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POLAR BEAR REPRODUCTIVE BIOLOGY AND DENNING

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SUMMARY

The Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service collected reproductive data from polar bears during a mark and recapture study conducted from 1967 through 1975. Polar bears have a seasonally constant estrus extending from late March to about mid-July. Minimum breeding age for females averaged 5.8 years and ranged from 4.5 to 8.5 years. Most females are probably sexually mature by 6.5 years of age. Maximum breeding age is probably between 20 and 25 years. Mean litter size for cubs, yearlings and 2-year-olds was 1.68, 1.66 and 1.51, respectively. For females 4 years old and older the average reproductive cycle was 4.13 years and the reproductive rate was 0.407 young per year.

Information on 34 overwintering maternity dens and 92 females with cubs recently out of the den was obtained by aerial and ground survey, 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 which provide for bears reaching the area in the fall; occurrence of food (seals) in the area and ice conditions facilitating their capture during the pre- and post-denning periods; and topography, snowfall, wind patterns and ambient temperatures, all of which provide for snowdrifts that do not thaw during the denning period. Dens consist of one or more denning chambers, connecting tunnels and entrance-exit tunnels. In the Alaska sector of the Polar Basin, dens are found inland as far as 40 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 adequate protective measures should be taken.

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BACKGROUND

Early Arctic explorers and naturalists contributed to a general understanding of polar bear (*Ursus maritimus*) reproductive biology and denning ecology (Koettlitz 1898, Manniche 1910, Freuchen 1935). Pederson (1957) provided more detailed information from field observations and Dittirich (1961) and Volf (1963) provided information from polar bears in zoos. More recent field investigations have included studies by Parovschikov (1964), Uspenski and Chernyavski (1965), Harington (1968), Kistchinski (1969), Lønø (1970), Uspenski and Kistchinski (1972), Jonkel et al. (1972), Lentfer (1975), Stirling et al. (1975) and Belikov (1976).

Polar bears have a relatively low reproductive rate which should be defined as precisely as possible to better assess possible effects of hunting and other disturbances to animals and habitat. Likewise, denning ecology should be better understood so that productivity, which is dependent on successful overwintering of females and cubs in snow dens, is not adversely affected by human disturbance. There is an immediate need for information and understanding because female polar bears with young, and also their young, may now be harvested without restriction by Alaskan natives under provisions of the Marine Mammals Protection Act of 1972; these segments of the population were formerly protected. Also, areas utilized for denning have oil and gas potential, and activities associated with exploration and development could adversely affect denning.

Many of the data for this report were collected by the Alaska Department of Fish and Game and transferred to the U.S. Fish and Wildlife Service at the time the Marine Mammals Protection Act transferred management authority for polar bears from the State of Alaska to the Department of Interior. Fish and Wildlife Service personnel have collected additional data since the Marine Mammals Act and have prepared this report to make information available and fulfill State of Alaska Federal Aid in Wildlife Restoration reporting requirements.

OBJECTIVE

To describe reproductive biology and denning ecology of polar bears.

PROCEDURES

Reproductive Biology

A polar bear marking and recovery program conducted since 1967 by the Alaska Department of Fish and Game and since 1968 by the U.S. Fish and Wildlife Service provided most of the information on reproduction. This was supplemented by literature review and personal interviews. Specific procedures were as follows.

Ages of cubs, yearlings and 2-year-olds were determined by body size, except when it was occasionally necessary to distinguish yearling males from 2-year-old females by degree of eruption of canine teeth. Older bears were aged primarily by cementum layering of a rudimentary, lower premolar tooth extracted while they were immobilized for marking (Lentfer et al. 1968). This was confirmed or adjusted by comparing with an estimated age based on tooth wear, body measurements and reproductive condition.

An indication of breeding condition of immobilized females was obtained by noting whether the vulva was infantile or whether it was turgid or open in appearance, and by noting stage of development of mammae, including size and pigmentation of nipples and whether or not lactation had previously occurred.

