ALASKAN POLAR BEAR DENNING

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Abstract: Information on 35 overwinter maternity dens of Alaskan polar bears (*Ursus maritimus* Phipps) and on 101 female polar bears with cubs, recently emerged from dens, was obtained by aerial and ground surveys, interviews with Arctic coast residents, and literature review. Pregnant females form snow dens in October and November and give birth in December and January. Females and cubs emerge from dens in late March and April. Factors necessary for continued successful denning in an area include ice movements that enable bears to reach the area in the fall; the availability of seals as a food source and ice conditions facilitating their capture during the predenning and postdenning periods; and suitable weather conditions (snowfall, wind, and ambient temperatures) and topography that combine to produce snowdrifts that do not thaw during the denning period. Dens consist of 1 or more chambers, connecting tunnels, and entrance-exit tunnels. Alaskan dens were found as far inland as 48 km from the coast, along the coast, on offshore islands, on shorefast ice, and on drifting sea ice. Bears denning in the coastal zone are subject to human disturbance and should receive protection.

Parturient female polar bears give birth in winter snow dens occupied from late October or November to late March or April. For their first 3 months, cubs born in December or January require a den for protection from the harsh arctic environment. Thus, good denning conditions are essential for maintenance of populations.

Land areas where bears concentrate for denning have been described by Uspenski and Chernyavski (1965), Harington (1968), Jonkel et al. (1972), Uspenski and Kistchinski (1972), and Larsen (1976). Bears do not concentrate for denning on the Alaskan coast, and it was formerly thought that recruitment to the Alaskan populations was from the Soviet Union and Canada.

An objective of this study was to determine if denning occurs on or offshore from Alaska's coast, and if so, where and to what extent. Another objective was to obtain information on which to base recommendations for protection of denning polar bears from the impacts of energy exploration and extraction in the Alaskan Arctic. The need for protection is especially critical because the Marine Mammal Protection Act of 1972 removed all restrictions on harvest of polar bears by Natives; therefore, denning females are no longer protected.

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METHODS

Interviews to obtain denning information were conducted with residents of northern Alaska coastal villages and Prudhoe Bay oil camps. Pilot-guides were queried after hunting flights. Of particular value were detailed records of H. Helmericks, who has lived on the Colville Delta for more than 20 years and guided polar bear hunters until 1973. Files of the Naval Arctic Research Laboratory at Barrow and literature review provided additional information.

In a well-publicized program started in 1973, the U.S. Fish and Wildlife Service offered $50 to anyone reporting an overwinter maternity den and leading a biologist to it to verify the report and inspect the den. Payment was increased to $200 in 1974.

After freeze-ups in the falls of 1965, 1967, 1971, 1973, 1974, and 1976, surveys were flown (Cessna 180 and 185) along the coast and offshore islands between Point Barrow and the Canadian border. Objectives were to track bears inland to denning sites, determine from tracks the relative densities of bears at different locations, and record ice conditions and relative abundance of ringed seals (*Phoca hispida*). Flights and observations were hampered by adverse flying conditions, and only 1 den was found during fall surveys.

Fish and Wildlife Service personnel using light aircraft searched for dens in late March and early April 1973, 1974, and 1975, when females with cubs were emerging from dens. Renewable Resources Consulting

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Services, obtaining data for a proposed natural gas pipeline from Prudhoe Bay to the Mackenzie Delta, also searched for dens from aircraft in 1974 and 1975. Areas searched were shorefast ice, offshore islands, the mainland beach, and inland for approximately 50 km. Search efforts were concentrated in areas where drifting snow had accumulated in the lee of pressure ridges and cutbanks and in river and stream bottoms. It was assumed that tracks of bears leaving dens could be followed back to dens, as was done in Manitoba, Canada (Jonkel et al. 1972). Snow was so hard-packed in many areas, however, that Alaska observers could not see tracks from aircraft. Windblown snow also covered some tracks and den exits.

Two 2-man teams hired from the village of Kaktovik in the Arctic National Wildlife Range searched between the Hulahula and Katakturuk rivers and the Jago and Kongakut rivers in April 1975 but found no dens.

