

# USE OF SEA ICE HABITAT BY POLAR BEARS

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**Abstract:** Use of habitat by polar bears (*Ursus maritimus*) on coastal sea ice was investigated through observation of undisturbed polar bears and their environment. Nearshore sea ice was kept under 24-hour surveillance from 4 field camps established successively from 19 May to 19 July 1979 on island coasts bordering Barrow Strait, Northwest Territories, Canada. Two of these study areas received relatively more use by polar bears than the other 2. Polar bears also exhibited selection of sea ice types within each study area. Recorded activities of the bears included travel, play, sleep, and several hunting behaviors.

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In the High Arctic, sea ice is the primary habitat of the polar bear (Stirling et al. 1975, 1980; C.J. Jonkel, unpubl. rep., Dep. Indian and Northern Affairs, Ottawa, Ont., 1976). The convergence and divergence of sea ice induced by winds and ocean currents causes buckling and separation of ice sheets (Kovacs and Mellor 1974). Ice hummocks, pressure ridges, cracks, and leads are created by this deformation. The variety and abundance of these features contribute to habitat diversity on the sea ice. Tidal phenomena also affect sea ice topography near shore (Dunbar and Wittman 1963).

The predominant prey of the polar bear throughout the Arctic is the ringed seal (*Phoca hispida*) (Stirling and McEwan 1975). These seals utilize sea ice for rest and parturition (I. Stirling, in *Smithsonian Inst., Adaptions within Antarctic Ecosystems*: 741–748, 1977). Lairs are excavated by ringed seals above breathing holes in the accumulated snow on the windward side of an ice hummock or pressure ridge. Polar bears hunt for ringed seals near these features and also stalk them while they are basking near breathing holes on smooth ice. Polar bears utilize sea ice for a variety of other activities, including resting and travel between locations.

Four sites in coastal sectors of Barrow Strait and Lancaster Sound, Northwest Territories, Canada were investigated between 19 May and 19 July 1979 to assess relationships of polar bears to habitat components of the sea ice. Undisturbed polar bears were observed in 3 of the 4 study areas and their activities recorded. Sea ice features in each area were mapped, and basking seals seen in the areas were counted periodically.

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## METHODS

### Field Methods

Field camps were successively established between 19 May and 19 July 1979 at 4 sites near Barrow Strait and Lancaster Sound. Study sites were occupied as follows: southeast corner of Lowther Island (74°28'N, 97°35'W), 19 May to 5 June; 0.8 km west of Dyke Ackland Bay, Bathurst Island (75°01'N, 99°00'W), 8 June to 21 June; 0.4 km west of Erebus Bay, Beechey Island (74°42'N, 91°52'W), 27 June to 9 July; western shore of Intrepid Bay, Cornwallis Island (74°56'N, 96°12'W), 13 July to 19 July. The sites included 2 chosen to represent areas heavily utilized by polar bears (Lowther Island and Erebus Bay) and 2 areas lightly used (Dyke Ackland Bay and Intrepid Bay). Choice of these sites was based on previous field work in the area by the 2nd author.

The coastal sea ice at each study site was inspected by spotting scope every 1-1/2 hours. Basking seals were counted during each survey of the sea ice. When polar bears were sighted, they were watched continuously and their activities recorded. Activity was classified as travel, play, sleep, feeding, or hunting. Five types of behavior were included in the hunting category: (1) walking while sniffing the snow or air (searching), (2) stalking, (3) standing still for

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Table 1. Relative levels of use of ice types by polar bears in study areas in which bears were observed.

Study area and ice type	97% confidence intervals on availability vs. use	Use relative to availability
<b>Lowther Island</b>		
Smooth ice	+0.03, +0.53	Less
Rough ice—low	-0.32, -0.05	More
Rough ice—medium	-0.32, -0.04	More
Rough ice—high	-0.16, +0.64	Same
<b>Dyke Ackland Bay</b>		
Smooth ice	+0.36, +0.65	Less
Rough ice—low	-0.16, +0.13	Same
Rough ice—medium	-0.59, -0.30	More
Rough ice—high	-0.11, +0.03	Same
<b>Erebus Bay</b>		
Smooth ice	+0.37, +0.66	Less
Rough ice—low	-0.16, +0.04	Same
Rough ice—medium	-0.11, +0.08	Same
Rough ice—high	-0.04, +0.24	Same
Open lead	-0.70, -0.40	More

several minutes near a seal breathing hole, (4) lunging into a snow mound (presumably into a seal lair) without success, and (5) successful predation. Travel was defined as locomotion without sniffing behavior. Other activity categories are self-explanatory.

Use of sea ice features by polar bears was also recorded. Features were categorized as smooth ice, open leads, and 3 types of rough ice: rough ice—low, with ice ridges or protruding blocks less than 0.3 m in height; rough ice—medium, with ice ridges 0.3 to 1.5 m in height; and rough ice—high, with ice ridges greater than 1.5 m in height. Ridges and hummocks were more numerous in areas with the greatest altitude of these features.

