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the polar bear in
the James Bay and
Belcher Islands area**

**by Charles Jonkel,
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**Occasional Paper
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**Canadian
Wildlife Service**



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Service de la Faune

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Issued under the authority of the
Minister of the Environment

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Minister of Supply and Services Canada 1976
Catalogue No. CW69-1/26
Ottawa

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Dedication

To Francis Anderson Walden, 1919–74.

This research report, and the co-ordinated management of polar bears in southern Hudson Bay and James Bay, could not have been achieved without the efforts of the Federal–Provincial Polar Bear Technical and Administrative Committees. The committees, in turn, could not have achieved as complete inter-governmental co-operation without the friendly direction provided by Frank Walden. His clear grasp of legal implications, possibilities, and impossibilities helped to guide the committees through the uncharted tangles of native people’s claims, inter-jurisdictional problems, and old-fashioned bureaucracy. His efforts were instrumental in building the cooperative polar bear research and management structure present in Canada today.

Acknowledgements

We gratefully acknowledge the following: Canadian Wildlife Service (CWS), Northwest Territories Fish and Wildlife Service, Ontario Ministry of Natural Resources (OMNR), and the Quebec Wildlife Service (QWS) for financial support. We are also grateful to B. Carter, S. Curtis, H. P. L. Kiliaan, B. M. Knudsen, P. Madore, T. H. Manning, D. McIlveen and R. H. Russell (all from CWS); R. Hawkins and J. T. Strong (NWT), and I. Juniper and D. Le Henaff (QWS), the Fort George Band, Austin Airways, F. Blackned (Paint Hills), and M. Hunter (Winisk), who gave valuable assistance in the field, and to H. P. L. Kiliaan for sectioning and ageing the teeth. Numerous other government and non-government personnel and native peoples provided information and specimens. To a large degree, the success of this project was due to the continued patience, assistance, and encouragement of Mr. J. E. Bryant, Director, Eastern Region, CWS.

Abstract

The present status of the polar bear (*Ursus maritimus*) in the James Bay and Belcher Islands area was assessed from the results of 8 years of investigation of the habitat and biology of polar bears in that area by the Canadian Wildlife Service (1967–75), surveys carried out by the Ontario Ministry of Natural Resources since 1963, and from kill records.

The most important factor that affected the seasonal distribution and movement of polar bears was the seasonal variation of sea-ice conditions. Aerial surveys indicated that the bears retreated to the islands of James and Hudson bays and the Quebec and Ontario coastline from late July onwards as the sea-ice melted. Polar bears were rarely seen on the islands or coast of southern James Bay. Areas of summer sanctuary were vacated as soon as the ice cover began to form in November.

Sixty polar bears were tagged. The recorded movements of 28 tagged animals suggested the existence of a single sub-population within the James Bay and Belcher Islands area. The possible lack of fidelity of individual bears for a specific island or coastal area as a summer sanctuary was also suggested.

From aerial and ground surveys, and from Inuit and Indian reports, two maternity denning areas have been confirmed: 1) southwest of Cape Henrietta Maria, Ontario, and 2) the islands of James Bay (Twin islands and Akimiski Island). Three other suspected denning areas are: 1) southwestern Belcher Islands, 2) Nastapoka Islands, and 3) Quebec mainland southeast of Cape Jones. The extent and annual productivity of the confirmed areas are unknown but indications were that productivity per female and per year were high. If denning occurs in other areas present evidence indicates that concentration of dens and annual productivity are probably low.

The predominant summer behaviour of polar bears is resting. In the analyses of polar bear scats, birds dominated the summer–autumn diet of the James Bay bears, whereas grasses and marine algae appeared to be the most important food item for bears on the Ontario and Manitoba mainland. Summer dens of two types were reported: 1) shallow depressions or pits, and 2) shallow burrows or dens. On the islands and on the Ontario coast, summer dens provided resting places sheltered from the sun and insect pests. The effects of man's ground activities and aerial surveys on the distribution of polar bears, particularly in areas of summer sanctuary, were not clear.

Hunting of polar bears is restricted to native people. Most of the 30–50 bears now taken each year are killed in the western Belcher Islands area during winter and spring, on the Quebec mainland and coastal islands in summer, and on the Ontario coast in spring and fall. The increase in fur prices probably accounted for the apparent increase in polar bear hunting in recent years. The average age of polar bears killed or captured in James Bay was significantly greater than those from the Belcher Islands area.

A crude estimate of the population size in 1973, based on a Lincoln Index, was 254 bears. If this estimate approximates reality, the proposed annual quotas for the area (totalling 45) could be as high as 18% of the total population.

Research is required: 1) to monitor the age structure of bears harvested; 2) to delineate the northern and western boundaries of management Zone A3; 3) to fully document the maternity denning areas, and 4) to determine the possible effects of hydro and other developments on the species.

Résumé

L'évaluation de l'état actuel de l'ours blanc (*Ursus maritimus*) dans la région de la baie James et des îles Belcher se fonde sur huit années d'étude de l'habitat et de la biologie de l'espèce dans ce secteur par le Service canadien de la faune (1967-75), des relevés effectués depuis 1963 par le ministère ontarien des Ressources naturelles et les statistiques de prises.

Les variations saisonnières de la glaciation marine ont constitué le principal facteur de celles de la distribution de l'ours blanc. Il ressort des relevés aériens que les ours se réfugient aux îles des baies James et d'Hudson ainsi que sur les côtes du Québec et de l'Ontario à compter de la fin de juillet au fur et à mesure de la fonte des glaces marines. On a vu très peu d'ours dans les parages méridionaux, insulaires ou côtiers, de la baie James. Les animaux quittent leurs refuges d'été dès que s'amorce, en novembre, la formation de la banquise.

On apposa des étiquettes à soixante ours blancs et le relevé des déplacements de 28 d'entre eux a porté à conclure à l'existence d'un même bassin de population dans la région de la baie James et des îles Belcher. On a par ailleurs envisagé la possibilité que le même ours ne jette pas à chaque été son dévolu sur le même secteur ou la même île.

Les relevés, tant aériens qu'au sol, conjugués aux rapports des Inuits et des Indiens, ont permis de confirmer la localisation de deux aires de mise bas, l'une au sud-ouest du cap Henriette-Marie (Ontario) et l'autre dans les îles de la baie James (îles Jumelles et île Akimiski). L'existence de trois autres n'a cependant pu être vérifiée; de celles-ci, l'une se trouverait dans le sud-ouest des îles Belcher, la deuxième dans les îles Nasta-poka et la troisième sur la terre ferme, au Québec, soit au sud-ouest de la pointe Louis-XIV. Malgré que l'étendue des aires dont la loca-

lisation est confirmée ainsi que la productivité annuelle de leurs populations d'ours restent inconnues, divers indices donnent à penser que la productivité, par femelle et par année, y est élevée. S'il y a mise bas en d'autres aires, la concentration des repaires et la productivité annuelle y sont probablement faibles.

L'été, les ours blancs se reposent le plus clair du temps. Il ressort de l'analyse de leurs excréments que l'été et l'automne, les ours des parages de la baie James se nourrissent surtout d'oiseaux tandis que leurs congénères des côtes du Manitoba et de l'Ontario mangent surtout des herbes et des algues marines. Nous avons découvert deux genres d'abris d'été: soit des dépressions peu profondes, ou fosses, et des trous profonds ou repaires. Dans les îles et sur la côte d'Ontario, les repaires d'été sont des endroits où se reposer à l'abri du soleil et des insectes. Nous n'avons pas réussi à mesurer avec précision les répercussions des activités au sol et des relevés aériens sur la distribution des ours blancs, notamment dans les aires où ils se réfugient l'été.

La chasse à l'ours blanc est réservée aux indigènes. Des 30 à 50 ours tués chaque année, la plupart sont pris soit en hiver et au printemps dans l'ouest de l'archipel Belcher, soit l'été dans les parages du littoral québécois, soit enfin du côté ontarien au printemps et à l'automne. La montée du prix des fourrures rend probablement compte de l'intensification de la chasse ces dernières années. L'âge moyen des ours tués ou capturés à la baie James était significativement plus élevé que pour les prises faites aux îles Belcher.

De nouvelles recherches seront nécessaires pour déterminer la répartition des prises selon l'âge, établir les limites nord et sud de l'aire A³, documenter à fond la localisation des aires de mise bas et déterminer l'incidence sur l'espèce de grands travaux tels l'aménagement de centrales hydroélectriques.

Introduction

Studies of polar bears in the James Bay and Belcher Islands area were begun by the CWS in 1967 as part of a long-term investigation of polar bear habitats and biology throughout Canada. Previous polar bear studies in southern Hudson and James bays include notes on general ecology by Kolenosky and Standfield (1966) and on summer dens by Doult (1967), and various unpublished reports of coastal surveys by the Ontario Ministry of Natural Resources (OMNR). More recent studies on polar bear denning habits (Jonkel *et al.* 1972), ecology (Knudsen 1973), and food habits (Russell 1975) have also been completed.

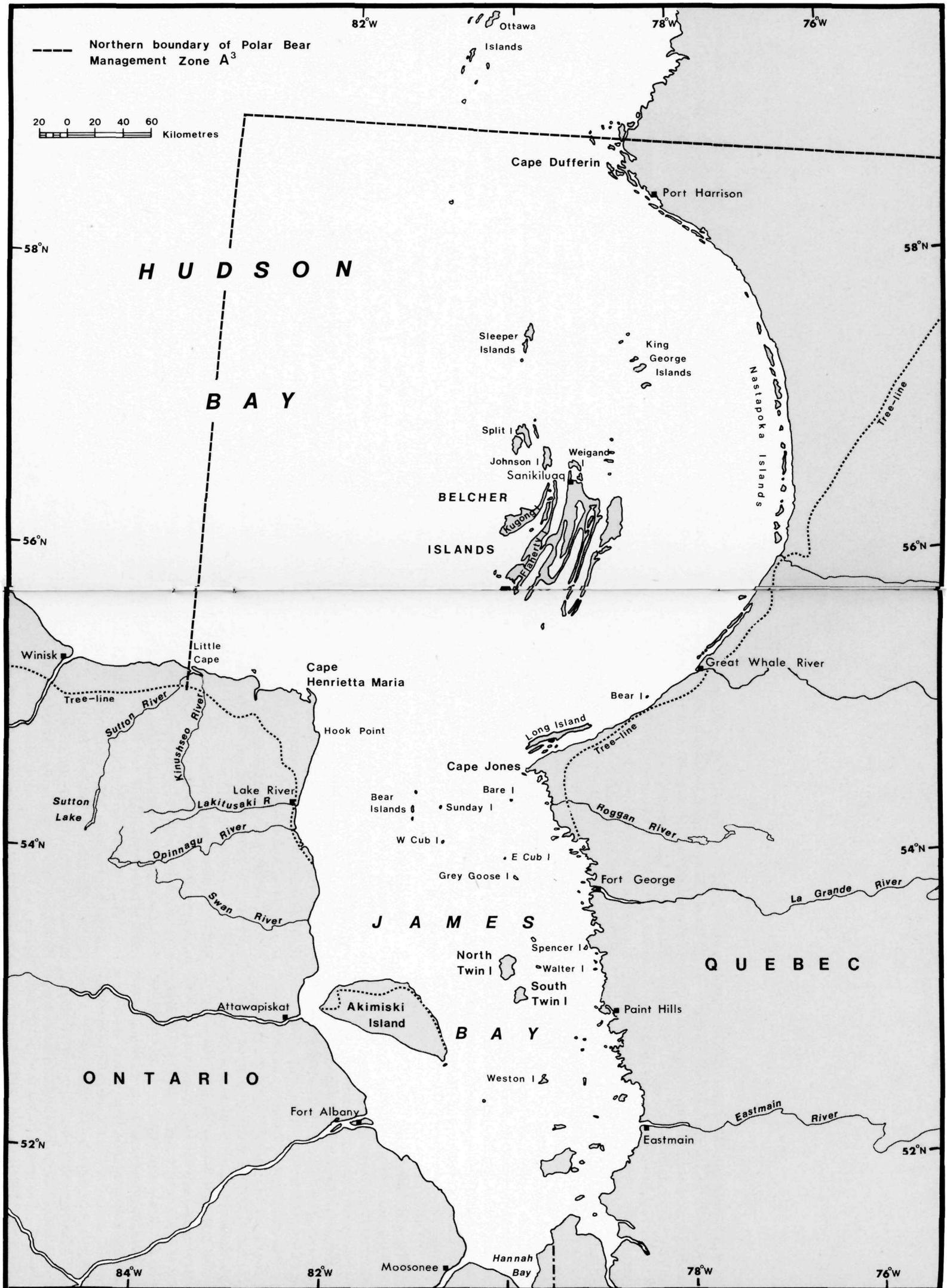
The polar bears of James Bay are of particular importance and interest for four reasons:

- (1) they comprise the most southerly sub-population of the species, being fully 1000 km south of most 'normal' polar bear habitats;
- (2) they are of significant cultural and economic importance to the Quebec Inuit and Indians, NWT Inuit, and Ontario Indians;
- (3) they face several possible new dangers through disturbance of their habitat as a result of hydro development by the James Bay Development Corporation (at present concentrated in the La Grande and Eastmain river basins, Quebec) and other possible developments; and
- (4) they are close to dense human population centres in eastern Canada and northeastern United States, and therefore have considerable tourist potential.

The Federal-Provincial Polar Bear Technical Committee suspected that the polar bears of the James Bay - Belcher Islands region formed a discrete sub-population and thus tentatively designated it as Management Zone A³ (Fig. 1). This report summarizes recent work designed to: 1) quantify and describe the sub-population; 2) locate maternity denning areas; 3) locate important areas of summer sanctuary and determine

the components of such areas; 4) try to relate continuing behavioural and physiological studies of polar bears to man's activities in James Bay; and, 5) indicate what further research is needed to ensure the best species and habitat management. For a general review of polar bear biology, research, and management objectives in Canada, see Jonkel (1970*a*) and Stirling and Jonkel (1972).

Figure 1



Materials and methods

1. Surveys of numbers and distribution

Aerial surveys of numbers of bears and their distribution during the ice-free period of the year have been conducted by CWS, OMNR, and QWS using both fixed-wing aircraft and helicopters. Fixed-wing flights were at 1 km intervals over the Twin islands and part of Akimiski Island. The total areas of smaller islands were covered whenever they were surveyed. A fixed-wing flight along the Ontario coast north of Hook Point, James Bay, has been carried out annually by OMNR in late August – early September since 1963 (unpublished reports). Fixed-wing flights were usually at an altitude of 150–250 m, helicopter flights at 50–100 m. Observations of bears, bear tracks, ice conditions, and seals were recorded.

2. Tagging programs

To determine population size, discreteness, and seasonal movements, it is essential to tag individual polar bears and recover the tags at a later date, either by recapture of the bear or return of the tags from hunters. The techniques used to recapture and mark bears with the aid of immobilizing drugs, snares, and helicopters are described by Jonkel (1967), Lentfer (1968), and Larsen (1971). Immobilized bears were weighed, measured, and examined for general physical condition. Numbered ear tags were applied to each ear and the same number was tattooed on the inside of each upper lip. The first premolar tooth on the lower jaw was removed from the immobilized bear for age determination. During tagging operations, observations on bear densities, movements, food habits and behaviour, and on ice conditions were also recorded.

Helicopters were used during CWS tagging programs in the Twin islands and northern James Bay area 4–13 April 1968, 19 March–8 April 1969, and 18–23 March 1970; and in the Twin islands

and northern James Bay – Belcher Islands area 23 March–15 April 1973. Overland vehicles and traplines were operated in the Cape Henrietta Maria area in late September 1967; on the east coast of North Twin Island from 12–25 July 1968, almost continuously from 15 July–24 October 1970, and from 15 September–14 October 1972; and on the west coast of South Twin Island from 26 July–18 August 1970. A tagging and survey trip to the Belcher, Sleeper, King George, and Ottawa islands was made by canoe and longliner from 6 May–22 September 1971. Since the beginning of the studies in 1967, tagging programs have been carried out each year from 1968 to 1973. Few tagging trips were made into southern James Bay as not many bears have been reported south of South Twin and Akimiski islands.

3. Maternity denning surveys

Surveys by CWS, Northwest Territories Fish and Wildlife Service (NWT-FWS), OMNR, and QWS have been carried out each spring since 1968 to locate maternity denning areas, determine their extent, and attempt to estimate their productivity. The early surveys were timed to coincide with the estimated peak time of emergence (Uspenski and Chernyavski 1965, Harington 1968). When it became apparent from the early survey results, and from reports of Ontario Indians, that emergence occurred earlier than was originally suspected, the timing of the surveys was advanced. Data on possible maternity dens, females with young, and tracks of females with young were recorded.

The islands of northern James Bay, the Ontario coast between Attawapiskat and Winisk, and the inland Hawley Lake area (north of Sutton Lake, Ontario) were searched in April 1968. The Ontario coast between the Manitoba border and James Bay and inland to a distance of about 120 km was surveyed from fixed-wing air-

craft 12–21 March 1974 and 6–13 March 1975. Akimiski Island in James Bay was surveyed on 1 April 1968 and 15 March 1975. During the first part of March 1969 and in the second part of March 1971, the area between Winisk and the Sutton River was searched using an oversnow vehicle.

The NWT-FWS carried out a preliminary aerial survey of the Belcher Islands on 19 March 1974, followed by ground searches using oversnow vehicles from 19–30 March 1974 and 18–22 March 1975. A fixed-wing aerial survey by QWS was flown 10–15 March 1975 along the Quebec coast from Long Island to Port Harrison and included flights over the Belcher Islands and the area between the Belcher and Long islands.

The Ontario denning surveys were flown during March and April 1974 and 1975 along transects parallel to the Hudson Bay coast, spaced 6.4 km apart north of the tree-line, 12.8 km apart south of the tree-line and extending about 120 km inland. Surveys were flown at 230–300 m and at a speed of 190–220 km/h. In other aerial surveys the coastlines of the islands and mainland and the floe edges were searched for tracks of females and newborn young. When possible, trails were back-tracked in the hope of locating the den. Suspected denning areas were searched for breakout holes and tracks of females with young. The ground searches were concentrated along the coastlines of the Belcher Islands.

Additional information was obtained from the Indians at Winisk, Attawapiskat and Fort George (Quebec); the Inuit at Great Whale River (Quebec) and Sanikiluaq (NWT), and during spring tagging operations by CWS.

Table 1
Periods of research activity on the Twin islands, 1968–73

Year	Dates	No. of persons present
1968	12–25 July	5
1969	15 July–16 Sept.	2
1970	15 July–24 Oct. 21 July–18 Aug.*	3–5 2–3
1971	25 July–22 Oct. 12 Nov. 1971–5 Jan. 1972	2–4 2
1972	13–30 July† 17 Sept.–18 Oct.	6 2
1973	7 May–29 July	2

* South Twin Island most of time.

† Goose banding crew.

4. Summer ecology

A CWS field camp was established on the east coast of North Twin Island in 1968 and was the focal point for a large part of the polar bear research activities in the James Bay area (Table 1). Temporary satellite camps were established on South Twin Island and on the north and south ends of North Twin Island. During 1970–72, North Twin Island was travelled frequently during observation, trapping, and bird-banding activities. Movement was usually on foot, but a canoe with an outboard motor and a trail-bike were also used.

Data on annual and seasonal movements, population size, age and sex composition, distribution, summer food habits, and activity-time budget of polar bears were gathered 15 July–15 September 1969, 15 July–24 October 1970, 25 July–22 October 1971, and 12 November 1971–5 January 1972. Details of the techniques and results of the general ecological study of polar bears on North Twin Island are given by Knudsen (1973).

A total of 455 polar bear scats were collected between 1 July and 1 November in both 1968 and 1969 from the James Bay islands and the coastal mainland of Manitoba and Ontario. Identification and volumetric analyses of the contents of the scats were carried out. The techniques used in this study, designed to describe

and compare the food habits of polar bears in different ice-free environments, are described by Russell (1975).

Information on summer and autumn denning habits was collected incidental to other studies, mainly during aerial surveys, and during the occupation of North Twin Island. In November 1969, and September–October 1972, surveys were conducted to determine the use of earth dens in autumn on the islands of James Bay.

5. Surveys of seal distribution and availability

A survey of the distribution and numbers of seals in James and Hudson bays was conducted by the Fisheries Research Board of Canada (FRBC) and CWS during the early summer of 1974 (Smith 1975). Of particular interest was the ringed seal (*Phoca hispida*) which forms the major part of the winter diet of the polar bear. Eleven transects were flown at 90 m and 200 km/h over the James Bay – Belcher Islands area on 26 and 27 May 1974.

6. Provincial and territorial game records and miscellaneous sources

Past game reports from NWT, Ontario, and Quebec were reviewed for kill data. Observations incidental to other wildlife studies, records from local interviews, recent literature, and ice records were reviewed for any additional data relevant to this study.

7. Laboratory studies

Premolar teeth were removed for age determination from polar bear skulls collected from native hunters and from immobilized bears. The teeth were decalcified and thin-sectioned following the basic methods of Marks and Erickson (1966) and Stoneberg and Jonkel (1966) as modified by H. P. L. Kiliaan (summarized in

Stirling *et al.* 1975). When possible, morphometric data based on the methods of Manning (1964) were used to aid age determination.

Results and discussion

I. Surveys of numbers and distribution

Table 2 summarizes the results of surveys carried out in the James Bay area between 1963 and 1975 and gives minimal estimates of the sub-population size.