Department of Fish and Game personnel stationed in coastal villages to monitor hunting activity prior to the Marine Mammals Act obtained polar bear female reproductive tracts. Reproductive tracts were measured and examined for placental scars but have not yet been examined for ovarian bodies; these data will be presented in another report. Polar bear testes were obtained from Alaska-based guides and hunters and from hunters in waters adjacent to Spitsbergen in August 1967. Sections of selected testes and epididymides were examined for sperm (Lentfer and Miller 1969).

Several reproductive parameters necessary to measure productivity have been obtained. The reproductive cycle, or interval between fertile breedings, was obtained by recapturing females with second litters or recapturing females without young whose state in the reproductive cycle could almost definitely be determined by other means (e.g., it would have been assumed a post-lactating female paired with a mature male and in estrus when captured was entering another breeding cycle). Not all females attain sexual maturity at the same age, and length of average breeding cycle was adjusted to compensate for differences in the pre-pregnancy period, i.e., time between earliest known pregnancy at age 4 and age at actual first pregnancy. A reproductive rate, or average number of young produced per year per breeding age female was obtained by dividing average cub litter size by length of adjusted breeding cycle.

Denning

Denning information was obtained by interviews with coastal residents and oil field workers, reports of pilot-guides, a review of files at the Naval Arctic Research Laboratory at Barrow and other literature, a den reward program and field studies consisting of aerial and ground searching and observations made incidental to marking of dens and cubs recently out of dens or their tracks. This resulted in 34 dens and 92 family groups with newborn cubs being recorded.

Interviews were conducted at Point Hope, Wainwright, Barrow, Nuiqsuit and Kaktovik. Oil field personnel in the Prudhoe Bay area also provided information. Of particular value was information supplied by H.R. Helmericks who has lived on the Colville Delta for more than 20 years and guided polar bear hunters until 1972. Mr. Helmericks kept detailed records of hunting flights including locations of cubs and dens observed.

Pilot-guides were queried at the conclusion of hunting flights and information recorded on standard forms. This included location of family groups with cubs.

A reward program for reporting den sites was started in 1973. This was publicized by letters and posters to villages and oil camps. A $50 reward was offered to anyone who could locate and lead a biologist to an overwintering maternity den for verification and examination. The reward was increased to $200 in 1974 and 1975 in an attempt to increase search efforts.

Surveys were flown along the coast and offshore islands between Point Barrow and the Canadian border after freeze-up in falls 1965, 1967, 1971, 1973 and 1974. A major objective was to follow tracks of bears inland to denning sites. Other objectives were to determine relative densities of bears at different locations from tracks, and record ice conditions and relative abundance of ringed seals (*Phoca hispida*). Flying and observing at this time of year were hampered by short periods of daylight, stormy weather, light snow cover and newly frozen sea ice, much of which was too thin to land on. No dens were found in 56 hours of fall flying.

Spring surveys were conducted in late March and early April 1973, 1974 and 1975 when females with cubs were emerging from dens. Fish and Wildlife Service personnel of the Research Division and the Arctic National Wildlife Range participated all 3 years. Renewable Resources Consulting Services, Ltd, obtaining data for Canadian Arctic Gas Study, Ltd. and Alaska Gas Study Company, gathering information relative to a proposal for a natural gas pipeline from Prudhoe Bay to the Mackenzie Delta, also searched for dens in 1974 and 1975. Survey crews were based at Barrow, Oliktok, Deadhorse and Barter Island. Search areas were shorefast ice, offshore islands, the mainland beach and inland for approximately 40 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 tracks were not visible on a single pass with an aircraft. Also, wind could quickly cover tracks and den exits with drifting snow. Six overwintering maternity dens and two dens of undetermined type were discovered during 162 aerial survey hours in the spring.

