ABUNDANCE, DISTRIBUTION AND POPULATION STRUCTURE OF POLAR BEARS IN THE LOWER CENTRAL ARCTIC ISLANDS

R. E. SCHWEINSBURG

D. J. FURNELL

S. J. MILLER

N.W.T. WILDLIFE SERVICE

1981

Northwest Territories Renewable Resources
Wildlife Service

ABSTRACT

Polar bear population studies were conducted in the lower central Arctic Islands from 1972 to 1978. Potential bear habitats were searched by helicopter during late March to early June. Bears were immobilized by drugs administered with a dart gun and marked with ear tags, lip tatoos and numbers printed on the fur. Standard biological measurements were taken. Ages were later determined from the cementum layer in an extracted pre-molar. The age distribution was compared with a sample of bears taken by hunters. The capture-recapture information indicated that polar bears largely confined their movement within Zone E as designated by the Federal-Provincial Polar Bear Technical Research and Management Committee. Although we recognized four sub-groups there was a limited exchange of marked animals among groups. There was a high degree of fidelity to specific concentration areas. Females first bred at 4 years of age and had an average parturition probility of 0.287 for all age classes. The mean litter size was 1.53 and the mean natality rate was 0.43 cubs per female per year. The total population was conservatively estimated at 1100 animals with an equal sex ratio. Males were selectively killed by hunters, mainly from four communities although a few were taken from three other communities. The annual production was estimated at 152 cubs and the annual mortality was 88 animals of which 54 were taken by hunters. An increase in the harvest quota was recommended.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

In 1972, the Northwest Territories Wildlife Service (N.W.T.W.S.) began research on the abundance, distribution, and population structure of polar bears (Ursus maritimus Phipps) in the lower central Arctic Islands (Fig. 1). This area is called Zone E by the Federal-Provincial Polar Bear Technical Research and Management Committee. Inuit from Cambridge Bay, Gjoa Haven, Spence Bay and Pelly Bay kill polar bears from this area (Igloolik and Arctic Bay conduct a limited hunt on the eastern periphery) under a quota system. The quotas were originally based on kill records and subjective estimates, not on information about the biology of polar bears. This study was intended to provide data on polar bear population structure and productivity to determine the number of bears which could be shot annually without depleting the population.

The study which began in M'Clintock Channel and Victoria Strait was expanded in 1973 to include the Hadley Bay region of northeast Victoria Island because the Inuit of Cambridge Bay reported concentrations of bears and bear dens there. With the exception of a preliminary survey in 1972, Boothia Peninsula was included in the study area only when funding was increased in 1975 through the Arctic Islands Pipeline study.

Previously, little was known about polar bears in the area. Manning and MacPherson (1961) reported polar bears on and around Prince of Wales Island; Stirling et al. (1975, 1977a) obtained tag returns from polar bears marked in the Beaufort Sea and shot by hunters in the study area. However, data on abundance, subpopulation limits, seasonal distribution, critical habitat

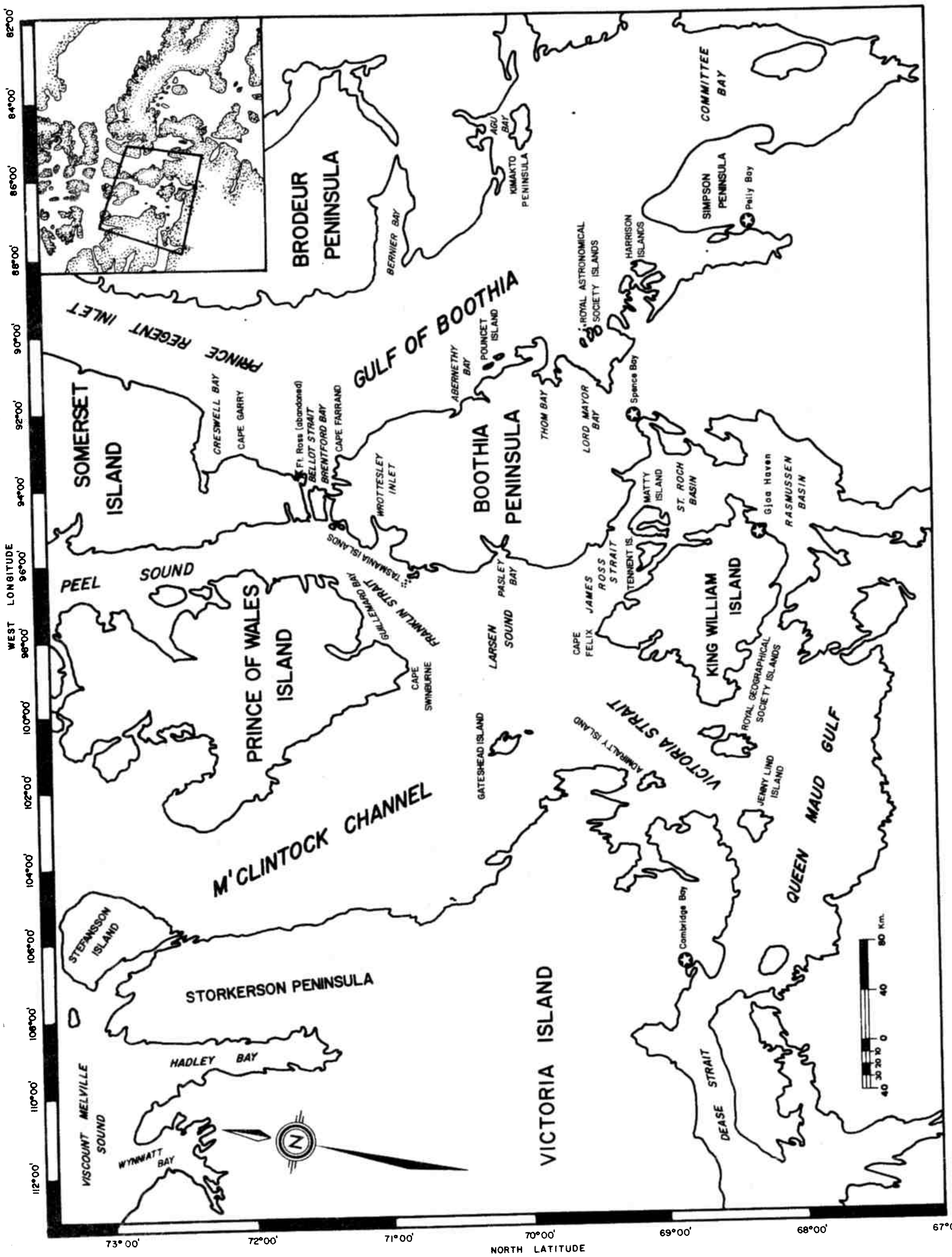

Figure I. The Central Arctic Islands Polar Bear Study Area locations, and the population structure of polar bears in the study area were unknown.

The objectives of this study were:

1) To determine the range limits of the subpopulation(s) in Zone E;
2) To determine sex and age structure, as well as productivity and mortality rates in the subpopulation;
3) To determine seasonal distribution and movements;
4) To locate denning, feeding and summer retreat areas;
5) To determine the subpopulation size;
6) To determine present hunting patterns of settlements within the study area; and
7) To recommend quotas for the kill by hunters from Cambridge Bay, Gjoa Haven, Spence Bay and Pelly Bay.

STUDY AREA

General

The study area included Wynniatt Bay, Hadley Bay, parts of Viscount Melville Sound, the south end of M'Clintock Channel, Victoria Strait, James Ross Strait, Franklin Strait, the Gulf of Boothia, the south portion of Prince Regent Inlet, Committee Bay, Pelly Bay, and intervening islands and channels (Fig. 1). This area approximates Zone E of the Federal-Provincial Polar Bear Technical Committee.

Physiography

The main geological provinces of the study area are the Arctic Platform or lowlands interrupted by the Boothia Uplift and the Minto Arch of the Canadian Shield (Fig. 2). The Arctic Platform consists of a Precambrian basement overlain by undisturbed Cambrian to Late Devonian sediments. The Boothia Uplift (occurring through Boothia Peninsula, Somerset Island, and southeast Prince of Wales Island) is composed of Precambrian rocks flanked by Cambrian to Lower Devonian sedimentary deposits. The Minto Arch is a 400 km long inlier of Precambrian rocks flanked by gently inclined Paleozoic strata. It extends from Hadley Bay southwest across Victoria Island. Complete details of these formations are given in Thorsteinsson and Tozer (1970).

At the northeast end of the Minto Arch, the coastlines of Wynniatt Bay and north Hadley Bay are steep bluffs with little coastal plain. There is less relief at the south end of Hadley Bay, Stefansson Island, and northeast

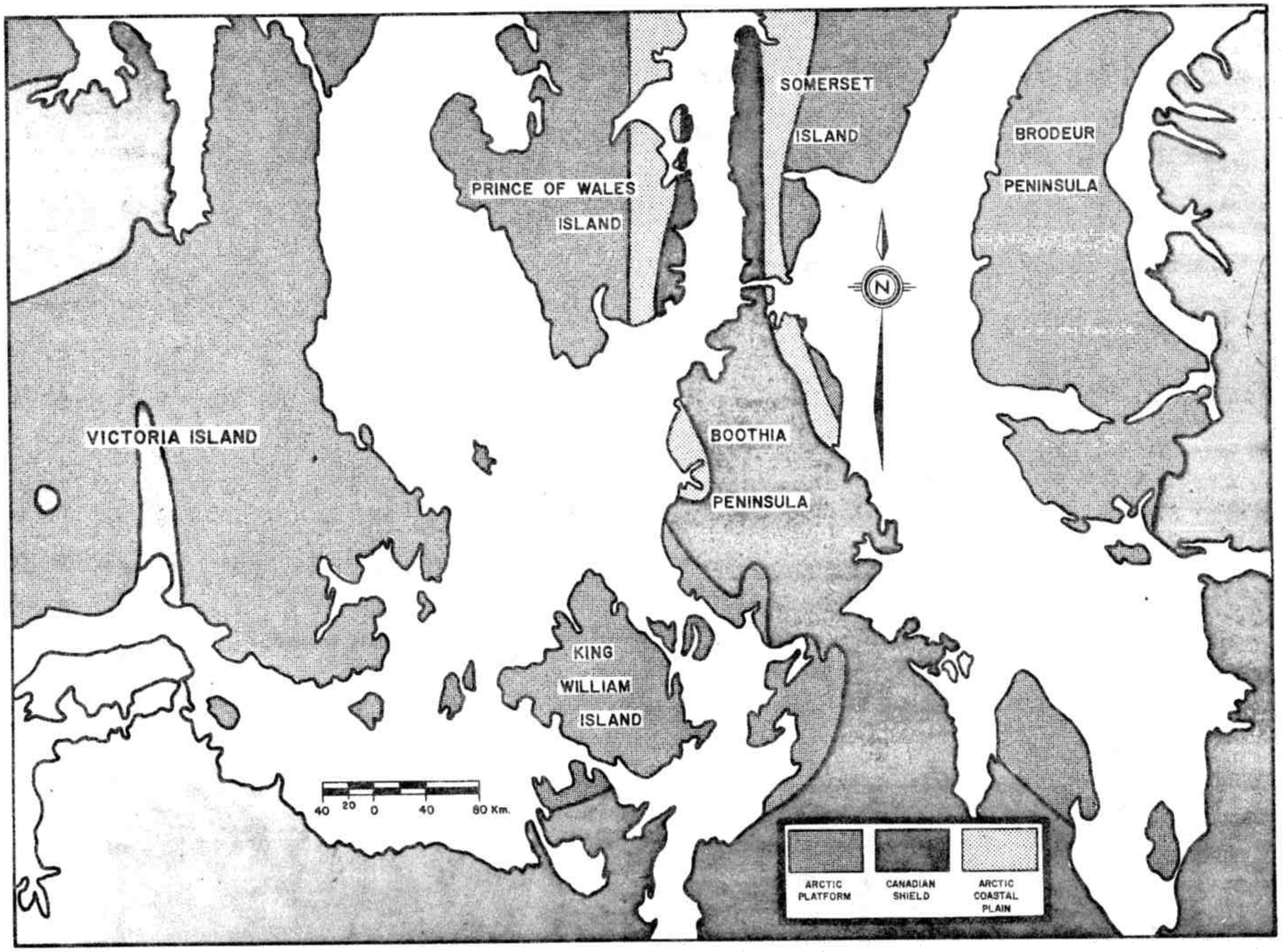

Figure 2. Geological provinces of the study area (adapted from Thorsteinsson and Tozer 1970).

Victoria Island and from an aircraft it is often difficult to discern the boundary of land and sea in winter. This is especially true of the coastlines of eastern Victoria Island, Gateshead Island, the south end of Prince of Wales Island, Royal Geographical Society Islands, and King William Island which all have low, gently rolling relief and do not exceed a few hundred metres in elevation.

Because of the Boothia Uplift, the general low-lying nature of the landscape changes drastically along Boothia Peninsula, Somerset Island, and the northeast side of Prince of Wales Island. Here much of the shoreline consists of steep bluffs or rocky slopes. In some areas, particularly the southeast and northeast sides of Boothia Peninsula and the southeast side of Somerset Island, the rocky uplands are separated from the coast by a wide coastal plain. Details of topography, drainage and coastline are given in Dunbar and Greenaway (1956).

Ice

The following ice condition descriptions are from Dunbar and Greenaway (1956) and our observations.

Prince Regent Inlet to Committee Bay

New ice begins forming in October. The west side of Prince Regent Inlet freezes last. In Prince Regent Inlet and the Gulf of Boothia, the ice pack moves during the winter and a lead usually opens along the coasts of Somerset Island and Boothia Peninsula. In some years the ice in Committee Bay remains unconsolidated. Bellot Strait freezes over except for two patches near the east end kept open by currents.

In Prince Regent Inlet, ice starts to break up in late June and a counter clockwise movement packs it into the Gulf of Boothia, with some ice passing through Fury and Hecla Strait into Foxe Basin. Open water continues south into Prince Regent Inlet to about the confluence with the Gulf of Boothia. Some rough, unconsolidated ice remains in the lower Gulf of Boothia and Committee Bay throughout the summer. Occasionally, flat puddled ice remains in the inner reaches of Brentford and Creswell Bays until the middle or end of August.

Peel Sound to James Ross Strait

A continuous sheet of pack ice covers Peel Sound, Franklin Strait, Larsen Sound and James Ross Strait from October until late spring. Cracks and leads begin to appear in June. By late June, the ice starts to break up. North Peel Sound usually becomes ice free, but the rest of the Strait frequently contains pack ice. There is little or no movement of broken ice out of Franklin and James Ross Straits. The amount of open water in these straits depends on melting only; in some years much ice remains and in others little ice is present.

M'Clintock Channel and Victoria Strait

Ice remains throughout the year and by late September new ice forms among the floes and along the shores. By November the pack consolidates into a sheet of rough ice. In summer, melting occurs along the coasts, but the pack loosens very little except in south Victoria Strait.

Queen Maud Gulf to Spence Bay

About October 1st, the bays freeze over and by early December, Queen Maud Gulf is covered by a sheet of ice. Open water appears in July.

Viscount Melville Sound

The ice in this area never completely disappears. New ice forms in September, but the pack does not usually consolidate until well into December. Puddling and leads appear in July and melt-water from the land produces narrow open leads along the shore. The southern reaches of Hadley Bay and Wynniatt Bay are usually ice free by mid-August, but in 1977 neither bay was completely void of ice (Anon, 1977, Atmospheric Environment Service Ice Condition Maps).

Climate

Climatic conditions in the study area are from reports of the Meteorological Branch, Department of Transport, Canada, 1970.

Summer in the study area occurs during July and August when the landscape is free of ice and snow. The first day of spring is defined as the date on which the average air temperature rises above 0° C. Conversely, autumn begins with the first day below 0° C. Spring arrives usually between 1 June and 15 June, autumn between 1 September and 15 September. Spring and autumn usually last about 2 weeks each; the remainder of the year is winter.

Climatological tables for Cambridge Bay, Pelly Bay and Spence Bay are given in Appendix I. We were unable to locate data for Gjoa Haven.

Currents

The following summary of surface currents in the area draws heavily from Dunbar and Greenaway (1956) and Collin (1958).

A strong current flows south along the east coast of Somerset Island and Boothia Peninsula (Fig. 3). Part returns up the east side of Prince Regent Inlet and part escapes through Fury and Hecla Strait into Foxe Basin. Further west in Peel Sound, M'Clintock Channel and Victoria Strait, the currents probably have a general weak southern flow. We believe that tidal currents are more important in this area than further east. Strong currents, perhaps tidal, keep water open in Bellot Strait, Hadley Bay, and Wynniatt Bay, and create weak patches in the ice around Tasmania Islands.

Plant Life, Terrestrial Mammals and Birds

Because of their indirect relationship to polar bears, only references to these subjects are given. Adaptations of Arctic plants are discussed in Savile (1972). Porsild (1955) describes the vascular flora of the western Archipelago. Descriptions of terrestrial mammals are found in Banfield (1974), and of birds in Godfrey (1966).