The most important single factor affecting the seasonal distribution and movements of polar bears throughout their range is the seasonal variation in the presence and distribution of sea ice. Without ice, polar bears are unable to hunt

Table 2
Number of polar bears counted and estimated in the James Bay area in summer, 1963-75

Date	Survey method	Polar bears observed (estimated)					Total for year
		N. Twin	S. Twin	Akimiski	Ontario*	Other†	
1963 25, 29 Aug.	aerial	—	—	11	16	—	
1964 4 Aug.	aerial	—	—	—	16	—	
9, 11 Sept.	aerial	—	—	—	12	—	
1965 25, 27 Aug.	aerial	—	—	—	14	—	
28-29 Sept.	aerial	—	—	—	24	—	
1966 2-3 Sept.	aerial	—	—	—	17	—	
26-27 Sept.	aerial	—	—	—	37	—	
1967 29, 31 Aug.	aerial	—	—	—	93	—	
12 Sept.	aerial	28(40)	12(20)	6(10)	—	6(10)	145(173)
26-28 Sept.	aerial	—	—	—	75	—	
1968 22 June	aerial	0	—	—	—	—	
12 July	aerial	0	—	—	—	—	
20 July	ground	17(30)	—	—	—	—	
14-15 Aug.	aerial	—	—	—	34	—	
30 Sept.	aerial	61(70)	20(25)	15(20)	—	6	136(155)
30 Sept-1 Oct.	aerial	—	—	—	34	—	
1969 15 July	aerial	0	—	—	—	—	
28 July	ground	1	—	—	—	—	
July-16 Sept.	ground	(8)	—	—	—	—	
28-29 Aug.	aerial	—	—	—	13	—	
24 Nov.	aerial	32(50)	12(20)	—	18(30)	2(10)	64(110)
6-7 Oct.	aerial	—	—	—	53	—	
1970 26-27 Aug.	—	—	—	—	47	—	
2 Sept.	ground	22	—	—	—	—	
14 Sept.	ground	24	—	—	—	—	
15 Sept.	aerial	39	—	—	—	—	
24-28 Sept.	aerial	—	—	—	47	—	
29 Oct.	aerial	41(45)	—	—	—	—	
1971 28 July	aerial	5	—	—	—	—	
12 Aug.	aerial	11	—	—	—	—	
24 Aug.	aerial	12	—	—	29	—	
12 Sept.	aerial	17	—	—	—	—	
3 Oct.	aerial	15	—	—	—	—	
16-17 Oct.	aerial	—	—	—	41	—	
22 Oct.	aerial	22	—	—	—	—	
12 Nov.	aerial	21(25)	—	—	—	—	
1972 13 July	aerial	0	0	—	—	—	
23-29 July	ground	3	10	—	—	—	
29-30 Aug.	aerial	—	—	—	61	—	
Sept.-Oct.	ground	(15-20)	—	—	—	—	
4-5 Oct.	aerial	—	—	10	76	—	
1973 12-14 July	aerial	1	2	—	—	—	
29 July	aerial	0	5	—	—	—	
5-9 Sept.	aerial	—	—	8	29	—	
28 Oct.	aerial	13(15)	18(21)	20(25)	—	1(5)	81(95)
1974 26 May	aerial	0	0	0	—	—	
30 Aug.	aerial	—	—	—	29	—	
28 Oct.	aerial	17(21)	12(15)	—	—	—	
1975 7 Aug.	aerial	17	4	—	—	2	
3-5 Sept.	aerial	—	—	—	57	—	

*Ontario coast between Little Cape and Hook Point.

†Includes Bare, Bear, the Cub, Grey Goose, Spencer, Walter and Weston islands.

seals. In James Bay, the annual ice usually begins to form in the small bays, along the shallow western and southern shores and around Akimiski Island, in late October – early November and reaches its maximum coverage in March. Freeze-up in the Belcher Islands area is usually slightly later. Land-fast ice is generally present around the island groups and along shallow coasts from January to May. By late December to the beginning of January, moving ice pans in James Bay become consolidated into a rough, solid ice cover which is usually separated from the Hudson Bay ice cover either by an area of open water (known as a lead), or by loose ice pans stretching from Cape Jones to Cape Henrietta Maria. Because of the prevalence of easterly and southeasterly winds, a semi-permanent shore lead extends northwards from near Fort George and merges with the open water – pack ice area to the southwest and west of the Belcher Islands. In some years, fast-ice extends from the Belcher Islands to the Quebec coast making possible over-ice movement between the settlements of Great Whale River and Sanikiluaq. During winter, pregnant females move to maternity dens, but most other polar bears tend to hunt along the leads and near the edges of the fast-ice areas, because of the access to seals. Few tracks or captures were recorded on the ice between the coast and the floe edge. Ringed seals are found throughout central James Bay and northward but areas of major concentrations have not been identified. It seems likely that polar bears may concentrate in the area of open water at the confluence of James and Hudson bays (Fig. 2) during winter but this has not been confirmed. Bearded seals (*Erignathus barbatus*), walrus (*Odobenus rosmarus*), and white whales (*Delphinapterus leucas*) are also common in this area and are fed upon occasionally by the bears, but these species probably do not greatly influence bear movements.

Break-up begins in May, and by early July isolated ice fields move about under the influence of tides and winds. Ice maps of Hudson and James bays (Canada, Atmospheric Environment Service 1966–74) indicate that ice often persists longest in western James Bay north of Akimiski Island, and just west of Cape Henrietta Maria and the Belcher Islands, probably as a result of wind and current action. Depending on the winds, large masses of ice may move south from Hudson Bay late into July, but in most years James Bay is relatively ice free by 20 July. However, during the 1969 and 1971 ‘bad ice’ years, ice-floes persisted in the northern part of James Bay until late August. In 1968 very warm, calm conditions contributed to the rapid melting of the ice *in situ* by 16 July.

Although the pattern of the Hudson and James bay ice cover at maximum development is similar each year (Fig. 2) the patterns of freeze-up and break-up differ very widely from year to year and from locality to locality (Larneder 1968). However, the effect of these patterns, particularly during break-up, on the distribution of polar bears is still not clear. Polar bears appear to remain on the ice to hunt seals as long as possible. As melting continues, they apparently swim to the coasts and islands in increasing numbers from July through November. Although one brief aerial search was made for polar bears swimming in the open water to the west of the Twin islands in July 1973, none was observed. An early report from a pilot of “50 bears swimming south” in northern James Bay has never been confirmed and may have been an observation of white whales.

2. Capture–recapture data

A total of 60 polar bears were tagged in the James Bay – Belcher Islands area (including the Cape Henrietta Maria area) between April 1968

Table 3
Number of tagged polar bears recaptured or sighted (after 4 months) and killed (by year) in the James Bay – Belcher Islands area, 1968–75

	No. of tagged polar bears								Total 1967–75
	1968	1969	1970	1971	1972	1973	1974	1975	
Tagged	11	17	19	0	2	11	0	0	60
Recaptured	0	1	10	0	0	2	0	0	13
Sighted	0	3	2	0	0	0	0	0	5
Killed	0	1	2	5	2	1	4	1	16
<i>Max. no. of tagged bears that could still be alive at end of 1975</i>									44

and April 1973, with the main effort being concentrated on North Twin Island and north-central James Bay (Fig. 3). Logistic problems and budgetary restrictions prevented more extensive tagging on the Belcher Islands and in north-western James Bay.

Twenty-eight of 60, or 47% of the tagged bears were recaptured, shot, or sighted more than four months after tagging (Table 3). Six of the 16 bears shot had been recaptured or resighted previously. The recorded movements of bears from capture locations suggest that the polar bears of James Bay, Cape Henrietta Maria, and the Belcher Islands may form a single sub-population (Fig. 4). However, additional data are required to establish the northern and western boundaries of this sub-population. All recorded straight-line movements were under 300 km.

Twenty-five polar bears (including 10 bears around Cape Henrietta Maria and already included in Zone A³) were captured and tagged along the northern Ontario coast. Four of these bears, all originally tagged in the Cape Henrietta Maria area in 1968, were recaptured, two within 90 km west of their original capture site. The third, an adult female, was killed 15 km east of North Belcher Island in April 1972, and in December 1974 an adult female, originally tagged as a cub, was killed near Swan River on the James Bay coast, suggesting a high degree of fidelity to her birth site. However, only one

bear, a male, which was originally tagged in James Bay was observed west of Cape Henrietta Maria. Indian hunters from Winisk and Fort Severn (Ontario) kill approximately 15 to 20 bears annually along the Ontario coast. To date, they have killed three polar bears originally tagged on the Ontario coast west of Winisk, but none that was originally tagged in the James Bay – Belcher Islands area.

Northwest of the Belcher Islands there is no doubt a limit to the distance travelled by the James Bay – Belcher Islands polar bears. To date, however, despite an extensive and continuing capture–recapture program on the Manitoba coast which began in 1966, and the continued hunting of polar bears by Inuit hunters in northern Hudson Bay, there have been few recoveries of tagged bears outside Management Zone A¹ (western Hudson Bay). Transects flown out from the Manitoba coast, and based on counts of the number of tracks observed per kilometre of available habitat surveyed (unpublished), indicate that the density of bears decreases towards the centre of the Bay. However, an adult male polar bear originally tagged at Churchill (Manitoba) in October 1974 was killed by Port Harrison Inuit 80 km north of Port Harrison in March 1975. In February 1974 an adult male originally tagged 24 km north of Weigand Island in the Belcher Islands in March 1973 was taken in the same general area, north of Port Harrison. Farther north, Inuit hunters from Southampton Island (NWT) and from Povungnituk, Sugluk, and Ivugivik (Quebec) kill approximately 85 polar bears annually, but to date only two bears, both tagged males from near Churchill, have been recovered in northern Hudson Bay.

The lack of recapture on North Twin Island, in summer 1971, of any of the eight bears marked on the island in the previous summer

Figure 2
Pattern of Hudson and James bays ice cover at maximum development (after Larnder 1968)