Arctic National Wildlife Range personnel coordinated ground surveys made by two 2-man teams hired from the village of Kaktovik. They searched between the Hulahula and Katakturuk Rivers and the Jago and Kangakut Rivers in April 1975 and did not find any dens.

Polar bear marking and recapture studies based at Lisburne, Barrow and Barter Island provided incidental information on denning. Three maternal dens and 85 cub litters were recorded on drifting sea ice (Lentfer 1975).

FINDINGS AND DISCUSSION

Reproductive Biology

Breeding Season

Observations by pilot-guides and tagging crews indicated southward movements of mature male polar bears, presumably for breeding, in the area north of Point Barrow starting in late March. Observations are borne out by harvest figures showing the percentage of males harvested north of Barrow began increasing about the first of April (data contained in Alaska polar bear Federal Aid in Wildlife Restoration reports 1967-1973).

Field observations by tagging crews between 2 March and 13 May revealed the earliest pairing of a male with a female indicative of breeding activity on 21 March and the latest on 10 May. Seven occurrences of pairing were recorded the last week of March, 13 in April and one each on 5 May and 10 May. Copulation was never observed; one possible reason is that all observations were after bears had been disturbed by a helicopter. Similarly, the earliest and latest dates that turgid vulvas, indicative of estrus, were noted were 21 March and 10 May. It should be noted that field work was most intensive in late March and April and there was therefore more opportunity to make such observations during this period. Breeding probably continued after 10 May but indicators such as pairing and vulva turgidity were not observed.

In Spitsbergen, Lønø cited instances of breeding behavior by males but without copulation on 8, 10 and 26 March and observations of mating or attempted mating on 27 and 30 April, 7 May and 20 June.

Variability in weight of testes and presence of mature sperm in testes and epididymides also aid in delineating the breeding season. Erickson (1962) weighed testes from 69 Alaskan males killed between 13

February and 29 April. There were no definite trends of increasing or decreasing weight during this period, and he concluded that throughout this period some males are capable of breeding. Lønø (1970) examined testes from 88 mature Spitsbergen males, some of which were taken in most months of the year. Weights were lowest in October, November and December. Testes increased in weight from December to March and were at about the same high level in April as in March. There were no May specimens. Weights in June had started a decline which continued to the October-December low. There was much variation in weights in both Lønø's (1970) and Erickson's (1962) samples. Specimens from 43 polar bears including 3-year-olds, examined by Lentfer and Miller (1969) revealed sperm in testes and epididymides in February, March and April but not in August.

These observations indicate that pre-breeding physiological changes begin prior to March and that bears start coming together for breeding in March. The amount of pairing increases in April. The few observations in May and a lack of observations in June and July preclude conclusions from Alaska data about the latter portion of the breeding season. Lønø (1970), from histological examination of testes and ovaries from Spitsbergen bears, concluded that breeding continues through mid-July.

Minimum and Maximum Breeding Age

Minimum breeding age established for 23 tagged females averaged 5.8 years and ranged from 4.5 to 8.5 years (Table 1). A large portion of the population is probably sexually mature by 6.5 years.

Maximum breeding age is not as well defined as minimum breeding age because mark and recapture studies have not been conducted long enough to allow bears tagged as known-age cubs, yearlings and 2-year-olds to be recaptured as old animals. Also, fewer old animals remain in the population. One female estimated to be 21 and two estimated to be 18 years old from cementum layering were the oldest reproductively active females captured. The 21-year-old had prominent mammae and external genitalia when examined on 2 May. Both 18-year-olds had 5-month-old litters, and if they bred again could do so at age 20 after weaning 2-year-olds. Females at this age are probably approaching maximum breeding age. The oldest bear killed or immobilized for tagging off Alaska, from which a tooth was obtained for cementum examination, was estimated to be 25 years old.

Minimum and maximum ages at which males have breeding capability were 3 and 19 years, respectively, based on presence of mature sperm in testes and epididymides (Lentfer and Miller 1969). Presence of sperm, although indicating breeding capability, does not indicate that bears this young and this old are active breeders. An understanding of the significance of breeding by young and old animals requires study of social interactions and behavior.

