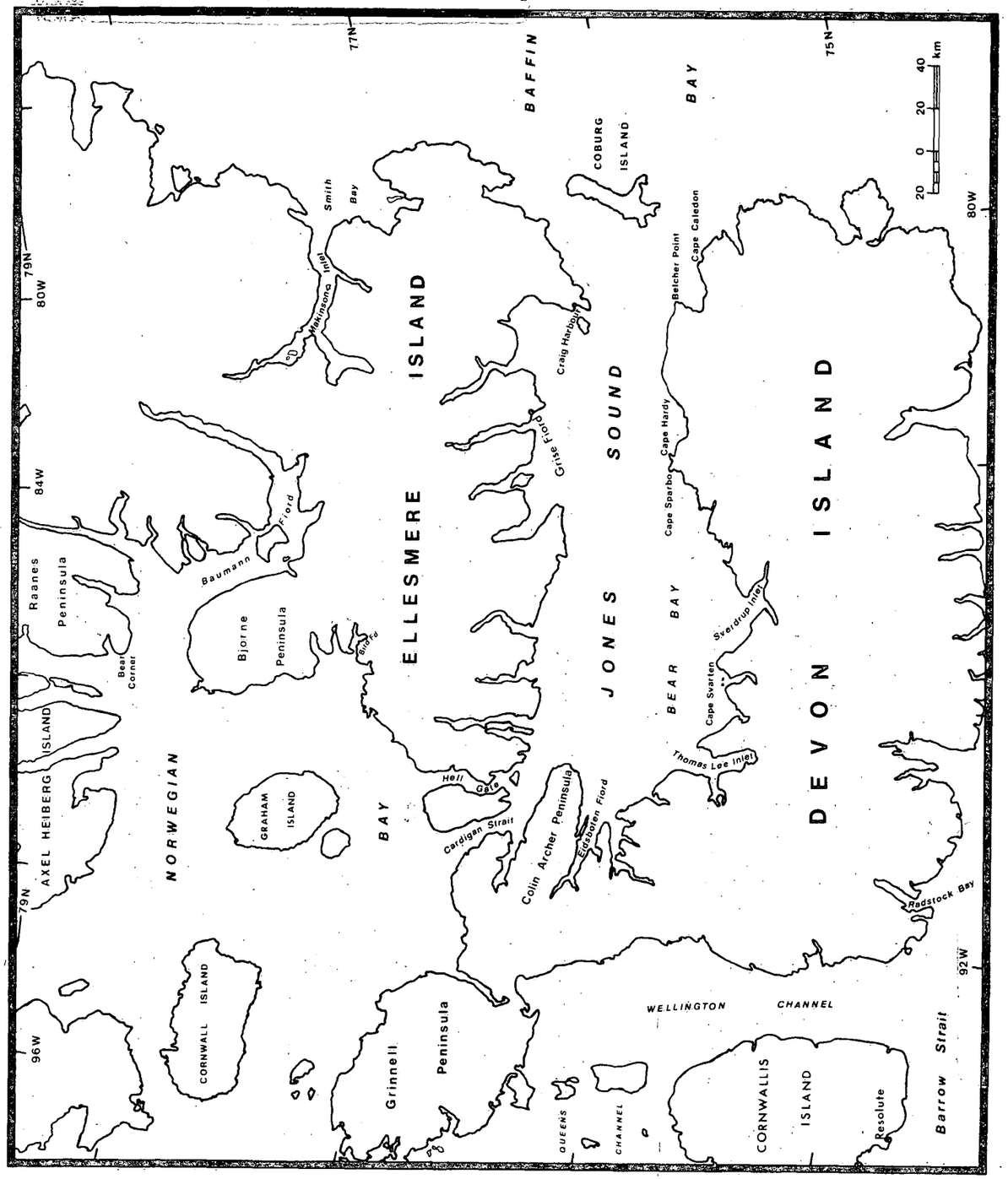


Table 1
Dates of surveys, tagging programs, and distances travelled in Jones Sound and Norwegian Bay areas, Northwest Territories, 1971–77

Year	Type	Project	Date		Dist. trav. (km)	
			Jones Sound	Norwegian Bay	Jones Sound	Norwegian Bay
1971	Snowmobile	Maternity denning	17 Mar.–23 Apr. (22 days)	–	1125	–
	Helicopter	Tagging, maternity denning	26–28 May (3 days)	May (2 days)	238	1120
1972	Snowmobile	Maternity denning	20 Mar.–20 Apr. (24 days)	–	1344	–
	Helicopter	Tagging, maternity denning	11 Apr.–10 May (4 days)	11 Apr.–5 May (8 days)	629	1025
	Fixed-wing	Maternity denning	9–20 Apr. (4 days)	–	1356	–
1973	Snowmobile	Maternity denning	17 Mar.–18 Apr. (25 days)	–	1600	–
	Helicopter	Tagging, maternity denning	31 Mar.–13 May (8 days)	8 Apr.–13 May (5 days)	3083	872
	Helicopter	Tagging	5–17 Aug. (7 days)	6–20 Aug. (2 days)	739	734
1974	Helicopter	Tagging	14–15 Aug. (2 days)	–	180	–
1977	Snowmobile	Maternity denning	27 Mar.–* 23 Apr. (16 days)	–	not known	–

*Includes Makinson Inlet area, southeastern Ellesmere Island.

by polar bears were examined to determine utilization of the seal carcasses and, if possible, how the seals were killed.

Maternity denning surveys

Female polar bears with newborn young had been reported in the spring along the northern coast of Devon Island by Inuit hunters (Grise Fiord Inuit, pers. comm.) and along the northern coast of Smith Bay, eastern Ellesmere Island, by Inuit hunters from Greenland (C. Vibe, pers. comm.). Because of these sightings, CWS initiated spring maternity denning surveys to determine the extent and productivity of the northern Devon Island area. Later, Northwest Territories–Fish and Wildlife Service (NWT–FWS) carried out a similar survey in the southern and southeastern Ellesmere Island area (Chowns 1977). The timing of the surveys was planned to coincide with the estimated peak time of emergence based on available information from other areas (Uspenski and Chernyavski 1965, Harington 1968), and on reports from Grise Fiord Inuit. Data were recorded on family groups sighted, tracks of family groups, age of young (whether cubs of the year, yearlings, two-year-olds), litter size, and den locations.

Surveys using snowmobiles

In 1971, 1972, and 1973, the coastline of northern Devon Island, between Cape Sparbo and Eidsboten Fiord, was systematically searched four times each year by snowmobile for family groups, tracks of family groups, and possible maternity den sites. Table 1 lists the dates and areas covered during the ground surveys. The search parties consisted of four observers (H. Kiliaan, CWS, and three Grise Fiord Inuit), two snowmobiles and komatiks, and sufficient supplies for the entire survey period. Fuel caches were placed prior to the surveys.

One party (two observers with one snowmobile) travelled on or as close as possible to the beach. The second party

travelled about 1 km offshore. Precise routes varied according to tracking conditions and the nature of the terrain. Surveys were done during the hours of best light, normally between 09:00 and 19:00. At this time of year (March–April) the length of daylight and therefore hours of best light are rapidly increasing from day to day. Travel speeds were 8 to 16 km/h. Faster speeds precluded the recording of old and wind-blown tracks.

Little time was spent in large bays because of the possibility of frightening any family groups already on the ice into returning inland. Backtracking revealed that families which did return to land tended to remain there for one or two days before coming back onto the ice, thus creating the impression of a new family group. By noting the number of tracks leading from the shore to the ice and *vice versa*, the age of tracks, stride length, and peculiarities like limps, some double counts were prevented. However, the possibility of duplication remained.

Backtracking to dens was found to be time-consuming, due to the hilly nature of the terrain and insufficient snow. It was only attempted if fresh tracks came offshore, and no other tracks of family groups were found that day. If fresh tracks were encountered early in the morning, they were backtracked for up to two hours.

Between 27 March and 23 April 1977, NWT–FWS, using snowmobiles, attempted to determine if any maternity denning occurred along the southern Ellesmere Island coast or in the Makinson Inlet area (Chowns 1977). The procedure was essentially the same as that carried out by CWS, with one snowmobile travelling close to the shore and one 0.5 to 1 km offshore.

Surveys using fixed-wing aircraft

Fixed-wing surveys were flown in April 1972 with a single Otter aircraft at altitudes of 30 to 100 m and airspeeds of 120 to 180 km/h (Table 1). The surveys concentrated on pressure ridges near shore, icebergs in bays and fiords, islands, and snowbanks. The northern Devon Island coast east of Thomas Lee Inlet was surveyed and special efforts were directed to areas not covered by the ground survey.

