

PRODUCTIVITY AND MATERNITY DENNING OF POLAR BEARS IN ONTARIO¹

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Abstract: Aerial surveys to assess polar bear (*Ursus maritimus*) productivity were conducted along the northern coast of Ontario during February and March, 1974 through 1978. Cub production varied from 33 to 112 annually, and averaged 71 during the 5-year period. Average litter size was 2.0. Emergence extended from late February to early April with the peak around 1–15 March. Maternity dens occurred throughout the northern coast; distances inland extended from 29 to 118 km. The section between the Winisk and Severn Rivers consistently contained the greatest concentration of family groups. Most dens were situated in open or treed bog habitat where snow accumulation was greatest. Maternity dens lacked the presence of an earth chamber or intricate internal structures recorded in areas further north. After emergence, family groups remained in the den vicinity for 2 to 3 weeks. Movement to the sea was usually quite direct, and invariably towards Hudson Bay, although James Bay was sometimes much closer. Some groups travelled over 300 km to reach seal (*Phoca hispida*) hunting areas on the Hudson Bay ice. Maternity denning on Akimiski Island represents the most southerly occurrence of reproducing polar bears currently known anywhere in the world.

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The polar bear is circumpolar in distribution, but appears to occur in discrete, or semi-discrete, subpopulations (Larsen 1971, Lentfer 1974, Smith et al. 1975). Morphologically, the species is similar throughout its range, but a gradual reduction in size occurs from west to east (Manning 1971). The most southerly group in the world, which occurs in lower Hudson and James Bays and the Ontario mainland, differs both ecologically and behaviorally from bears in the High Arctic. Major differences are the southern bears' use of earth dens or pits during summer for resting and cooling (Kolenosky and Standfield 1966, Jonkel et al. 1972), higher frequency of waterfowl in summer diet (Russell 1975), and lengthy travels of females and cubs from natal dens to seal feeding areas (this study). Their relative proximity to populated urban areas further south presents excellent opportunities for viewing by tourists.

In Canada, initial investigations centered on denning studies in the High Arctic (Harington 1964, 1968), and later were expanded to include population and food habits studies in Hudson and James Bays (Jonkel 1967, 1969, Russell 1975, Jonkel et al. 1976). In the western Arctic, studies focused on summer behavior (Stirling 1974) and population ecology (Stirling et al. 1976). Denning and productivity studies oc-

curred in Manitoba (Jonkel et al. 1972, Stirling et al. 1977), James Bay–Belcher Islands (Jonkel et al. 1976), and Ungava Bay (Smith et al. 1975).

In Ontario, we conducted studies of maternity denning and cub production from 1974 to 1978. The objectives of the study were to assess annual productivity, delineate major denning regions, describe maternity den sites, and record travel routes and behavioral patterns of family groups after spring emergence. Similar studies were conducted in Manitoba (Jonkel et al. 1972), Svalbard (Larsen 1974), and Wrangel Island (Uspenski and Kistchinski 1972).

The timing and pattern of ice formation and recession in Hudson Bay largely determines the period when bears occupy the Ontario coast (Jonkel et al. 1976). As the ice recedes in mid-summer, bears are forced ashore and remain on land until ice conditions permit a return to the Bay to hunt seals. Pregnant females, however, retreat further inland to search for den sites. Although actual times and travel routes have not been well documented, most of this activity probably occurs from late September to early November. After birth of cubs in late December to early January, family groups remain in their dens for another 6–8 weeks. Emergence and return travel to the sea occurs from mid-February to early April with the peak around 1–15 March.