Table 1. Minimum breeding age for 23 female Alaskan polar bears.

Age	3.5	4.5	5.5	6.5	7.5	8.5	9.5
No. first time breeders	0	6	7	8	1	1	0
Percent frequency	0	26	30	35	4	4	0
Average litter size	-	1.5	1.7	1.4	2	1	

Other workers have commented or presented data on minimum and maximum breeding ages of bears. Erickson and Somerville (1965) thought polar bears, like brown/grizzly bears (*Ursus arctos*), achieved sexual maturity when approximately 4 years old. Lønø (1970) stated that 3.5 years was the likely age of sexual maturity for female polar bears although some females do not mate until 4.5 years of age. Stirling et al. (1975), with a good data base from northwestern Canada, found a low conception rate for 3- and 4-year-old female polar bears, suggesting that sexual maturity for most females occurs at 5 years. Craighead et al. (1969) stated that female grizzly bears are not sexually mature until 4.5 years old. Hensel et al. (1969) said female brown bears become sexually mature at 3 to 6 years but usually at 4 years of age. Thus, sexual maturity for female polar bears is later than for female brown bears.

The maximum breeding age reported by Stirling et al. (1975) for female polar bears in northwestern Canada was 18 years. Craighead et al. (1976) reported a grizzly bear that gave birth when 22 years old and weaned young when 24 years old. They also noted that two females produced litters when 19 years old and stated that reproductive longevity approximates physical longevity.

Size and Survival of Litters

Numbers of young in litters at birth or while in maternity dens have not been obtained during Alaskan studies. Table 2 presents litter size data for family groups tagged in March, April and early May. Mean litter size of cubs, yearlings and 2-year-olds was 1.68, 1.66 and 1.51, respectively.

Reproductive Cycle and Rate

Seven females immobilized for tagging provided data on breeding cycles and reproductive rates (Table 3). Six provided data for one complete breeding cycle, i.e., the period from one conception to the next, and one provided data on two cycles. The total of eight cycles consisted of one 2-year cycle, five 3-year cycles and two 4-year cycles. Sequential events in a normal 3-year breeding cycle, using 1970 as the year of first breeding, would consist of breeding in the April to June period, giving birth in December 1970 or January 1971, separating from the young in April 1973 when they are about 28 months old and breeding again shortly thereafter. There is no evidence from Alaskan studies that young remain with the female for more than about 28 months, and it is assumed in a 4-year cycle that the female remains unbred for a year after separating from her young. Stirling et al. (1975), from studies in the Canadian section of the Beaufort Sea, cited two instances of 3-year-olds still with the female but stated that a 3-year breeding cycle is probably the most common. Lønø (1970) stated that in Spitsbergen separation of young from the female normally occurs at about 17 months, and a 2-year breeding cycle is the most common.

To derive a reproductive rate it is necessary to adjust length of average reproductive cycle to account for individual differences in the

Table 2. Litter sizes of polar bear young tagged in Alaska.

	No. of Litters With			Total	Total	Mean
	1 Young	2 Young	3 Young	Litters	Young	Size
Cub	7	15	0	22	37	1.68
Yearling	16	27	1	44	73	1.66
2-year-old	19	20	0	39	59	1.51

Table 3. Alaskan polar bear productivity data.

Bear No.	Age at 1st Conception	Age at 2nd and 3rd Conception	Pre-pregnancy Period in Yrs.	Reprod. Cycle in Yrs.
1061	4	7	0	3
125	6	9	2	3
1200	6	9	2	3
191	4	8, 11	0	4, 3
220	6	9	2	3
1312	5	9	1	4
1502	5	7	1	2
			8	25

number of years between average age of first pregnancy (4 years) and actual age of first pregnancy. For seven tagged females 4 or more years old at first pregnancy the cumulative pre-pregnancy period was 8 years (Table 3). The sum of reproductive cycles plus the sum of pre-pregnancy periods when divided by the number of cycles gives an average reproductive cycle of 4.13 years. The mean litter size (Table 2) divided by the average reproductive cycle (1.68/4.13) gives a reproductive rate of 0.407 young per year per female 4 years old and older.