Polar bear mark and recapture studies based at Lisburne, Barrow, and Barter Island provided incidental information on denning (Lentfer 1975).

RESULTS

The general characteristics of maternity dens and their use in the Alaska coastal zone were similar to those reported previously for other areas (Uspenski and Chernyavski 1965, Harington 1968, Lønø 1970, Uspenski and Kistchinski 1972, and Larsen 1976). Pregnant females came to the coastal zone in late October or early November; exact times and locations depended on ice movement and freezing. First observations were east of Point Barrow and then southwest of Point Barrow in the same sequence that shorefast ice forms. Bears were more numerous in years when winds from the north and west brought old ice to the coast than when new ice drifted in (Lentfer 1972).

Parturition occurred in midwinter, and females and cubs broke out from dens in late March or early April. After emergence, family groups continued to use their dens intermittently for several days before abandoning them.

Dens were sparsely distributed on the mainland, on offshore islands, on fast ice, and on drifting ice (Table

Table 1. Search effort (whole or part crew-days), number, and mean distance from mainland coast (km) of polar bear maternity dens and cub litters, northern Alaska. A, B, C, and D refer to map (Fig. 1). Numbers in parentheses are ranges.

	Land	Offshore island	Shorefast ice	Drifting ice
A. *Point Hope-Lisburne-Northeastern Siberia area*				
Search effort	25	25	50	100
Number of dens	1	0	1	1
Distance from coast	9	-	6	93
Number of cub litters	0	1	0	16
Distance from coast	-	26	-	96(37-204)
B. *Barrow area*				
Search effort	50	50	75	400
Number of dens	6	0	0	2
Distance from coast	8(0-24)	-	-	117(65-169)
Number of cub litters	0	0	2	58
Distance from coast	-	-	4(2-6)	77(7-204)
C. *Oliktok area*				
Search effort	60	100	150	100
Number of dens	5	2	3	1
Distance from coast	30(19-48)	13(7-19)	6(2-9)	21
Number of cub litters	2	0	3	15
Distance from coast	10(2-19)	-	15(9-19)	43(9-111)
D. *Barter Island area*				
Search effort	65	65	65	30
Number of dens	7	1	4	1
Distance from coast	15(4-22)	4	7(2-9)	28
Number of cub litters	0	0	0	4
Distance from coast	-	-	-	127(28-278)
Total				
Search effort	200	240	340	630
Number of dens	19	3	8	5
Distance from coast	16(0-48)	10(4-19)	6(2-9)	75(21-169)
Number of cub litters	2	1	5	93
Distance from coast	10(2-19)	26	11(2-9)	77(7-278)