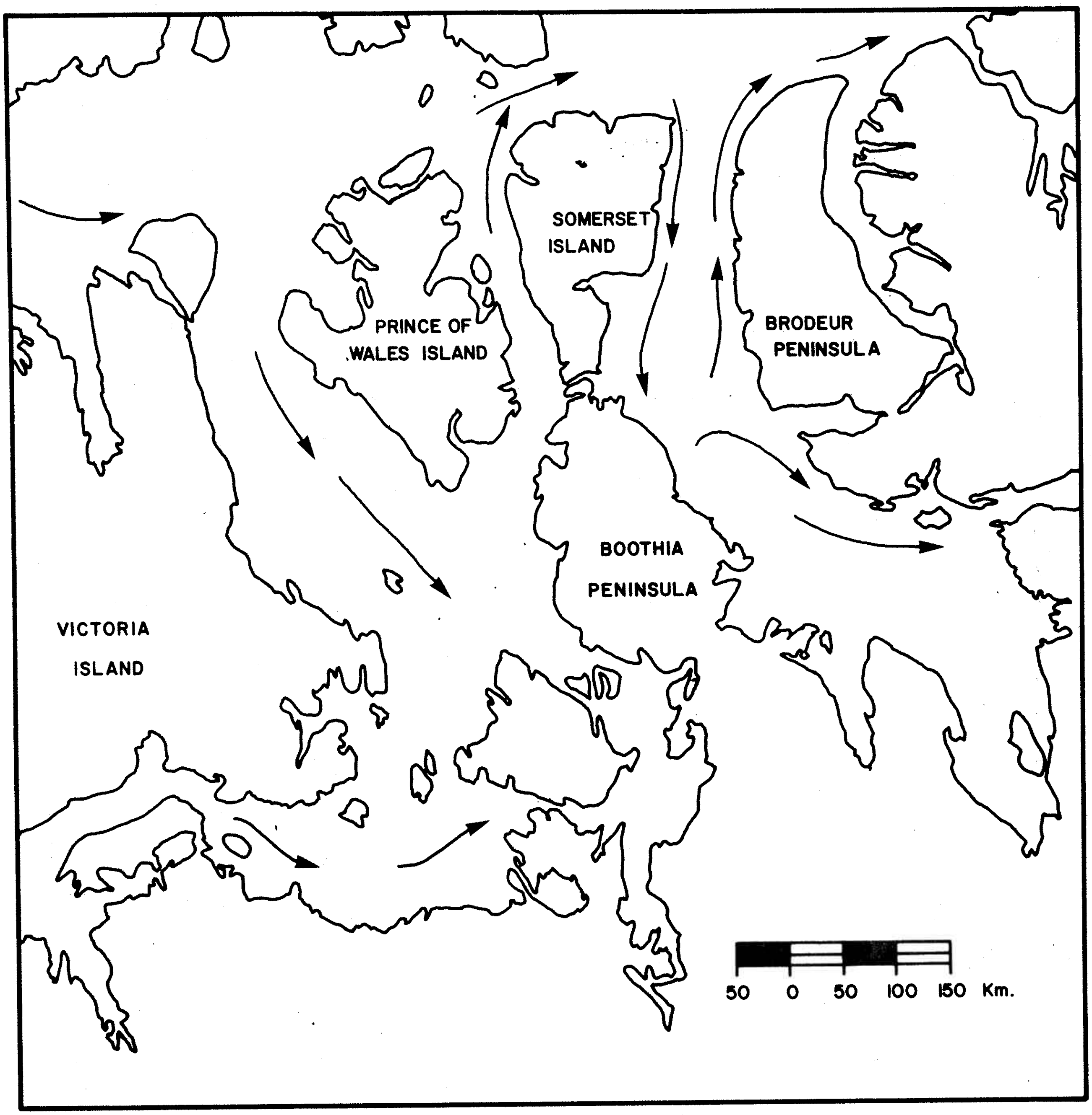

Figure 3. Ocean surface currents in the study area (adapted from Collin 1958).

Marine Mammals

Ringed seals (Phoca hispida) and bearded seals (Erignathus barbatus) range throughout the study area. Ringed seals are concentrated in Brentford Bay and Creswell Bay in June. Numerous ringed seals were observed north of Tasmania Island, in Bellot Strait, and along the open leads on the east coast of Boothia Peninsula. Hundreds, if not thousands, of beluga whales (Delphinapterus leucas) congregate along the east side of Somerset Island in the summer, especially in Creswell Bay. Some narwhals (Monodon moncerus) also occur in Prince Regent Inlet, Creswell Bay and Bellot Strait during the summer. Occasionally a narwhal or a walrus (Odobenus rosmarus) is killed as far south as Committee Bay. Walruses sometimes occur in Prince Regent Inlet.

MATERIALS AND METHODS

Field Techniques

To assess quotas, we first established the range of the hunted polar bear population, then made estimates of abundance, productivity, and mortality using mark-recapture techniques and age determination.

We used a helicopter to find and capture polar bears, as described by Lentfer (1968) and Larsen (1971). The bears were immobilized with Sernylan (phencyclidine hydrochloride), the dosage approximating 100 mg/45 kg body weight. Some bears also received the tranquilizer Sparine (promazine hydrochloride) in varying dosages.

Initial searches to locate tracks and bears covered wide areas. After areas of concentration were found, searches were confined to places in which bears could be captured safely and efficiently. We avoided areas of extremely rough or unconsolidated ice because of the danger both to our crews and to drugged bears. Most capture surveys took place in late winter and to a lesser extent in summer (Table 1). Family groups and some single bears were not captured during the summer because there was danger that drugged bears might drown. Otherwise, we captured most of the bears we found. Once immobilized, the bears were marked with individually numbered aluminium/polyurethane ear tags made by Western Industrial Research and Training Centre, Edmonton, Alberta. These replaced the plastic Rototags used until 1975 which often failed through breakage. Bears were also tattooed on both upper lips with a number corresponding to the ear tags. Data recorded for each bear included weight, sex, total length, thoracic girth, physical

Table 1. Areas searched and results of the helicopter surveys.

Area	No. of Days of Helicopter Survey		No. of Bears	
	Spring	Summer	Captured	Not Captured
1972				
Mainland Coast	3	0	0	0
Gateshead Island	4	0	3	0
Royal Geological Society Islands	4	0	7	0
Cape Margaret, Boothia	2	0	3	2
1973				
Cape Stang, Victoria Island	1	0	1	0
Gateshead Island	5	0	10	3
Prince of Wales Island	1	0	1	0
Hadley Bay	4	0	12	5
Royal Geographic Islands	4	0	10	0
1974				
Hadley Bay	7	0	12	4
Kilian & Stefansson Islands	1	0	3	0
Gateshead Island & Victoria Strait	9	0	18	4
1975				
Hadley Bay	6	0	20	2
Kilian & Stefansson Islands	2	0	11	0
Hadley & Wynniatt Bays	2	0	8	0
Royal Geological Society Isalnds	4	0	5	3
Gateshead Island	2	0	0	0
East Coast Boothia Peninsula	0	2	2	0
Franklin Strait, West Coast Boothia Pensula	0	2	1	0
1976				
Brentford Bay	1	1	12	15
East Coast Boothia Peninsula	3	2	18	0
Franklin Strait-Larsen Sound	8	1	57	16
Astronomical Soc. Is - Lord Mayor Bay	2	0	9	0
Victoria Strait	3	0	12	2
Southern Somerset Island	0	3	0	0

Table 1. Cont'd

Area	No. of Days of Helicopter Survey Spring	Summer	No. of Bears Captured	Not Captured
<u>1977</u>				
Brentford Bay	1	0	0	0
Franklin Strait-Larsen Sound	10	0	95	5
East Coast Boothia Peninsula-Astronamical Society Is.-Harrison Islands	7	0	54	3
Victoria Strait	5	0	47	0
<u>1978</u>				
East Coast Boothia Peninsula	1	0	7	0
Lord Mayor Bay, Astronamical Society Islands, Thom Bay, Harrison Is.-N. Pelly Bay	8	0	22	1

condition and any abnormalities. The first premolar (a small, vestigial tooth) was pulled for age determination. Some bears were painted with a number using Lady Clairol hair dye for subsequent identification from the air.

We identified individual bears later from painted numbers, by recapturing ear-tagged specimens, or from tags returned by hunters. We determined movements and ranges from the bears' capture and recapture locations.

Recording of Tracks

Tracks were useful in determining concentration areas and distribution of bears. During March and April, tracks of females with cubs of the year helped us to locate maternity denning areas, and tracks on shore in summer revealed where bears probably spent the ice-free period.

Denning Surveys

Denning surveys were carried out by helicopter and snowmobile. In April, captured or sighted females with cubs of the year were probably close to denning areas, and we could sometimes follow their tracks by helicopter back to land and ultimately to the den. For ground surveys we used two snowmobiles. The crew camped on the ice and fuel was cached along proposed routes. We drove parallel to the shore and when bear tracks were found, we followed them back to the dens whenever possible. Sometimes dens were spotted by observing heaps of excavated snow at the entrance. Because of variations in tracking conditions and terrain, and the relatively long period over which bear families emerge compared with the short time of the surveys, denning surveys could not accurately determine the number of cubs produced in an area.

Specimen Collection from Inuit Hunters

Rewards were paid for returns of tags or tag numbers and the lower jaws of killed bears. Collections were conducted by N.W.T. Wildlife Officers in each settlement as part of the N.W.T.W.S. Kill Statistics program.

Hunting Patterns

To determine whether the ratio of male to female bears killed by hunters from the different Zone E settlements varied seasonally, a Chi-square analysis was applied to the spring and autumn kill (hunting season was between 1 October and 31 May) of each settlement and for all the communities together. To establish if Inuit tend to selectively hunt one sex, a Chi-square analysis was used to test whether the sex ratio of the kill differed from that of the capture sample (i.e. 1:1).

Laboratory Techniques

Ages of bears were determined by counting the annual growth rings in the cementum of teeth collected from captured or hunter-killed bears. The methods of Thomas and Bandy (1973) were modified according to Stirling et al. (1977b).

Data Analysis

Population Estimates

Population estimates, based on mark-recapture data, were calculated using a modified Peterson method (DeMaster et al. 1980). This technique was used because we had insufficient samples to provide accurate population estimates by the Jolly-Seber method.

The modified Peterson technique assumes that:

1) The annual survival rate (Ø) and its variance (var Ø) are known, are constant throughout the sampling period, and are the same for marked and unmarked polar bears.
2) All animals have an equal probability of being captured.
3) Animals do not lose their marks and all marks are reported when recovered.
4) All samples are instantaneous.
5) All polar bears caught in the ith sample have the same probability of being returned to the population as bears in any other sample.

To address these assumptions the following conditions are presented. The survival rate (Ø) used in the population estimate calculations was 0.92 (based on the compliment of mean mortality rate from life table data (Caughley 1977) with an arbitrarily assigned variance (var Ø) of 0.0037 (Demaster et al. 1980)).

The use of helicopters eliminated problems of unequal capture probability because few bears were able to escape. The distribution of tracks from rough to smooth ice indicated bears never occurred solely in an area where they could not be caught. In cases where ear tags were lost, lip tattoos provided ready identification of individuals. Only recaptures, not hunter returns, were used in calculating population estimates and therefore all marks can be assumed reported. Sampling was not instantaneous; however unique marks prevented double counting animals, thus eliminating the bias introduced by prolonged sampling. With the field techniques employed, handling losses were not a problem and one can assume animals have a 100% probability of returning to the population.

The capture-recapture data used in the population estimate calculations were collected between 1972 and 1978 from the entire E Zon*excluding Hadley Bay. The Hadley Bay population was estimated separately because of its isolated nature. For comparison, we estimated the number of bears in the smaller groups as well.

Age Structure

Age structure samples were taken from all bears of known age in Zone E from four sources; the female kill sample, the female capture sample, the male kill sample and the male capture sample. To determine if age class frequencies were independent of sex, capture and kill samples were compared separately using 2 X 17 and 2 X 12 contingency tables respectively. In comparing the capture samples, bears of all ages were considered, with animals older than 14 years grouped into two classes to provide sufficiently high expected frequencies. Only bears older than 1 year were considered in comparing the male and female kill samples as N.W.T. Wildlife Regulations select against younger individuals. In the kill sample comparison, bears greater than 10 years were grouped into three classes to yield sufficiently high expected frequencies. The 2 X C contingency table has been demonstrated to be a robust test and produces a good approximation of the Chi-square distribution if all expected frequencies are greater than 1 (Lewontin and Felsenstein 1965).

After demonstrating a lack of sex dependence for kill and capture class frequencies, age classes for both sexes were pooled and the kill and capture samples tested for sample independence in a 2 x 15 contingency table. Only bears older than 1 year were compared and frequencies of bears older than 14 were grouped into two categories to give expected frequencies of at least 1.00.

The age class frequencies of the kill and capture samples were shown to be independent of the sample source and were pooled. Before pooling, values were derived for the 0 and 1 year age class of the kill sample based on the proportion of these age classes in the capture sample.

Because life table calculations require that each age class have a lower frequency than the one preceding, it was necessary to smooth the frequencies of the pooled sample. As log-polynomial smoothing (Caughley 1977, Snedecor and Cochran 1967) was unnecessary, the pooled sample was fitted to a linear regression (Zar 1974). The regression was then expanded to equal a sample as large as the estimated population of Zone E. The expanded regression was used to predict age class frequencies (fx) for the life table and the remaining life table statistics calculated as presented by Caughley (1977).

Productivity

Productivity was estimated using observations of family groups made during capture operations. Data were gathered from all females of known age captured in Zone E from 1975 to 1978. Cubs captured prior to 1975 had not been aged by tooth analysis and could not be used.

In calculating productivity three statistics were employed: age-specific probability of parturition, age-specific litter size, and age-specific natality rate (mx). The methods of calculation were taken from Stirling et al. (1978). Mortality of yearlings and 2 year olds was not incorporated in age specific calculations but was allowed for in the over all mean.

Age-specific probability of parturition:

The following formula was used to calculate age-specific probability of parturition:

$$\frac{\text{Number of X females with cubs of the year} + \text{Number of X + 1 females with yearling cubs}}{\text{Number of X females} + \text{Number of X + 1 females}}$$

Where X = Age Class for which the calculations are being made.

The number of X + 2 year-old females accompanied by 2 year-old cubs was not included because family groups normally disperse during the cubs' second year. Therefore, females captured soon after their 2 year-old cubs had left would negatively bias the statistic. The statistic would also be negatively biased by complete loss of litters and yearling mortality; however samples were too small to base the statistic on cubs of the year only.

Age-specific litter sizes:

Age-specific litter size was calculated as follows:

$$\frac{\text{Number of cubs of the year with X females} + \text{Number of yearling cubs with X + 1 females} + \text{Number of 2 year-old cubs with X + 2 females}}{\text{Number of X females with cubs of the year} + \text{Number of X + 1 females with yearling cubs} + \text{Number of X + 2 females with 2 year-old cubs}}$$

In calculating age-specific litter size, 2 year-old cubs were included because only observations of family groups, not lone females, were used. Partial loss of a litter would negatively bias this statistic; however for conservative management we considered underestimation of productivity preferable to overestimation.

Age-specific natality rate:

Combining the above two statistics in the following formula gave the age-specific natality rate:

Age-specific litter produced rate x Age-specific litter size

The age-specific natality rate (mx) had units of cubs/females/year. To calculate recruitment for the entire E Zone population, a weighted mean natality rate was calculated which incorporated the survival rate of age classes used to determine the statistic. In this manner it was possible to estimate productivity in older age classes where sample sizes were too small to produce a reliable statistic. It was believed that this method was justified by the relatively constant rate of adult fecundity generally found in large mammals (Caughley 1977) and because the reproductive competence of genus <u>Ursus</u> extends through ecological longevity (Bunnell and Tait 1978).

RESULTS AND DISCUSSION

Sub-population Range

Four hundred and sixty polar bears were captured, 80 bears recaptured (77 individuals), 144 were resighted and 16 sets of ear tags returned from hunters. Bears marked in the study area ranged north to approximately 73°, south to approximately 68°, east to Baffin Island and Melville Peninsula, and west to Victoria Island (Fig. 4).

Because little work had been done in Committee Bay and east of Committee Bay to Foxe Basin, the relationship between the bears in the Gulf of Boothia, Committee Bay and Foxe Basin was not clear.

In Prince Regent Inlet, there appeared to be a separation between bears to the north and south of Creswell Bay. Although it varied in occurrence, the open water during summer at the confluence of Prince Regent Inlet and the Gulf of Boothia may have kept the bears of the Gulf of Boothia separate from those in Prince Regent Inlet. However, the small sample of tagged bears in Creswell Bay may account for the apparent separation.

Few polar bears were in Peel Sound during late winter and summer (although Frank Miller, Canadian Wildlife Service, pers. comm. reported numerous tracks there during spring and summer of 1977 and 1978) indicating that the bears of Franklin Strait and the northern part of Peel Sound were separate.