Figure 2

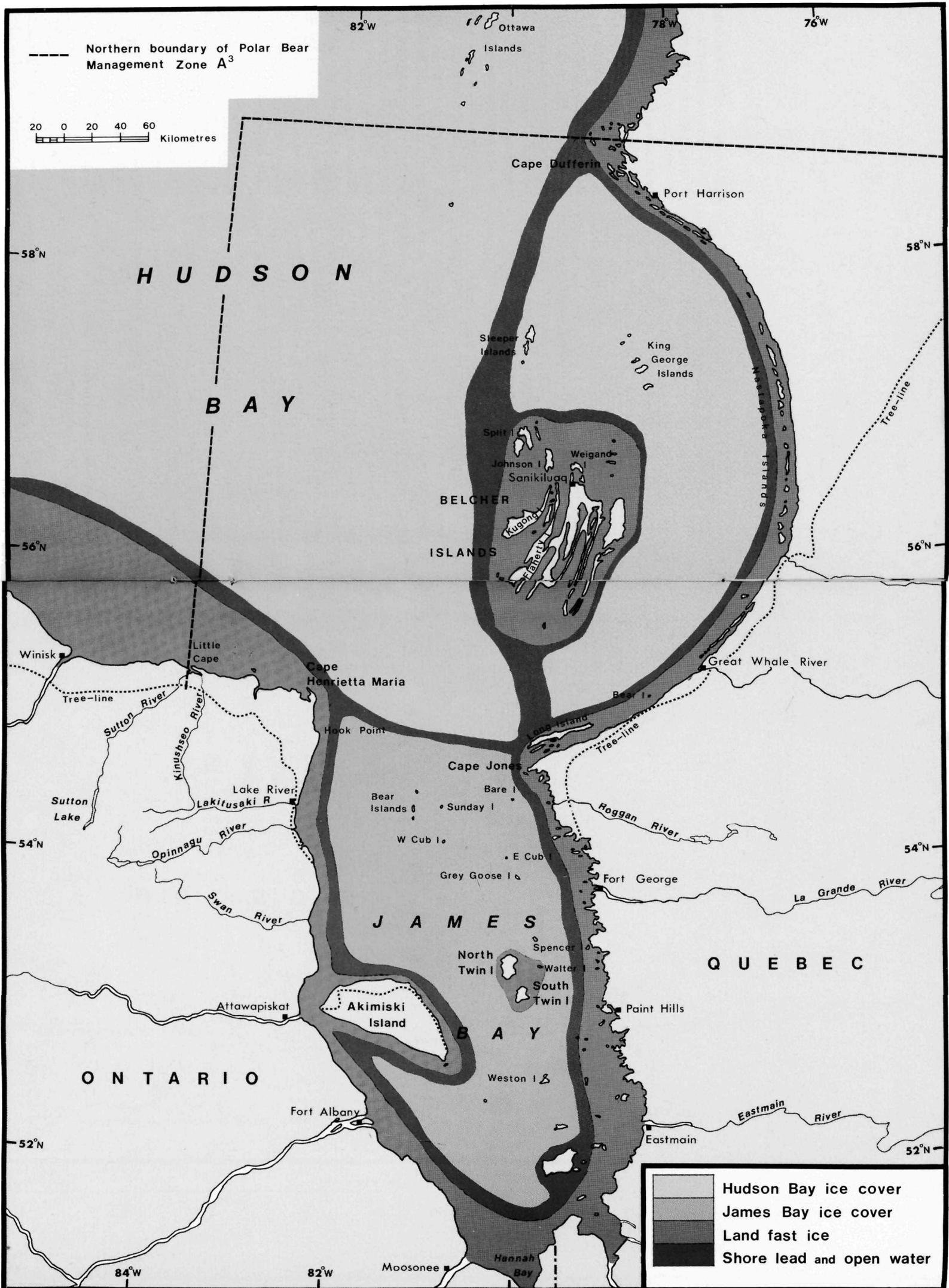


Figure 3
Polar bear tagging locations in James Bay –
Belcher Islands, April 1968 to April 1973

Figure 3

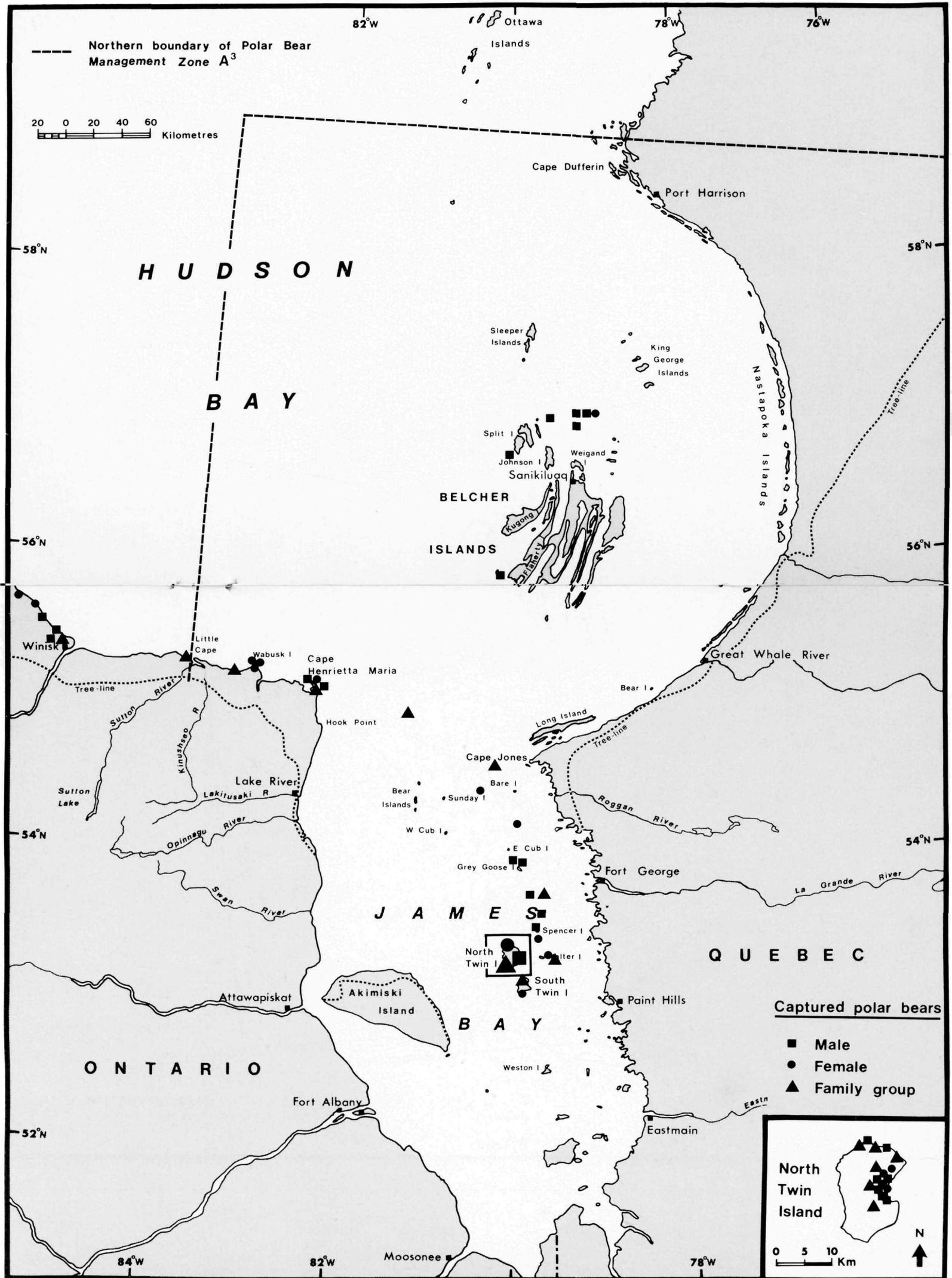
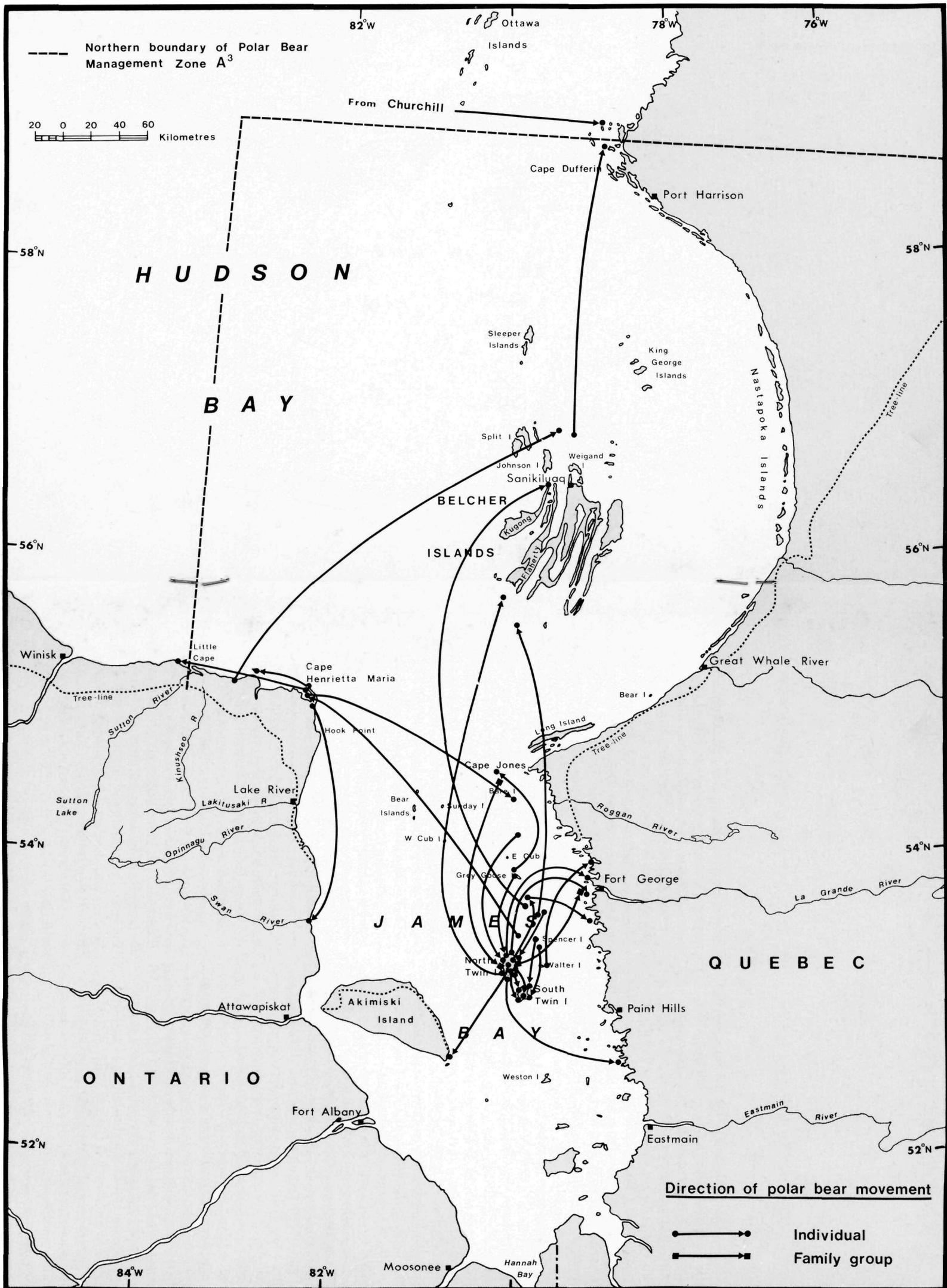


Figure 4
Recorded movements of tagged polar bears in James Bay – Belcher Islands

Figure 4



indicates a possible lack of fidelity for a specific island as a summer sanctuary. This may be a result of annual variations in the pattern of break-up and melting of the sea-ice. A female with two yearlings, originally tagged on North Twin Island in March 1970 and observed on the island in August and September 1970, were killed by Indian hunters 15 km from Fort George, 90 km northeast of North Twin Island in August 1971.

3. Summer sanctuary

Most of the small islands in central and northern James Bay, northern Akimiski Island, several small islands west of Cape Henrietta Maria, Long Island, and the out-lying Belcher Islands are important areas of summer sanctuary. On North Twin Island, the number of bears gradually increases throughout the summer and fall (Table 2). Knudsen (1973) found that bears continued to arrive after the ice in the bay had drifted over 30 km from the island and showed little evidence of emigration from the island although some movement between the Twin islands was recorded. Analyses of distributions of polar bears through the summer, based on aerial surveys, showed no definite pattern, although it was suspected that a more uniform pattern might develop with increasing time spent on the island. However, of 32 bears observed on North Twin Island during November 1969, most were observed in groups along the low-lying west shore. Bears identified as sub-adults appeared to be separated from the main group.

Segregation of polar bears by sex and age has been observed along the Ontario coast, and also on Cape Churchill (Jonkel 1970*b*, Nero 1971), where adult males congregated on the headlands and small islands and females, young, and sub-adults along the coast. In September 1967, 26 large male bears were observed on a small island 40 km west of Cape Henrietta Maria.