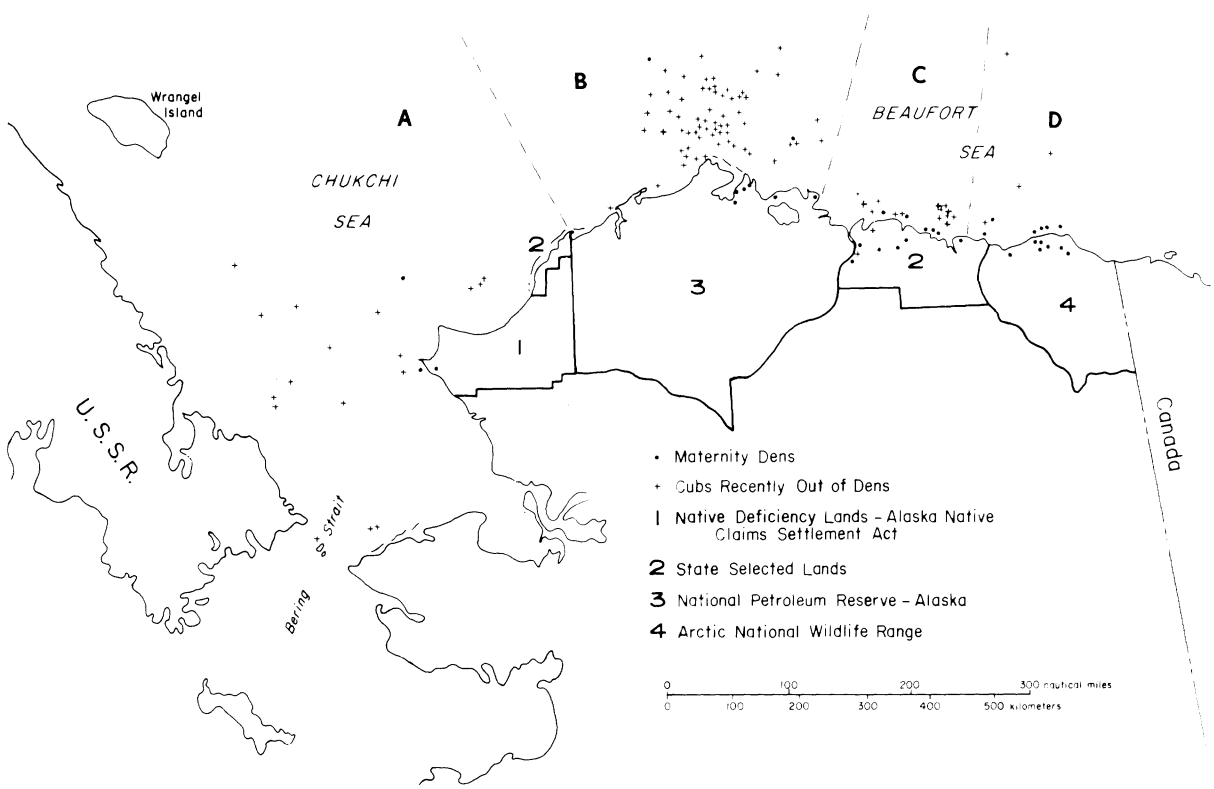

Fig. 1. Northern Alaska, showing distribution of polar bear maternity dens and of cubs recently out of dens, and land status along coast. A, B, C, and D refer to areas of search effort (Table 1).

1, Fig. 1). The den farthest offshore was 169 km from the coast, and the den farthest inland was 48 km from the coast. More dens were found on land and on shorefast ice between the Colville River and the Canadian border than on other areas searched. A large number of cubs were observed on drifting ice north of Point Barrow. The greatest distance from shore that a cub was sighted was 278 km.

Inspection of 10 dens (Table 2) revealed 7 with 1 denning chamber and 3 with 2-3 chambers. Two dens had additional chambers 50 cm or less in height that had probably been formed by cubs. Surfaces of ceilings, walls, and floors varied from hard-packed snow showing recent signs of digging to ice layers 2-7 cm thick. In dens with more than 1 chamber, chambers with the least amount of ice had been used most recently. Two dens had vents to the surface, 38 and 45 cm in diameter. Five dens contained fecal material and 5 (not all the same dens) contained urine. In 3 dens, feces were from the adult only and in 2 dens from cubs only. No attempt was made to examine the snow beneath den floors for feces or urine that might have been covered by snow.

As females and cubs traveled from denning areas to leads in the sea ice, where they fed on seals, they sometimes formed temporary resting shelters consisting of simple depressions in the snow, generally in the lee of the wind. No dens used over long periods were observed or reported, except those of parturient females. Observations and kill reports by Alaskan Eskimos indicate that all age/sex-classes of bears except parturient females and cubs live outside of dens throughout the winter. Denning for extended periods by polar bears other than parturient females has been reported in Canada (Van de Velde 1957, 1971; Harington 1968) and in northern Taimyr and northern Greenland (Uspenski and Chernyavski 1965). Earth dens like those used in the Hudson Bay and James Bay areas of Canada (Kolenosky and Stanfield 1966, Doutt 1967, Jonkel et al. 1972) have not been reported along the Alaskan coast. Alaskan bears need not spend summers on land as bears do at Hudson Bay, where sea ice melts completely, leaving no permanent pack ice on which bears can summer.

Table 2. Measurements (cm) of 10 polar bear dens, Alaska, 1972-74.