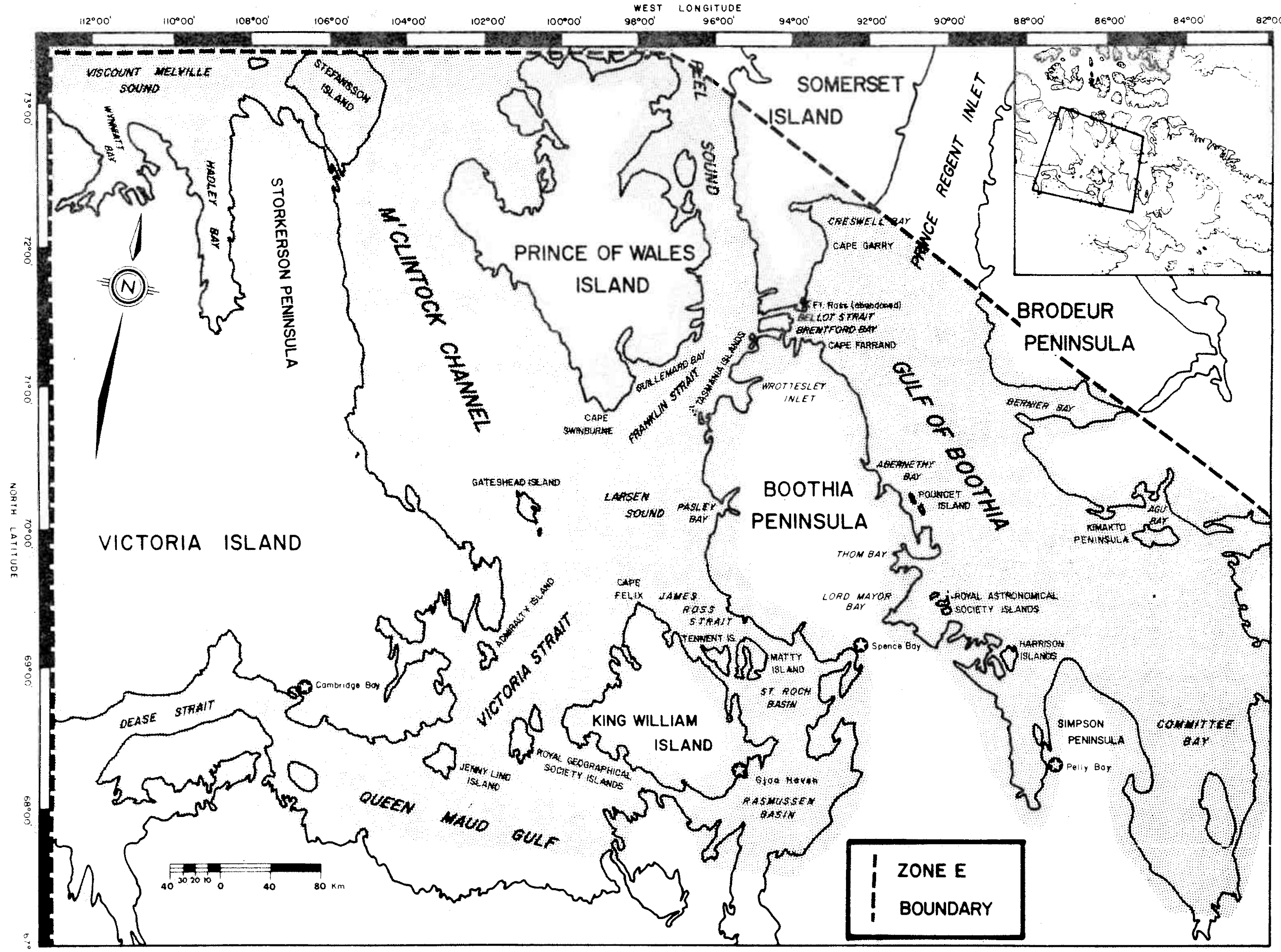

Figure 4. The outline of the subpopulation range.

No exchange was recorded between the bears of Hadley Bay on northeast Victoria Island and those of M'Clintock Channel. However, very little tagging was done in north M'Clintock Channel.

Hunter reports and reconnaissance surveys confirmed that very few polar bears were in Queen Maud Gulf, Rae Strait, and Rasmussen Basin.

Groups within the Sub-population Limits

Capture-recapture and hunter kill returns indicated that there were semi-discrete groups of bears within the larger sub-populations (Fig. 5). The locations of the groups were as follows:

Group 1. Franklin Strait, Larsen Sound, Bellott Strait, Brentford Bay, and the north end of the Gulf of Boothia.

Group 2. The south end of the Gulf of Boothia.

Group 3. Victoria Strait and the south end of M'Clintock Channel.

Group 4. Hadley Bay, Wynniatt Bay and the south edge of Viscount Melville Sound.

A fifth group occurred to the north in Prince Regent Inlet, Lancaster Sound and Barrow Strait (Stirling et al. 1978).

Limited exchange occurred between the groups. Of 72 bears from Group 1 returned (recaptured, resighted and hunter killed), four (6%) were returned from Group 2, three (4%) were returned from Group 3, and two (3%) were returned from Group 5. Of 24 bears from Group 2 returned, two (8%) were returned from Group 1. Of 21 bears from Group 3 returned, two (10%) were returned from Group 1, one (5%) was returned from Group 2, and one (5%) was returned from Group 5. There were no returns from outside Group 4.

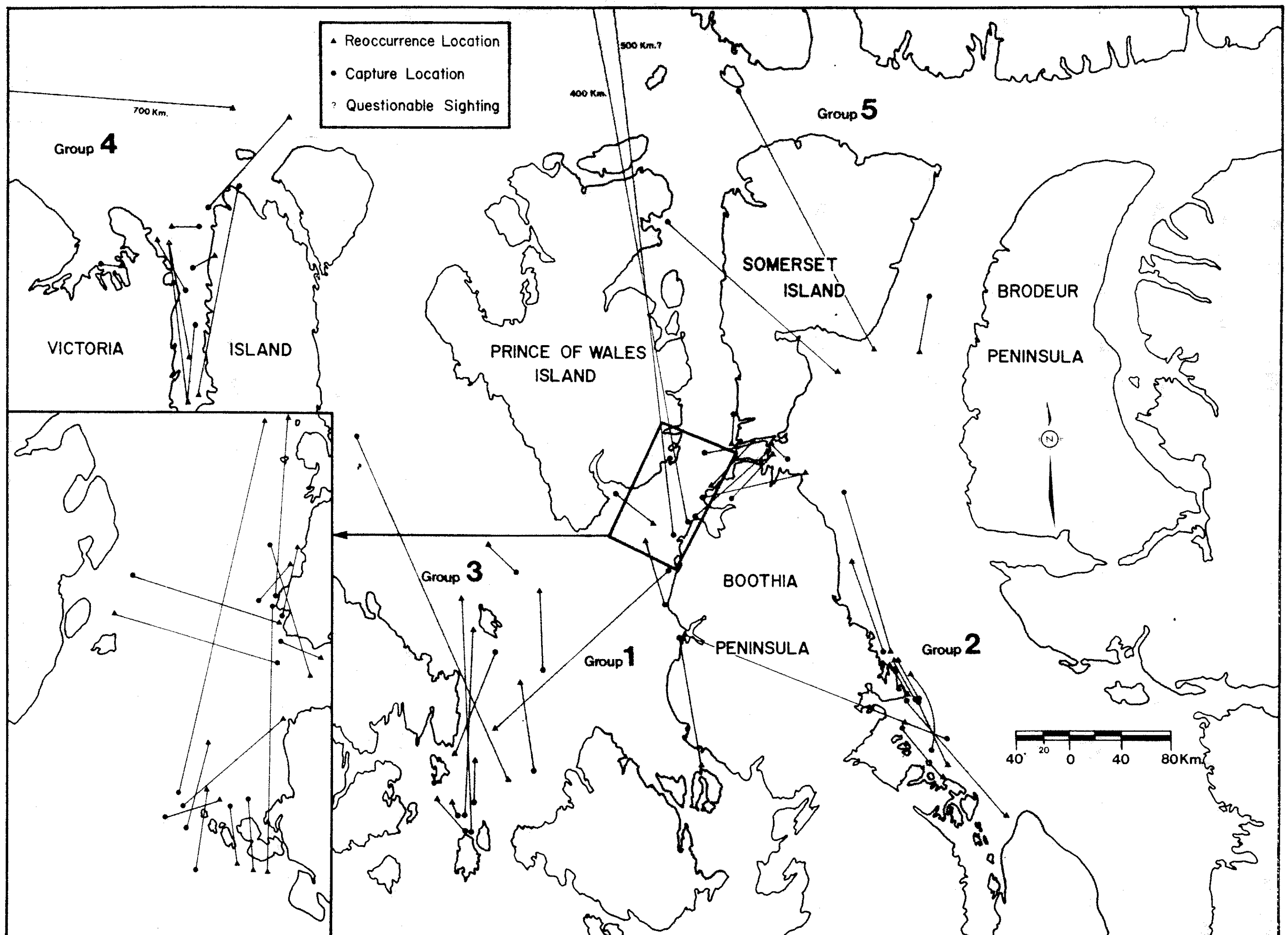

Figure 5. Groups of polar bears within the subpopulation range and locations of polar bears captured or killed in March - June and recaptured, resighted, or killed during March - June of any subsequent year.

Seasonal Movements and Distribution

Recaptured polar bears displayed a high degree of geographic fidelity during late winter (March, April, May) (Fig. 5). The mean distance (all sexes and ages) from the point of original capture during late winter to the point of recapture during the late winter of any following year was 67 ($\pm$ SE = 9, n = 15) kilometres.

However, polar bears shot during the fall and winter were significantly further (147 $\pm$ SE = 38 km, n = 49) from their points of marking than were those recaptured in late winter (Fig. 6). Because of bias in sampling time, seasonal fidelity to areas was not demonstrated except for late winter.

Males and females of various age classes did not differ in the average rate of movement between capture and recapture (Table 2). However, of six bears that moved the farthest distances between their points of original capture and first recapture, four were females 3 years or younger.

Late Winter

Although polar bears or tracks were observed throughout the study area, bears were definitely concentrated in late winter near small islands or coastlines (Fig. 7). Some areas (e.g. the east coast of Boothia Peninsula between Cape Farrand and Abernethy Bay) had numerous tracks, but few bears were observed. It is possible that these areas were travel routes where bears spent relatively little time while moving between two concentration areas.

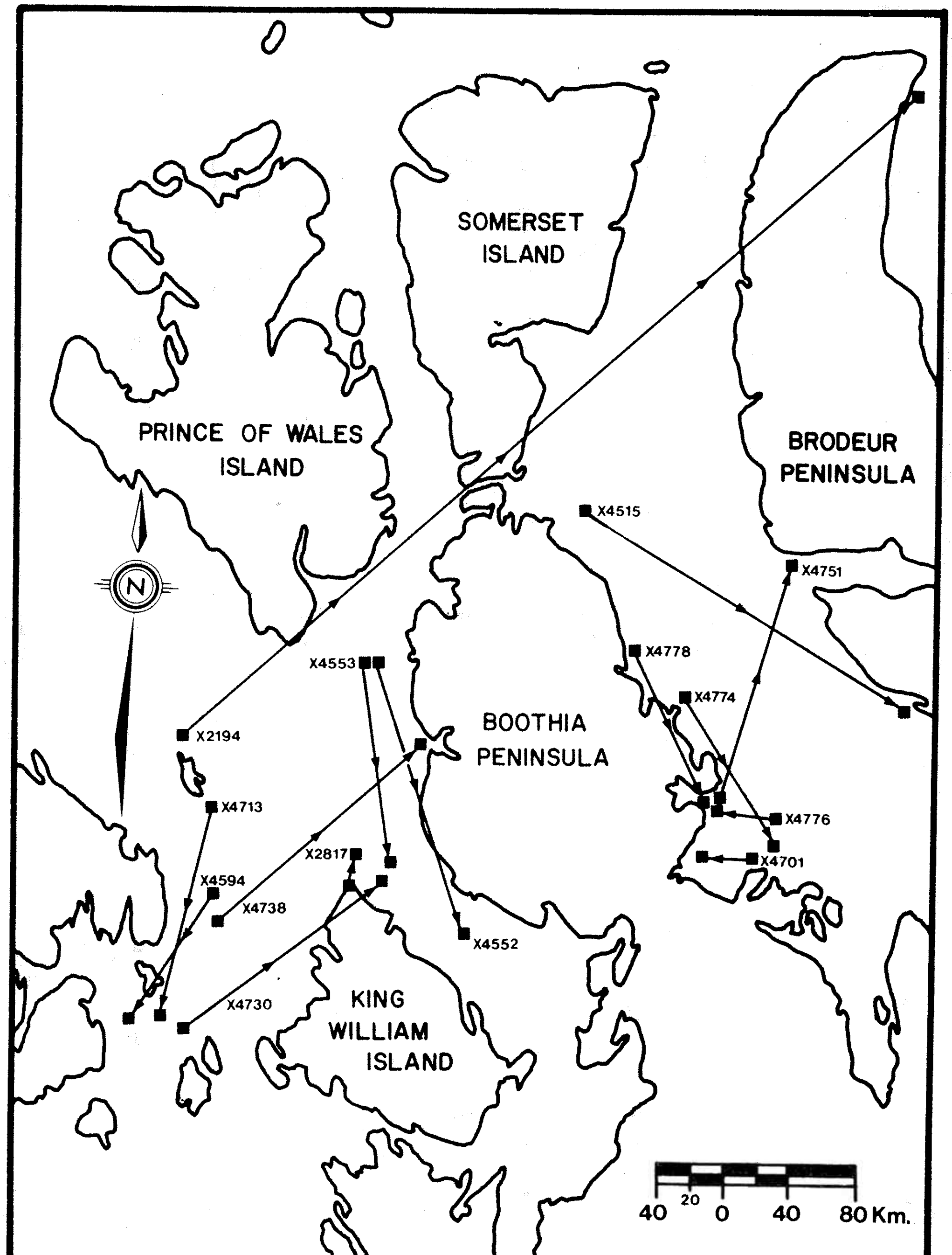

Figure 6 . Movements of polar bears captured in March, April, May, and June and killed between October and February.

Table 2. Results of ANOVA tests of polar bear movements.

Movements expressed as a rate (i.e. distance/time)

Age-sex class compared	F	DF	P[F(1)]	Conclusion
Male: 1-5 yr. vs. 6-10 yr. vs. 11-15 yr.	2.932	2,40	0.10>P>0.05	Means are equal
Female: 1-5 yr. vs. 6-10 yr vs. 11-15 yr.	0.650	2,21	P>0.25	Means are equal
1-5 yr: Male vs. female	0.498	1,25	P>0.25	Means are equal
6-10 yr: Male vs. female	1.151	1,16	P>0.25	Means are equal
11-15 yr: Male vs. female	0.903	1,20	P>0.25	Means are equal

Movements expressed as distance only

Age-sex class compared	F	DF	P[F(1)]	Conclusion
Male: 1-5 yr. vs. 6-10 yr. vs 11-15 yr.	2.503	2,40	0.10>P>0.05	Means are equal
Female: 1-5 yr. vs. 6-10 yr. vs. 11-15 yr.	0.385	2,21	P>0.25	Means are equal
1-5 yr.: Male vs. female	0.124	1,25	P>0.25	Means are equal
6-10 yr.: Male vs. female	3.483	1,16	0.10>p>0.05	means are equal
11-15 yr.: male vs. female	0.002	1,20	P>0.25	Means are equal

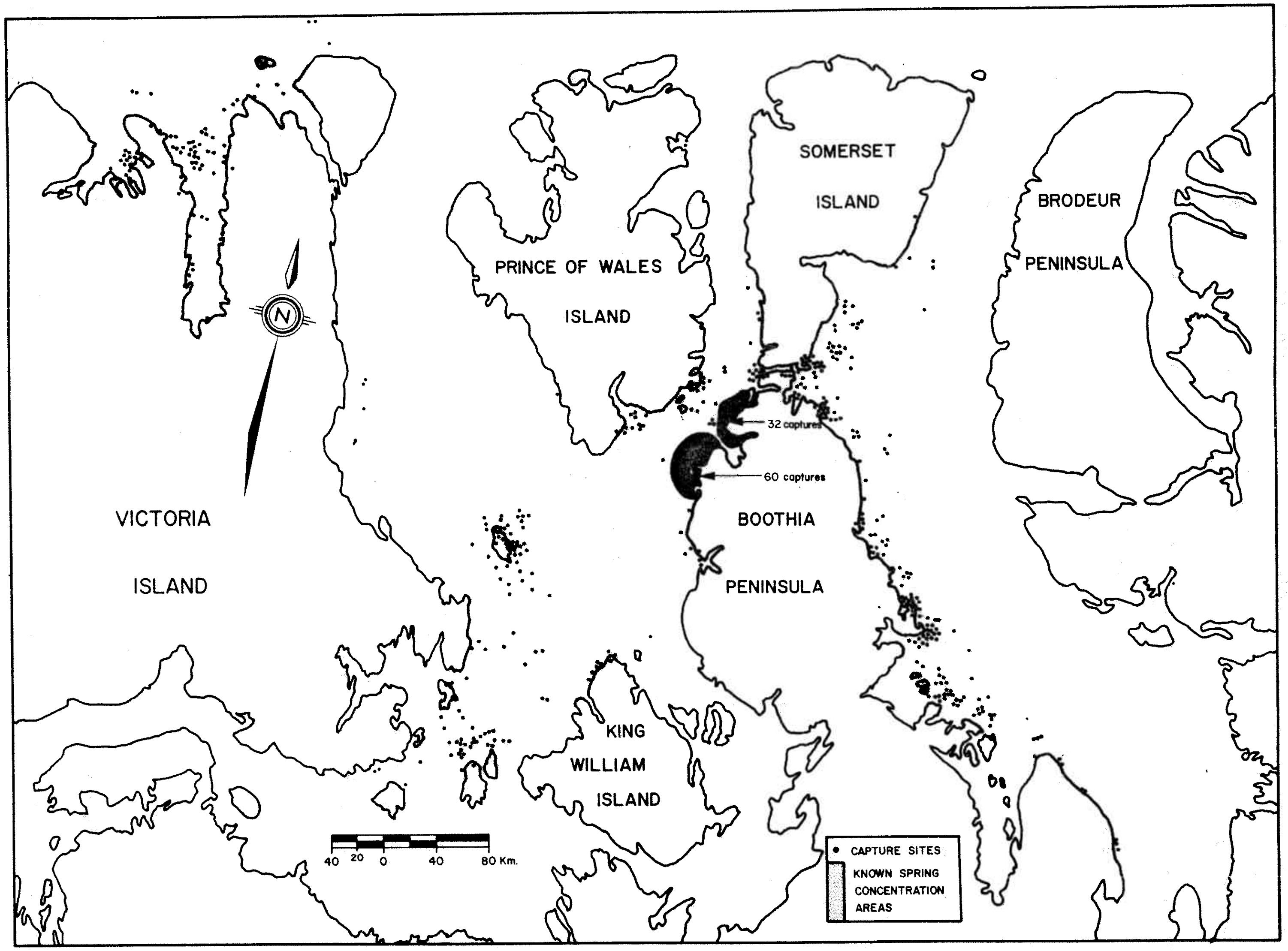

Figure 7. Spring (March - June) polar bear capture locations and concentration areas.