### Data Analysis Methods

Availability of ice types to polar bears at each study site was derived from maps drawn in the field using a dot grid. The percentage of dots in the different ice types defined their availability. Use of ice types by bears was determined by noting the area of bear activity at 10-minute intervals. Chi-square tests were used to examine differences between use of ice types. Observed use of ice types by polar bears was compared with that expected, based on the percentages of ice types available. Use of ice types relative to availability was calculated using simultaneous confidence intervals (Marcum and Loftsgaarden 1980).

Observations of the sea ice at each study site were categorized as those with and those without sightings of polar bears. Independence between these 2 classes and the study site under observation was tested using the *G*-test (Sokal and Rohlf 1969; 598–600). Percentages of sea ice in each ice type were compared among study sites. An equality of percentages test was used to find differences (Sokal and Rohlf 1969; 608–609). Ice types within bays and coastal ice were analyzed separately. The number of basking seals per km<sup>2</sup> of sea ice were averaged over all observations in each study area. Calculations were performed separately for observations made in bays and those made in coastal sectors of the study sites because basking seals appeared to be consistently more numerous on bay ice. Ringed seals exhibit preference for stable sea ice (McLaren 1958). Coastal ice is subject to greater stress from currents and winds than the more protected bay ice.

Differences in the amounts of time apportioned by polar bears at each study site to the 5 activity categories were analyzed. Ten percent of the total number of bear observation minutes at each site served as the analysis sample. A random numbers table was used to generate sample points. The numbers of sample points in each activity category were summed and converted to percentages. The equality of percentages test was used to compare amounts of time polar bears spent in each activity among the 4 study sites.

## RESULTS

### Selection of Sea Ice Types by Polar Bears

Significant differences were found between observed and expected use of ice types by polar bears at all study sites ( $P < 0.01$ ). Observed use was derived from noting ice types used by polar bears at 10-minute intervals. The average walking speed of a polar bear is 1.1 m/s (Best 1976). At that speed, a bear could travel 660 m in 10 minutes, and thereby would have had a choice of the complete array of ice types at any of the study sites within each observation period. Ice categories used more than expected (based on their availability) included rough ice—low at Lowther Island, rough ice—medium at Lowther Island and Dyke Ackland Bay, and open leads at Erebus Bay (Table 1).

**Table 2.** Observations made at the 4 study areas, May–July 1979: Mean proportion of ice types present, mean density of basking seals, and occurrence of polar bear sightings on sea ice.

Study area	Percent of study area in ice types									$\bar{x}$ No. of seals basking per km <sup>2</sup> of sea ice in	Number of observations of sea ice		
	Coastal ice					Bay ice							
	Smooth ice	Rough ice			Open lead	Smooth ice	Rough ice			Coastal areas	Bay areas	With bears	Without bears
	Low	Med.	High			Low	Med.	High					
Lowther Island	59	11	17	13	0					0.04		14	133
Dyke Ackland Bay	39	45	14	2	0	91	6	0	3	0.05	1.93	3	96
Erebus Bay	70	6	5	18	1	67	2	4	27	0.33	3.13	11	52
Intrepid Bay						95	4	1	0		0.80	0	43

### Comparison of Study Areas

The number of observations resulting in polar bear sightings was not independent of study site ( $P < 0.05$ ), indicating differential selection of these areas by polar bears (Table 2). The percentages of ice types present at each study site differed among the 4 sites ( $P < 0.05$ ). Differences occurred in coastal and bay ice areas (Table 2). Data on average number of basking seals per km<sup>2</sup> of sea ice were collected at different times of the field season and therefore were not statistically comparable (Table 2).

### Activity

Similarities were found between proportions of total observation time spent in travel by polar bears at Lowther Island and Dyke Ackland Bay; in sleeping, feeding and playing at Lowther Island and Erebus Bay; and in hunting and feeding at Dyke Ackland and Erebus bays (Table 3). All other tests found significant difference between the percent of time spent in an activity in each pair of study areas ( $P < 0.05$ ).

### DISCUSSION

Habitat selection by polar bears exhibited in this study occurred at 2 levels: choice of whole study areas, and preference for sea ice types within study areas. The amounts of use the Lowther Island and Erebus Bay study areas received from polar bears were relatively higher than those received by the Dyke Ackland Bay and Intrepid Bay study areas. The data support the original hypothesis regarding differential use of the 4 areas by polar bears. In proportion to availability, there

was less use of smooth ice and either equal or greater use of rough ice. These are 2 levels in a continuum of categories of habitat selection by polar bears which includes home range selection, location of seasonal activities, the 2 types of selection discussed in this paper, and use of single ice features among an array in the immediate surroundings.