	N	Mean	Range
Main chambers			
Number	14	1.4	1-3
Height	13	78	51-109
Width	14	162	81-229
Length	14	180	81-508
Exit tunnel length	10	257	0-732
Exit-entrance height	9	62	32-81
Exit-entrance width	9	87	61-109
Snow depth above chambers	9	67	13-137

DISCUSSION

Distribution of Denning

One reason that more dens were found on land and on shorefast ice between the Colville River and Canadian border than elsewhere along the northern Alaskan coast is that ice first forms in the fall between Point Barrow and the Canadian border, and therefore pregnant females may come ashore in that area earlier than in others. Another reason is that oil and gas development started east of the Colville River, prompting searches for dens.

Like many other mammals, female adult polar bears may show fidelity to parturition sites and therefore try to reach specific denning areas. Return of females to previously used denning areas could help maintain subpopulation of bears (Manning 1971, Lentfer 1974, Wilson 1976). The number of bears returning to specific coastal areas to den may vary from year to year, however, depending on the type of ice and the time it forms. As mentioned, bears are more abundant along the coast in years when winds bring heavy ice to the coast early in winter than in years when newly frozen ice drifts in to shore or freezes in place a considerable distance offshore (Bailey and Hendee 1926, Lentfer 1972). The numbers of bears in denning areas elsewhere in the polar basin also vary from year to year, depending on ice conditions (Harington 1968, Kistchinski 1969, Lønø 1970, Uspenski et al. 1978).

Snowfall, ambient temperatures, wind, and topography, all occurring in such a manner as to result in snowdrifts that do not thaw during the denning period, are necessary for continued successful denning in an area. Another requirement is the availability of seals nearby and ice conditions enabling bears to catch them during predenning and postdenning periods.

Bears that do not reach offshore islands, fast ice, or the mainland may den on drifting sea ice. Drifting ice can transport denned bears through areas where ice movement is a threat to dens or to areas where feeding conditions are poor when bears emerge from their dens.

The best method for determining the area where bears emerging from dens on sea ice may have entered the dens 5 months earlier is to refer to long-term mean ice drift calculated from many years' data collected at drifting stations (R. Colony and D. Rothrock, AIDJEX, University of Washington, personal communica-

tion). The method is not precise because winds causing ice drift vary considerably from year to year. Stresses transmitted between floes also affect drift, and maps of surface pressure, which determines the wind, do not give exact estimates. Along the Beaufort Sea coast, ice drifts from the Canadian border toward Point Barrow at a mean speed of 2-5 km per day. It moves away from the coast as it passes Point Barrow. It would be useful to be able to predict with some degree of certainty the drift patterns from dens originating in various locations. Data from the Arctic Ice Dynamics Joint Experiment (AIDJEX), a United States-Canadian study of Beaufort Sea ice, could be used to refine existing data obtained from ice stations.

From long-term data on mean drift, it was calculated that a den on drifting ice 169 km northwest of Point Barrow, when bears emerged 1 April, had been less than 20 km offshore in the vicinity of Barter Island when first occupied about 1 November (drift calculated by D. Rothrock, AIDJEX, University of Washington). The den had drifted about 650 km.

Several circumstances may explain why more dens, and cubs recently out of dens, were reported offshore from Alaska then from other offshore areas. Ice may not be suitable for denning in some other locations, as Lønø (1970) reported for Spitsbergen. Also, there was more opportunity to record cubs recently out of dens in the Alaska sector during the 15-year period before 1972, when hunting guides searched for bears with airplanes and reported sightings. An intensive offshore research program by federal and state biologists has also provided data. We do not know if the large number of cubs reported and tagged north of Point Barrow indicates that denning is concentrated in this region or if cubs occur at about the same density over a large portion of the sea ice north of Alaska. Cubs observed on sea ice in March or early April are probably born fairly close to where they are observed, but by late April cubs may have traveled considerable distances.

Dens are more sparsely distributed in the Alaska coastal zone than in core denning areas in other countries (Uspenski and Chernyavski 1965, Harington 1968, Jonkel et al. 1972, Uspenski and Kistchinski 1972, Larsen 1976). A comparison of the Alaskan coastal zone with Wrangel Island off the eastern Siberian coast, where 150-200 females produce cubs each year, suggests an explanation. A primary requisite for successful denning is deep snow. Wrangel Island has hills up to 1,100 m above sea level, where drifted snow collects on open slopes. These hills may provide many more suitable denning sites per unit of area than the flat Alaskan coastal zone, where snow collects only along drainages, cutbanks, and rough ice. Also, Stirling et al. (1975) suggested that intensive hunting along the Alaskan coast, since whalers introduced firearms more than 80 years ago, may have reduced the stock of bears that traditionally came ashore to den. This suggestion is based on the premise that adult female polar bears show a fairly high degree of fidelity to parturition sites.