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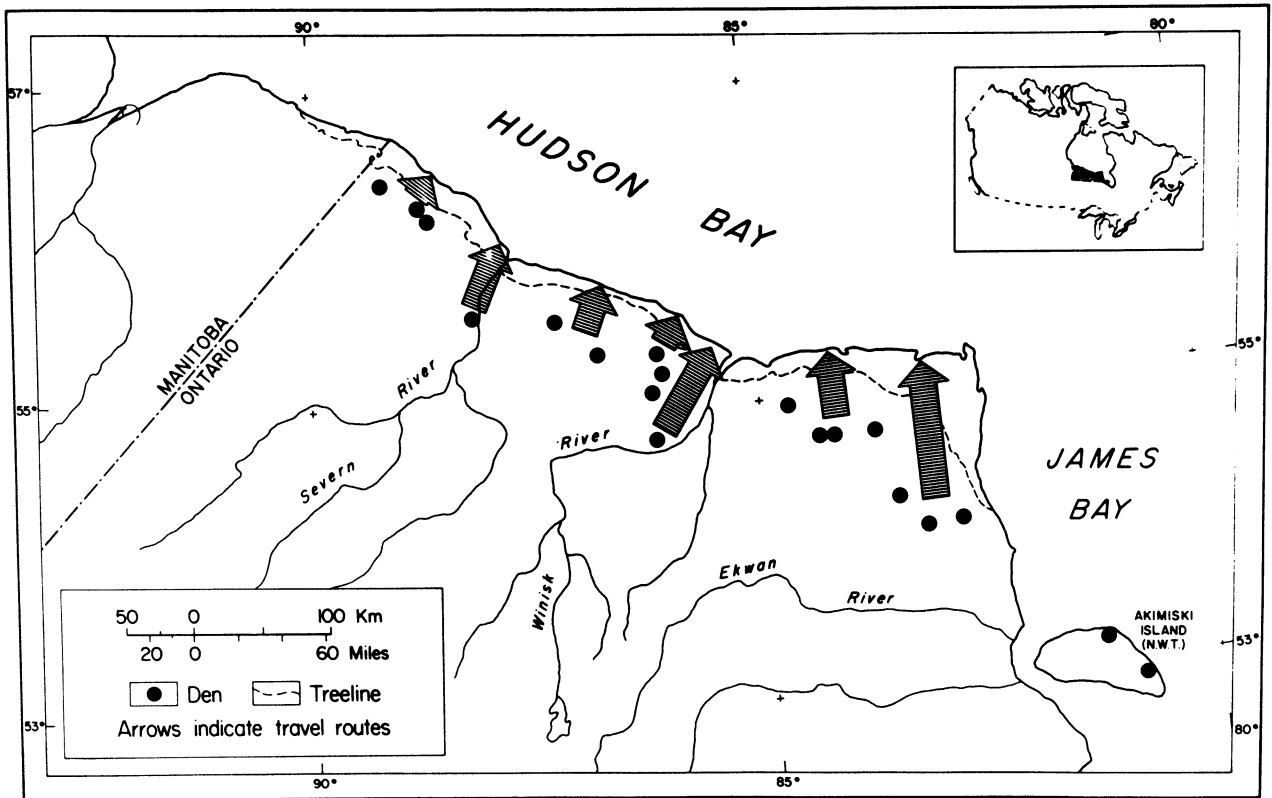


Fig. 1. Locations of polar bear maternity dens and spring travel routes of family groups in Ontario, 1974–78.

long hours in sometimes uncertain weather conditions. Without their expertise, the study could not have been completed. The help of Fred Johnson, Ontario Ministry of Natural Resources, Moosonee, who assisted in 4 of the 5 years is greatly appreciated.

STUDY AREA

The study area encompassed 2 major physiographic types, the coast and a treeless zone that extended inland from 2 to 50 km (Fig. 1). Characteristics of the coastal zone (Coombs 1954) were extensive marine clay tideflats, slot lakes, and sedge marshes between gravel beach ridges. Immediately inland is the Hudson Bay Lowlands, a vast, low-lying, poorly drained region consisting of numerous lakes, meandering streams, raised bogs, fens, and swamps, with intermittent permafrost (Brown 1968). The vegetation has been called an edaphic forest tundra by Hustich (1957). It has a "subarctic" appearance because of the extremely wet nature of the terrain and

the prominence of stunted black spruce (*Picea mariana*) and tamarack (*Larix laricina*) in the muskogs and patterned fens (Rowe 1972).

The climate of the area is typically arctic, with long, cold winters and short, cool, wet summers (Thompson 1968). Hudson Bay is ice covered for much of the year, although patterns of formation and breakup vary considerably by locality and year (Danielson 1971). Southern Hudson Bay is essentially ice-free from early August to mid-November.

METHODS

We monitored numbers and composition of family groups and maternity den sites during February and March 1974 to 1978 by flying transects parallel to the coast. Flights were conducted in OMNR Turbo Beaver aircraft at altitudes of 230–300 m and speeds of 190–220 km/hour. Generally, 2 observers plus the pilot were present. We recorded observations on a 1:250,000 map.