Surveys using helicopter

During coastline searches and spring tagging programs, all sightings of females with cubs of the year were recorded in order to delineate possible maternity denning areas. Backtracking to the den or denning area was done whenever snow conditions were suitable. When searching for dens, helicopters flew at altitudes of 15 to 50 m and airspeeds of 120 to 180 km/h. The dates and areas covered are listed in Table 1.

Specimens from Inuit hunters

CWS paid rewards for skulls and lower jaws, and for the return of eartags or information on lip tattoos from polar bears killed by Inuit hunters. Some reproductive organs were purchased for reproductive studies, as were samples for pesticide and heavy metal analyses (Bowes and Jonkel 1975).

Age determination

Premolar teeth collected from immobilized bears or from the skulls of bears killed by Inuit were decalcified, thin sectioned, stained, interpreted and photographed, We used the basic methods of Thomas and Bandy (1973) modified by H.P.L. Kiliaan and W. Calvert (Stirling, Archibald, and DeMaster 1977*a*). Age class determination for some captured bears was based on total length and weight measurements.

Hunter questionnaire

We attempted to determine:

(1) the hunting territory and routes used by Grise Fiord Inuit during the last three polar bear hunting seasons[3], i.e. 1974–5, 1975–6, and 1976–7;

(2) the hunting areas preferred and why;

(3) the basis of present hunting patterns.

Information was obtained from a questionnaire sent to Grise Fiord Inuit hunters. A map of the Jones Sound–Norwegian Bay area was included in the questionnaire and hunters were asked to trace by year, for the last three years, the routes travelled on their hunting trips. To avoid possible confusion between years and between trips, data for earlier years were not requested. Personal knowledge of the area helped in interpreting the information.

Nine of the 43 registered Grise Fiord hunters responded to the questionnaire. The 64 hunting trips recorded for the period 1974–77 were plotted on a map of the study region which had been divided into nine areas (Fig. 2). We also tabulated the number of times a hunter entered or passed through each area (Table 2), independent of time spent or distance travelled. Visits to each area were tabulated for both the outward and return trips. On the 64 trips, the nine areas were visited 220 times.

Other sources of information

Past game reports from the Northwest Territories and the RCM Police were reviewed for kill data. Observations incidental to other wildlife studies, records from local interviews, and recent literature were reviewed for any additional data relevant to the study.

Results and discussion

Mark-recapture data

From 1971 to 1974, we tagged a total of 31 bears: 17 in the Jones Sound area and 14 in the Norwegian Bay area (Table 3, Fig. 3). No mark-recapture studies were carried out along the southern and eastern coasts of Ellesmere Island. Four of these tagged bears were later recaptured, and eight were killed by Inuit hunters (Table 3). Three bears were recaptured within the Jones Sound–Norwegian Bay area and one outside (Table 4). Four of the tagged bears killed were taken by Grise Fiord Inuit and four by Inuit hunters outside the area. If natural mortality is discounted, a maximum of 23 bears tagged in the Jones Sound–Norwegian Bay area could still have been alive at the end of 1977.

Three bears tagged in Norwegian Bay in May 1972 were shot by Inuit hunters. Two were killed by Grise Fiord hunters: one of them two days after tagging in Norwegian Bay,

[3]Throughout most of the Northwest Territories, the polar bear hunting season opens on 1 October and closes on 31 May the following year.

Figure 2
Hunting areas of Grise Fiord Inuit hunters

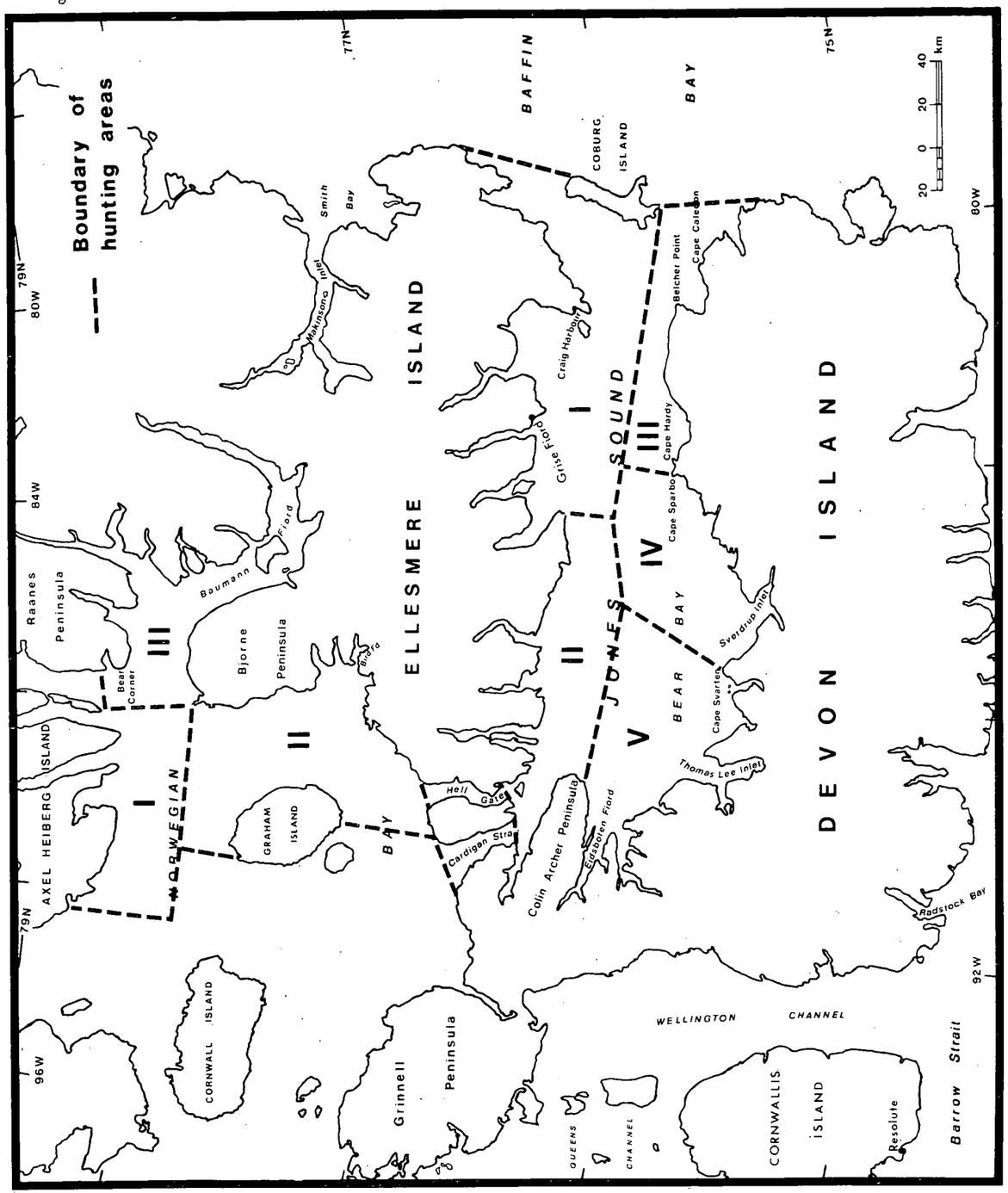


Table 2
Number of hunting trips, 1974–77, and number of polar bears killed, 1974–77, by Grise Fiord hunters by area

Area	Trips: Enter or pass through No.	Trips: Enter or pass through %	Trips: Terminate No.	Trips: Terminate %	Kills No.	Kills %
South Ellesmere Island						
Jones Sound I	133	61	14	22		
II	23	10	10	16		
Total	156	71	24	38	46	48
North Devon Island						
Jones Sound III	13	6	9	14		
IV	18	8	5	8		
V	5	2	5	8		
Total	36	16	19	30	21	22
Norwegian Bay I	2	1	1	2		
II	4	2	4	6		
III	15	7	9	14		
Total	21	10	14	22	26	27
East Ellesmere Island	7	3	7	11	2	2
All areas	220		64		95	