Summer

Southern Somerset Island and northeastern Boothia Peninsula, particularly Brentford Bay, were the main areas of summer retreat (concentration areas, on or near land, which are used during the open water period) (Fig. 8). Other possibilities include the west coast of Brodeur Peninsula, northern Prince of Wales Island (Frank Miller pers. comm.), and Hadley Bay.

Schweinsburg (1976) found summer retreats were used by either females with cubs, or subadult bears of either sex. However, relatively few bears were located in these retreats indicating either that the location of all summer retreats is not known or that some bears passed the summer on permanent ice, such as at Committee Bay and M'Clintock Channel.

No bears were seen in Franklin Strait during July 1975 and August 1976. The few movements between March-April and May-June, suggest migration out of Franklin Strait into M'Clintock Channel (Fig. 9). Kiliaan (1974) cited Idlout's description of an annual polar bear migration northward through Peel Sound to Barrow Strait during late April and May. Because few polar bears were sighted in Peel Sound during late winter and summer months, it is possible the northward movement was of bears from Franklin Strait. However, this was not confirmed by tagging returns.

Fall and Winter

No surveys were conducted during fall and winter so the distribution of bears during these times was unknown. We assumed that as ice formed in October, bears gradually moved from summering areas to areas where they were

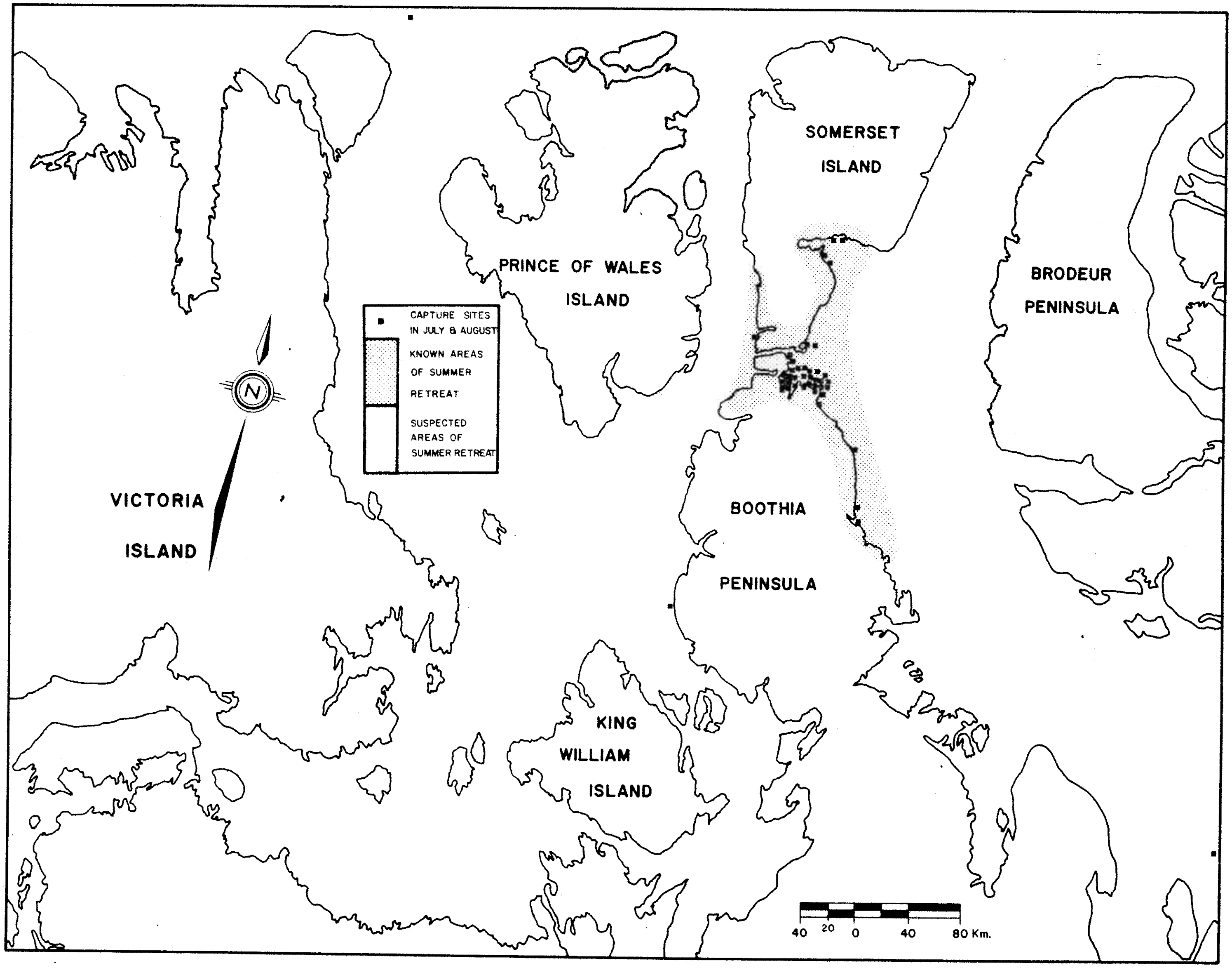

Figure 8. Summer polar bear capture locations and concentration areas.

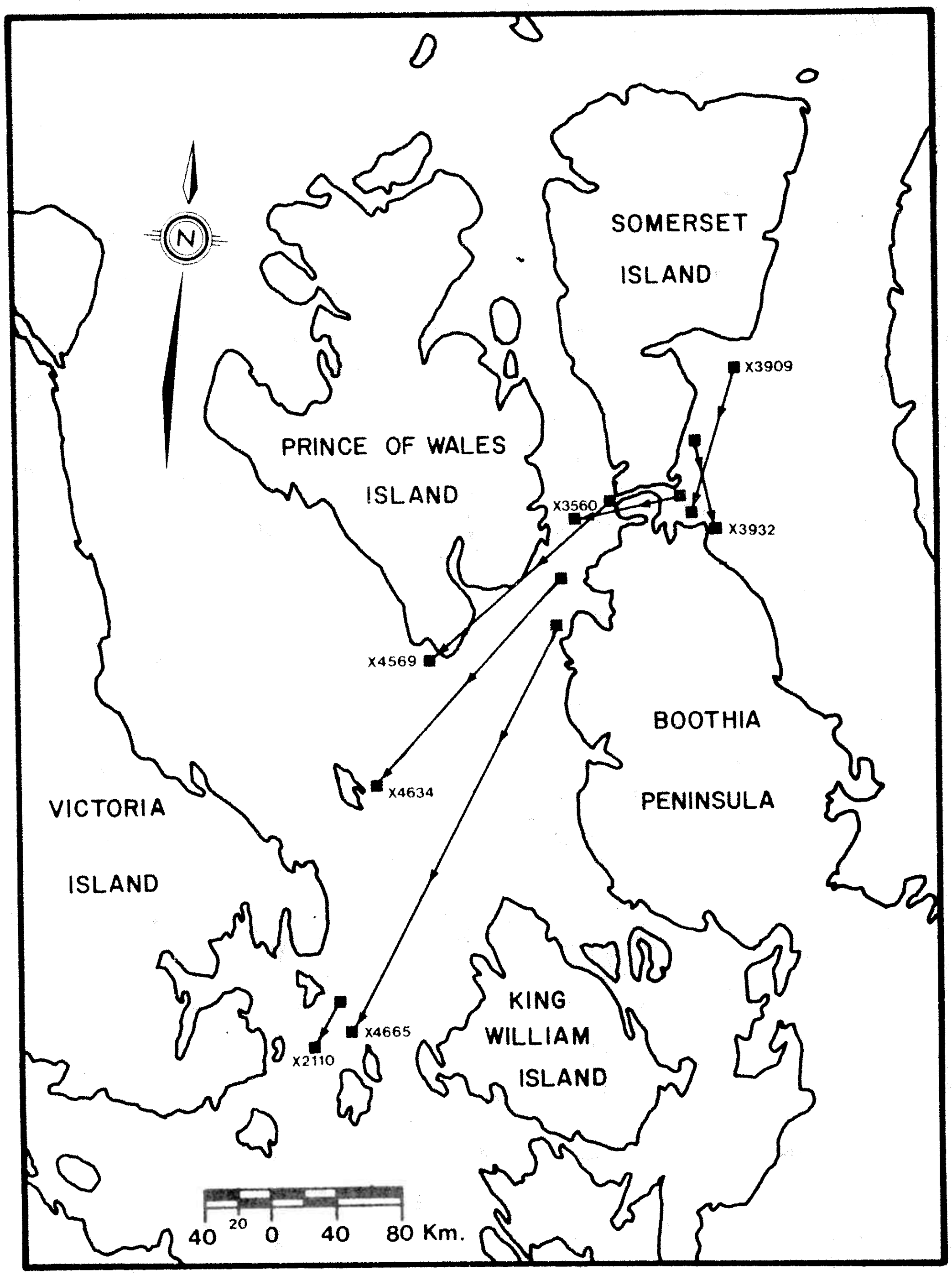

Figure 9. Movements of polar bears captured in March and April and resighted, recaptured, or killed in May or June of the same year.

found in late winter and spring. However, there may have been separate early winter and mid-winter concentration areas. Pregnant females, some females with cubs, and possibly other sex and age groups of bears den on land during winter (Harington 1968).

Denning Areas

Pregnant females enter dens on land during October, November and December (Harington 1968). Known and suspected denning areas are shown in Figure 10 and areas where family groups with cubs of the year were sighted are shown in Figure 11.

The Simpson Peninsula and Harrison Islands were not surveyed during this study but are reported to be important maternity denning areas (Harington 1968, Van de Velde 1971). We observed females with cubs of the year near these places. The east coast of Boothia Peninsula especially around Pouncet Island and Cape Farrand were probable denning areas. The entire north end of the Boothia Peninsula and the west coast down to Wrottesley Inlet were also probable denning areas. Several family groups were captured or observed near the west end of Bellot Strait and Wrottesley Inlet. One den was found at the north end of Boothia Peninsula. This denning area likely extends to the south end of Somerset Island.

The southeast coast of Prince of Wales Island was probably a low density denning area and family groups with cubs of the year were captured in Guillemard Bay.

Matty, Tennant, King William and Royal Geographical Society Islands were also suspected or reported by Inuit to be denning areas.

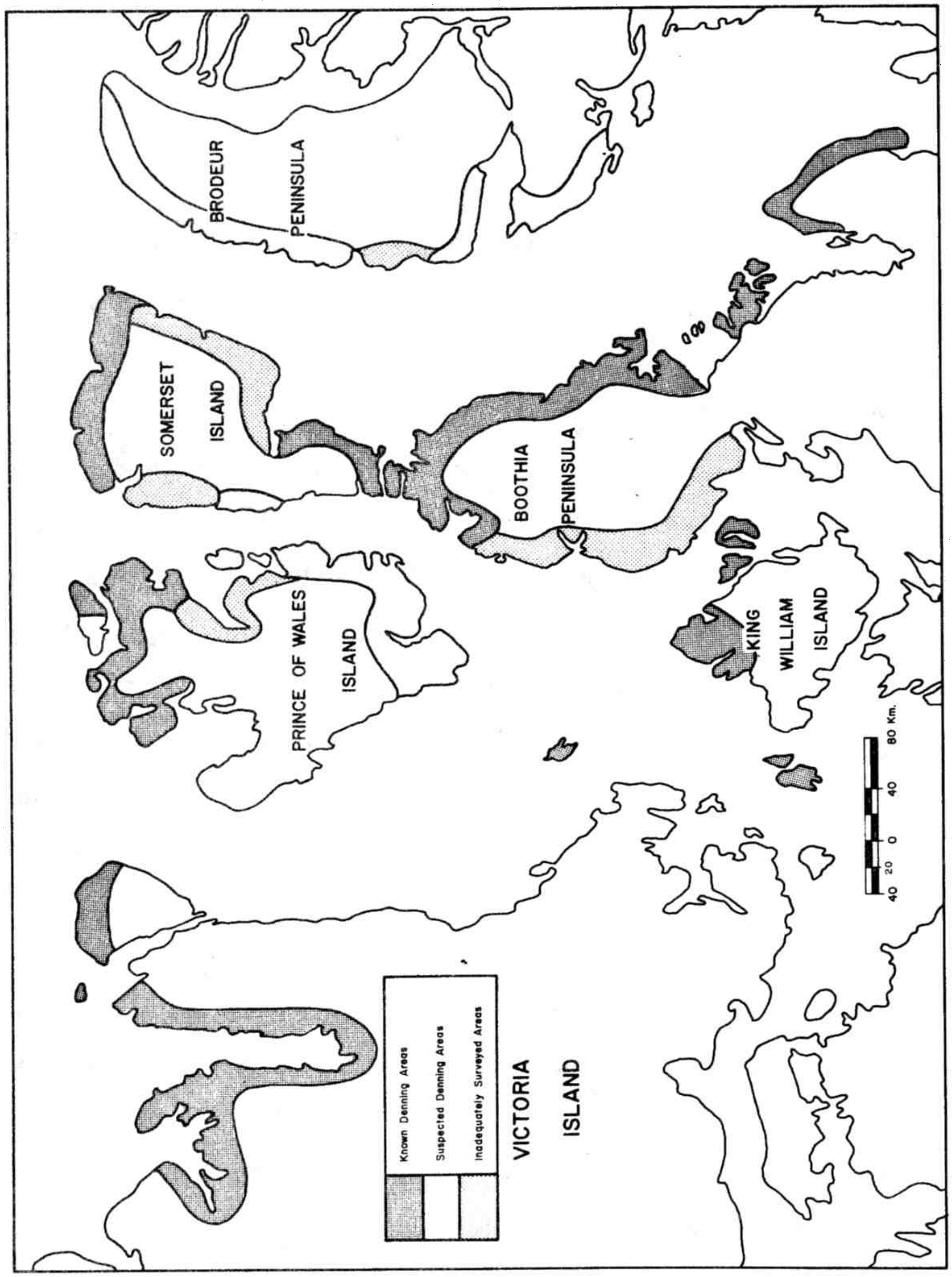

Figure 10. Known and suspected polar bear denning areas.

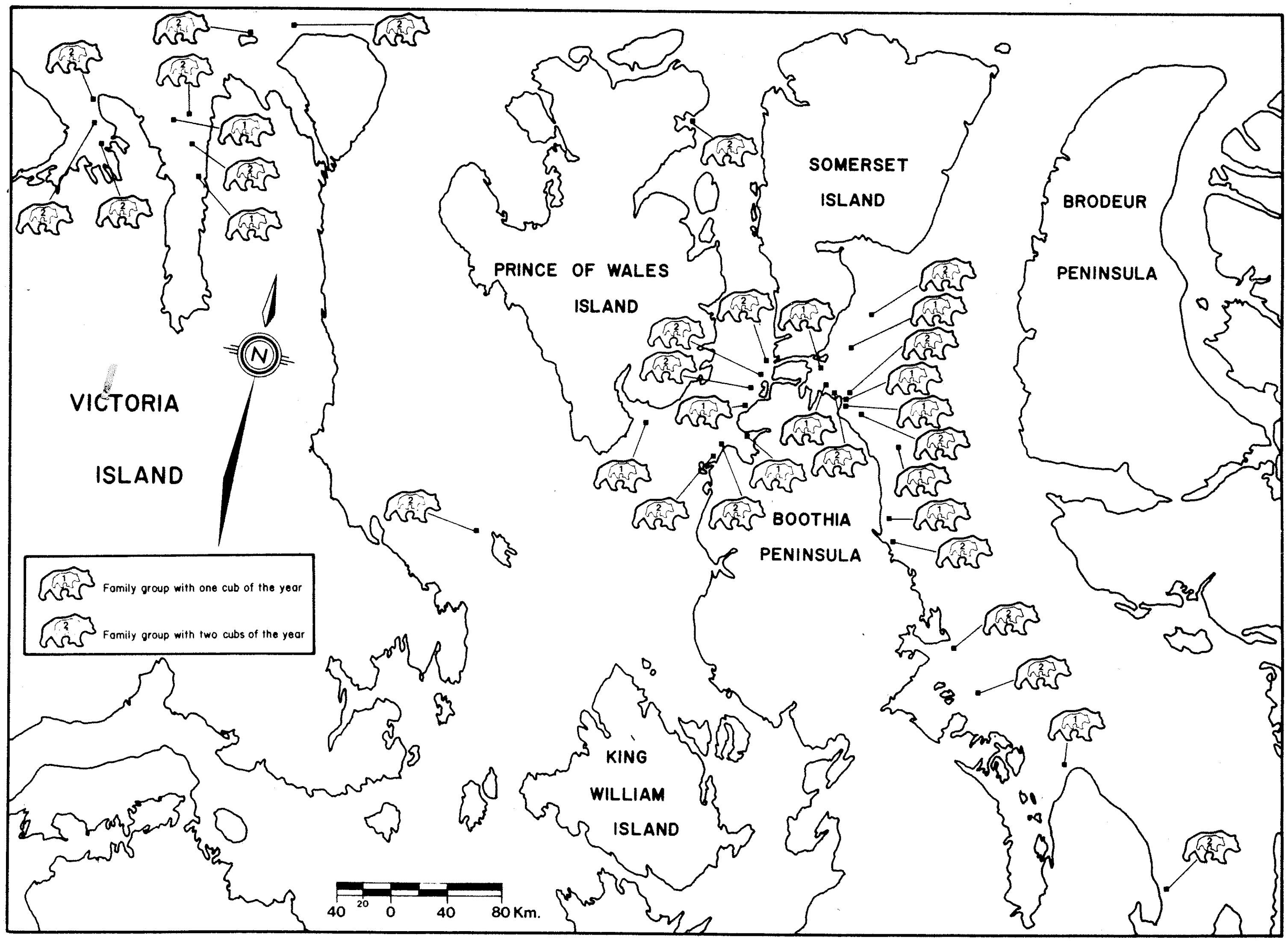

Figure II. Locations of observations and captures of females with cubs of the year.