Similar concentrations have not been recorded anywhere along the Quebec mainland coast although some bears are known to spend the summer on the adjacent islands. However, old Indians from Fort George tell of summer denning on Long Island about 100 years ago (G. Snowboy, pers. comm.). Bears are rarely seen on islands or along the James Bay coast south of Akimiski and Weston islands. In November 1968 a polar bear was seen on the railroad tracks 20 km south of Moosonee (S. Cameron, pers. comm.) and in early April 1969, two bears were seen in Hannah Bay, southern James Bay (R. A. Connell, pers. comm.). In October 1938 a bear was killed near the mouth of the Peribonka River in the Lac St. Jean area (Jackson 1939). Areas of summer sanctuary are vacated as soon as the annual ice cover begins to develop.

Variations in the final pattern of ice break-up may explain the annual variation in the numbers of bears that have been observed in the areas of summer sanctuary (Table 2). However, the actual relationship between the distribution of bears throughout these areas and the final melting of the ice in the James Bay – Belcher Islands area is not yet understood. As noted earlier from limited capture–recapture data, there is no indication that bears regularly return to particular areas during the summer.

About 200 bears are estimated to spend the ice-free months on the islands of James Bay and on the Ontario mainland between Little Cape and Hook Point (Table 2). No estimates can be given for other areas within Zone A³ due to the lack of any comprehensive survey of the Belcher Islands, the other islands in Hudson Bay and the Quebec mainland, and to the difficulty of observing bears on land, in the water, or on ice.

4. Maternity denning areas

4.1. Known maternity denning areas

From the spring surveys, two areas, the Ontario mainland and the islands of northern James Bay, have been confirmed as maternity denning areas (Fig. 5). The extent and the total annual productivity of these areas are, as yet, unknown but indications are that productivity per female and per year is high.

4.1.1. Area southwest of Cape Henrietta Maria, Ontario

The 1969, 1971, 1974 and 1975 spring surveys (Kolenosky 1974 and 1975*a*) and reports by local Indians indicated that the area east of the Winisk River and extending southeast towards the James Bay coast was utilized as a maternity denning area. In 1969, between 2 and 16 March, five possible maternity den sites were located in the area east of the Sutton River and north of Hawley Lake, about 60 km southeast of Winisk. Two females each with two cubs were killed near their den sites. The tracks of two other females each with two cubs and one female with one cub were back-tracked to their den sites. In 1971, a den with the tracks of a female and a cub issuing from it was reported about 10 km southwest of Little Cape on 17 March. Five possible maternity den sites were located between 20 March and 2 April 1971 in the area between Winisk and the Sutton River, about 40 km inland. The dens were unoccupied and in poor condition, indicating that they had been vacated for some time. In 1974, two possible maternity den sites, two females each with two cubs, and the tracks of a third female with two cubs, were seen in the treed area south of Little Cape. Tracks of a female with two cubs were seen south of Winisk. In 1975, four possible maternity den sites were observed, two along the Opinnagu River valley south of Lake River and two east

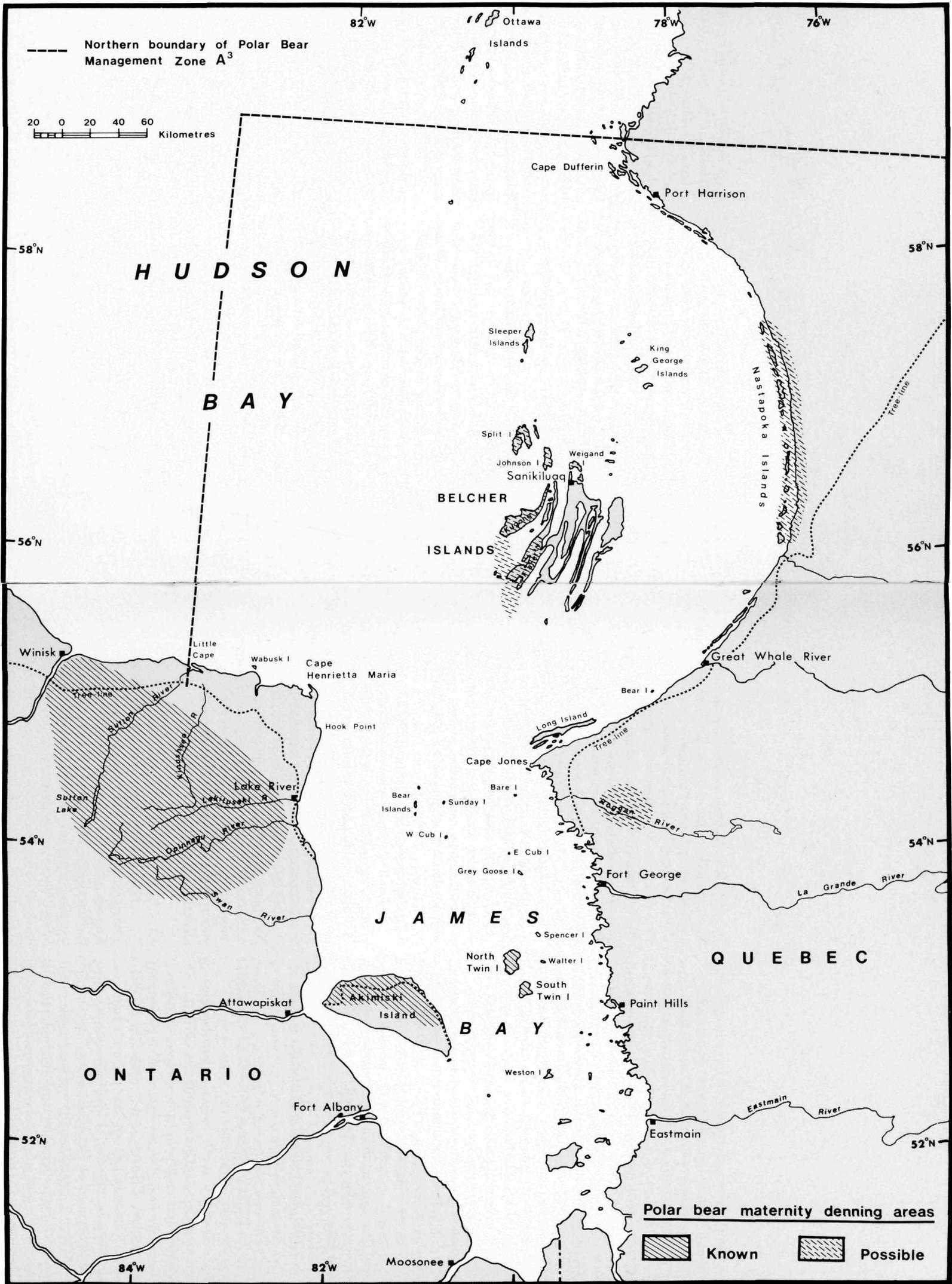
of the Sutton River and southwest of Little Cape. A female and two cubs were seen in the vicinity of one of the dens. From the tracks, it appeared that a female with two young and two females each with three young had recently emerged from the other dens. Additional tracks of females with two and three young were seen between the Kinusheo and Lakitusaki rivers west-northwest of Lake River and southeast of Winisk. In spring 1964, Lake River Indians killed a female and two cubs while en route from her den, inland west of Lake River, to the James Bay coast. Attawapiskat Indians killed a female and a cub in spring 1971, a female with two cubs on 24 February 1972 (fate of the cubs unknown), and a female and cub near Nowashe Creek, north of Attawapiskat, on 16 March 1975.

The extent of the maternity denning area on the Ontario mainland is uncertain. Evidence of family groups and possible maternity dens has been recorded throughout the northern Ontario coastal region with the greatest concentration between the Shagamu River and Ministik Creek, west of Winisk. Whether the denning area between Winisk and the James Bay coast is separate from or continuous with the more westerly areas is uncertain. However, some females with young leave maternity dens in the area southwest of Cape Henrietta Maria and make their way towards the James Bay shoreline rather than the Hudson Bay coast and are, for management purposes, included in the James Bay – Belcher Islands polar bear sub-population. The uncertain classification of the bears west of Cape Henrietta Maria still poses a problem for management purposes.

Kolenosky (1975*a*) concluded that the emergence of polar bears from their maternity dens was bimodal in 1975, *i.e.* a group of bears emerged in late February while a second group emerged around 13 March. This bimodal pattern

Figure 5
Polar bear maternity denning areas in James Bay -
Belcher Islands

Figure 5



may have been a reflection of the weather conditions in 1975, and therefore was not necessarily an annual characteristic. All of the den sites located were south of the tree-line in bog areas 60–120 km inland. The excavations, with the openings facing east-southeast, were totally in snow, and all lacked the presence of an earth den. An earth den beneath the snow is characteristic of many of the winter dens further to the north in Manitoba (Jonkel *et al.* 1972). Tracks leading from the dens, plus other tracks of females with cubs, indicated a general northward movement towards the Hudson Bay coast. However, one den was located only 20 km inland from the James Bay coast and tracks of the emerged animals led in an easterly direction towards James Bay. A minimum of nine cubs were produced in this area in 1969, eight in 1974, and 19 in 1975. The average litter size recorded (eight litters) for 1975 was 2.4 cubs. Although the sample was small this represents the highest average litter size recorded for polar bears throughout their range.

4.1.2. Islands of James Bay (Twin islands and Akimiski Island)

Twin islands

In 1970 three maternity dens were located in snowbanks on the ridge on the east side of North Twin Island. All three dens were unoccupied when first seen on 19–20 March 1970. A female and three cubs had only recently vacated the largest of the dens which was located close to the CWS camp. A den located 3 km inland from the southern coast of South Twin Island was occupied until 18 March and appeared to contain a female and at least one cub. By 20 March it had been vacated but conditions were such that attempts to track and locate the recently emerged animals were unsuccessful. All dens were dug out of snowbanks along ridges

or hills. There was no evidence of excavations in the underlying ground. The Twin islands are located north of the tree-line and consequently the habitat conditions in the immediate vicinity of the den sites are different from those of the Ontario mainland. South of the tree-line, trees break the wind and tracking conditions are better. In 1970 the productivity of the Twin islands was at least six young.

Akimiski Island

One possible maternity den and tracks of four family groups (females with two cubs) were observed in the northern coastal area of the island. The den was located almost 6 km inland in a treed area by a small lake. At least eight cubs were produced on Akimiski Island during 1975.

4.2. Other maternity denning areas

Limited data on females with newborn young were collected during the spring surveys of other areas, but no dens were seen. Timing of the surveys may not have coincided with emergence times. Some evidence (see below) suggests that there may be additional maternity denning areas on the southwestern Belcher Islands, the Nastapoka Islands, and the Quebec mainland southeast of Cape Jones (Fig. 5). Even if denning does occur in these areas, present evidence indicates that the concentration of dens and the annual productivity are probably low.

4.2.1. Southwestern Belcher Islands

The tracks of one or possibly two females with cubs were found on the southern end of Kugong Island in March 1973. In March 1974, the tracks of one female with two cubs were recorded off the southwest coast of Kugong Island. There was more evidence of females with newborn cubs around the many small islands located to the south of Kugong and Flaherty

islands and along the floe edge between the Belcher Islands and Long Island. Two females each with two newborn cubs were shot by Great Whale River hunters, one on 5 April 1974 about 50 km south of the Belcher Islands and the second on 23 April 1974 about 70 km south of the Belcher Islands. The locations of their dens were unknown. However, movements of female polar bears with newborn cubs to the southern Belcher Islands from denning areas in James Bay or on the Ontario mainland cannot be proved or disproved at present. From Figure 4, it is apparent that movement between James Bay and the Belcher Islands occurs. It is known that females with newborn cubs can cover large distances. Kolenosky (1975b) observed a female and two cubs out on the ice in Hudson Bay 240 km north-northeast of Winisk on 9 April 1975, approximately a month after leaving the maternity den. A female and two cubs were tagged on the ice 65 km east of Cape Henrietta Maria on 11 April 1973.