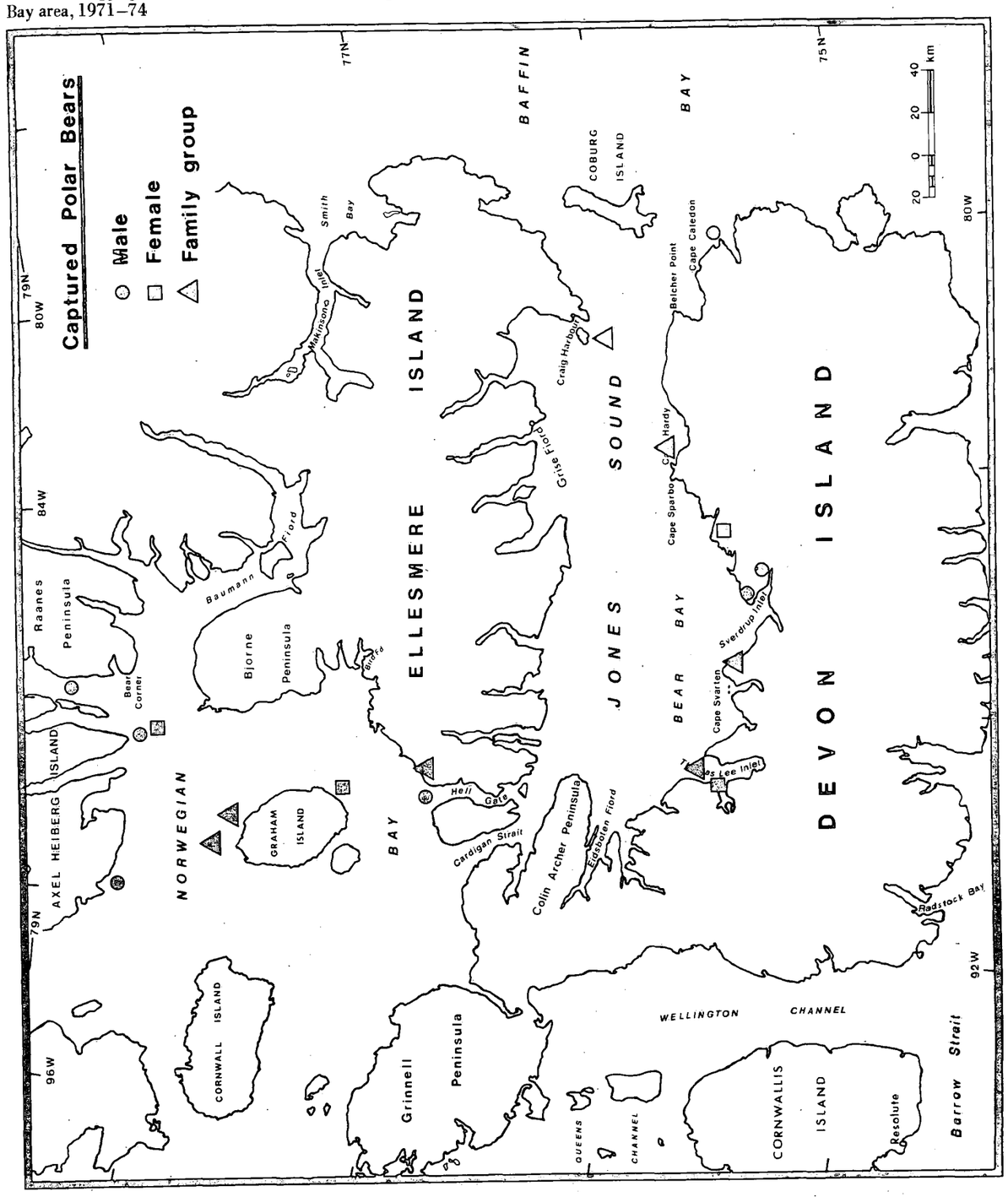
Table 3
Number of polar bears tagged in Jones Sound–Norwegian Bay area, and later recaptured or killed, 1971–77

Type	1971	1972	1973	1974	1975	1976	1977	Total
Eartagged	3	13	11	4	0	0	0	31
Recaptured	0	3	0	1	0	0	0	4
Killed	0	1	0	1	2	3	1	8

Table 4
Number of polar bears tagged in Jones Sound and Norwegian Bay and later resighted (including recaptures and kills)

Area	Tagged in area	Resighted	Resighted in area orig. tagged	Resighted: Jones Sound	Resighted: Norwegian Bay	Resighted: Baffin Bay area	Resighted: Elsewhere
Jones Sound	17	6	2	2	0	0	4
Norwegian Bay	14	6	5	0	5	1	0
Jones Sound–Norwegian Bay	31	12	7	2	5	1	4

Figure 3
Polar bear tagging locations in Jones Sound–Norwegian Bay area, 1971–74



and one in Baumann Fiord in 1977. The third was killed by Greenlanders in 1974 in the Smith Sound area. One family group, which had been tagged as a female with two cubs of the year in Norwegian Bay in May 1971, was recaptured in May 1972 close to its original capture site. A second family group, which had been tagged as a female with two cubs of the year on the southeastern corner of the Grinnell Peninsula in May 1972, was recaptured in April 1973 in Norwegian Bay. In August 1973 the group was recaptured close to its original capture site.

Two kills, but no recaptures, were made in Jones Sound of polar bears tagged there. One polar bear was recaptured the following year (1974) in Radstock Bay, southwestern Devon Island. Two bears tagged as two-year-old cubs with a female near Cape Svarten, northern Devon Island, in August 1973, were killed in northern Jones Sound in 1976. One was killed near Grise Fiord in April and the other about 45 km to the west in November. A family group tagged in August 1974 as a female and two cubs of the year in Thomas Lee Inlet, northern Devon Island, were killed outside the area. The female and one yearling were taken in November 1975 in Admiralty Inlet, northern Baffin Island, by Arctic Bay hunters. The second yearling survived the winter, but was killed in April 1976 near Cape Cargenholm, northeastern Baffin Island, by Inuit hunters from Clyde. This bear, then just over two years old, was reported to have been in good condition. Four polar bears killed in Jones Sound had originally been tagged elsewhere. Two of these bears had been tagged in Queen's Channel and two near Borden Peninsula, northern Baffin Island. Recorded movements of tagged polar bears in the Jones Sound–Norwegian Bay area are shown in Figure 4. Based on the observations of tracks in April–May, records showed overland movements between the heads of fiords in northwestern Jones Sound and southeastern Norwegian Bay and between southwestern Norwegian Bay and northern Wellington Channel.

Six polar bears tagged in Canada are known to have been killed by Inuit hunters from Greenland. One bear was tagged in Norwegian Bay, two east of Baillie-Hamilton Island, in northern Wellington Channel, and one in Strathcona Sound, northern Baffin Island. Two of the bears (a family group) may have been tagged near Kilian Island, northern Victoria Island, but the eartags were broken, thus precluding positive identification of these two bears. The Greenlanders traditionally hunt in the northern Baffin Bay area, including the eastern coast of Ellesmere Island, and are still thought, on occasions, to hunt in areas under Canadian jurisdiction.

From the recorded movements above, it appears that the polar bears in the Jones Sound–Norwegian Bay area do not form a discrete sub-population (Table 4, Fig. 4). Furthermore, some of the tagged bears killed by Greenland hunters in the Baffin Bay area originated from areas further west and south than Jones Sound and Norwegian Bay. Until a larger sample of bears are tagged and more extensive recapture programs take place throughout the Jones Sound–Norwegian Bay area (including the northern Baffin Bay area), it is impossible to determine the boundaries of the sub-population. Schweinsburg *et al.* (1977) and Stirling *et al.* (1978) tentatively concluded that the polar bears of Lancaster Sound, Barrow Strait, and Jones Sound were probably of the same sub-population.

The most important factor affecting the seasonal distribution and movements of polar bears is the seasonal variation in the presence and distribution of sea ice. Without ice, polar bears are unable to hunt seals, their main food source. The distribution and movements of polar bears throughout the winter in the Jones Sound–Norwegian Bay area are unknown. It is thought that bears concentrate along the pressure ice that parallels the coastlines and cuts across the mouths of bays, or along open leads or polynias, where seals are apparently more accessible to the bears (Stirling and McEwan 1975, Stirling *et al.* 1975). Ringed and bearded seals maintain breathing holes in the ice, usually along the last cracks to freeze over (Smith and Stirling 1975). From polar bear kill information and RCMP reports (quoted in Riewe 1977), and from CWS and Northwest Territories polar bear kill forms, it appears that polar bears may concentrate around Bear Bay on northern Devon Island, the area around Hell Gate, and Coburg Island.

As break-up proceeds during July and August, the bears probably move with the ice in order to be able to hunt seals. The distance covered or speed of a bear's movements in a particular year probably vary with the rate of change of the ice conditions. In years when the ice melts completely, the bears are forced to move onto land where they may either wait for freeze-up or move to an area which is still ice-covered. The sea currents are predominantly southerly and easterly through the area, and passive movements of some bears with the ice may occur, particulary during break-up. In western Hudson Bay, a southerly flowing current is thought to influence the southward movement of polar bears from their winter hunting area on the ice in northwestern Hudson Bay to the areas of summer retreat in Manitoba (Stirling *et al.* 1977*b*).