Nine dens were found on the Gateshead Island (Spencer 1979). This is one of the highest density denning areas known in the Arctic Islands. The survey was not repeated.

The east coast of Victoria Island and the west coast of Prince of Wales Island were not surveyed for dens. Although no dens were found at Wynniatt and Hadley Bay, the number of family groups with cubs of the year captured there indicated that these were important denning areas.

Inuit Hunting Patterns

Each Inuit community concentrated its hunting in specific areas (Fig. 12). Pelly Bay reported most kills from the Harrison Islands and Simpson Peninsula. Spence Bay also reported kills from the Harrison Islands as well as from the Royal Astronomical Society Islands, the southeast coast of Boothia Peninsula, the southwest coast of Boothia Peninsula up to Pasley Bay, Matty Island, Tennant Islands, and the north end of King William Island. A few Spence Bay kills were also reported from the south end of Prince of Wales Island, Tasmania Islands in Franklin Strait, and in the Bellott Strait-Creswell Bay area.

Gjoa Haven reported kills from the east and north coasts of King William Island and around Royal Geographical Society Islands. Cambridge Bay reported kills in Victoria Strait and in M'Clintock Channel as far north as Gateshead Island. Hunters from Cambridge Bay also killed bears in Hadley Bay.

On the periphery of the study area, Resolute Bay hunters reported kills at Creswell Bay. Arctic Bay hunters killed bears at Bernier Bay, and Igloolik hunters reported kills at Agu Bay and Kimakto Peninsula.

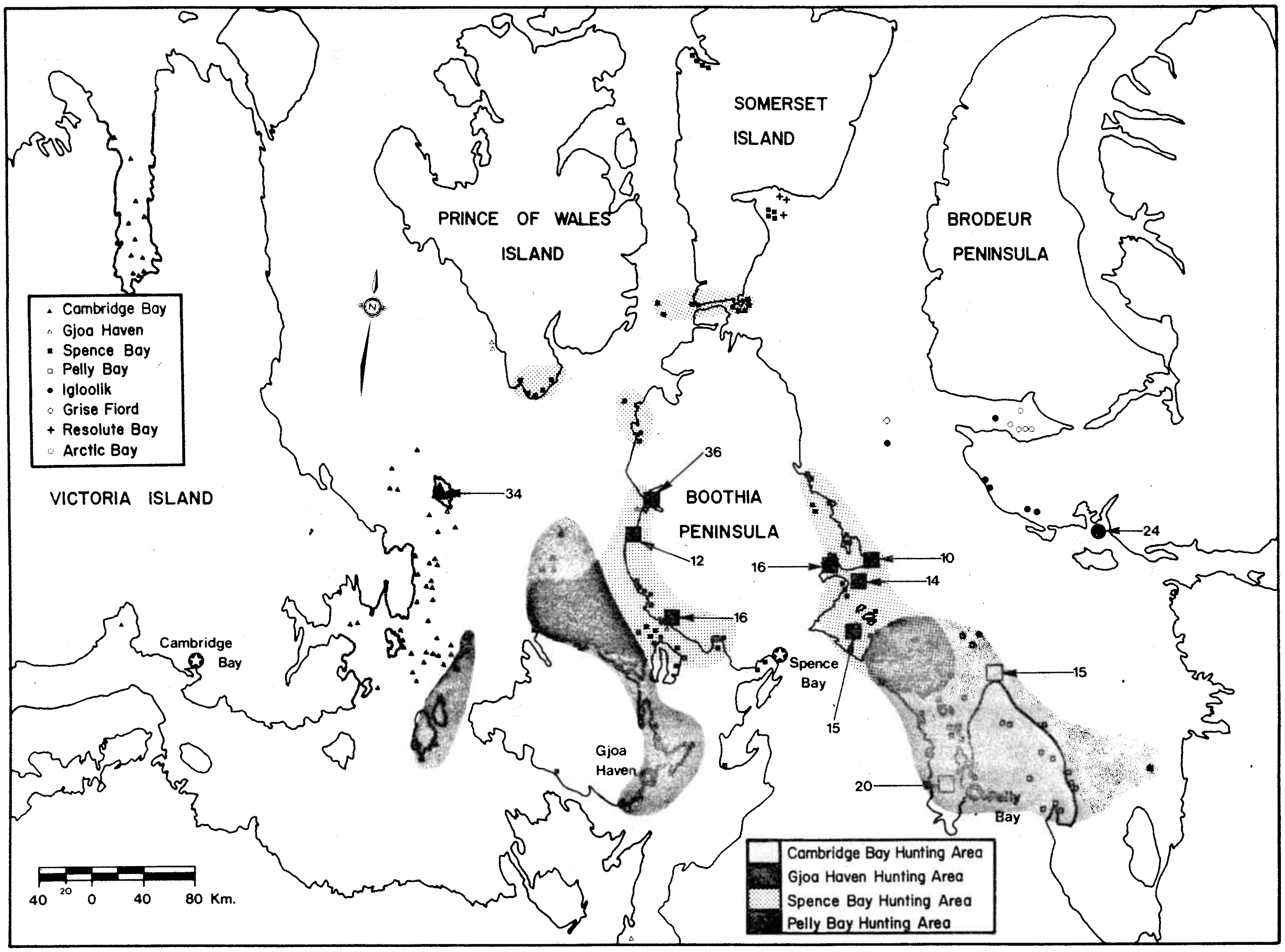

Figure 12. The areas at which each settlement reported bear kills.

Only Spence Bay hunters killed bears from areas hunted by other settlements. They reported kills from the same areas as Pelly Bay, Gjoa Haven and Resolute Bay.

Settlement Quotas and Reported Kill

The polar bear quotas for each settlement are given in Table 3. Arctic Bay, Igloolik, and Resolute Bay take only part of their quotas in the study area. Reported kills by settlements are given in Table 4. The available data, excluding Hadley Bay, show approximately 53 polar bears killed by hunters each year in the study area. Four years of data from Hadley Bay show an average of 2.5 bears per year killed there.

Table 5 presents chi-square analysis of the kill-sex ratio. Cambridge Bay, Gjoa Haven, and Spence Bay appeared to selectively harvest males. Overall, males represent 63% of the harvest in the study area.

Settlement Hunting Seasons

Table 6 shows the months that each settlement reported kills. In recent years, hunters from Gjoa Haven, Pelly Bay and Spence Bay have killed many bears in autumn before pregnant females entered dens. However, only Pelly Bay killed more females in autumn than in spring (Table 7).

Table 3. Polar bear quotas for each settlement, 1967 - 1977.

Settlement	1967 1968	1968 1969	1969 1970	1970 1971	1971 1972	1972 1973	1973 1974	1974 1975	1975 1976	1976 1977	1977 1978
Arctic Bay*	10	12	12	12	12	12	12	12	12	12	12
Cambridge Bay	10	12	12	12	12	12	10	10	10	10	10
Hadley Bay	0	0	0	0	0	0	4	4	4	4	4
Gjoa Haven	8	10	10	8	8	8	8	9	9	9	9
Igloolik*	23	23	23	16	16	16	18	16	18	18	18
Pelly Bay	9	11	11	10	10	10	10	10	10	10	10
Resolute Bay*	50	40	40	34	34	34	34	34	34	34	34
Spence Bay	23	23	23	22	22	22	22	22	22	22	22

* Not all taken from the study area.

Table 4. Reported polar bear kills in the study area for each settlement from 1968 to 1977.

Settlement	1967 1968	1968 1969	1969 1970	1970 1971	1971 1972	1972 1973	1973 1974	1974 1975	1975 1976	1976 1977	
Arctic Bay			3				2				
Cambridge Bay- Hadley Bay		11	9	9	10	11	10(3)	10(3)	5(3)	9(1)	
Gjoa Haven		6	10	5	7	8	15	9	8	7	
Igloolik		2	9	4	-	4	8	3	-	-	
Pelly Bay		9	6	8	10	8	9	10	7	10	
Resolute Bay		-	-	-	-	-	-	-	2	1	
Spence Bay		23	24	21	24	27	23	20	20	19	
		51	61	47	51	58	67(3)	52(3)	42(3)	46(1)	$\bar{x}$=52.8* $\bar{x}$=53.9**

() Hadley Bay Kill.
* Mean excluding Hadley Bay Kill.
** Mean including Hadley Bay Kill.

Table 5. Chi-square analysis of the sex ratio of the kill sample.

	Male kill	Female kill	Chi-square	Conclusions
Arctic Bay	2	3	Not tested	
Cambridge Bay	55	25	11.252**	males dominate the kill
Gjoa Haven	36	20	4.589*	males dominate the kill
Igloolik	17	13	0.567	males and females occur equally
Pelly Bay	38	36	0.068	males and females occur equally
Spence Bay	124	63	19.904**	males dominate the kill
Resolute Bay	3	0	Not tested	
All settlements	275	160	30.405**	males dominate the kill

* Significant difference.

** Highly significant difference.

Table 6. The months that each settlement reported kills.

Settlement	1968 1969	1969 1970	1970 1971	1971 1972	1972 1973	1973 1974	1974 1975	1975 1976	1976 1977	1977 1978
Arctic Bay		Feb.- Apr.			Nov.					Nov.
Cambridge Bay	Apr.- May	Apr.- May		Feb.- May	Mar.- Apr.	Mar.- Apr.	Apr.- May	Apr.	Feb.- May	Feb.- Apr.
Gjoa Haven	Apr.- June	Mar.- Apr.	Mar.- May	Feb.- Apr.	Oct.	Nov.- Apr.	Oct.- Mar.		Jan.- Feb.	Nov.- Jan.
Igloolik	Oct.	Aug.- Apr.	Oct.- Feb.		Feb.- Apr.	Nov.	Nov.			
Pelly Bay	Nov.- May	May	Feb.- May	Nov.- May	Nov.- Apr.	Nov.	Oct.- Apr.	Oct.	Oct.- May	Nov.- Apr.
Resolute Bay								Nov.	Apr.	Apr.- May
Spence Bay	Nov.-	May	Apr.		Apr.		May	Apr.		
Resolute Bay								Nov.	Apr.	Apr.- May
Spence Bay	Nov.- May	Oct.- May	Nov.- Apr.	Oct.- Mar.	Oct.- Feb.	Oct.- Feb.	Oct.- Nov.	Oct.- Mar.	Oct.- Apr.	Nov.- Mar.

\- Indicates months inclusive.

Table 7. Summary of chi-square analysis to test differences between spring and autumn hunting patterns.

Area	Sex	f(x) (Oct.-Dec.)	f(x) (Jan.-May)	X^2	Season of most kills
Pelly Bay	M	18	21	0.230	equal
	F	24	11	4.828*	autumn
Cambridge Bay	M	0	53	na[1]	spring
	F	0	28	na[1]	spring
Gjoa Haven	M	12	24	4.000*	spring
	F	7	18	4.840*	spring
Spence Bay	M	63	62	0.008	equal
	F	43	27	3.658	equal
All settlements	M	93	160	17.744**	spring
	F	74	84	0.632	equal

* Significant difference between autumn and spring kill frequency.

** Highly significant difference between autumn and spring kill frequency.

1 Cannot be tested as one f(x) value equals 0.

Life Table Information

Productivity

The calculation of population productivity requires a known sex ratio. An even sex ratio was demonstrated by chi-square analysis of the capture sample (Table 8). Calculation of productivity were based on the number of females and different aged cubs (Table 9). Of mature females (5+ years), 50.3% were accompanied by cubs. The mean litter size of these females was 1.53 [$\pm$0.06 n=77] cubs/litter. This litter size was lower than values for the central and western Arctic, Greenland, Wrangel Island (U.S.S.R) and Alaska (Stirling et al. 1978). The proportion of females which were accompanied by cubs was lower than that reported for the western Arctic prior to 1974, but was similar to post 1974 western Arctic, central Arctic (Stirling et al. 1978), and Lancaster Sound (Schweinsburg et al. 1976) values.

There may have been some cub mortality. This was indicated by a change in mean litter size from cubs of the year to yearling cubs to 2 year-old cubs with values of 1.64 [$\pm$0.08 n=36] to 1.44 [$\pm$0.10 n=27] to 1.43 [0.14 n=14] cubs per litter respectively. There was, however, no significant difference in mean litter sizes when tested by analysis of variance [$0.25>P(F_{0.05(1)2,74}\geq 1.544)>0.10$]. These figures were intermediate between the higher number of cubs per litter reported in the Beaufort Sea (Stirling et al. 1975) and lower values from the central Arctic (Stirling et al. 1978).

Table 8. Chi-square testing of the capture sample sex ratio.

N = 511

	$f(m)$	$\hat{f}(f)$	$X^2 = f(m) - f(f)^2/f(x) + f(f)$
Male	264	255.5	0.283
Female	247	255.5	0.283
			0.566

Ho: The sex ratio is 1:1.

$\alpha = 0.05$

$.25<P(X^2_{0.05(1)} \geq 0.566)$

Accept Ho; The sex ratio is 1:1.

Table 9. Observations of family groups.

Age of females	Number of females	Number of females with cubs	Coy 1	Coy 2	Yrlg. 1	Yrlg. 2	2-yr. 1	2-yr. 2
			Age and litter sizes of cubs accompanying females					
3	19	0						
4	14	0						
5	15	4	3	1				
6	24	15	3	4	6	2		
7	15	7	1	3			1	2
8	10	8		6	2			
9	8	8	3	1	2	2		
10	3	1					1	
11	5	4		3		1		
12	6	5	1			2	1	1
13	11	9	1	2	2		1	3
14	3	2		1			1	
15	2	1		1				
16	0	0						
17	3	3			1	2		
18	2	2				2		
19	2	2		1	1			
20	2	2	1		1			
21	3	2				1	1	
22	1	1					1	
23	1	1					1	
24	2	0						
25	0	0						
26	0	0						
27	0	0						
28	1	0						
29	1	0						
30	0	0						
	153	77	13	46	15	24	8	12

First breeding occurred during a female polar bear's 4th year with first parturition occurring at 5 years of age (Table 9). This agrees with Stirling et al. (1977a) for the central and high Arctic, but is one year earlier than the age of first reproduction for Beaufort Sea bears (Stirling et al. 1975).

Age-specific probability of parturition:

Table 10 summarizes the calculation of age-specific probability of parturition. The weighted mean probability of parturition was used in calculating the mean natality rate for the life table. To calculate the mean probability of parturition, the mean survival rate from the life table was used to correct the number of females with yearling litters and yearlings lost to mortality between the X and X+1 age classes.

Age-specific litter size:

Table 11 summarizes the calculations of age-specific litter size. The weighted mean litter size was used in calculating the mean natality rate for the life table. The mean survival rate from the life table was used to correct the number of females, yearlings and 2 year-olds lost to mortality during one and two winters respectively.

Age-specific natality rate:

The weighted mean probability of parturition and litter size, were used to compute the natality rate for the entire population ($\bar{m}$) in the life table (Table 12). This statistic probably was more reliable than the variable age-specific natality rates which resulted from large variations in sample size.

Table 10. Calculation of age-specific and mean probability of parturition.