The Inuit do not consider the Belcher Islands to be an important denning area, although dens (whether maternity or temporary is not known), tracks of females and cubs, and sightings of females and cubs have been reported. The limited evidence available suggests that the western islands (Split, Johnson, Kugong, Weigand, and southern Flaherty islands) may be a denning area.

4.2.2. Nastapoka Islands

A female with two newborn cubs was killed by Great Whale River hunters on 11 March 1973 on the Nastapoka Islands, but an aerial survey conducted between 10 and 15 March 1975 failed to reveal any evidence of denning on the islands or the adjacent mainland.

4.2.3. Inland, north of Roggan River, Quebec

The Fort George Indians maintain that some denning takes place in an area just north of the Roggan River, about 30 km inland. In December 1974, tracks heading in a southeasterly direction were followed by Indians and lost in this area. The following spring (March–April 1975) tracks of a female and two cubs were observed further east, heading in a northwesterly direction back towards Cape Jones. A female was killed some kilometres inland, just south of the Roggan River in March–April 1973.

5. Litter size and productivity

The average litter size of cubs in the James Bay and Belcher Islands area, based on surveys carried out at different times of the year, from 1967–73, was 1.5 ($n = 68$), while the average litter size of family groups with cubs one year of age and older was 1.7 ($n = 26$). In comparison, the litter sizes of cubs on the Ontario mainland east of Winisk in March 1974 and 1975 were 2.0 ($n = 4$) and 2.4 ($n = 8$) (Kolenosky 1974 and 1975a). No accurate estimate can be made about the annual productivity of cubs in Zone A³. However, based on the cumulative data summarized in the above sections, annual productivity could be in the range of 35–45 cubs.

6. Summer ecology

Knudsen (1973) recorded that the predominant behaviour of the polar bears on North Twin Island was resting, presumably to conserve energy, but some feeding on crowberry (*Empetrum nigrum*) patches did occur. Due to the problems of seeing bears in the dark, most of the observations were made during the day (1000–1800 hours). Stirling (1974) found that in the High Arctic, polar bears were least active during this period and that the peak of activity occurred between about 0100 and 0800 hours.

From scat analyses it was found that birds, particularly Oldsquaw (*Clangula hyemalis*), dominated the summer diet of the James Bay bears whereas grasses and marine algae appeared to be the most important food items on the Ontario and Manitoba coastal mainland (Russell 1975). Consumption of the five main food groups (birds, mammals, marine algae, grasses, and berries) differed considerably, both in frequency and volume, between the two areas. Only the greater intake of berries on the islands and small mammals on the mainland could be explained by their relative abundance in the two areas. Otherwise food availabilities were considered uniform in both areas. The greater use of marine algae and grasses by the mainland bears may compensate for their lower protein intake from birds. The islands were more favourable for predation of seabirds because of the turbid waters and the abundance of Oldsquaws and eiders (*Somateria* spp.). Ringed seals, the main food source during the winter, were of minor importance during the summer and there was little difference between the islands and the mainland. Stirling and McEwan (1975) found that the summer period of reduced seal availability coincided with reduced levels of fat and caloric content in the seals. Therefore seals were of more limited nutritional value to the polar bear at that time of the year. Russell (1975) suggested that the bears' diet on the islands better prepared these bears for the winter and was the result of learned behaviour. However, the summer and autumn diet is probably of minor importance, as the polar bear requires little energy for maintaining its body temperature during this period and most individuals observed late in the autumn in both island and mainland areas still appeared to be in good physical condition.

The occurrence of summer denning has been reported by Kolenosky and Standfield

(1966), Doust (1967) and Jonkel *et al.* (1972). The Ontario and Manitoba coasts and some of the islands in James Bay have a high incidence of earth dens, with maximum densities of one every 2 or 3 m. In one area in Manitoba, 20 to 30 dens were observed in the banks of one small lake. Elsewhere in the polar bear range such summer dens are rare, but their development may be prevented by the lack of unconsolidated ground materials and/or by the greater development of permafrost.

In the James Bay and Belcher Islands area, the summer dens are of two main types: shallow depressions or pits; and shallow burrows or dens. The shallow pits are usually dug on fairly level, exposed terrain on beach and lake ridges near the sea. Bears rest there and take advantage of cooling winds. Recently excavated pits are easily distinguished by sharp, uneroded outlines, but distinguishing between some of the older pits and natural blowouts is difficult. Pits are about 1 m in diameter and 0.2 to 0.5 m deep. The burrows or dens are usually dug into steeply sloping terrain (30–40° slope) below the crests of sand or gravel ridges. These excavations provide resting places and shelter from the sun's direct rays. In some areas, additional cooling is gained through the close proximity of the permafrost layer, which also discourages insect pests (Jonkel *et al.* 1972). Typical dens were about 2 m long, 2 m wide and 1 m deep with an overhang formed of ground materials and vegetation. When the overhang collapses subsequent den development is extended immediately up-slope, which in time results in a long trench formed by a series of collapsed overhangs. Only one deep burrow (about 4.6 m deep) has been reported, about 30 km south of Cape Henrietta Maria. Deep burrows form a third type of summer earth den, best developed in the Manitoba denning areas (Jonkel *et al.* 1972).

Fidelity of individual bears to particular pits or dens may or may not occur. Kolenosky (1968) noted that a pit near the centre of a small island 40 km northwest of Cape Henrietta Maria had been occupied by a large male each year since the annual OMNR surveys began in 1963. Whether the same animal was involved each year is unknown.

The summer earth dens on the Twin islands occur in the same area as winter denning and at first it was thought that the earth dens beneath the snow were in fact winter dens (Doutt 1967). However, no evidence of this has been found. In Ontario the summer and winter denning areas appear to be separate, with maternity denning taking place some distance inland south of the tree-line, whereas the summer denning is concentrated along coastal beach ridges and lake shores, particularly in the Cape Henrietta Maria area. It is of interest to note that prior to the introduction of firearms, the Fort George Indians have reported the existence of earth dens on Long Island, off the north coast of Cape Jones (G. Snowboy, pers. comm.)

The effects of human ground activities and aerial surveys on the distribution and numbers of polar bears on North Twin Island and possibly some of the other islands and in the James Bay area are not clear. During 1968–75 bears showed a preference for the western side of the island. Whether this was caused by the CWS camp and its associated human activities on the east side is unknown because of insufficient survey data prior to the establishment of the camp. However, bears travelled through the immediate area of the camp and used the earth dens in the ridge to the west when the camp was occupied. On a few occasions bears were seen to leave the island after encountering personnel, and may or may not have returned. On other occasions, bears seemed unconcerned and fol-

lowed the trail bike tracks and removed bait from foot snares. After 1970, the number of bears using North Twin Island as a summer sanctuary appears to have declined. In 1969 and 1971 ice persisted late into August and may partially explain the general lack of bears in James Bay during those years, but it does not explain the reduced numbers of bears in later years. Timing of surveys and variations in overall weather conditions may have some influence on numbers observed since 1971. The greatest number of bears on North Twin Island occurred in 1968 when the ice melted early.

7. Surveys of seal distribution and availability

Low densities of seals were observed on all transects flown over James Bay in 1974 (Smith 1975). The highest densities recorded were north of James Bay, on the more stable landfast ice around the Belcher Islands. However, the low numbers of seals recorded may not be accurate because the timing, ice conditions, and survey aircraft were not ideal. Seal catches by native people in James Bay are low, but this may simply be a reflection of the fact that Indians hunt sea mammals less than Inuit.

Total seal numbers were estimated from the numbers of seals counted on the various ice types and the percentage of each ice type contained in the total (from Earth Resources Technology Satellite (ERTS) photographs). At present there is no proven way of determining the relationship between the number of seals counted on the ice and the total population. On the basis of limited data, Smith (1975) suggested that doubling the numbers of seals counted would approximate the total population. This was done to derive the estimates given in Table 4. No estimate is given for the Belcher Islands area but the observations made there indicated that

Table 4
Estimates of ringed seal numbers in James Bay (from Smith 1975)

Ice category	Area (km ²)	C _i suitable breeding habitat	Seals/km ²	Total estimated no. of seals
Stable ice to 16 km offshore	21 712	80–100	2.97	51 551
Unstable offshore ice	67 091	20–30	0.73	9 858
Total				61 409

the seal densities were probably higher than in James Bay. Because of the crudeness of the data now available, it is not practical to attempt to calculate the sustainable yield of seals for bears. The need for more accurate seal population data is apparent, especially in view of the possibility of major perturbations to the whole ecosystem.

8. Kill data

The recorded numbers of polar bears killed in the James Bay – Belcher Islands area for 1967–75 is summarized in Table 5. Because of the unreliability of reporting systems in the past, these values represent the *minimum* number of polar bears taken during that period. Only since January 1972, when Quebec introduced a tagging system, has there been a reasonably reliable record of the harvest. In both Ontario and Quebec, hides kept for personal use are not tagged and, consequently, they are often not recorded in the kill data; reliable records for the Belcher Islands Inuit kill were maintained since 1969 because all hides were tagged. Known locations of polar bear kills from 1969 to 1975 are shown in Figure 6.

The harvesting of polar bears varies within the James Bay – Belcher Islands area. Hunting by the Ontario Indians is confined to the Ontario mainland and Akimiski Island. Most of the bears hunted are females, and females with cubs. Only three adult males were taken of a total of 28 bears known to have been killed between 1969 and 1975 by hunters from Winisk, Attawa-

piskat, and Fort Albany. Seven of nine adult females could have been pregnant and en route to their denning area when taken during mid-October–December. Seven females with cubs and 13 cubs (the fates of four additional cubs are unknown) have been taken, mainly during the spring while leaving the denning area. Precise data on the ages of bears taken by Ontario hunters are currently not available but preliminary examination of the specimens collected to date indicate that a high proportion of them are quite young.

The Quebec Indians, like the Ontario Indians, mainly confine their hunting to the mainland and coastal islands that fringe the Quebec coast, and the islands of eastern James Bay. In the past, because of low fur prices and limited local use of the meat and fur, there was little incentive to hunt polar bears and therefore the animals were probably not heavily harvested. In 1973–74 increased fur prices (Smith and Jonkel 1975*b*) and the development of a local fur market associated with the personnel of the James Bay Development Corporation probably accounted for an apparent increase in hunting. Very little hunting is done on the ice, apparently because only a narrow strip of landfast ice fringes the east coast of James Bay, and a semi-permanent lead separates the shore ice from the James Bay ice cover (Figs. 2 and 6). An estimated 70% of the polar bears are taken during the ice-free period of the year, incidental to other hunting, trapping, or fishing trips. Females and young comprise about half the kill. Four of the five males known killed were taken on coastal islands in July–August; only one was killed in winter, possibly indicating that most of the males stay farther out on the ice in James Bay during winter.