The 4 study areas differed in the relative abundance of the 5 classes of sea ice. The coastal sectors of both the Lowther Island and Erebus Bay study areas had a higher proportion of smooth ice than did Dyke Ackland Bay. Stability of ice is an important quality of preferred seal habitat (McLaren 1958) and the presence of smooth ice suggests recent stability. Prey abundance undoubtedly is an important factor influencing habitat selection by polar bears.

The bays at the Dyke Ackland Bay and Intrepid Bay study areas had more smooth ice than did Erebus Bay. Erebus Bay received more use by polar bears than did either of the other 2 study areas. This appears inconsistent with the explanation above relating relative use by polar bears to the proportion of an area with smooth ice. However, while stability of the sea ice may be

**Table 3.** Percent of polar bear activity classified in each of 5 activity categories, for observations made in the 3 study areas where polar bears were observed.

Activity	Lowther Island	Dyke Ackland Bay	Erebus Bay
Hunt	49	14	19
Sleep	32	58	29
Travel	13	18	35
Feed	2	9	8
Play	4	1	9

important in attracting seals and therefore polar bears to an area, there may also be an upper limit to stability over which a concurrent lack of diversity in the sea ice habitat discourages use by polar bears.

As the season progresses from spring to summer, an increasing proportion of a seal population will be found basking at any 1 time (McLaren 1958). This phenomenon peaks in mid-July at approximately 50% of a population basking at 1 time. In light of this fact, examination of basking seal densities from each of the 4 study areas suggests that some differences in population densities may have existed. Data were collected at Lowther Island 3 weeks earlier than those collected at Dyke Ackland Bay. Basking seal densities in the coastal sectors of these 2 areas were nearly identical. If true population densities in the 2 areas were similar, a higher basking seal density at Dyke Ackland Bay would be expected, assuming movements of seals in these populations were roughly restricted to the study areas. Since this was not observed, a higher population density at Lowther Island may be inferred. For similar reasons, population density may have been higher in the bay sector at Erebus Bay than at Intrepid Bay. Comparisons of basking seal densities in coastal and bay ice at Dyke Ackland and Erebus Bays were less clear. Warming weather and higher population density may both have influenced the higher basking seal densities observed at Erebus Bay. These inferences suggest that prey abundance may be 1 factor explaining relative selection of the 4 study areas by polar bears.

Large quantities of smooth ice in an area may be important in attracting seals because of the relative stability the presence of these ice features represents. However, polar bears do not selectively use smooth ice. In all 3 study areas where bears were observed, smooth ice was used less than expected. Hunting and sleeping were almost exclusively observed in rough ice. These 2 categories accounted for 48–81% of all polar bear activity observed in the study areas. Most behavior recorded as hunting involved either sniffing the air or snow, or breaking into lairs. These lairs are generally located in snow drifts that form in rough ice (Smith and Stirling 1975). Stalking of basking seals by polar bears was rarely recorded. Sleeping bears were usually observed next to a

pressure ridge or ice hummock, and not on smooth ice.

Stirling et al. (I. Stirling, D. Andriashek, P. Latour, and W. Calvert, unpubl. rep. Can. Dep. Environ. Victoria, B.C., 1975) discussed polar bear distribution in the Beaufort Sea in relation to sea ice types. They delineated 5 categories of ice based on the relative stability of the ice and the relative amounts of snow drifts suitable for seal lairs. They made polar bear sightings between late fall and late spring and found that the highest incidence of sightings (47%) occurred in "active zones" of sea ice, where winds and sea currents cause constant deformation of ice, creating intermittent habitat features. Another 40% of their polar bear sightings occurred near the ice floe edge. The 4 study areas chosen for our investigation did not include any "active areas" of sea ice. In the vicinity of the study areas, ice breakup usually begins in May (Collin 1963), but in 1979 ice breakup did not occur during the study period. Our findings should be considered characteristic of habitat selection by polar bears in areas where ice movement is minimal in comparison with that in active zones such as ice floe edges.

Interpreting differences in polar bear behavior among study areas is difficult. While the structure of the habitat surely affects behavior, a number of other factors can also be cited, including the physiological state of the animal and social relationships.

The relatively low percent of observation time recorded as hunting at Dyke Ackland Bay (14%) and the high percent recorded as sleeping (58%) were influenced by the fact that a kill was recorded there. A female with 1 cub of the year pulled a ringed seal from its lair next to a pressure ridge at the mouth of the bay. She and her cub spent the following 8 hours alternately feeding and sleeping.

Proportionally, the greatest amount of time spent traveling was recorded for the polar bears observed at Erebus Bay. This bay is located on the southwest corner of Devon Island, at the confluence of 2 major channels. It may lie on a heavily traveled route used by polar bears to cross from 1 channel into the next.

This study has shown that habitat selection by polar bears does occur. The bears are most likely

responding to variation in a complex assortment of environmental components, including prey availability, physical structure of the habitat, and intraspecific interactions. An understanding of the interrelationships of these components, and their relationships to polar bear abundance in specific locales, requires further research.

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