Table 1. Sighting and track count data showing minimum numbers of single polar bears, family groups, and cubs produced in Ontario, 1974–78.

Year	Single bears		Family groups				Estimated number of cubs		
	Sightings	Tracks	Total	Females + cubs		Groups, size not determined ^a	Total No. of groups	Minimum	Adjusted ^b
				Sightings	Tracks				
1974	0	0	0	6+13	6+12	8	20	41	47
1975	0	4	4	8+18	23+43	1	32	63	72
1976	1	2	3	9+20	28+54	3	40	80	92
1977	0	2	2	4+7	3+6	9	16	30	33
1978	1	6	7	6+13	37+69	10	53	102	112
Totals	2	14	16	33+71	97+184	31	161	316	356

^a Groups assumed to be productive when estimating total cubs produced.

^b Minimum + 15% (1974–76) or 10% (1977–78) to allow for early- and late-emerging groups not surveyed.

Distances flown along lines each year varied from 4,100 to 6,200 km and averaged 4,982 km over the 5 years. Distances between lines varied from 6.4 to 12.8 km in 1974 to 19.2 to 32.0 km in subsequent years. In 1974, lines were flown consecutively commencing with those nearest the coast; in later years transects were selectively spaced to ensure broader coverage in a shorter time. The same survey lines were flown each year. The total area surveyed annually encompassed about 48,000 km².

During the first 3 years, we employed a single survey of approximately 10 days duration believed to coincide with the expected peak of emergence. In 1977 and 1978, we conducted 3 separate surveys distributed from mid-February to late March to ensure coverage of early- and late-emerging groups. Reports from Indian hunters supplemented our own observations.

In addition to the coastal region, Akimiski Island was surveyed each year commencing in 1975. That survey consisted of a single flight approximately 3 km inland. The entire periphery was covered in 1975, but the southern shore was not checked in subsequent years because of lack of any denning activity.

Prior to surveys, dates of recent storms were examined to assess track retention and visibility. Elapsed times between the onset of the surveys and the last major storm were 10, 4, and 6 days for the years 1974, 1975, and 1976, respectively.

We classified tracks as fresh (≤ 1 day), recent (2–6 days), and old (≥ 7 days). Ages of tracks

were determined by repeatedly examining tracks of family groups actually observed. We followed tracks to determine number of bears, and, if tracks were fresh or recent, to attempt to locate dens. When possible, den sites were examined on the ground.

Weather conditions were classified as excellent (bright sun) during 3 surveys, good (sun and high overcast) during 4 surveys, and fair (overcast) during 2 surveys. Flights were discontinued when weather conditions restricted visibility of tracks.

Supplemental data on numbers and distribution of the various population components using the coastal region during the ice-free period of the year were derived from annual fall aerial surveys initiated in 1963 (Standfield et al. 1964, Kolenosky and Standfield 1966). Flights were conducted during late August to early September when maximum numbers of bears utilize the Hudson Bay coast.

Comparisons of single bears and family groups, seasonally and geographically between areas, were by chi-square tests. Procedures followed Sokal and Rohlf (1969).

RESULTS

Cub Production and Litter Size

Annual minimum cub production in Ontario from 1974 to 1978 varied from 30 to 102 and averaged 63 (Table 1). To account for emerging groups that may have been missed, estimates of

Table 2. Litter sizes of polar bears in Ontario based on sightings and track counts, 1974–78.

Year	No. of family groups	Litters with			Average litter size
		1	2	3	
1974	12	0	11	1	2.1
1975	31	4	24	3	2.0
1976	36	3	30	3	1.9
1977	6	1	5	0	1.8
1978	43	4	39	0	1.9
Totals	128	12	109	7	2.0
Percent		9.4	85.1	5.5	

production were adjusted by adding 15% to minimum estimates for 1974–1976 and 10% for 1977–1978. Correction values reflected different survey strategies and were based on numbers sighted during early and late surveys in 1977 and 1978, and on reports of emerging groups from Indian hunters. The average corrected estimate of cub productivity was 71 cubs/year.

Average litter size, derived from sightings of family groups or track series where numbers of young were accurately established, was 2.0 ($N = 128$ litters) for all years and ranged from 1.8 to 2.1 annually (Table 2). Litter size was smallest in 1977 when the fewest family groups were counted.