Age of (X)	Females with cubs: X females with Coy (Cx)	Females with cubs: X+1 females with yrlgs. (Dx)	Total females: X females (Fx)	Total females: X+1 females F(x+1)	Cx + Dx	Fx + F(x+1)	Probability parturition $\frac{Cx + Dx}{Fx + F(x+1)}$
5	4	8	15	24	12	39	0.31
6	7	0	24	15	7	39	0.18
7	4	2	15	10	6	25	0.24
8	6	4	10	8	10	18	0.56
9	4	0	8	3	4	11	0.36
10	0	1	3	5	1	8	0.13
11	3	2	5	6	5	11	0.45
12	1	2	6	11	3	17	0.18
13	3	0	11	3	3	14	0.21
14	1	0	3	2	1	5	0.20
15	1	0	2	0	1	2	0.50
16	0	3	0	3	3	3	1.00
17	0	2	3	2	2	5	0.40
18	0	1	2	2	1	4	0.25
19	1	1	2	2	2	4	0.50
20	1	1	2	3	2	5	0.40
21	0	0	3	1	0	4	0
22	0	0	1	1	0	4	0
23	0	0	1	2	0	3	0
	36	27	116	103			

Weighted mean probability of litter production (incorporates survival 0.92)

$$= \frac{\sum_{x=23}^{5} Cx + \frac{\sum_{x=23}^{5} Dx}{\varnothing}}{\sum_{x=23}^{5} Fx + \frac{\sum_{x=23}^{5} F(x+1)}{\varnothing}} = \frac{36 + \frac{27}{0.92}}{116 + \frac{103}{0.92}} = 0.287$$

Table 11. Calculation of age-specific and mean litter size.

Age (x)	Females with cubs born at year X: X females (fx)	X+1 females F(x+1)	X+2 females F(x+2)	Cubs born at year X: 0 yr cubs (C_0)	1 yr cubs (C_1)	2 yr cubs (C_2)	Fx+F(x+1) +F(x+2)	$C_0+C_1+C_2$	$\frac{C_0+C_1+C_2}{Fx+F(x+1)+F(x+2)}$
5	4	8	3	5	10	5	15	20	1.33
6	7	0	0	11	0	0	7	11	1.57
7	4	2	0	7	2	0	6	9	1.50
8	6	4	1	12	6	1	11	19	1.73
9	4	0	0	5	0	0	4	5	1.25
10	0	1	2	0	2	3	3	5	1.67
11	3	2	4	6	4	7	9	17	1.89
12	1	2	1	1	2	1	4	4	1.00
13	3	0	0	5	0	0	3	5	1.67
14	1	0	0	2	0	0	1	2	2.00
15	1	0	0	2	0	0	1	2	2.00
16	0	3	0	0	5	0	3	5	1.67
17	0	3	0	0	4	0	2	4	2.00
18	0	1	0	0	1	0	1	1	1.00
19	1	1	1	2	1	1	3	4	1.33
20	1	1	1	1	2	1	3	4	1.33
21	0	0	1	0	0	1	1	1	1.00
22	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0
	36	27	14	59	39	20	77	118	

Weighted mean litter size (incorporates survival 0.92)

$$= \frac{\sum_{x=23}^{5} C_0 + \frac{\sum_{x=23}^{5} C_1}{\emptyset} + \frac{\sum_{x=23}^{5} C_2}{\emptyset^2}}{\sum_{x=23}^{5} Fx + \frac{\sum_{x=23}^{5} F(x+1)}{\emptyset} + \frac{\sum_{x=23}^{5} F(x+2)}{\emptyset^2}} = \frac{59 + \frac{39}{0.92} + \frac{20}{0.92^2}}{36 + \frac{27}{0.92} + \frac{14}{0.92^2}} = 1.527$$

Table 12. Calculation of age-specific and mean natality rate (mx).

Age (X)	Age-specific probability of parturition (Table 10)	Age-specific litter size (Table 11)	Age-specific natality rate (Cubs/female/year)
5	0.31	1.33	0.41
6	0.18	1.57	0.28
7	0.24	1.50	0.36
8	0.56	1.73	0.97
9	0.36	1.25	0.45
10	0.13	1.67	0.22
11	0.45	1.89	0.85
12	0.18	1.00	0.18
13	0.21	1.67	0.35
14	0.20	2.00	0.40
15	0.50	2.00	1.00
16	1.00	1.67	1.67
17	0.40	2.00	0.80
18	0.25	1.00	0.25
19	0.50	1.33	0.67
20	0.40	1.33	0.53
21	0	1.00	0
22	0	0	0
23	0	0	0
overall weighted mean	0.287	1.527	$0.438 = \bar{m}$

The age-specific natality rates determined in this study were comparable to those found by Stirling et al. (1978) in the central and high Arctic. These rates were 1.6 times those of bears in the Beaufort Sea after 1974 but only 80% of the pre-1974 Beaufort Sea natality rate (Stirling et al. 1978). They were more than twice the rates found in bears from Lancaster Sound (Schweinsburg et al. 1977). Natality at this level probably indicates a population with good potential for recruitment assuming juvenile mortality is not excessive.

Estimates of Numbers of Bears in the Sub-population

Tables 13 and 14 summarize the estimates of sub-population size based upon capture-recapture data. For the last 2 years the estimates were 1,049 and 1,478 bears (with a 5 year average of 1,060) in the sub-population (excluding Hadley Bay, Table 14). For purposes of analysis, we used the figure of 1,100 polar bears for this sub-population. However, as samples were not random throughout the study area and bears did not randomly mix, this estimate was probably minimal.

The number of bears in each group was also estimated (Tables 15, 16, 17, and 18). Group 1 contained an estimated 442 bears in 1977 (probably the better estimate due to the large mark sample in 1976), Group 2 contained an estimated 333 bears in 1978 (probably the better estimate) and Group 3 contained an average estimate of 305 bears for the years 1974 to 1977. The sum of these estimates gave a second estimate of 1,080 bears in the study area (excluding Hadley Bay). Hadley Bay contained an average of 140 bears for 1974, 1975 and 1976.

Table 13. Estimate of number of bears (N_i) for the total study area including Hadley Bay.

	Year						
	1972	1973	1974	1975	1976	1977	1978
n_i	11	31	32	49	181	197	27
m_i	0	0	3	6	8	37	6
R_i	11	31	32	49	181	197	27
P_i	0	0	0.0938	0.1224	0.0442	0.1878	0.2222
$\hat{M}_i$	0	10.120	37.830	61.484	96.125	247.595	374.987
$SE.\hat{M}_i$	-	1.121	3.229	5.529	8.629	18.751	30.729
$\hat{N}_i$	-	-	403.30	502.32	2174.77	1318.40	1687.61
$SE.\hat{N}_i$	-	-	227.76	199.328	778.66	219.823	634.478

$\bar{X}\ \hat{N}_i = 1217$

n_i	The total number of bears captured on the ith sample.
m_i	The total number of previously marked bears captured in the ith sample.
R_i	The total number of marked animals (including recaptures) released in the ith sample.
P_i	The proportion of animals marked in the population.
$\hat{M}_i$	The number of tagged animals available for sampling just prior to the ith sample.
$SE.\hat{M}_i$	The standard error of $\hat{M}_i$.
$\hat{N}_i$	The number of animals present in the population at time i.
$SE.\hat{N}_i$	The standard error of $\hat{N}_i$.
$\emptyset$	0.92

Table 14. Estimate of number of bears (N_i) for the total study area excluding Hadley Bay.

	Year						
	1972	1973	1974	1975	1976	1977	1978
n_i	11	19	16	17	169	197	27
m_i	0	0	1	1	5	37	6
R_i	11	19	16	17	169	197	27
P_i	0	0	0.0625	0.0588	0.0296	0.1878	0.2222
$\hat{M}_i$	0	10.12	26.79	38.45	50.09	196.96	328.40
$SE.\hat{M}_i$	-	1.121	2.535	3.898	5.305	14.477	26.013
$\hat{N}_i$	-	-	428.64	653.91	1692.23	1048.78	1477.93
$SE.\hat{N}_i$	-	-	430.555	657.401	768.725	173.816	546.193

$\bar{X}\ \hat{N} = 1060$

Table 15. Estimates of number of bears (N_i) for Group 1.

	Year		
	1975	1976	1977
n_i	12	137	102
m_i	0	2	31
R_i	12	137	102
P_i	0	0.0146	0.3039
$\hat{M}_i$	0	11.04	134.36
$SE.\hat{M}_i$	-	1.416	9.537
$\hat{N}_i$	-	756.16	442.12
$SE.\hat{N}_i$	-	538.892	73.605

$\bar{X}\ \hat{N}_i = 599$

Table 16. Estimates of number of bears (N_i) for Group 2.

	Year		
	1976	1977	1978
n_i	20	65	27
m_i	0	3	6
R^i	20	65	27
P^i	0	0.0462	0.2222
$\hat{M}_i$	0	18.40	73.97
$SE.\hat{M}_i$	-	1.718	5.699
$\hat{N}_i$	-	398.24	332.90
$SE.\hat{N}_i$	-	229.237	122.620

$\bar{X}\ \hat{N}_i$ = 366

Table 17. Estimates of number of bears (N_i) for Group 3.

	Year					
	1972	1973	1974	1975	1976	1977
n_i	11	19	16	5	12	30
m_i	0	0	1	1	3	3
R_i	11	19	16	5	12	30
P_i	0	0	0.625	0.2000	0.2500	0.1000
$\hat{M}_i$	0	10.12	26.79	38.45	39.05	44.21
$SE.\hat{M}_i$	-	1.121	2.535	3.898	4.792	5.641
$\hat{N}_i$	-	-	428.64	192.25	156.20	442.10
$SE.\hat{N}_i$	-	-	430.555	193.235	83.794	252.666
$\bar{X}\ \hat{N}_i$ =	305					

Table 18. Estimates of number of bears (N_i) for Group 4.

	Year			
	1973	1974	1975	1976
n_i	12	16	32	12
m_i	0	2	5	3
R_i	12	16	32	12
P_i	0	0.1250	0.1563	0.2500
$\hat{M}_i$	0	11.04	23.04	46.04
$SE.\hat{M}_i$	-	1.190	2.335	4.213
$\hat{N}_i$	-	88.32	147.41	184.16
$SE.\hat{N}_i$	-	61.080	61.512	97.639

$\bar{X}\ \hat{N}_i = 140$

Age Structure

The age distribution of the captured bears and hunter killed bears are presented by sex in Table 19. The contingency tables (Tables 20 and 21) demonstrated that the age class frequencies of the capture and kill samples respectively were independent of sex (Table 22). The comparison of the pooled male and female capture sample with the kill sample established that the proportions of each cohort were independent of the sample source so the data were pooled to produce a single age class frequency structure (Table 22).

To produce an age frequency distribution where each age class frequency is lower than the one preceding, (as life table calculations require) standard log-polynomial smoothing was attempted (Caughley 1977, Snedecor and Cochran 1967). The reduction of the mean square in analysis of variance was not significant when a second degree variable of X (age class) was added [$P(F_{(1,24)} \geq 0.8980) > 0.50$]. This indicated the regression of age class on age class frequency was linear, not curvilinear as might be expected.

To fit a linear regression in which linearity can be tested, it was necessary to have multiple values of cohort size for each age class (Zar 1974). Age class frequencies of the two kill samples and two capture samples were therefore pooled to form a single kill and single capture sample giving two age class frequencies for each age. The regression was fitted after calculating values for the 0 and 1 year age classes of the kill sample based on the proportion of these age classes in the capture sample since these animals are not often killed. The slope of this regression line was significantly different from 0 [$P(F_{0.05(1)1,58} \geq 61.003) < 0.0005$] and the

Table 19. Age frequency structure of the study area polar bear population based on kill statistics between 1967 and 1977 and the capture data from 1972 to 1978.

Age	Number of bears: Kill sample Male	Kill sample Female	Capture sample Male	Capture sample Female
0	0	0	33	24
1	3	4	17	27
2	15	2	26	23
3	15	7	14	22
4	7	6	22	16
5	6	4	20	16
6	2	2	19	23
7	3	7	25	19
8	5	2	7	15
9	2	1	11	7
10	3	3	11	7
11	2	0	7	8
12	1	0	9	6
13	0	1	8	11
14	2	1	7	3
15	0	2	4	1
16	0	1	6	0
17	2	0	3	4
18	0	0	1	2
19	1	1	1	2

Sample mean ages

$\bar{X}$ kill male $\geq$ 2 yr = 6.06 $\pm$ 1.44 (S.E.)

$\bar{X}$ kill male $\geq$ 5 yr = 10.10 $\pm$ 2.38 (S.E.)

$\bar{X}$ kill female $\geq$ 2 yr = 9.23 $\pm$ 2.07 (S.E.)

$\bar{X}$ kill female $\geq$ 5 yr = 12.03 $\pm$ 2.77 (S.E.)

$\bar{X}$ capture male $\geq$ 2 yr = 8.17 $\pm$ 3.30 (S.E.)

$\bar{X}$ capture male $\geq$ 5 yr = 10.30 $\pm$ 5.93 (S.E.)

$\bar{X}$ capture female $\geq$ 2 yr = 7.83 $\pm$ 3.09(S.E).

$\bar{X}$ capture female $\geq$ 5 yr = 10.07 $\pm$ 5.90 (S.E.)

Table 19. (cont'd)

	Kill sample		Capture sample	
	Male	Female	Male	Female
20	0	0	3	2
21	0	3	5	3
22	0	1	1	1
23	0	1	2	1
24	1	1	2	2
25	0	1	0	0
26	0	0	0	0
27	0	0	0	0
28	0	0	0	1
29	0	0	0	1
	70	51	264	247

Table 20. Contingency table testing the dependence of age class frequency on sex for the capture sample.

Age	Male f(x)	Male $\hat{f}(x)$	Male x^2	Female f(x)	Female $\hat{f}(x)$	Female x^2	R total
0	33	29.45	0.43	24	27.55	0.46	57
1	17	22.73	1.44	27	21.27	1.54	44
2	26	25.32	0.02	23	23.68	0.02	49
3	14	18.60	1.141	22	17.40	1.22	36
4	22	19.63	0.29	16	18.37	0.31	38
5	20	18.60	0.11	16	17.40	0.11	36
6	19	21.70	0.34	23	20.30	0.36	42
7	25	22.73	0.23	19	21.27	0.24	44
8	7	11.37	1.68	15	19.63	1.80	22
9	11	9.30	0.31	7	8.70	0.33	18
10	11	9.30	0.31	7	8.70	0.33	18
11	7	7.75	0.20	6	7.25	0.22	15
12	9	7.75	0.20	6	7.25	0.22	15
13	8	9.82	0.34	11	9.18	0.36	19
14	7	5.17	0.65	3	4.83	0.69	10
15-19	15	12.40	0.55	9	11.60	0.58	24
20-29	13	12.40	0.03	11	11.60	0.03	24
Totals	264	264.02	8.80	247	246.98	8.68	511

$X^2 = 17.48$ DF = (R-1) (C-1) = (17-1)(2-1) = 16

Ho: the samples are independent of sex.

$\alpha = 0.05$

$0.50 > P[X^2_{(0.05,16)} \geq 17.48] > 0.25$

accept Ho: the samples are independent of sex.

Table 21. Contingency table testing the dependence of age class frequency on sex for the kill sample.

	Male			Female			
Age	f(x)	$\hat{f}(x)$	X^2	f(x)	$\hat{f}(x)$	X^2	R total
2	15	9.99	2.51	2	7.01	3.58	17
3	15	12.93	0.33	7	9.07	0.47	22
4	7	7.64	0.05	6	5.36	0.08	13
5	6	5.88	0.00	4	4.12	0.00	10
6	2	2.35	0.05	2	1.65	0.07	4
7	3	5.88	1.41	7	4.12	2.01	10
8	5	4.11	0.19	2	2.89	0.27	7
9	2	1.76	0.03	1	1.24	0.05	3
10	3	3.53	0.08	3	2.47	0.11	6
11-14	5	4.11	0.19	2	2.89	0.27	7
15-19	3	4.11	0.19	2	2.89	0.27	7
20-29	1	4.70	2.91	7	3.30	4.15	8
Totals	67	66.99	8.05	47	47.01	11.49	114

$X^2 = 19.54$ DF = (R-1) (C-1) = 11 x 1 = 11

Ho: The samples are independent of sex.

$\alpha = 0.05$

$0.10 > P[X^2_{(0.05,11)} \geq 19.54] > 0.05$

accept Ho: the samples are independent of sex.

Table 22. Contingency table testing the dependence of age class frequency on the sample source (i.e. capture and kill).

Age	Capture $f(x)$	Capture $\hat{f}(x)$	Capture X^2	Kill $f(x)$	Kill $\hat{f}(x)$	Kill X^2	R total
2	49	51.64	0.13	17	14.36	0.49	66
3	36	45.38	1.94	22	12.62	6.97	58
4	38	39.90	0.09	13	11.10	0.33	51
5	36	35.99	0.00	10	10.01	0.00	46
6	42	35.99	1.00	4	10.01	3.61	46
7	44	42.25	0.07	10	11.75	0.26	54
8	22	22.69	0.02	7	6.31	0.08	29
9	18	16.43	0.15	3	4.57	0.54	21
10	18	18.78	0.03	6	5.22	0.12	24
11	15	13.30	0.22	2	3.70	0.78	17
12	15	12.52	0.49	1	3.48	1.77	16
13	19	15.65	0.72	1	4.35	2.58	20
14	10	10.17	0.00	3	2.83	0.01	13
15-19	24	24.26	0.00	7	6.74	0.01	31
20-29	24	25.04	0.04	8	6.96	0.16	32
Totals	410	409.99	4.90	114	114.01	17.71	524

$X^2 = 22.61$ DF = (R-1) (C-1) = 14

Ho: the samples are independent of source.

$\alpha = 0.05$

$0.10 > P\ [X^2_{(0.05,14)} \geq 22.61] > 0.05$

accept Ho: the samples are independent of source.

function was linear $[P(F_{0.05(1)28,30} \geq 0.300) > 0.25]$. The regression function ($Y=27.9842-1.1796X$) is illustrated with its 95% confidence interval in Figure 13.