The estimated ages by sex of polar bears captured in the Jones Sound–Norwegian Bay area are shown in Table 5. Because of inadequate sample sizes and the bias towards the capture of family groups, little can be said about these data.

Hunting patterns of the Grise Fiord Inuit

Concern in the 1950's about the depletion of game in some areas of the Arctic prompted the government to assist Inuit families willing to settle in the game-rich Jones Sound area (Bruemmer 1968). In 1953, six families from Port Harrison and three families from Pond Inlet settled near the RCMP post at Craig Harbour, but in 1956 all moved to a climatically more favourable location at Grise Fiord. Throughout most of the history of the Grise Fiord settlement, the people have been dependent on hunting. During the last few years increased employment and the use of snowmobiles have reduced this dependence and altered their hunting patterns. Trips tend to be shorter (1 to 3 days) and concentrate on the harvesting of multiple species (polar bears, seals, caribou, muskoxen, etc.) to give the maximum return for effort expended. The reliance on snowmobiles rather than dog teams, and the high prices of fuel and spare parts, have also become factors in determining the direction and duration of trips. Some fuel and snowmobile spare parts are stored in a cabin at Baumann

Figure 4
Recorded movements of tagged polar bears in Jones Sound–Norwegian Bay area

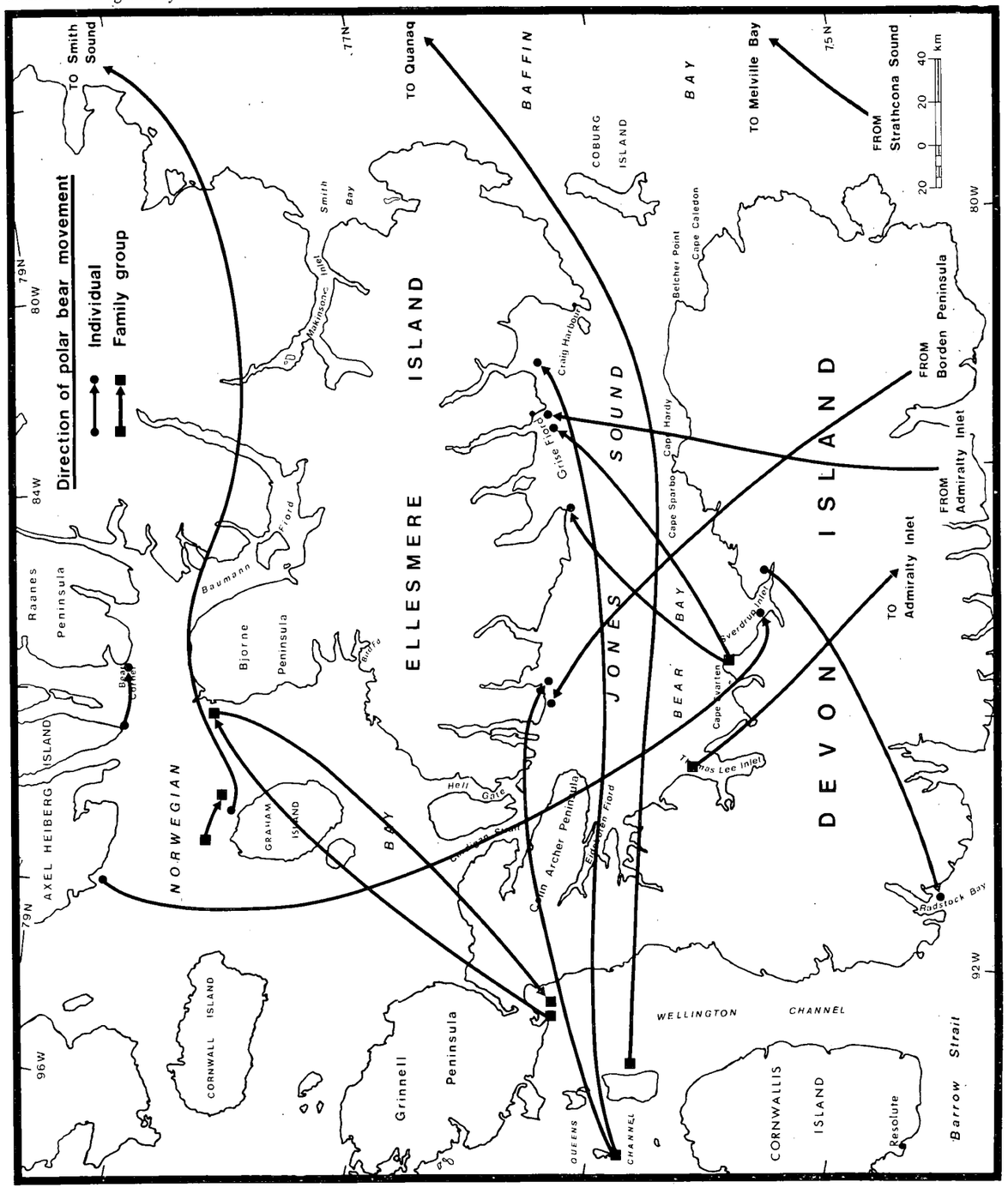


Table 5
Estimated age and sex class of polar bears tagged in Jones Sound–Norwegian Bay area (single bears 3 and 4 years old, sub-adults; bears 5 years and older, adults)

Age and sex class	1971	1972	1973	1974
Adult male	–	3	3	–
Adult female	–	2	–	–
Sub-adult male	–	–	–	–
Sub-adult female	–	–	1	–
Adult female with cubs	1	3	2	1
Cub of year				
male	2	1	–	–
female	–	1	–	2
Yearling cub				
male	–	1	–	–
female	–	2	2	–
Two-year-old cub				
male	–	–	–	–
female	–	–	2	–
Male unclassified	–	–	1	–
Female unclassified	–	–	–	1

Fiord on the western coast of Ellesmere Island, thereby offering some security and convenience to hunters who travel there. The routes followed by the Grise Fiord hunters during the winter hunting trips in 1974–77 were similar to those travelled prior to 1973 (Riewe 1977).

The number of trips to or passing through each area during 1974–77 are shown in Table 2. The high number of trips (133) recorded for Jones Sound area I is partly due to the fact that trips to Jones Sound areas II, III, IV, and V pass through Jones Sound area I. Most trips (33 out of 64) terminated in Jones Sound areas I, II, and III to hunt for polar bears and seals. Rough ice and the removal of the quota for muskoxen on the Grinnell Peninsula in 1975 resulted in the minimal traffic in Jones Sound area V. Trips to Norwegian Bay areas I, II, and III offer opportunities for hunting muskoxen, caribou, polar bears, seals, foxes, and hares and are partly encouraged by the existence of quotas for polar bear and muskoxen in those areas. Hunting of polar bears, wolves, and seals, and some char fishing take place along the eastern coast of Ellesmere Island. However, the overland trip is fairly difficult and limits the amount of hunting there.

Kill data

The known numbers of polar bears killed by Grise Fiord hunters from 1956, when the settlement was established, until 1977 are summarized in Table 6. The data collected after 1967 are probably more reliable because, after that date, all hides had to be tagged before they could be exported from the Northwest Territories. Greenlanders have also hunted to an unknown extent along eastern Ellesmere Island and in eastern Jones Sound. The numbers or locations where polar bears were taken by them are unknown. Figure 5 shows the known locations where polar bears were killed by Grise Fiord hunters from 1966 to 1977.

The kill data were tabulated by sex, area, and time period (Table 7). The average ages of harvested bears by area and time periods are given in Table 8. The territory hunted was divided into four main areas: Norwegian Bay, southern Ellesmere Island, northern Devon Island, and eastern Ellesmere Island. Only data for the period 1966–77 were used because earlier records lacked information on the age, sex, and location of kills. Even so, data on sex were available for 317 (94%), on location for 293 (87%), and on age for 121 (36%) of the 338 bears known to have been killed in 1966–77. The total time period was divided into two sub-periods, 1 July 1966 to 30 June 1972, and 1 July 1972 to 30 June 1977, to test for any changes in the age, sex, or distribution of the kills as a result of changes in Inuit hunting patterns.