On Akimiski Island, annual minimum production of cubs ranged from 2 to 8 between 1975 and 1978 (Table 3). In all instances when group size could be determined, litter size was 2.0.

Single Bears

From 1974 to 1978, the percentage of single bears ranged from 0.0 to 11.7 and averaged 9.0. Differences in abundance among years were not significant ($P > 0.1$). Significantly more ($P < 0.05$) single bears occurred in the region between the Winisk and Severn Rivers (12) than in the region east of the Winisk River (0). Numbers west of the Severn River (4) were not significantly different from those in the other two areas ($P > 0.5$).

Maternity Dens

A total of 15 maternity dens and 2 probable maternity dens were located in Ontario during the

Table 3. Sighting and track count data showing minimum numbers of polar bear females, cubs, and family groups on Akimiski Island, Northwest Territories, 1975–78.

Year	Females + cubs		Groups, size not determined	Total No. of groups	No. of cubs	Average litter size
	Sightings	Tracks				
1975	0	4 + 8	0	4	8	2.0
1976	0	0	3	3	6 ^a	2.0 ^a
1977	0	1 + 2	0	1	2	2.0
1978	1 + 2	0	0	1	2	2.0
Totals	1 + 2	5 + 10	3	9	18	2.0

^a Estimated.

spring surveys and an additional 2 were seen on Akimiski Island (Fig. 1). Distances inland for the 17 mainland dens averaged 61 km (range 29–118 km, Table 4). On 3 occasions track patterns indicated groups originated further inland than the above maximum, but dens could not be found.

Maternity dens occurred in a wide variety of habitats, but most were on the leeward side of clumps of spruce or tamarack where snow accumulation was greatest. Treed bogs (Jeglum et al. 1974) and the edges of small lakes, rivers, and creeks were favorite sites. However, dens also occurred at the base of an esker and adjacent to rock outcrops. Active or recently vacated den sites were readily visible from the air because of associated tracks, beds, trails, and digging activities.

All but 1 den consisted of 1 or more excavations approximately 75 cm in diameter that extended to the soil layer. We determined the aspect of the entrance of 11 dens; 8 (73%) faced east or southeast. Digging and evidence of feeding activities were recorded at 4 of 7 den sites checked on the ground. Herbaceous species utilized included grasses, sedges, and mosses (*Sphagnum* spp.). Less frequently used were arboreal lichens and Labrador tea (*Ledum* sp.). Areas near dens were often marked by uniations and scats. The latter usually contained the remains of grasses and sedges.

Although dens, groups of bears, and tracks of groups were widely scattered, the section between the Winisk and Severn Rivers consistently had the greatest number of reproducing females. Of

Table 4. Locations and habitat types of suspected polar bear maternity dens in Ontario, 1974–78.

Year	Location		Habitat	Direction of entrance	Examined from	Distance inland (km)
	Lat.	Long.				
1974	54°20'	83°32'	Scattered spruce–tamarack	S	Air	103
	56°31'	89°03'	Scattered spruce–tamarack	–	Air	34
	55°35'	87°10'	Edge of small lake (open tamarack–spruce)	–	Ground	38
	54°45'	83°47'	Edge of river bank	ESE	Air	59
	55°40'	88°07'	Edge of small creek	SSE	Air	58
	1975	54°08'	82°42'	Spruce muskeg	E	Air
54°48'		86°08'	Spruce bog	ESE	Air	100
55°09'		86°08'	Spruce bog	E	Air	61
54°43'		84°17'	Edge of small lake (scattered spruce and willows)	–	Ground	61
54°06'		83°16'	Base of esker (<i>Populus tremuloides</i>)	E	Ground	118
54°43'		84°13'	Base of rock outcrop	–	Ground	63
Akimiski Island						
53°10'		81°12'	Edge of small lake (spruce)	–	Air	6
1976	54°57'	84°42'	Scattered spruce–tamarack	–	Ground	32
	55°22'	86°04'	Black spruce–tamarack	E	Air	34
	56°19'	88°29'	Open spruce	SE	Air	45
1977	56°22'	88°41'	Black spruce–tamarack bog	–	Ground	29
1978	55°15'	86°04'	Black spruce–tamarack bog	–	Air	43
	55°22'	86°42'	Edge of swampy depression	SW	Ground	51
Akimiski Island						
	52°55'	80°50'	Base of ridge (spruce–poplar)	NE	Air	5

161 family groups tallied during the study, 44% occurred between the Winisk and Severn Rivers, 32% between the Severn River and the Manitoba border, and 24% between the Winisk River and James Bay. Over the 5-year period, densities for these 3 sections were 1 group per 2.4, 2.5, and 4.9 km of coast, respectively. The single greatest concentration of groups occurred north-northeast of the Shagamu Lakes between 86°00' and 87°15' longitude.