Climatic changes may also affect distribution of dens. Long-term warming and cooling trends in the Arctic have been demonstrated (Budyko 1966, Vibe 1967). As warming trends cause ice to form later in the fall, bears may be unable to reach areas that formerly supported denning. A warming trend would also impair the snow conditions necessary for successful denning. Conversely, cold trends would increase numbers and sizes of areas suitable for denning. Snow depth is also related to climate. In years when little snow accumulates, bears may den later, emerge from dens temporarily in midwinter, or leave their dens earlier than when normal snow depths provide satisfactory denning situations. Such activity causes an energy drain that could directly or indirectly increase mortality. The IUCN Polar Bear Specialist Group (1978) pointed out that managers should be particularly aware of the vulnerability of polar bear populations during periods when detrimental human activities coincide with unfavorable climatic conditions.

Den Structure

Alaskan dens are similar in structure to dens described for other areas (Harington 1968, Uspenski and Kistchinski 1972, Larsen 1976), but several points merit discussion. Den site and configuration may affect physiology of bears, especially thermoregulation and energetics. They are especially critical for females, which do not feed for a 5-month period that includes the last term of pregnancy, parturition, and lactation. They are also critical for cubs, which have only short hair and no fat layer to aid in thermoregulation.

Not all dens had vent holes to the outside. Bears may control temperature by blocking or enlarging vents, actions observed for a denning zoo bear (Mitchell 1921). Adjusting the size of vent holes may help maintain the insulating quality of snow by keeping temperatures in dens low enough to prevent thawing and subsequent ice layering. Vent holes may also allow gas exchange between the dens and outside if snow conditions or ice layers on the den ceilings reduce this exchange. Heavy ice layers in some denning chambers indicated that temperatures sometimes rose above freezing. Bears

may dig other chambers when ice decreases the insulating value of snow and the gas exchange through the snow.

Tunnels showed varying degrees of use. A portion of a tunnel formed in the fall may be used for the entire denning period. A new tunnel may be formed to lead to a new chamber, and an exit tunnel to the outside may be formed in the spring. Some tunnels were long, possibly to conserve heat in the denning chamber.

Evidently some bears claw at the ceiling, as snow drifts over the den, to maintain a fairly constant snow depth above the den and perhaps to eliminate an ice layer as it forms. The snow from the ceiling falls to the floor, so the height of the denning chamber remains about the same. In some instances, however, bears tolerate deep snow over a den. Harington (1968) reported snow depths of more than 2.25 m over dens. Dens with floors on or close to the ground or ice may receive more heat dissipated from the ground or from the water beneath the ice then dens with thick layers of snow beneath them (Elsner and Pruitt 1959). Depth and density of snow over dens may also affect den temperatures. Some of these physiological aspects of denning have been studied on Wrangel Island (S. Belikov, personal communication) and will be studied in the Churchill, Manitoba, denning area (N. Oritsland and P. Watts, personal communication).

Management Considerations

Alaskan polar bears that den on shore and fast ice can be hunted or subjected to other human disturbance for several months each year. Therefore, denning requires special management consideration.

The Marine Mammal Protection Act of 1972 transferred management authority for polar bears from the State of Alaska to the U.S. Department of the Interior and removed all restrictions on taking of polar bears by Natives, provided waste does not occur. Females accompanied by young, and their young, were protected even from subsistence hunters before the Marine Mammal Act. The State of Alaska has requested return of management with a proposed program that would protect the young and females with young throughout the year and would protect pregnant females coming ashore to den by establishing a closed season from 1 June through 31 December.