The total known kill for the Jones Sound–Norwegian Bay area varied only slightly from 177 bears in 1966–72 to 161 in 1973–77. However, there were marked changes in the distribution of the kill, particularly in Jones Sound (Table 7). The total number of bears known to have been killed in Jones Sound increased slightly from 108 bears in 1966–72 to 118 in 1973–77 (the kill location within Jones Sound was not recorded for two of the 118 bears). During 1966–72, 37 (34%) of the 108 bears were taken along the southern Ellesmere Island coast, whereas 81 (70%) of the 116 bears were taken there in 1973–77 (Table 8). The balance were taken along the northern Devon Island coast mainly between Sverdrup Inlet and Cape Caledon. The Norwegian Bay harvest increased by 86%, from 21 polar bears in 1966–72 to 39 in 1973–77. The harvest along the eastern Ellesmere Island coast changed little, from 5 bears in 1966–72 to 4 in 1973–77. These comparisons may be slightly biased as no data on sex or location were available for 32 of the 177 bears killed between 1966–72.

Figure 5
Known locations of polar bear kills by Grise Fiord Inuit, 1966–77

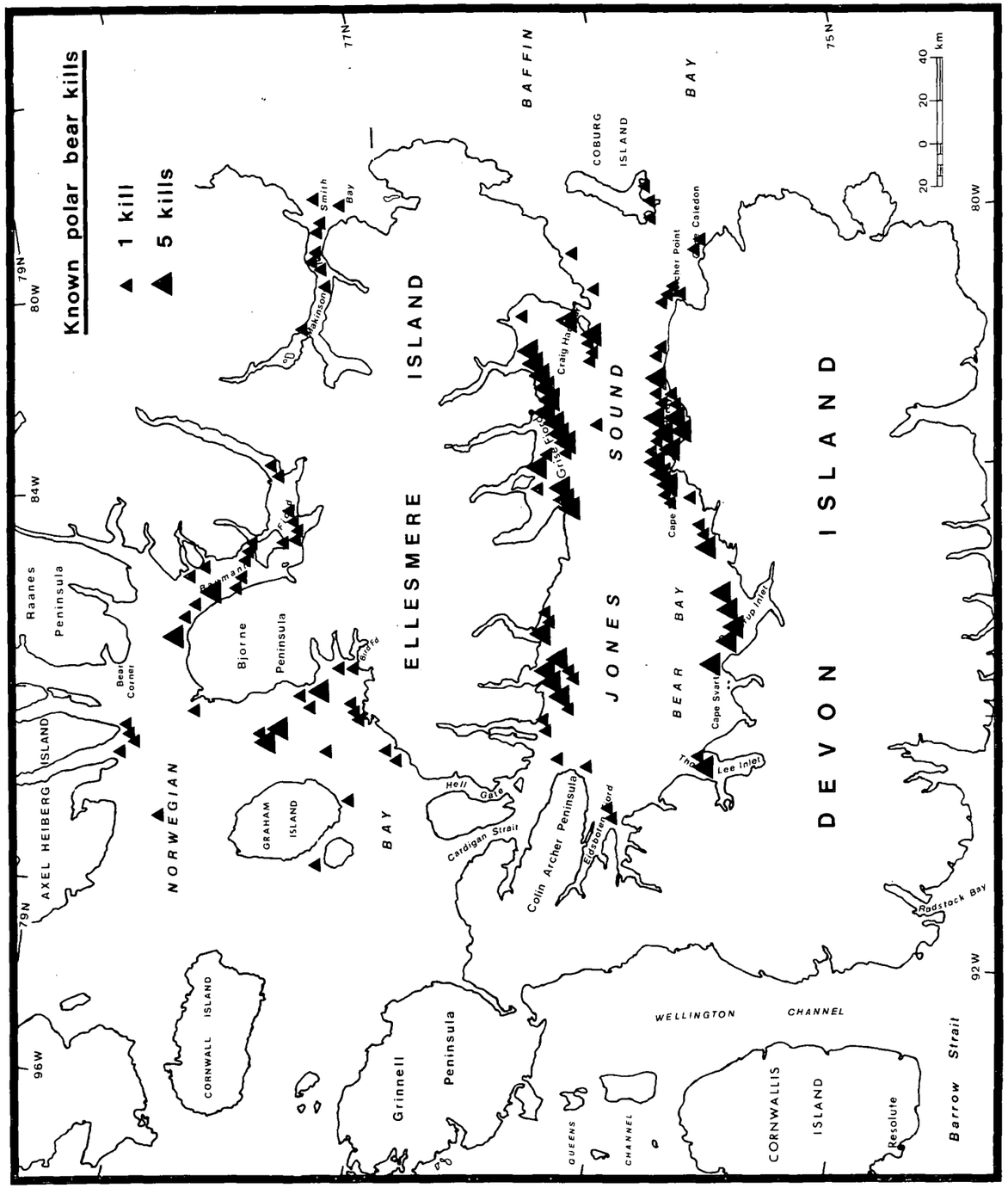


Table 6
Known polar bear kill statistics for Grise Fiord, Northwest Territories, 1956–77

Year	Quota	Kill	Male	Fem.	Unsexed
1956–57		13*	0	0	13
1957–58		8*	0	0	8
1958–59		7*	0	0	7
1959–60		22*	0	0	22
1960–61		16*	0	0	16
1961–62		18*	0	0	18
1962–63		45*	0	0	45
1963–64		16*	0	0	16
1964–65		29*	0	0	29
1965–66		37	23	14	0
1966–67		45	16	18	11
1967–68	17	16+9†	7	3	15
1968–69	27	27	22	5	0
1969–70	27	26	20	6	0
1970–71	27	27	15	12	0
1971–72	27	27	7	14	6
1972–73	27+6‡	33	20	13	0
1973–74	27+6‡	33	18	15	0
1974–75	27+6‡	29	20	9	0
1975–76	27+6‡	33	18	15	0
1976–77	27+6‡	33	21	12	0

*From Riewe (1977).
†Killed by Greenlanders.
‡Norwegian Bay quota.

Inuit hunters from Resolute are apparently harvesting bears from a larger population, so that data collected there may be representative of a healthy high arctic polar bear population. Thus, the kill data for Grise Fiord were compared to those for Resolute (Table 9). The sex was known for each of the 329 polar bears killed by Resolute hunters between 1966–77, but ages were available for only 75 of these bears. The average ages of male and female bears harvested by Grise Fiord hunters were not significantly different for those harvested by Resolute hunters, during 1966–72, 1973–77, or 1966–77 (Table 9).

The ratios of males to females taken by Grise Fiord hunters were significantly lower than in the Resolute harvest for 1973–77 (Grise Fiord 1:0.66, Resolute 1:0.27, X^2 = 12.23, p = <0.005) and for 1966–77 (Grise Fiord 1:0.66, Resolute 1:0.37, X^2 = 11.74, p = <0.005). The ratios of males to females harvested by Resolute hunters in 1966–72 (1:0.46) and in 1973–77 (1:0.27) were significantly different (X^2 = 4.44, p = <0.05). This marked increase in the proportion of males in the Resolute harvest may reflect a change in hunting patterns whereby hunting had been postponed until late April–early May when there were more large male bears closer to Resolute. It appears that by the end of April a relatively large number of adult males concentrate along a number of semi-permanent leads and polynias in Barrow Strait, and along the floe edge which in most years stretches across Barrow Strait–Lancaster Sound east of Resolute. If it can be assumed that the Resolute hunters are harvesting polar bears from a healthy sub-population, then the data presently available indicate that the sub-population of bears hunted by Grise Fiord Inuit is also healthy and is not being overharvested. However, any conclusions drawn in this section may be biased because age, sex, and location of kill data are incomplete.

Management

The polar bears of the Jones Sound–Norwegian Bay area fall within the jurisdiction of the Northwest Territories, where hunting is restricted to the Inuit except for a limited, Inuit-guided sport-hunt which takes place at the request of the settlement.