Post-Denning Movements and Behavior

Females and cubs emerged from dens from mid-February to early April with the peak around 1–15 March. Immediately after emergence, family groups remained in the den vicinity for 2 to 3 weeks. Patterns of behavior near den sites were similar to activities reported for polar bears in Manitoba (Jonkel et al. 1972) and Southampton Island (Harington 1968).

The reaction of family groups to the aircraft varied from maintenance of position to active flight. Of 31 groups classified, 61% maintained position, 19% attempted to hide, 13% adopted overt defense positions, and 6% attempted to

flee. Two females carried all their cubs for about 30 m as they hurried to escape the aircraft.

Once movement started, travel routes were essentially perpendicular to the Hudson Bay coast (Fig. 1). Instances of meandering or movements paralleling the coast were rare. During all years, deviations from the main route exceeded 10 km 3 times. Occasionally groups followed watercourses for short distances. Only 2 groups moved towards James Bay rather than Hudson Bay, although the former was relatively closer for 5 other groups. One group possibly moved towards James Bay to avoid a hunting party.

Arrays of tracks and frequencies of beds along initial segments of trails indicated rates of travel were initially leisurely. Later, less frequent stops along routes suggested an accelerated pace. There was no indication groups rested when within 6 km of the coast.

Upon reaching the coast, groups continued north at least 60 km to prey upon seals. During 8–10 April 1975, bear tracks and seals were most numerous in the region immediately southwest of the Belcher Islands and adjacent to a long ice lead 112 km north of Winisk. A female with 2 cubs

was seen on the south side of a pressure ridge approximately 240 km north-northwest of Winisk on 8 April. Therefore spring travel between denning and feeding sites by some groups exceeded 300 km.

DISCUSSION

Estimates of cubs produced annually varied as much as 170% between years. Possible factors contributing to these differences were survey strategies, tracking conditions, number of females available for breeding, numbers that bred successfully, and early survival of young. Similar annual variations in productivity occurred in Manitoba (Stirling et al. 1977). In 1977, weather conditions were the least favorable of all 5 years and were considered at least partly responsible for the low count. In sheltered spots and without a major snowfall, dens and tracks may remain detectable for over 4 weeks. This contrasts to most other areas of polar bear range where dens and tracks may be obliterated by blowing snow within a few days (Harington 1968; Larsen 1974; J.W. Lentfer, unpubl. rep., Alaska Fed. Aid Projs. W-17-3, W-17-4, 1976).

The mean litter size of 2.0 was similar to estimates from Manitoba (2.0) (Stirling et al. 1977), but exceeded values recorded for the James Bay–Belcher Island region (1.5) (Jonkel et al. 1976), the Canadian High Arctic (1.8) (Harington 1968), Wrangel Island (1.7) (Uspenski and Kistchinski 1972), and Alaska (1.7) (J.W. Lentfer, unpubl. rep., Alaska Fed. Aid Projs. W-17-3, W-17-4, 1976). If reproductive success in polar bears is related to the physical condition of the female, as shown for black bears (*Ursus americanus*) (Rogers 1976), then lower Hudson Bay populations appear well nourished.

Although triplets suggest high productivity, survival of all young from large litters beyond the first few months rarely occurred. Only 1 of 115 family groups spotted during aerial coastal surveys in late August and early September from 1963–78 had 3 young. In all instances when triplets were observed during the spring studies, 1 cub was noticeably smaller and invariably trailed the moving group.

A further indication of early mortality in polar bear cubs was derived from the autumn surveys. For 1974–78, average litter size in autumn was

1.71 ($N = 17$), a decline of 15% from the average during the period of den abandonment. The decrease may be greater than indicated, since loss of entire litters could not be detected. That figure is somewhat higher than that of Stirling et al. (1976), who assumed that mortality of immature bears in the Western Arctic was equal to that of adult females (8%). If adult female mortality is similar in Ontario, the 1st-year mortality rate would exceed 20%.