The Sanikiluaq Inuit hunt along the floe edge and landfast ice to the west and north of the Belcher Islands where well-developed leads form

Table 5Known numbers of polar bears killed in Zone A³ from 1 July 1967 to 30 June 1975 based on records from CWS, NWT, OMNR, and QWS

Settlement	1967-68	1968-69	1969-70	1970-71	1971-72	1972-73	1973-74	1974-75
Belcher Islands area								
Port Harrison	—	—	—	—	—	3	7	4
Great Whale River	—	—	—	1	3	6	14	6
Sanikiluaq	—	10	15	12	13	15	17	17
Miscellaneous	2	—	—	—	—	—	—	—
Sub Total	2	10	15	13	16	24	38	27
James Bay area								
Fort George	1	—	1	—	—	2	4	8
Paint Hills	—	—	—	—	3	—	—	1
Fort Albany	—	—	—	—	—	2	—	—
Attawapiskat	—	—	—	2	3	2	—	8
Miscellaneous	1	2	4	2	1	—	1	—
Sub Total	2	2	5	4	7	6	5	17
Total for Zone A³	4	12	20	17	23	30	43	44

each year (Figs. 2 and 6). Hunting activity occurs throughout the legal hunting season (1 October to 31 May) but is concentrated between December and March. Hunting specifically for polar bear takes place.

The hunters from Great Whale River and Port Harrison are usually restricted to hunting along the narrow coastal strip of landfast ice. The success of the Great Whale River hunters in 1973-74 was mainly attributed to ice conditions which allowed travel between Great Whale River and the Belcher Islands. Undoubtedly, the incentive of increased fur prices stimulated greater efforts and accounted for two females, each with two cubs, being taken near the floe edge between the Belcher Islands and Long Island. Usually the hunting of bears is restricted to the coastal islands, particularly during the summer months.

9. Population estimates and structure

From aerial and ground surveys, an estimated 200 bears spend the ice-free months on the islands of James Bay and the Ontario mainland within Zone A³ (see p. 22). No estimates were made for other areas within Zone A³. A crude estimate of the total population size in 1973 (the last year in which a sample of polar bears was

captured throughout a substantial portion of the study area) was calculated using a simple Lincoln Index.¹ Although the estimate of 254 bears was based on small sample sizes, it was in the same order of magnitude as the estimate based on aerial surveys of summer sanctuaries.

The average ages of male and female polar bears killed or captured in the James Bay and Belcher Islands areas are given in Table 6. The average ages of male and female bears from James Bay are significantly greater than those from the Belcher Islands (males, $t = 1.76$, d.f. = 57; females, $t = 1.93$, d.f. = 46; $p < 0.1$). Cubs of the year were included although they were not part of the legal kill in the NWT, or in Quebec since June 1975. Thus, although the data on the movements of tagged

¹ Lincoln Index:

$$\begin{array}{r}
 \frac{\text{No. bears recaptured in 1973}}{\text{Total no. bears captured in 1973}} = \frac{\text{Total no. marked bears available for recapture in 1973}}{\text{Total population in 1973}} \\
 \frac{2}{13} = \frac{38}{\text{Total pop. in 1973}} \\
 \text{Total population in 1973} = 254
 \end{array}$$

Figure 6
Known locations of polar bear kills, 1969-75

Figure 6

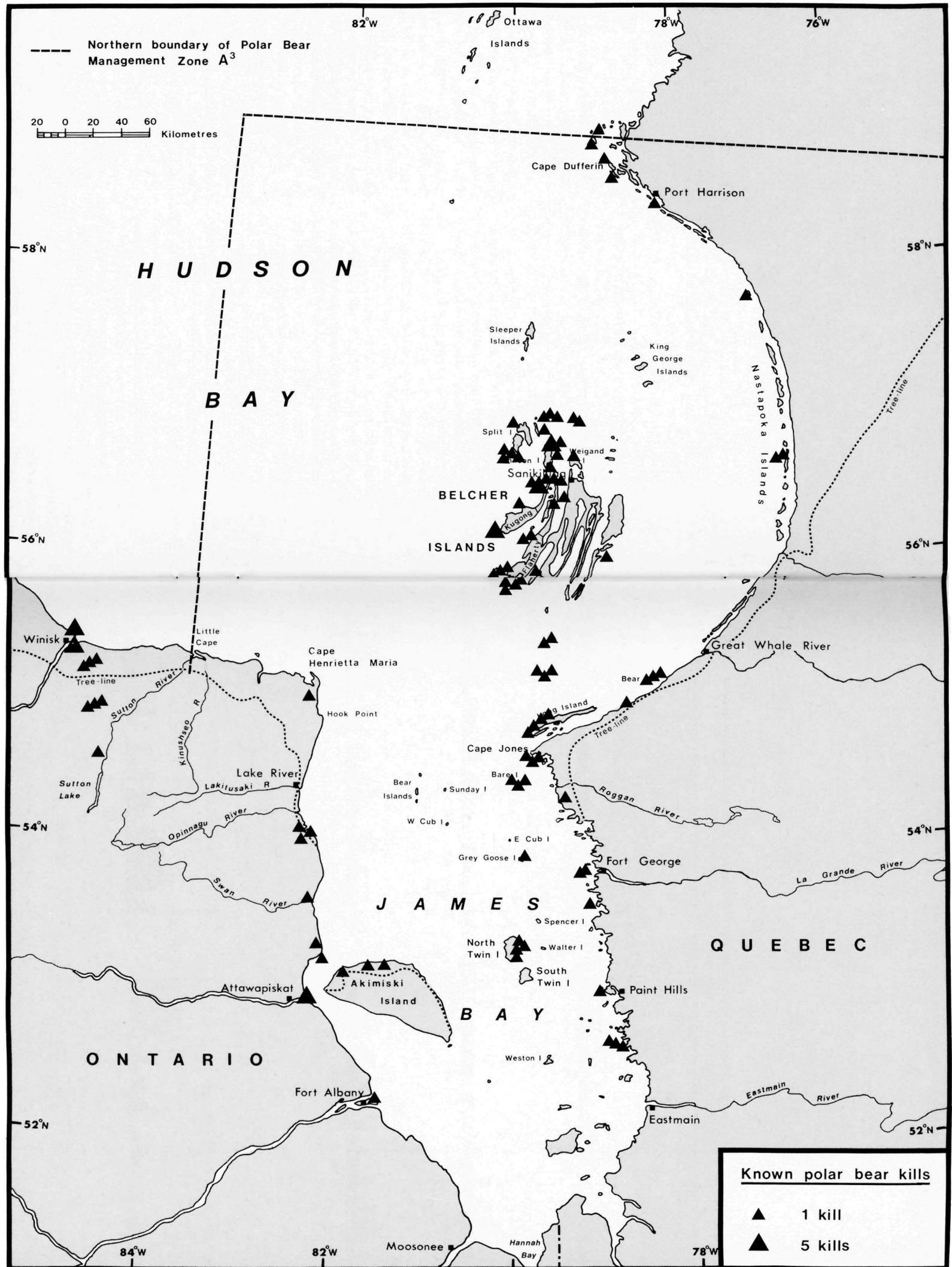


Figure 7
Age structure of polar bears killed and captured in James Bay – Belcher Islands