Since 1967 the Northwest Territories has had quotas on the taking of polar bears. Settlements are penalized for any overkills by reducing the quota accordingly for the following year. The hunting season is open from 1 October to 31 May the following year. Females with cubs (<137 cm long) are protected; the cubs do not reach the legal hunting length until they are about one year old. The initial quota of 17 bears for Grise Fiord was increased to 27 in 1968. No stipulation was made as to where the bears were to be taken. In 1973 an additional six bears were added with the provision that they be taken in the Norwegian Bay area. In 1973, a quota of 12 bears was designated for the Melville Island area. Since no permanent Inuit settlements fall within this zone, the quota

Table 7
Number of polar bears killed by Grise Fiord Inuit in Jones Sound–Norwegian Bay area, 1966–77, by sex, area, and time period

Area	Sex	1966–72 Killed	1966–72 Sex ratio	1966–72 % kill	% change 1966–72/ 1973–77	1973–77 Killed	1973–77 Sex ratio	1973–77 % kill	1966–77 Killed	1966–77 Sex ratio	1966–77 % kill
South Ellesmere Island	M	23	1	13.0	+128.5	49	1	30.4	72	1	21.3
(Jones Sound areas I, II)	F	14	0.61	7.9	+113.0	32	0.65	19.9	46	0.64	13.6
	Unsexed	–		–	–	–		–	–		–
Total		37		20.9	+118.9	81		50.3	118		34.9
North Devon Island	M	46	1	26.0	- 52.0	23	1	14.3	69	1	20.4
(Jones Sound areas III, IV, V)	F	25	0.54	14.1	- 50.0	12	0.52	7.5	37	0.54	10.9
	Unsexed	–		–	–	–		–	–		–
Total		71		40.1	- 50.7	35		21.7	106		31.4
Norwegian Bay	M	13	1	7.3	+100.0	23	1	14.3	36	1	10.7
(areas I, II, III)	F	8	0.62	4.5	+ 76.9	16	0.70	9.9	24	0.67	7.1
	Unsexed	–		–	–	–		–	–		–
Total		21		11.7	+ 85.7	39		24.2	60		17.8
East Ellesmere Island	M	2	1	1.1	0.0	1	1	0.6	3	1	0.9
	F	3	1.50	1.7	- 50.0	3	3.00	1.9	6	2.00	1.8
	Unsexed	–		–	–	–		–	–		–
Total		5		2.8	- 20.0	4		2.5	9		2.7
Jones Sound–	M	87	1	49.2	+ 10.3	97	1	60.2	184	1	54.4
Norwegian Bay area	F	58	0.67	32.8	+ 11.5	64	0.66	39.8	122	0.67	36.1
	Unsexed	32		18.1	–	–		–	32		9.5
Total		177(134)*		100.0	- 9.0	161(159)*		100.0	338(293)*		100.0

*Number of bears with data on sex and location of kill.

Table 8
Average ages and adult:sub-adult ratios of polar bears killed in Jones Sound–Norwegian Bay area, by sex, area, and time period, 1966–77. (Sub-adults, 3 and 4 years old; adults, 5 years old and older)

Area	Males		Females		Unsexed	
	Av. age (years)	AD:SA* ratio	Av. age (years)	AD:SA ratio	Av. age (years)	AD:SA ratio
South Ellesmere Island (Jones Sound areas I, II)						
1966–72	4.4 (n=7)	1:1.00 (n=6)	6.0 (n=2)	1:10 (n=2)	–	–
1973–77	6.6 (n=19)	1:0.70 (n=17)	5.1 (n=13)	1:0.60 (n=8)	–	–
1966–77	6.0 (n=26)	1:0.77 (n=23)	5.2 (n=15)	1:0.67 (n=10)	–	–
North Devon Island (Jones Sound areas III, IV, V)						
1966–72	5.8 (n=12)	1:1.20 (n=11)	6.0 (n=16)	1:0.56 (n=14)	–	–
1973–77	3.5 (n=2)	0 (n=1)	5.4 (n=5)	1:1.00 (n=4)	–	–
1966–77	5.4 (n=14)	1:1.00 (n=12)	5.9 (n=21)	1:0.66 (n=18)	–	–
Norwegian Bay (areas I, II, III)						
1966–72	9.0 (n=3)	0 (n=3)	8.25 (n=4)	1:0.33 (n=4)	–	–
1973–77	5.2 (n=9)	1:0.75 (n=7)	18.0 (n=2)	0 (n=2)	–	–
1966–77	6.2 (n=12)	1:0.43 (n=10)	11.5 (n=6)	1:0.20 (n=6)	–	–
East Ellesmere Island						
1966–72	2.0 (n=1)	–	3.0 (n=1)	–	–	–
1973–77	–	–	–	–	–	–
1966–77	2.0 (n=1)	–	3.0 (n=1)	–	–	–
Jones Sound–Norwegian Bay area						
1966–72	5.4 (n=25)	1:0.91 (n=21)	5.8 (n=27)	1:0.53 (n=23)	–	–
1973–77	6.8 (n=33)	1:0.56 (n=28)	6.0 (n=26)	1:0.50 (n=18)	4.0 (n=10)	1:0.75 (n=7)
1966–77	6.1 (n=58)	1:0.69 (n=49)	5.9 (n=53)	1:0.52 (n=41)	4.0 (n=10)	1:0.75 (n=7)

*AD = adult, SA = sub-adult.

Table 9
Numbers, sex ratios, average ages, and adult to sub-adult ratios of polar bears killed by Grise Fiord and Resolute Inuit, 1966–77. (Sub-adults, 3 and 4 years old; adults, 5 years old and older)

Category	Grise Fiord							Resolute						
	1966–72		1973–77		1966–77			1966–72		1973–77		1966–77		
	M	F	M	F	M	F	Unsexed	M	F	M	F	M	F	Unsexed
No. killed	87	58	97	64	184	122	32	128	59	112	30	240	89	
Sex ratio	1	0.67	1	0.66	1	0.66		1	0.46	1	0.27	1	0.37	
Av. age*	5.4	5.8	6.8	6.0	6.1	5.9	4.0	4.0	8.1	7.0	8.5	6.6	8.4	4.4
	n=25	n=27	n=33	n=26	n=58	n=53	n=10	n=6	n=7	n=50	n=12	n=56	n=19	n=13†
Adult: sub-adult	1:0.91	1:0.53	1:0.56	1:0.50	1:0.69	1:0.52	1:0.75	1:1.00	1:0.20	1:0.59	1:0.80	1:0.6	1:0.5	1:0.8
	n=21	n=23	n=28	n=18	n=49	n=41	n=7	n=4	n=6	n=46	n=9	n=50	n=15	n=9

*Average ages do not include cubs of the year, which are not part of the legal kill.
†Year and hunter's settlement only data available on these teeth.

was allotted to settlement(s) in adjacent areas, based on proposals submitted to NWT–FWS by the settlement(s). Quota allotments are in addition to the regular settlement quota. In 1975–76 the quota was allotted to Resolute and Grise Fiord. Six bears were taken by Grise Fiord hunters, but as these bears were taken outside the normal hunting range of these hunters, they are not considered further in this paper.

The hunting of polar bears forms an important part of the cultural and economic base of the community. Since 1972 a close check on the prices paid for polar bear hides has been maintained (Smith and Jonkel 1975*a* and *b*, Smith and Stirling 1976, Smith 1977 and 1978). During the early 1970's the prices paid rose very rapidly reaching a peak in December 1973, when the maximum price of $3600 was paid (Smith and Jonkel 1975*b*). Since then prices have declined considerably, but are still higher than prices paid in 1971–72. During the last six years (1971 to 1977) the harvesting of polar bears has grossed, on average, $20 000–25 000 annually for Grise Fiord. During 1973–74, when prices were highest, the gross income from the sale of polar bear hides was in the order of $45 000 for the settlement as a whole. During 1974–75 and 1975–76 estimated total revenues of $15 000–18 000 were much reduced from the previous year. Income for 1976–77 was estimated to be slightly higher ($20 000) as the market for polar bear hides has recovered slightly. The average known price paid to a native hunter for a polar bear hide taken in Canada in 1976–77 was $624 (Smith 1978). In general, the larger the hide the more valuable it is, but the condition of the hunted bear and the care taken in preparing the hide also markedly affect its value (Smith and Stirling 1976).

Maternity denning and productivity

The tracks of 75 family groups were recorded in the Jones Sound–Norwegian Bay area between 1971 and 1973, and in 1977. Three family groups each with two cubs of the year were sighted. Fifty-nine of the tracks and the six possible maternity dens located on the surveys were concentrated on northern Devon Island along the coast of Bear Bay, between Cape Sparbo and Colin Archer Peninsula (Table 10, Fig. 6). Grise Fiord Inuit have also reported maternity denning in these areas. Historical evidence indicates that denning may have occurred farther to the east in the Cape Sparbo–Belcher Point area. In February 1909, Cook (1911) discovered a den containing two cubs near Cape Sparbo. The female was absent at the time. On 6 April 1926 a female and two cubs were killed near Belcher Point (Joy 1926). Observations of tracks indicate that Graham Island, the southern coast of Axel Heiberg Island, and the western coast of the Bjorne Peninsula, Ellesmere Island, and the Smith Bay–Makinson Inlet area on southeastern Ellesmere Island may be maternity denning areas.