The proportion of single bears (9%) was 3 times greater than the value (3%) reported for Manitoba (Stirling et al. 1977). Whether those were females that had not bred successfully, females that had lost their cubs shortly after birth, or males (Stirling et al. 1977) was not known.

Maternity dens examined in Ontario appeared simpler in design and construction than dens investigated elsewhere. We did not observe earth chambers as recorded in Manitoba (Jonkel et al. 1972), or intricate internal structures such as separated rooms reported for dens north of 60° latitude (Harington 1968; Van de Velde 1971; J.W. Lentfer, unpubl. rep., Alaska Fed. Aid Projs. W-17-3, W-17-4, 1976). However, our sample may not have included all possible den types, since only 7 were examined on the ground.

In Ontario, the chief requirement for a maternity den appeared to be sufficient snow to completely cover the occupants. As indicated earlier, most dens were on the leeward sides of clumps of trees where snow accumulation was greatest. Generally, drifts were highest on the southeast corners of such sites because of the prevailing northwest winds. In the High Arctic, dens frequently occurred on south-facing slopes where prevailing northerly winds created maximum drifts (Harington 1968). On Wrangel Island, the direction of slopes used for denning varied annually in relation to local snow accumulation (Uspenski and Kistchinski 1972). In Manitoba, winter dens occurred most often in treeless, or almost treeless, areas where the combination of steep banks along lakeshores or streams and heavy snow accumulation permitted den construction (Jonkel et al. 1972).

The occurrence of den sites from 29 to 118 km inland differed from den locations north of 60°. Harington (1968), Uspenski and Kistchinski (1972), and Larsen (1974) found dens less than

20 km from shore and concentrated in specific areas. The reason for females denning so far inland remains unknown, since apparent den sites occurred in many areas much nearer the coast. Perhaps arrival time on the coast in late summer dictates den location. If arrival is early, pregnant females may continue to move inland until stimulated to den by colder temperatures, heavy snowfall, or both. If arrival is delayed, travel time inland may be shortened and denning occurs nearer the coast. Fat reserves may influence onset of denning (Harington 1968), but whether physical condition differed between inland bears and those nearer the coast was unknown. Reports by local residents of occasional denning within 5 km of the coast could not be confirmed. However, blowing snow could soon obliterate any sign in the more open terrain near the coast.

The time of emergence of polar bears from dens in Ontario was similar to that in Manitoba (Stirling et al. 1977) but approximately 2–3 weeks earlier than recorded times on Southampton Island (Harington 1968), Wrangel Island (Uspenski and Kistchinski 1972), and Svalbard (Larsen 1974). Undoubtedly, the difference was a function of the earlier spring in the more southerly latitude.

The ability of females to travel direct routes over featureless terrain was remarkable and indicated a highly developed system of navigation. Near the sea, the odor of open water may assist orientation, but inland there appeared to be few navigational aids. After reaching the sea, families must travel at least 60 km across the ice to areas of seal concentration in Hudson Bay. The reduced attractiveness of James Bay was probably related to its lower seal population (Smith 1975).

Information on movements and behavior of females with young after they move onto the ice of Hudson Bay is scarce. In particular, their location during the subsequent ice-free season is poorly understood. During autumn aerial coastal surveys in 1974–78, the number of females accompanied by young was only 21% of females known to have produced cubs the preceding spring. The distribution of families along the coast differed from that of other sex and age classes ($P < 0.001$) but was similar to the pattern of females emerging from dens ($P < 0.10$). In particular, females with cubs seemed to avoid the usual con-

centration areas in late summer, primarily the vicinities of Cape Henrietta Maria and the Pen Islands. They were most abundant along the coast between the Winisk and Severn Rivers, the primary denning regions. Females with young may move inland from the coastal strip to avoid large males and the attendant risk of predation on the young. Although females and cubs, as well as single bears, have been observed inland, aerial coverage has been light and unsystematic.

The documentation of maternity denning on Akimiski Island (53° latitude) represents the most southerly occurrence of reproducing polar bears known in the world. The importance of the island as a summer sanctuary has been known for a long time (Standfield et al. 1964), but its use as a maternity site was only confirmed in 1975. Although annual production of 2 to 8 cubs in 1975–78 was small, its extreme southerly location renders it an area of special scientific interest. Whether or not the same females use it at different times of the year awaits further studies with tagged individuals.

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