The linear regression was used to generate an age structure from 0 to 23 years of age for a population the size of the sample (Fig. 13). By calculating the probability of survival for each age class, it was possible to extrapolate a second age frequency structure which represented a population the size of the estimated Zone E population (1100 bears, Fig. 13). This expanded age frequency distribution was used for life table calculations.

The life table is presented in Table 23 with the life table functions illustrated in Figure 14. Multiplying the female age class frequencies by the weighted mean natality rate produced the annual recruitment values in column 9 (Table 23). The annual death rate was the product of the age class mortality rate and the age class frequency. On the basis of these calculations it was concluded that 152 cubs are born and 88 bears die annually.

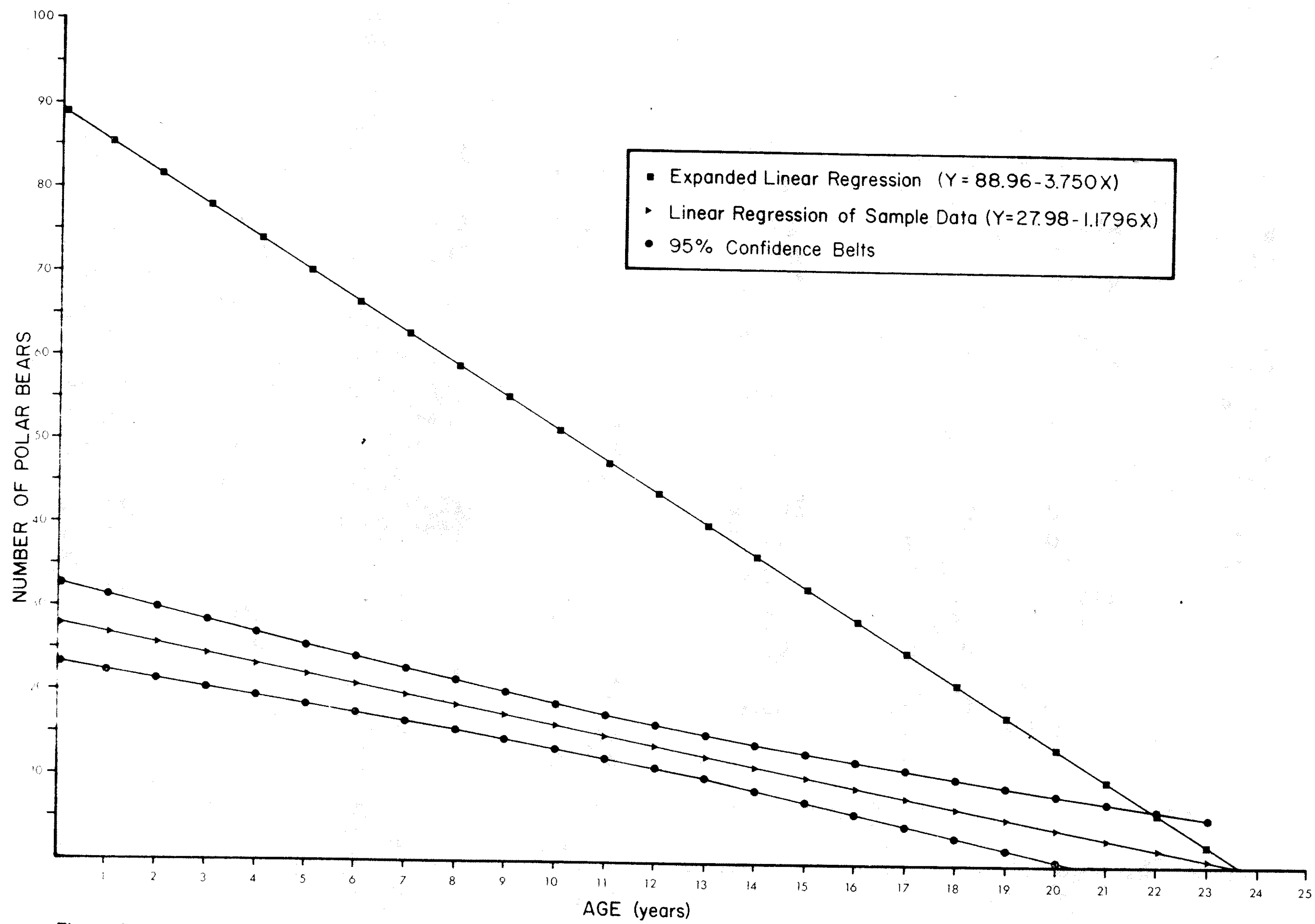

Figure 13. Regression of age class vs. age class frequency with 95% confidence belts and the age class frequency regression expanded to equal a population of 1,100 bears.

Table 23. Life Table of Zone E polar bear population.

Age	Total Frequency f(x)	Female Frequency ff(x)	Survival L(x)	Mortality D(x)	Survival Rate P(x)	Mortality Rate Q(x)	Mean Natality $\bar{m}(x)$	Annual Births	Annual Deaths
0	88.94	44.47	1.000	0.042	0.958	0.042	-	-	3.375
1	85.20	42.60	0.958	0.042	0.958	0.042	-	-	3.664
2	81.47	40.74	0.916	0.042	0.957	0.043	-	-	3.748
3	77.73	38.87	0.874	0.042	0.952	0.048	-	-	3.731
4	74.00	37.00	0.832	0.042	0.950	0.050	-	-	3.700
5	70.17	35.09	0.789	0.042	0.947	0.053	0.438	15.37	3.719
6	66.44	33.22	0.747	0.042	0.994	0.056	0.438	14.55	3.721
7	62.70	31.55	0.705	0.042	0.940	0.060	0.438	13.73	3.762
8	59.97	29.49	0.663	0.042	0.937	0.063	0.438	12.92	3.715
9	55.23	27.62	0.621	0.042	0.932	0.068	0.438	12.10	3.756
10	51.50	25.75	0.579	0.042	0.927	0.073	0.438	11.28	3.760
11	47.67	23.84	0.536	0.042	0.222	0.078	0.438	10.44	3.718
12	43.94	21.97	0.494	0.042	0.915	0.085	0.438	9.62	3.735
13	40.20	20.10	0.452	0.042	0.907	0.093	0.438	8.80	3.739
14	36.47	18.24	0.410	0.042	0.898	0.102	0.438	7.99	3.720
15	32.73	16.37	0.368	0.042	0.886	0.114	0.438	7.17	3.731
16	28.99	14.50	0.326	0.042	0.871	0.129	0.438	6.35	3.740
17	25.17	12.59	0.283	0.042	0.852	0.148	0.438	5.51	3.725
18	21.43	10.72	0.241	0.042	0.826	0.174	0.438	4.70	3.729
19	17.70	8.85	0.199	0.042	0.789	0.211	0.438	3.88	3.735
20	13.96	6.98	0.157	0.042	0.732	0.268	0.438	3.06	3.741
21	10.23	5.12	0.115	0.042	0.635	0.365	0.438	2.24	3.734
22	6.49	3.25	0.073	0.042	0.425	0.575	0.438	1.42	3.732
23	2.67	1.34	0.030				0.438	1.17	2.670
Totals	1100	500						152.30	88.100

Annual births = ff(x) X $\bar{m}$ (x)

Annual deaths = f(x) X Q(x)

Mean mortality rate = $\bar{q}$ = 0.08

Mean survival rate = 1 - $\bar{q}$ = 0.92

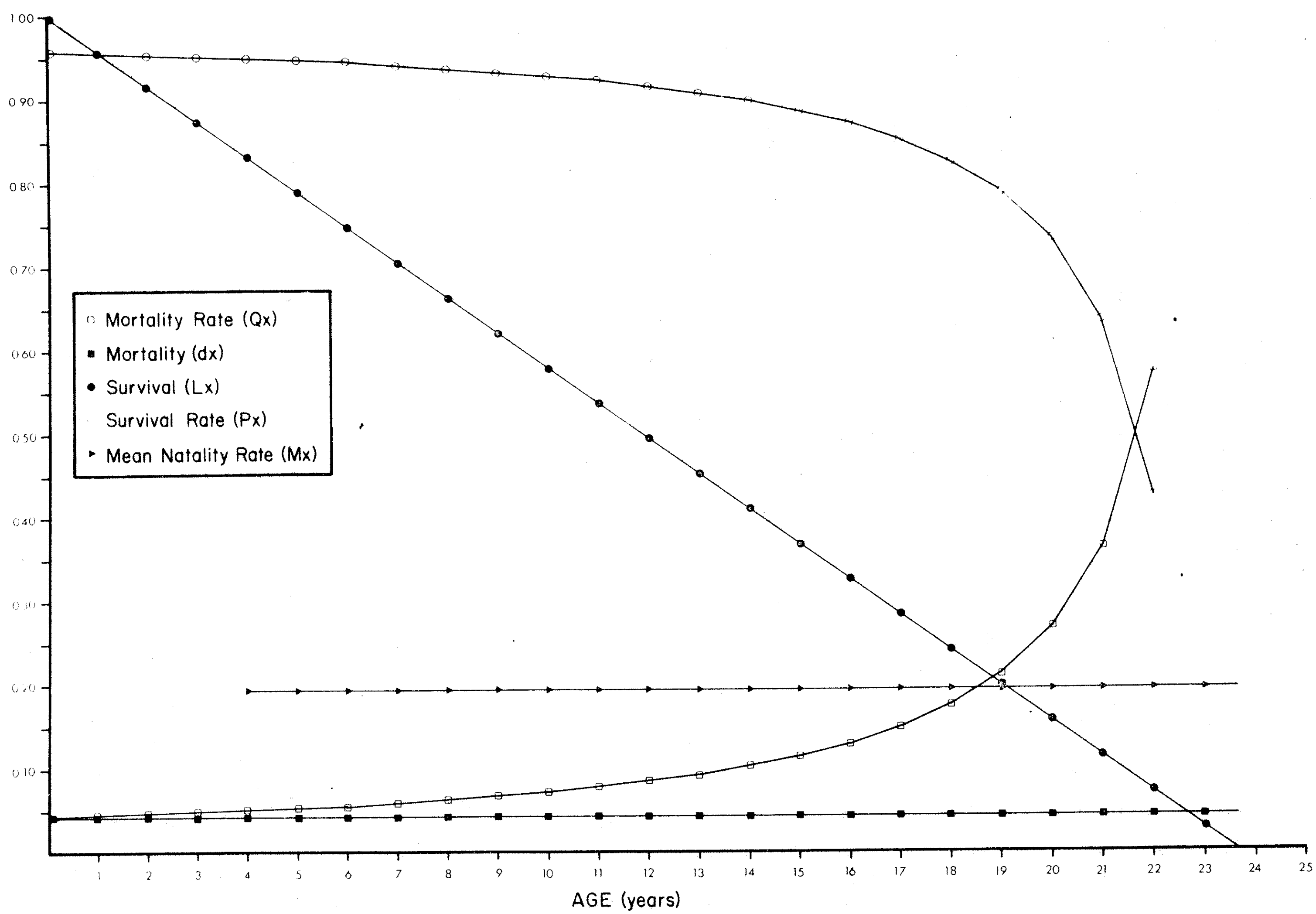

Figure 14. Life table functions.

CONCLUSIONS

Sub-population Limits

Polar bear sub-populations with a high degree of predictable separation probably do not exist (Stirling et al. 1978). Instead, there appears to be a continuous distribution of bears whose home ranges overlap to varying degrees. Seasonal fidelity to particular areas has been demonstrated in a large percentage of recaptured bears, but at least 5% to 10% of recaptured bears disperse from commonly shared areas. Although some bears were recaptured outside of Zone E, the boundaries delineated by the Federal-Provincial Polar Bear Technical committee were generally confirmed by this study. Range limits remain unknown in Committee Bay, north M'Clintock Channel and Hadley Bay.

Distribution and Seasonal Movements

Polar bears have definite seasonal congregation areas. There are also large areas in which they are seldom observed. The conditions accounting for this disparate distribution are unknown, but are probably related to ice type and seal distribution.

Capture-recapture information indicated that a tagged polar bear has a greater chance of being recaptured (seasonally) within 150 kilometres of its point of original capture than elsewhere. Whether bears move in groups or individually to seasonal areas is unknown. Nor are the variations in movements caused by sex and age differences clear. New techniques, such as satellite telemetry, may shed light on the movements of polar bears in response to environmental conditions.

In many cases denning areas overlap Inuit hunting areas. A later hunting season opening date would protect pregnant females until they denned.

Population Structure

From our data it appears that a minimal estimate for the polar bear subpopulation in the study area is 1100. We estimate that 152 cubs are produced and 88 bears die each year. From only one sample, it can not be concluded that the population is stationary (Caughley 1977). We have assumed a stationary age distribution on the following basis:

i) The population has been resident in the area sufficiently long to achieve a stationary age distribution.

ii) No major natural perturbations have been recorded in recent time to disrupt the age distribution (i.e. decline of seal population or resource development).

iii) Human predation levels have been held constant by quotas set at traditional levels of harvest since the advent of snowmobiles and a viable polar bear fur market in the late 1960's.

iv) There has been no marked change in the abundance of bears in the area recorded by either native or white observers.

Given the unavoidable violation of estimate assumptions, small sample sizes, and biasis in technique, we conclude that more bears were born than died in this sample.

Indications that the population is healthy include the presence of older age classes in both the capture and kill samples. The balanced sex ratio of the capture sample indicates that the preponderance of males in the kill sample is nullified by a much larger population.

The linear regression of age class on age class frequency may be an artifact. One would expect higher mortality in juvenile age classes (Caughley 1966) and a leveling off of mortality in experienced adult bears. A larger and more randomly collected sample is required to clearly define the age structure functions and confirm or invalidate the findings of this study. A larger kill sample would aid in defining mortality patterns.

Excluding Hadley Bay, 53 polar bears are lost annually to hunting from a total mortality of about 90 bears. Therefore, 30 to 40 bears (including bears too small to be legally hunted) die of natural causes in the study area each year. Additionally, 60 more cubs are recruited into the population than the 90 bears which die each year. On this basis an increase in kill seems justified.

Obviously, the hunter kill dominates present mortality. However, we do not know if an increase in hunting will have an additive or compensatory effect on mortality rates. This is an obvious question for further research.

Caughley (1977) states that in ungulates, most populations contain more males than are needed to fertilize all females capable of reproducing. Reduction of the number of males has little effect on the population until a threshold is reached at which females remain unbred. In promiscuous animals (polar bears) or animals in which a few dominant males monopolize the receptive females, this threshold is low. Thus the sex ratio can be unbalanced in favour of females without causing the population to decline. Kemp (1974) found that removal of male black bears caused the population to increase, a possible indication that males regulate bear populations. Whether these results are consistent for polar bears is unknown, but it is likely that a moderate increase in male kill would not cause polar bear populations to decline.

Since the effects of hunter kill on total mortality and the role of males in population regulation of polar bears are unknown, any increase in quotas must be accompanied by a strict monitoring of the kill to detect fluctuations in the kill age structure. Considering our empirical approach and the potential danger in overharvesting a long-lived, low-producing species such as polar bears, possible quota increases should be treated with caution.

Stirling et al. (1976) demonstrated through modelling that delaying the hunting season until 1 January (hence protecting pregnant females) and protecting family groups of all ages, allowed a higher kill without causing the population to decline.

Our relative ignorance and the potential for disaster dictate that any management plan for increasing quotas should incorporate sex-specific harvest, strict monitoring of the kill and protection of family groups and reproductive females. Ideally, we should be managing polar bears at the group, not the sub-population level. However, our data are inadequate for the task.

RECOMMENDATIONS

1) The regular quotas for Cambridge Bay, Gjoa Haven, Spence Bay, and Pelly Bay should stay the same.

2) A special or experimental quota of 20 bears should be evenly divided between these settlements.

3) Red tags should be used for the experimental quota to emphasize its special nature.

4) All bears killed on the special quota should be taken after 1 January. Settlements, especially Pelly Bay and Spence Bay, should be encouraged to hunt in spring, to save pregnant females.

5) No bears in family groups should be taken on the special quotas.

6) Emphasis for the special quota should be on adult males. This can be done by (a) stressing to the hunters the importance of only killing large adult males or (b) imposing hide length restrictions.

7) To ensure that the population is not being inadvertently overhunted, the special quota increase must be accompanied by a 100% return of jaws from the <u>total</u> quota.

8) Failure to comply with compulsory jaw return would cause the special quota for that settlement to be forfeited.

9) Hypotheses on population regulation, density dependent regulations, and sex-age hunting patterns of polar bears should be tested.

10) The relatively unhunted groups of bears of Franklin Strait and Hadley Bay should be saved for the above studies. Therefore the quota of Hadley Bay should not be raised.

ACKNOWLEDGEMENTS

This study was financed by the Northwest Territories Wildlife Service and the Environmental-Social Program, Northern Pipelines. Some logistic support was obtained from Polar Continental Shelf Project. Field assistance was provided by Ralph Archibald, Norman Barichello, Bill Carpenter, Peter Ookpik, David Kamayoak, Stephen Alookee, J. Jayko, Pat Lyall, Ernie Lyall, Bob Jay, A. Veidemen, John Gray, John Laurie, Jim Smithson, John Hodgson, Harry Niwranski, and Dave Small. Much valuable information on the location of bears and bear habitat was obtained from the Hunters' and Trappers' Associations of Cambridge Bay, Gjoa Haven, Spence Bay, and Pelly Bay. Aiko Sutherland of the Northwest Territories Wildlife Service supplied many hours of laboratory age analysis. Special thanks go to Dr. Ian Stirling of the Canadian Wildlife Service and his assistants, Dennis Andriashek, Wendy Calvert, and Henk Kiliaan for their help in the field and laboratory. Ian Stirling, D. DeMaster, K. Lloyd and F. Bunnell reviewed the manuscript.