Increasing human activity associated with oil, gas, and coal exploration and development could also adversely affect denning. Human activity might cause females coming to shore to den in October and November to move back onto drifting sea ice and den there. Drifting ice may provide a less stable platform than land or shorefast ice and thereby reduce denning success. Drifting ice may also transport bears to areas where they cannot find adequate food when they emerge from their dens. Human activity might interfere with bears that had selected sites for denning. Shereshevskii and Petriaev (1949) stated that females were easily frightened away from dens before parturition. Belikov (1976) reported that several bears deserted dens on Wrangel Island shortly after forming them in October and November because of the presence of investigators. Belikov (1976:37) further stated: "Contact of breeding females with man leads to a disturbance of the normal rhythm of breeding and rearing of young. Consequences are still unclear but undoubltedly there is a negative influence on the life cycle of the polar bear." Disturbances could also affect bears later in the denning period. Bears in zoos produce cubs successfully only if shielded from noise and visual disturbances during denning and for several months thereafter. There is some evidence that bears in the wild, when disturbed in their dens, neglect the cubs or lead their cubs out of dens before the young are sufficiently developed to withstand the severe midwinter environment. On 2 and 3 March 1974, a seismic crew observed a female with a new cub traveling northeast across Prudhoe Bay, Alaska. The bears had left their den a month earlier then normal, possibly because of seismic or other human activity. The cub was extremely small, had difficulty in traveling, and may not have survived. In contrast, however, oil company personnel observed a den with a female and 2 cubs for several weeks on Niakuk Island in Prudhoe Bay during the winter of 1973-74, and the bears did not abandon the den (C. Knowles, personal communication). Belikov (1976) observed a den throughout the denning period from October to April at fairly close range, and these bears did not abandon the den prematurely.

Possible effects of disturbance to denning bears appear serious in view of the potential for industrial development along much of Alaska's north coast. The Beaufort Sea outer continental shelf and the coastal plain from northwest Alaska to the Canadian border has high potential for oil and gas, and the coastal plain has extensive coal deposits. Extraction of these resources will likely be a major goal on state lands, Native lands, National Petroleum Reserve — Alaska, and the Beaufort Sea Outer continental shelf, and could occur in the Arctic National Wildlife Range (Fig. 1). A number of actions can be taken to protect bears and their habitat. An ecosystem approach over large areas

should be followed rather than a species-by-species approach in restricted zones. The ecosystem approach would require cooperative land and offshore management by federal, state, and local governments and holders of oil and gas leases and, if possible, by Soviet and Canadian governments. The concept of fairly large zones of minimal activity between developmental zones should be considered.

The coastal area of National Petroleum Reserve — Alaska should receive special area designation for protection of wildlife values as provided for in the National Petroleum Reserves Production Act of 1976. Jurisdiction over this area should be clearly established so that the agency responsible for environmental protection can implement protective measures in the near future (Skladel 1974).

There should be one-time-only seismic exploration on public lands, accomplished by treating information from seismic surveys as public property and making it available to all who might wish to evaluate oil potential on public lands. Near shore seismic exploration should be conducted with reduced charges from boats during summer rather than from fast ice during late winter.

Activity should be reduced along the coast during the late October-early November period, when bears come ashore to den, and also from late December through mid-April, when disturbance could cause bears to desert their dens after the cubs are born. Seismic lines, pipelines, and roads should be routed at right angles to the coast rather than parallel and adjacent to it. Specific proposals for development, including plans for removal of snow from drift areas for roads and pads, should be reviewed by wildlife specialists to minimize impact on denning bears. *No-activity* zones should be established around active polar bear dens.

Camps to support oil and gas activities should be established inland rather than on routes that bears normally travel along the coast. Studies to develop scaring devices and deterrents to keep bears away from camps should be continued (Wooldridge 1980, Wooldridge and Belton 1980). Garbage should be incinerated properly. Spilled oil, fuel, chemicals, and drilling muds should be contained in lined, bermed sumps and storage areas.

Studies to delineate areas of critical polar bear habitat, especially denning areas, should be continued. The relative importance of coastal areas and sea ice for denning should be determined. Effects of disturbance on individual bears, particularly denning females, should be quantified. These determinations would require observations of the effects of disturbance, either artificial or actual, during the predenning, denning, and postdenning periods. Effects of human activity and of oil spills on ringed seals and other organisms in the food chain supporting polar bears should also be determined.

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