Figure 7

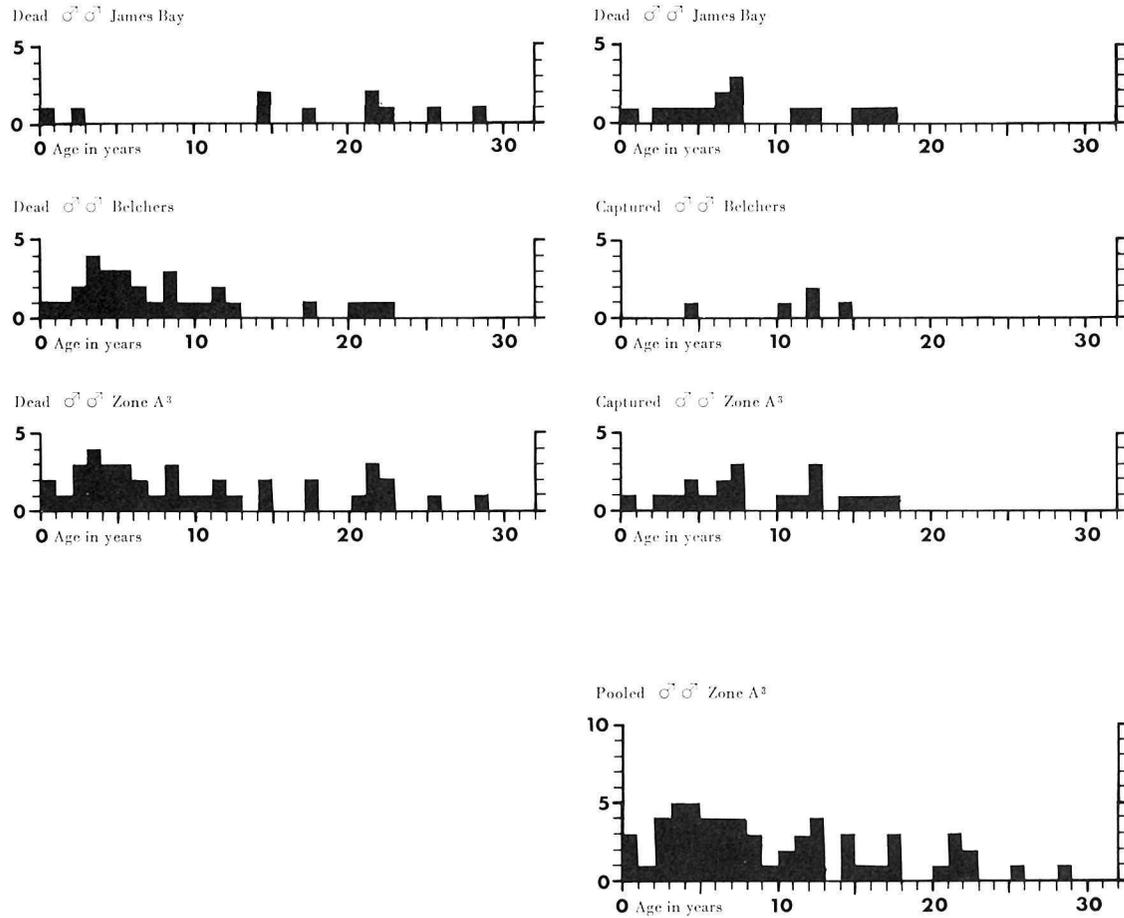


Figure 7

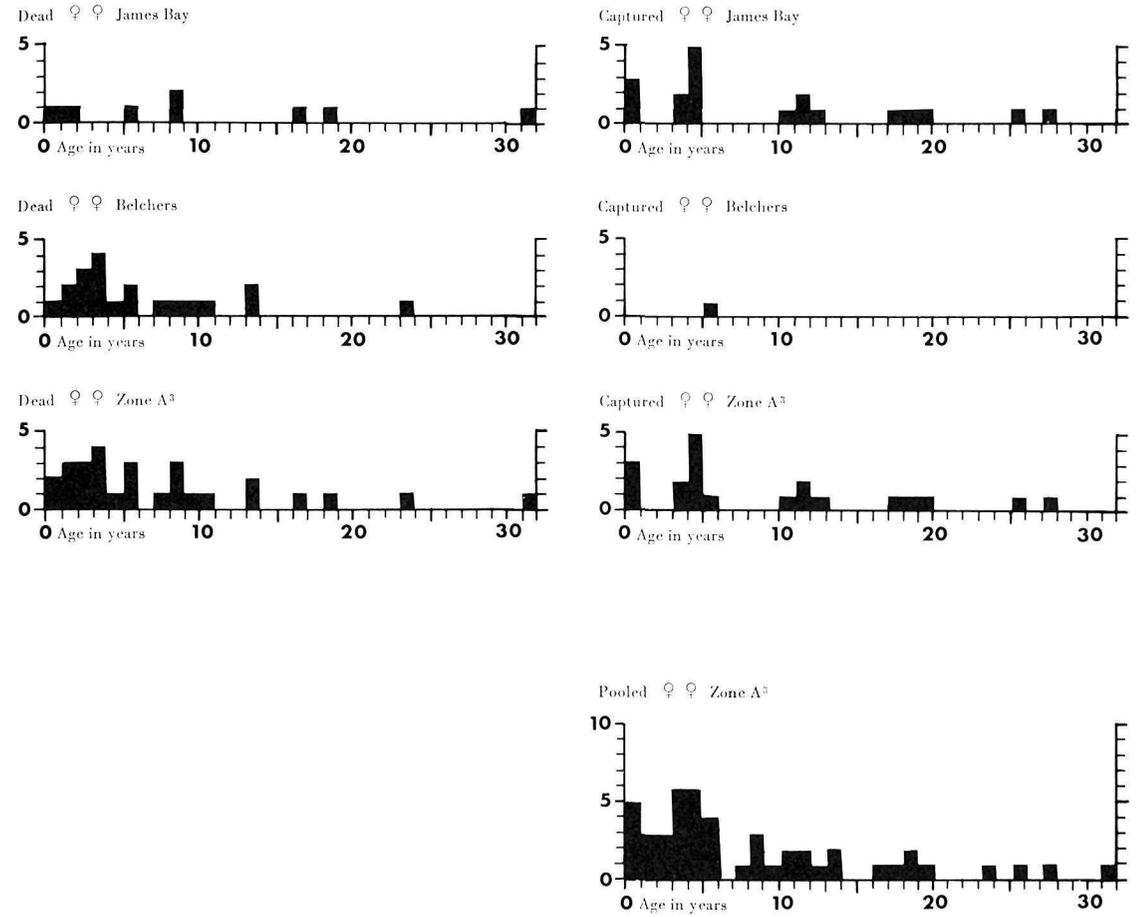


Table 6
The average age by sex of polar bears captured or killed in the James Bay – Belcher Islands area, 1968–75

	Males		Females		Unsexed		Total	
	Average age in yrs	No. of bears	Average age in yrs	No. of bears	Average age in yrs	No. of bears	Average age in yrs	No. of bears
James Bay								
Captured	7.9	15	9.3	19	—	—	8.6	34
Dead	16.4	10	10.9	8	3.5	2	12.9	20
Pooled	11.3	25	9.7	27	3.5	2	10.2	54
Belcher Islands area								
Captured	10.4	5	5.0	1	—	—	9.5	6
Dead	7.6	29	5.9	20	6.0	5	6.8	54
Pooled	8.0	34	5.8	21	6.0	5	7.1	60
James Bay – Belcher Islands area								
Captured	8.5	20	9.1	20	—	—	8.8	40
Dead	9.8	39	7.3	28	5.3	7	8.4	74
Pooled	9.4	59	8.0	48	5.3	7	8.6	114

bears suggest that the polar bears of both groups are part of the same sub-population, it is quite clear that the age structures are different (Fig. 7). These age differences may have been caused by different levels of hunting intensity which resulted in a lower age-structure in the Belcher Islands area where most bears have been killed, compared to the James Bay area where comparatively few bears have been taken (Fig. 6). The high average age of the adult (> 5 years) population in the James Bay – Belcher Islands area (Table 7) and the presence, in James Bay, of some of the oldest bears recorded is indicative of an old population. In Alaska, Lentfer (1973) showed that in 7 years (1966–72), the pooled average age of harvested males and females (> 2 years) dropped from 8.1 (n = 47) to 5.6 (n = 72) and suggested that the difference was caused by overhunting. Although the data base in this study was small, the results suggest that the polar bear population in the Belcher Islands area is younger than the population in James Bay. This could have resulted, partially at least, from heavier hunting pressure being exerted in the Belcher Islands area.

Another possible explanation could be that the Belcher Island Inuit hunt polar bears during the winter when they are dispersed on the sea-ice. Stirling *et al.* (1975) documented how, in the Western Arctic, the pattern of Inuit polar bear hunting on the sea-ice resulted in the average age of bears killed being younger than that of the overall population. In comparison, most bears killed in James Bay were taken in areas of summer sanctuary when the dominant animals tended to occupy many of the most obvious sites along the coast. This could have resulted, on average, in the harvest of much older animals.

10. Management

The James Bay and Belcher Islands sub-population of polar bears falls within the jurisdictions of NWT, Ontario, and Quebec. Hunting is restricted to native peoples throughout the management zone. Since 1969, the NWT has imposed strict quotas on the taking of polar bears by the Belcher Island Inuit. An initial quota of 15 animals was increased to 17 during 1973 and to 20 during 1975. The settlement is penalized for any overkills by reducing the quota accord-

Table 7

The average age by sex of adult (> 5 years old) polar bears captured or killed in the James Bay – Belcher Islands area, 1968–75

	Males		Females		Unsexed		Total	
	Average age in yrs	No. of bears	Average age in yrs	No. of bears	Average age in yrs	No. of bears	Average age in yrs	No. of bears
James Bay								
Captured	9.9	11	16.7	9	—	—	13.0	20
Dead	20.3	8	14.3	6	—	—	17.7	14
Pooled	14.3	19	15.8	15	—	—	14.9	34
Belcher Islands area								
Captured	12.0	4	5.0	1	—	—	10.6	5
Dead	10.6	18	10.3	9	10.5	2	10.5	29
Pooled	10.9	22	9.8	10	10.5	2	10.5	34
James Bay – Belcher Islands area								
Captured	10.5	15	15.5	10	—	—	12.5	25
Dead	13.6	26	11.9	15	10.5	2	12.9	43
Pooled	12.4	41	13.4	25	10.5	2	12.7	68

ingly for the following year. The hunting season is open from 1 October to 31 May the following year and females with cubs are protected. A cub is defined as an animal with a hide < 137 cm (54 in.) long. In the James Bay – Belcher Islands area this only protects animals up to 6 to 8 months of age. Two female cubs, one 8 months old and the other 9.5 months old, measured 142 and 152 cm respectively. In the Western and High Arctic cubs do not attain the legal length until about 1 year old.

Ontario controls its harvest by allowing a certain number of permissible kills. Ten kills are allotted to the James Bay settlements of Attawapiskat and Fort Albany and ten to both Winisk and Fort Severn. The latter two settlements are within the present polar bear Management Zone A². The Ontario system is not a strict quota system as any bear taken in excess of the allotted number is not deducted from the next year's kill as in the NWT. The only deterrent to an overkill by the Ontario Indians is a year's delay in payment for the hide. All hides taken in Ontario must be tagged and marketed through the Ontario Trappers' Association. Theoretically the taking of polar bears is restricted to local

Indians for protection purposes only, and in most years the allotted kills are not filled. No season exists, so that in practice bears can be killed throughout the year with no protection afforded females with young. To date, the known kill has always remained below the permissible kill.

Quebec at present has no restrictions on the number of bears taken although a quota of 15 has been proposed for the area. Before September 1971 there were no restrictions on who could hunt. Since August 1974 hunting has been restricted to Inuit and Indians. In the interim, except for a brief period October 1971 to March 1972, in theory only Inuit were allowed to hunt polar bears. In June 1975 an Order-in-Council established a summer closed season from 1 June to 30 September and specifically provided protection for bears in their dens, females with cubs, and cubs under one year of age. Until that time there were no restrictions placed on the season, age, and sex of animals killed in Quebec. The problem is now one of communication and enforcement. The continued dispatch of cubs, and bears during summer, by Ontario and Quebec hunters means hides of less value than if taken in the later years, or in winter.

The main incentive for hunting polar bears during the last 2 years has been the high prices paid for the hides (Smith and Jonkel 1975*a*). The sudden decline in value of polar bear hides may result in a lowered kill (Smith and Jonkel 1975*b*). The average price paid for a hide during 1975 was about \$600 compared to about \$1400 during 1973–74. With fewer dog teams, the increased use of oversnow vehicles, and increased contact with the southern markets, few people currently rely on polar bears as a meat source. However, some polar bear meat is eaten by Indians at Fort George and Paint Hills. With the implementation of the proposed quota system in Quebec, the total annual harvest of polar bears in the James Bay – Belcher Islands area would be limited to 45 bears (NWT: 20, Ontario: 10, Quebec: 15). If the crude estimates of population size approximate reality the proposed quotas (permissible kill) in Zone A³ could represent approximately 18% of the total population. Even if annual productivity is as high as 45 cubs (p. 27), the proposed quota system makes no allowance for natural mortality prior to hunting. Since the sustainable yield from a healthy, stable polar bear population appears to be in the order of 5–7% (unpublished computer simulation studies), the present kill in Zone A³ could possibly be too high. Detrimental effects on the population might be ameliorated to some degree by immigration into Zone A³ from populations to the north and west. For this reason, it is critical that monitoring of the status of the population in Zone A³ should continue.

The traditional hunting areas of the Inuit and Indians transgress jurisdictional boundaries, which the native people do not recognize. For example, the Quebec Inuit traditionally hunt on the fast-ice between the Belcher Islands and the Quebec coast. The Indians at Fort George traditionally hunt on the NWT islands that

fringe the east coast of James Bay, and occasionally go out to the Twin and other smaller islands in James Bay. This has posed a number of problems in the past, with the Quebec natives hunting in the summer, and shooting females with young in areas which come under NWT jurisdiction and were therefore subject to NWT game management regulations. As a general rule it has been agreed to allow Quebec natives to hunt on NWT islands and waters as long as there are no flagrant infractions of the Territorial regulations. A similar problem exists with Ontario Indians hunting on Akimiski Island (NWT) in James Bay.

11. Research needs

On the basis of the data available to date, the following actions should be considered with respect to the polar bears of the James Bay – Belcher Islands area.

(a) Lower jaws should be collected from all polar bears killed by Inuit and Indian hunters in this area to facilitate a further check on the age structure of the polar bears being hunted.

(b) A sample of polar bears should be captured, tagged and recaptured between Cape Henrietta Maria and the Belcher Islands and additional tagging should be done along the northern Ontario coast for final delineation of the western boundary of the James Bay – Belcher Islands polar bear sub-population.

(c) Efforts should be made as soon as possible to further document the locations of active maternity dens so that the most important denning areas can be determined and, if necessary, protected.

(d) With the development of the James Bay Hydro Project, considerable changes may take place in seasonal productivity of marine food chains, as a result of water diversion or modifications in the annual cycle of stream flow. For

example, studies by Neu (1970) indicated that mixing and transport of nutrients to the surface, caused by the flow of rivers into the sea, were essential for high productivity in the marine environment. He equated detrimental changes in the marine environment resulting from the altered flow of rivers to those caused by massive *heat or oil pollution*. Therefore, the possible effects of such developments on species such as polar bears, which occupy the top of the ecological pyramid of the marine ecosystem, should be considered and monitored carefully.

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