LITERATURE CITED

Anon. 1977. Atmospheric Environment Service Ice Condition Maps. Atmospheric Environment Service, Toronto, Ontario.

Banfield, A.W.F. 1974. The Mammals of Canada. University of Toronto Press, Toronto, Ontario.

Bunnell, F.L. and D.E.N. Tait. 1978. Population dynamics of bears and their implications. Proc. of Int. Conf. on Pop. Dynamics of Large Mammals, May 1978, Logan, Utah.

Caughley, G. 1966. Mortality patterns in mammals. Ecology, 46:906-918.

Caughley, G. 1977. Analysis of Vertebrate Populations. John Wiley and Sons Ltd. Toronto, Ontario.

Collin, A.E. 1958. An oceanographic study of Prince Regent Inlet, the Gulf of Boothia and the adjacent waters. Fish. Res. Board Can. Ms. Rep. Ser. No. 13.

DeMaster, D.P., M. Kingsley, NVCS, I. Stirling. 1980. A multiple mark and recapture estimate applied to polar bears. Can. J. Zool. 58:633-638.

Dunbar, Moira and K.R. Greenaway. 1956. Arctic Canada from the air. Defence Research Board of Canada. Queen's Printer, Ottawa. 541 p.

Godfrey, W.E. 1966. The Birds of Canada. National Museums of Canada Bulletin No. 203, Information Canada, Toronto, Ontario.

Harington, C.R. 1968. Denning habits of the polar bear (Ursus maritimus Phipps). Canadian Wildlife Service Report Series, No. 5. 30 p.

Kemp, G.A. 1974. The dynamics and regulation of black bears (Ursus americanus) populations in northern Alberta. Third International Conference on Bears - Their Biology and Management. Binghamton N.Y. and Moscow, U.S.S.R. IUCN Morges, Switzerland, 1976.

Kiliaan, H.P.L. 1974. Polar bear productivity studies of northern Prince of Wales Island and Russell Island, N.W.T. March - April, 1974. C.W.S. unpublished Polar Bear Project Special Report. No. 75. 5pp.

Larsen, T. 1971. Capturing, handling, and marking polar bears in Svalbard. J. Wildl. Manag., 35:27-36.

Lentfer, J.W. 1968. A technique for immobilizing and marking polar bears. J. Wildl. Manag., 32:317-321.

Lewontin, R.C. and J. Felsenstein. 1965. The robustness of homogeneity tests in 2 x N tables. Biometrics, 21:19-33.

Manning, T.H. and A.H. MacPherson. 1961. A biological investigation of Prince of Wales Is., N.W.T. Trans. Roy. Can. Inst., 33(2):116-239.

Porsild, A.E. 1955. The vascular plants of the western Canadian Arctic Archipelago. Dept. Northern Affairs and Natural Resources, National Museum of Canada, Bull. 135. 226 p.

Savile, D.B.O. 1972. Arctic adaptations in plants. Dept. of Agriculture, Canada. Monograph No. 6. 81 p.

Schweinsburg, R. 1976. Polar bears - Research in and around Admiralty Inlet, July - August. In: (Kemper, B. Ed.) Environmental Baseline Studies 1975 Strathcona Sound Program, Preliminary Report. CWS. March, 1976.

Schweinsburg, R.E., Ian Stirling, S. Oosenburg, and H. Kiliaan. 1977. A Status Report on Polar Bear Studies in Lancaster Sound. NWT Fish and Wildlife Service Report to Norlands Petroleums Ltd. 22 p.

Snedecor, G.W. and W.G. Cochran. 1967. Statistical Methods. The Iowa State University Press, Ames, Iowa. 593 pp.

Spencer, W. 1979. Polar bear denning area at Gateshead Island, N.W.T., N.W.T. Wildlife Service, File Report No. 1. 8 p.

Stirling, I., D. Andriashek, P. Latour, and W. Calvert. 1975. The distribution and abundance of polar bears in the eastern Beaufort Sea. A Final Report to the Beaufort Sea Project. Fisheries and Marine Service, Department of the Environment. Victoria, B.C. 59 p.

Stirling I., A. M. Pearson, and F.L. Bunnell. 1976. Population ecology studies of polar and grizzly bears in northern Canada. Trans. 41st N. Amer. Wildl. Conf., 41:421-430.

Stirling, I., R.E. Schweinsburg, W. Calvert and H.P.L. Kiliaan. 1977a. Population ecology of the polar bear along the proposed Arctic Islands Gas Pipeline Route. Progress Report to the Environmental Management Service, Department of the environment, Edmonton, Alberta. 69 p. (typed).

Stirling, I., W.R. Archibald, and D. DeMaster. 1977b. Distribution and abundance of seals in the eastern Beaufort Sea. J. Fish. Res. Bd. Canada. 34:976-988.

Stirling I., R.E. Schweinsburg, W. Calvert, and H.P.L. Kiliaan. 1978. Population ecology of the polar bear along the proposed Arctic Islands Gas Pipeline Route. Final report to the Environmental Management Service, Department of the Environment, Edmonton, Alberta. 93 p.

Thomas, D.C. and P.J. Bandy. 1973. Age determination of wild black-tailed deer from dental annulations. J. Wildl. Manag. 37(2):232-235.

Thorsteinsson, R. and E.T. Tozer. 1970. Geology of the Arctic Archipelago; in Geology and economic minerals of Canada, R.J.W. Douglas, ed., p. 548-590. Geol. Surv. Can. Econ. Geol. Rept. No.

Van de Velde, F. 1971. Bear stories. Eskimo, (New Series) 1:7-11.

Zar, J. H. 1974. Biostatistical Analysis. Prentice-Hall, Inc. N.J.

APPENDIX I. Climatological Data in the Study Area.

CLIMATOLOGICAL TABLE # 73 . PELLY BAY , N.W.T.
LAT. 68 ° 26 ', LONG 89 ° 39 ' ELEVATION 1069 '

MONTH	TEMPERATURE							CLOUD				FOG
	MEAN DAILY	MEAN OF DAILY		MEAN OF MONTHLY		MONTHLY EXTREMES		Mean Monthly	8–10/10	3–7/10	0–2/10	
		MAX.	MIN.	MAX.	MIN.	MAX.	MIN.					
	°F	°F	°F	°F	°F	°F	°F	TENTHS	% FREQ			DAYS
JAN	–28.2	–22.3	–34.1	2	–50	22	–57					
FEB	–30.6	–25.2	–36.0	3	–49	20	–58					
MAR	–20.0	–15.0	–25.0	2	–47	19	–54					
APR	– 4.7	1.7	–11.1	22	–31	31	–42					
MAY	14.2	19.2	9.2	33	– 7	43	–16					
JUNE	32.5	37.4	27.6	50	15	65	8					
JULY	46.0	52.7	39.3	66	30	77	26					
AUG	40.4	45.6	35.2	62	27	75	20					
SEPT	27.1	30.4	23.7	44	12	54	5					
OCT	8.2	13.0	3.3	23	–13	35	–26					
NOV	– 7.0	– 0.8	–13.2	22	–35	29	–42					
DEC	–19.2	–13.3	–25.0	13	–40	27	–51					
YEAR	4.9	10.3	– 0.6	68	–53	77	–58					
PERIOD	1960–1964(ADJ)			1960–1969		1957–1969						

MONTH	PRECIPITATION							SUNSHINE	WIND
	MEAN MONTHLY			DAYS WITH MEASURABLE			MAX. PCPN. 24 HR.		MEAN VELOCITY
	RAIN	SNOW	TOTAL PCPN.	RAIN	SNOW	T. PCPN.			
	IN.	IN.	IN.	NO.	NO.	NO.	IN.	HOURS	M.P.H.
JAN	0.00	1.2	0.12	0	2	2	0.19		
FEB	0.00	1.2	0.12	0	2	2	0.20		
MAR	0.00	1.8	0.18	0	2	2	0.35		
APR	0.00	5.8	0.58	0	4	4	0.60		
MAY	0.00	3.7	0.37	0	6	6	0.47		
JUNE	0.21	1.4	0.35	2	2	4	0.60		
JULY	1.32	0.4	1.36	9	1	9	1.17		
AUG	2.77	1.5	2.92	13	1	14	1.72		
SEPT	0.44	6.5	1.09	3	7	9	0.80		
OCT	0.00	6.3	0.63	0	6	6	0.60		
NOV	0.00	3.4	0.34	0	4	4	0.98		
DEC	0.00	1.3	0.13	0	2	2	0.26		
YEAR	4.74	34.5	8.19	37	39	64	1.48		
PERIOD	1960–1964			1960–1964			1957–1969		

MAXIMUM OBSERVED HOURLY WIND SPEED	M.P.H.
COMPUTED MAXIMUM GUST FOR MAXIMUM HOURLY	M.P.H.

OCCURRENCE OF SNOW COVER 1 IN. OR MORE	EARLIEST	MEAN	LATEST
DATE OF FIRST IN FALL			
DATE OF LAST IN SPRING			

BREAK-UP AND FREEZE-UP DATES	PERIOD OF RECORD	MEAN BEGINNING	MEAN ENDING
BREAK-UP			
FREEZE-UP			
BODY OF WATER:			

CLIMATOLOGICAL TABLE # 88 . SPENCE BAY , N.W.T.
LAT. 69 ° 32 ', LONG 93 ° 31 ' ELEVATION 44 '

MONTH	TEMPERATURE							CLOUD				FOG
	MEAN DAILY	MEAN OF DAILY		MEAN OF MONTHLY		MONTHLY EXTREMES		Mean Monthly	8–10/10	3–7/10	0–2/10	
		MAX.	MIN.	MAX.	MIN.	MAX.	MIN.					
	°F	°F	°F	°F	°F	°F	°F	TENTHS	% FREQ			DAYS
JAN	–28.8	–21.7	–35.8	2	–52	23	–60					1.1
FEB	–31.1	–24.6	–37.6	0	–51	16	–60					0.4
MAR	–23.7	–16.0	–31.3	0	–49	23	–57					0.6
APR	– 5.9	2.1	–13.8	20	–36	32	–45					0.9
MAY	14.3	21.4	7.2	36	–12	39	–21					3.0
JUNE	33.6	38.7	28.5	51	16	64	7					2.0
JULY	45.4	52.9	37.9	64	23	73	29					3.1
AUG	44.6	50.5	38.6	60	31	67	26					3.6
SEPT	31.1	35.0	27.2	45	14	55	4					1.8
OCT	11.0	16.4	5.6	31	–17	36	–28					2.9
NOV	–11.6	– 5.3	–17.8	21	–38	33	–44					1.1
DEC	–23.1	–16.9	–29.2	12	–44	20	–53					0.9
YEAR	4.7	11.0	– 1.7	64	–55	73	–60					21.4
PERIOD	1951–1960			1960–1969		1951–1969						53–60

MONTH	PRECIPITATION							SUNSHINE	WIND
	MEAN MONTHLY			DAYS WITH MEASURABLE			MAX. PCPN. 24 HR.		MEAN VELOCITY
	RAIN	SNOW	TOTAL PCPN.	RAIN	SNOW	T. PCPN.			
	IN.	IN.	IN.	NO.	NO.	NO.	IN.	HOURS	M.P.H.
JAN	0.00	2.9	0.29	0	6	6	0.40		
FEB	0.00	3.4	0.34	0	5	5	0.46		
MAR	0.00	3.9	0.39	0	5	5	1.00		
APR	0.01	3.1	0.32	*	5	6	0.30		
MAY	0.01	6.4	0.65	*	7	7	0.76		
JUNE	0.40	5.9	0.99	4	5	8	1.39		
JULY	0.82	0.2	0.84	7	*	7	0.70		
AUG	1.19	0.0	1.19	10	0	10	0.95		
SEPT	0.37	3.7	0.74	4	4	7	0.80		
OCT	0.02	10.1	1.03	*	10	10	0.80		
NOV	0.00	4.5	0.45	0	7	7	0.38		
DEC	0.00	2.8	0.28	0	5	5	0.35		
YEAR	2.82	46.9	7.51	25	59	83	1.39		
PERIOD	1951–1960			1951–1960			1951–1969		

MAXIMUM OBSERVED HOURLY WIND SPEED ________ M.P.H.
COMPUTED MAXIMUM GUST FOR MAXIMUM HOURLY ________ M.P.H.

OCCURRENCE OF SNOW COVER 1 IN. OR MORE	EARLIEST	MEAN	LATEST
DATE OF FIRST IN FALL	Sept. 9	Sept. 29	Oct. 18
DATE OF LAST IN SPRING	June 16	June 25	July 2

BREAK-UP AND FREEZE-UP DATES	PERIOD OF RECORD	MEAN BEGINNING	MEAN ENDING
BREAK-UP	1949–62	–	July 26
FREEZE-UP	1949–63	–	Oct. 2
BODY OF WATER: SPENCE BAY HARBOUR & SPENCE BAY			

CLIMATOLOGICAL TABLE # 14 . CAMBRIDGE BAY A , N.W.T.
LAT. 69 ° 06 ', LONG 105 ° 07 ' ELEVATION 74 '

MONTH	TEMPERATURE							CLOUD				FOG
	MEAN DAILY	MEAN OF DAILY		MEAN OF MONTHLY		MONTHLY EXTREMES		Mean Monthly	8–10/10	3–7/10	0–2/10	
		MAX.	MIN.	MAX.	MIN.	MAX.	MIN.					
	°F	°F	°F	°F	°F	°F	°F	TENTHS	% FREQ			DAYS
JAN	−26.8	−20.1	−33.5	−1	−52	21	−63	4.2	34	15	51	1.3
FEB	−30.0	−24.0	−35.9	0	−48	14	−59	3.8	30	17	53	1.5
MAR	−21.3	−14.1	−28.5	3	−47	21	−53	3.9	30	17	53	1.2
APR	− 6.9	1.6	−15.3	19	−34	43	−44	4.6	36	17	47	1.7
MAY	15.3	22.1	8.4	36	−14	46	−31	6.9	62	12	26	4.9
JUNE	35.1	40.4	29.7	55	16	72	4	7.6	67	16	17	3.4
JULY	46.9	54.1	39.7	69	33	84	30	6.8	58	19	23	2.5
AUG	44.3	50.1	38.5	62	31	76	26	6.9	62	19	19	3.8
SEPT	31.7	35.4	28.0	46	16	60	1	8.4	79	12	9	2.9
OCT	11.7	17.5	5.9	33	−15	43	−25	7.3	68	11	21	3.3
NOV	−10.9	− 4.5	−17.2	19	−35	29	−44	5.1	43	16	41	1.5
DEC	−22.0	−15.5	−28.4	9	−40	18	−57	4.6	36	16	48	1.6
YEAR	5.6	11.9	− 0.7	69	−52	84	−63	5.8	50	16	34	29.6
PERIOD	1940–1960			1960–1969		1929–1932 1934–1969		1948–1960				1943–1960

MONTH	PRECIPITATION							SUNSHINE	WIND
	MEAN MONTHLY			DAYS WITH MEASURABLE			MAX. PCPN. 24 HR.		MEAN VELOCITY
	RAIN	SNOW	TOTAL PCPN.	RAIN	SNOW	T. PCPN.			
	IN.	IN.	IN.	NO.	NO.	NO.	IN.	HOURS	M.P.H.
JAN	0.00	3.2	0.32	0	7	7	0.47		13.5
FEB	0.00	1.7	0.17	0	5	5	0.22		12.1
MAR	0.00	2.2	0.22	0	6	6	0.40		11.0
APR	0.00	1.8	0.18	0	5	5	0.36		11.7
MAY	0.01	2.3	0.24	*	6	6	0.53		12.2
JUNE	0.32	1.8	0.50	3	3	6	0.83		12.7
JULY	0.99	0.1	1.00	7	*	7	1.32		12.1
AUG	0.97	0.1	0.98	7	*	7	1.21		12.6
SEPT	0.33	2.8	0.61	4	5	8	0.42		13.1
OCT	0.02	5.0	0.52	1	9	10	0.82		13.6
NOV	0.00	4.1	0.41	0	8	8	0.60		11.6
DEC	0.00	2.5	0.25	0	7	7	0.40		11.4
YEAR	2.64	27.6	5.40	22	61	82	1.32		11.3
PERIOD	1931–1932,1934–1960			1941–1960			1929–32 1934–69		1955–1966

MAXIMUM OBSERVED HOURLY WIND SPEED	55	M.P.H.
COMPUTED MAXIMUM GUST FOR MAXIMUM HOURLY	77	M.P.H.

OCCURRENCE OF SNOW COVER 1 IN. OR MORE	EARLIEST	MEAN	LATEST
DATE OF FIRST IN FALL	Sept. 15	Sept. 28	Oct. 22
DATE OF LAST IN SPRING	June 7	June 20	June 28

BREAK-UP AND FREEZE-UP DATES	PERIOD OF RECORD	MEAN BEGINNING	MEAN ENDING
BREAK-UP	1951–63	June 15	July 20
FREEZE-UP	1951–63	–	Oct. 13
BODY OF WATER: CAMBRIDGE BAY			