Female polar bears are thought to give birth to their young (usually two, each weighing about 0.5 kg) in late December–early January, and then remain within the maternity den for several weeks. The survey data from this study indicate that after breaking out of the maternity den, some time between late March and mid-April, the family groups remain in the vicinity of the den for three to five days and then return to it, or the female may dig a temporary den (or dens) nearby, in which to rest and suckle the young (Jonkel *et al.* 1972). Playing may occur around the den before the bears eventually depart for the nearest sea-ice to hunt for seals. Stirling *et al.* (1975) suggested that at this time the bears tend to segregate themselves from the rest of the population and feed on ringed seal pups on the land-fast ice mainly in the bays. The length of time spent in any area probably depends upon hunting success and disturbance from other animals. From the tracks it was apparent that the family groups remained in the bays or inlets for 5 to 8 days, moving 2 to 5 km daily, with frequent stops for rest and nursing. Females with newborn cubs recorded on the sea ice prior to the middle of April were probably close to their maternity denning area. However, later sightings were probably progressively less reliable with time as specific indicators of where denning occurred. Capture, sighting, and track data for females with cubs of the year shown in Figure 6 are coded to indicate their value relative to the identification of denning areas.

Most females with newborn cubs appeared to have emerged from the denning areas between 20 March and 20 April, with a peak between 1 and 15 April. On northern Devon Island, 51 of the 59 tracks of family groups were recorded prior to mid-April. Harington (1968), using data gathered at lower latitudes, found that most females with newborn cubs left their dens during the third week in March. The peak time of emergence for family groups farther south in Ontario and Manitoba was found to be during the first half of March (Jonkel *et al.* 1972 and 1976, Stirling *et al.* 1977*b*).

The number and density of tracks sighted each year during the ground surveys on northern Devon Island varied markedly (Table 10). In 1971, tracks of 1.95 cubs/100 km surveyed were seen; in 1972, 3.46/100 km; but in 1973, only 0.81/100 km. The number of cubs older than one year seen or tracked per 100 km surveyed also decreased from 0.89 and 1.19/100 km in 1971 and 1972 respectively to 0.69 in 1973. The apparent decrease in productivity cannot be attributed to weather and snow conditions, which were more favourable for tracking in 1973 than in either 1971 or 1972. Even acknowledging the possibility of some duplication, the number of tracks observed each year provides a minimum estimate of the number of cubs produced.

The tracks of 14 family groups, including one group which was captured and eartagged, were recorded during April and May 1971–73 surveys in the Norwegian Bay area (Fig. 6). Tracks of seven of the groups were sighted before 1 May.

In the Smith Bay–Makinson Inlet area one family group was sighted and another tracked during April 1977 (Chowns 1977). However, wind conditions hindered track identification throughout much of the survey.

The average litter size of cubs produced along the northern Devon Island coast, based on track observations of family groups during 1971–73, was 1.7 (n = 59) (Table 10). Average litter sizes were not calculated for the Norwegian Bay and Makinson Inlet areas because of the small number of tracks observed.

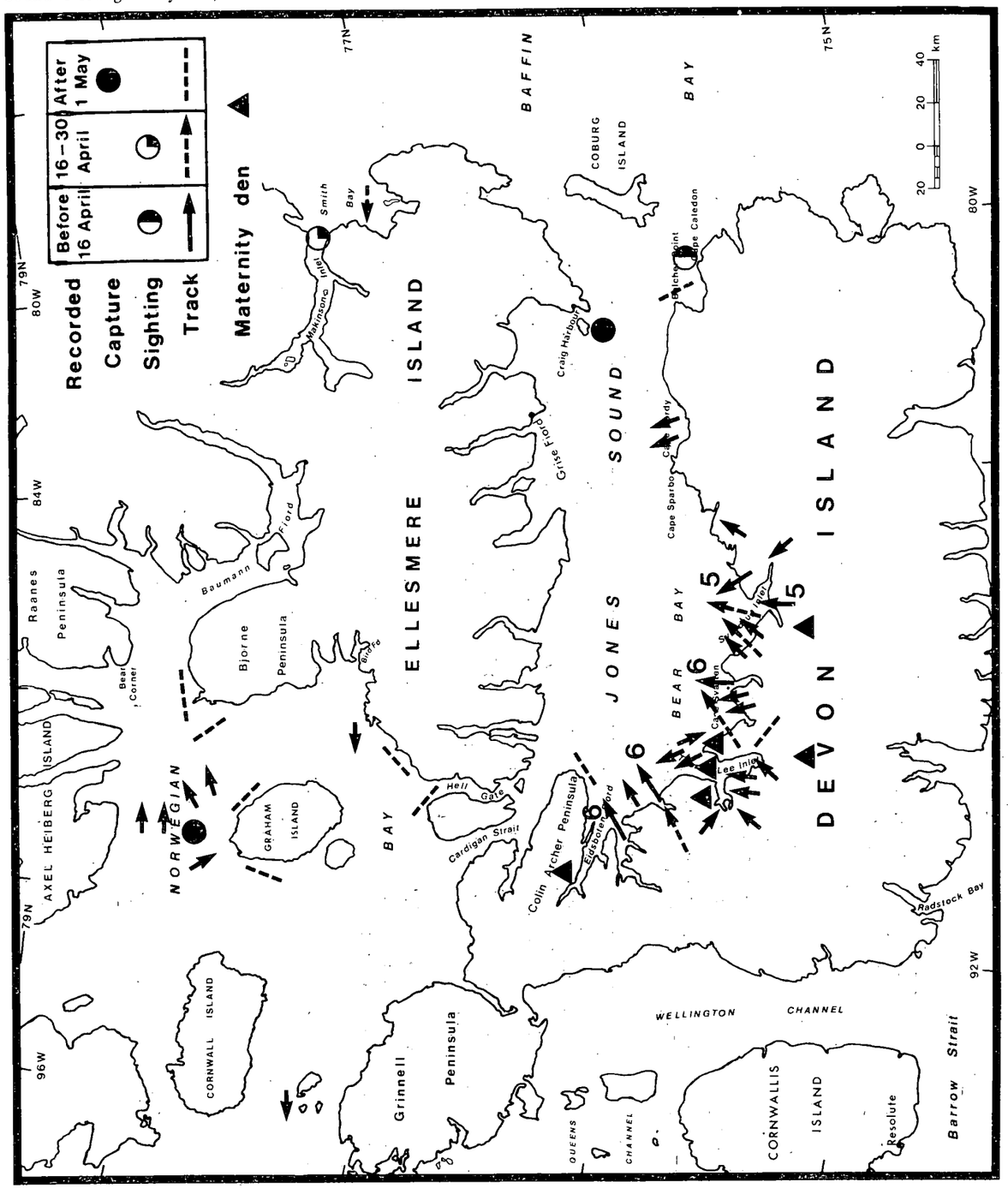
Tracks of females with cubs older than one year were less numerous than those of females with newborn cubs. Families with older cubs appeared to move onto the ice earlier,

Table 10
Tracks and litter sizes of family groups with cubs of the year observed prior to 1 May in Jones Sound by year, 1971–73

	Ground surveys								Aerial surveys				Total			
		No. fem.								No. fem.						
Year	No. fam. gps.	1 cub	2 cubs	3 cubs	Tracks/ 100 km	Av. lit. size	SD		No. fam. gps.	1 cub	2 cubs	3 cubs	No. fam. gps.	No. cubs	Av. lit. size	SD
1971	12	3	8	1	1.95	1.8	0.58		–	–	–	–	12	22	1.8	0.58
1972	28	10	17	1	3.46	1.7	0.55		6*	–	6	–	34	59	1.7	0.51
1973	8	3	5	–	0.81	1.6	0.52		5	2	3	–	13	21	1.6*	0.52
1971–1973	48	16	30	2		1.7	0.54		11	2	9		59	102	1.7	0.54

*Includes sightings of two family groups.

Figure 6
Tracks, sightings, and captures of family groups with cubs of the year, and locations of possible maternity dens in Jones Sound–Norwegian Bay area, 1971–73 and 1977



between the last week in March and the first week in April. In contrast to females with newborn cubs, the older family groups appeared immediately to move offshore, possibly to better feeding areas, reflecting the ability of older cubs to travel longer distances. None of those family groups was backtracked. Harington (1968) cites instances of females and older cubs and single bears both active and in dens in January. Van de Velde (1957, 1971) recorded females with cubs older than one year in dens on the Simpson Peninsula, NWT. Generally it is believed that only pregnant females den for any extended period.

Six possible maternity dens were located along the coastal area of Bear Bay on northern Devon Island (Fig. 6). One apparent maternity den was found on the sea ice in Thomas Lee Inlet on 13 April 1972. The deserted den had been occupied by a female with two cubs.

Two dens of single bears were found on northern Devon Island. One was located on 22 March 1972 in a pressure ridge about 300 m offshore, 25 km west of Truelove Lowland, southwest of Cape Sparbo. The second den was found on 19 March 1971 about 500 m inland on the eastern shore of Sverdrup Inlet. Whether these dens were made by females who had lost their young, by non-pregnant females, or by males is unknown.

Evidence gathered during the spring 1971–73 and 1977 surveys indicates that northern Devon Island is a maternity denning area. However, the number of cubs produced and the density of dens there are probably lower than those reported for other areas (Harington 1968, Jonkel *et al.* 1972, Uspenski and Kistchinski 1972, Larsen 1974, Stirling *et al.* 1977*b*).

Summer retreats

Captures and sightings of bears, and areas surveyed in August 1973 and 1974 in the Jones Sound–Norwegian Bay area, are shown in Figure 7. The dates of the surveys are given in Table 1, but coverage of the area was by no means complete. The northern Devon Island coast was surveyed for polar bears and muskoxen in August 1973 and 1974, and the northern Grinnell Peninsula coast and the coast of southwestern Ellesmere Island between Hell Gate and Bird Fiord were briefly surveyed for polar bears and seabirds in August 1973. No other areas were surveyed during the summer.

Most bears were sighted close to the coast along northern Devon Island between Sverdrup Inlet and Thomas Lee Inlet, and along the northern Grinnell Peninsula. These areas are probably important as summer retreats. Other areas may exist, but until a complete survey of the area is made it is not possible to delineate them. Cook (1911) in early September 1908 found polar bears to be relatively abundant in the Cape Hardy area. Sightings and tracks have been reported crossing the ice-cap of eastern Devon Island (Harington 1963, Polar Continental Shelf Project pers. comm., and this study). Similar observations have been made on the glaciers of Bylot Island and Borden Peninsula (Jonkel 1976).

The importance of summer retreats to the polar bear in the High Arctic is not clear. In the Jones Sound–Norwegian Bay area the ice rarely dissipates completely, although few ice floes persist in Jones Sound in late August–early September. Consequently the bears can remain with the ice almost all year and are not forced to spend long periods on land. Further south, in the Hudson Bay and James Bay area, where the annual ice cover melts completely every year and there are several months of no ice, bears are forced to remain on land for much of the ice-free period (Jonkel *et al.* 1976, Stirling *et al.* 1977*b*). Because of their shorter use and the availability of alternative areas, summer retreats may be less critical in the High Arctic than in the Hudson Bay–James Bay area.

Recommendations

The small number of bears tagged, the preference for tagging family groups, and the lack of tagging programs in many parts of the Jones Sound–Norwegian Bay area make any conclusions tentative. Consequently, a carefully designed quantitative population ecology study for three years throughout the Jones Sound–Norwegian Bay area (including the southeastern Ellesmere Island area) will probably be necessary for acquiring an adequate data base for management purposes.

Acknowledgements

We gratefully acknowledge the logistical support provided by CWS, the Polar Continental Shelf Project, and the Northwest Territories Fish and Wildlife Service. We are grateful to Simonie Akpaleeapik, Elijah Nutara, Imoshee Nutarayuk, and Okookoo Nutarayuk (all from Grise Fiord), Ningyou (Pond Inlet, formerly from Grise Fiord) and Lazarus Kyak (deceased, Pond Inlet) who acted as guides on the CWS ground surveys. R.H. Russell and D.N. Nettleship (both from CWS) helped in the field and W. Calvert (CWS) in the laboratory. B. Jesudasen (Grise Fiord) is thanked for his help as interpreter and in the organization of the ground surveys, and also for his hospitality. Corporals H. Johnston and A. Kerbyson (RCM Police, Grise Fiord) helped in the organization of the ground surveys. We thank B. Hubert (University of Manitoba) for his hospitality at the Arctic Institute of North America's camp on northern Devon Island. Pauline Smith helped in the writing of this paper and in the preparation of the maps.

References

Bowes, G.W. and C.J. Jonkel. 1975. Presence and distribution of polychlorinated biphenyls (PCB) in arctic and subarctic marine food chains. J. Fish. Res. Board Can. 32(11): 2111–2123.

Bruemmer, F. 1968. Eskimos of Grise Fiord. Can. Geogr. J. 77(2):64–71.

Chowns, T. 1977. Polar bear denning survey. 1977. South coast of Ellesmere Island and Makinson Inlet. Northwest Territ. Fish Wildl. Serv. Unpubl. rep. 12 pp.

Collin, A.E. 1963. Waters of the Canadian Arctic Archipelago. Pages 123–136 *in* Proceedings of the Arctic Basin Symposium. October 1962. Hershey, Penn. Arctic Inst. North Am.

Cook, F.A. 1911. My attainment of the Pole. Mitchell Kennedy, New York. 604 pp.

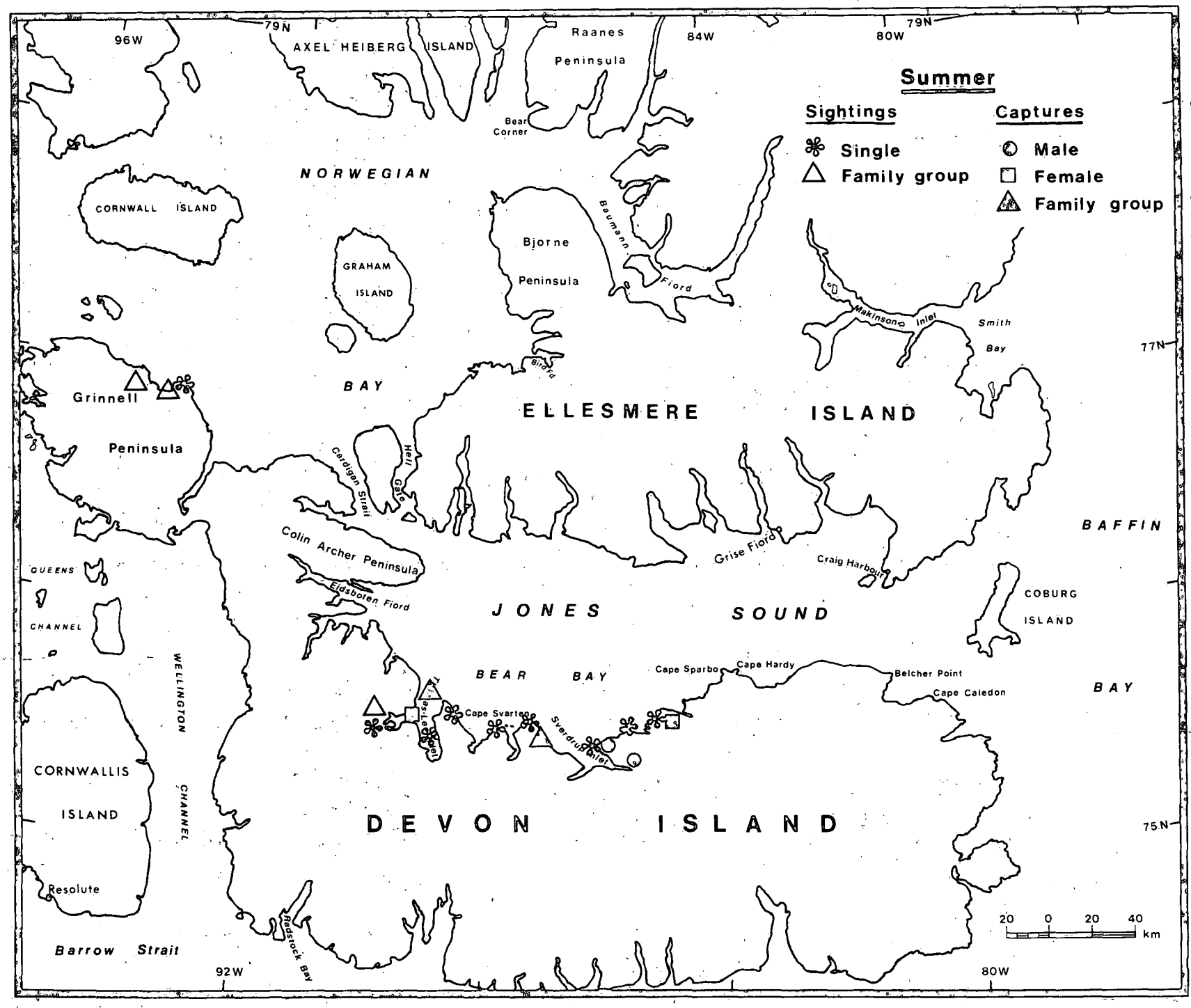


Figure 7
Polar bear captures and sightings, August 1973–74