It is important to note that these figures are based on a small sample and are preliminary and will be adjusted as more females are recaptured in future years. They do indicate a low reproductive potential, however. Assuming that females reproduce for 20 years, an average litter of 1.7 produced per average reproductive cycle of 4.13 years results in between 8 and 9 cubs produced by one female in a lifetime. Reproductive potential is lower than reported for grizzly bears in Yellowstone Park where an average litter size of 2.24 and an average reproductive cycle of 3.40 years gave an average reproductive rate of 0.658 (Craighead et al. 1976).

Denning

Denning Ecology

A general description of polar bear denning based mostly on Harington (1968), Lønø (1970), Uspenski and Chernyavski (1965), Uspenski and Kistchinski (1972) and Alaskan studies will first be presented. This will be followed by information more directly related to Alaska.

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. There are a few reports of single adults and females with yearlings or with 2-year-olds denning, with their dens varying from simple depressions serving as windbreaks during storms to permanent dens used for several months similar to those of parturient females. Denning for extended periods by polar bears other than parturient females has not been reported in Alaska, and observations and kill reports by Alaskan Eskimos indicate that all age classes of bears other than parturient females and cubs are outside of dens throughout the winter.

Another type of den is a temporary shelter formed in snow by females with cubs as they travel in the spring from maternity dens to sea ice and seal hunting leads.

In the Hudson and James Bay areas of Canada, polar bears construct earth dens in summer and fall (Kolenosky and Stanfield 1966, Doutt 1967, Jonkel et al. 1972). This area is unique for polar bears because ice is not present on Hudson Bay in the summer and bears must come ashore. They construct surface pits, shallow dens and deep burrows in the earth. Jonkel et al. (1972) stated that earth dens in the summer provide a cool substrate for resting and protection from sun, high ambient temperatures and insects. They may be used as a shelter from autumn storms and as maternity dens in winter merely because they exist.

Denning associated with parturition and cub production is the most significant from a population standpoint, and the discussion which follows will be limited mainly to maternity dens and temporary dens used by females and cubs after emerging from maternity dens.

Harington (1968) suggested that body condition may affect time of denning. Bears with a good fat layer may den earlier than animals without good fat reserves.

Harington (1968) described "core" areas where bears concentrate for denning. He attributed concentrations of bears in these areas to the general abundance of bears in adjacent areas and to ice movements which transport bears to these areas in the fall. There are several reports of bears being less abundant in denning areas in years when ice was late in forming or coming to the coast (Harington 1968, Kistchinski 1969, Lønø 1970).

Other factors necessary for continued successful denning in an area are topography, snowfall, wind patterns and low ambient temperatures, all of which provide for snow drifts that do not thaw during the denning period. Another requirement is the occurrence of seals nearby and ice conditions facilitating their capture during the periods immediately preceding denning and after dens are abandoned in spring.

In some areas bears den in snowdrifts remaining from the previous year and in other areas, including Alaska, most denning is in newly drifted snow. If the snow is deep enough a bear may tunnel into it and form a chamber within which it is completely enclosed. The entrance tunnel then drifts shut. In areas with relatively little snow in the fall, a bear may form a depression and then form a denning chamber as snow drifts over it.

Size and conformation of Alaskan dens (Fig. 1, Table 4) are similar to detailed descriptions provided by Uspenski and Chernyavski (1965), Harington (1968) and Uspenski and Kistchinski (1972). Dens range from single chambers with short exit tunnels to complex structures with several chambers and tunnels. Some dens have vents to the outside which a bear may block or enlarge for temperature regulation. Vents may also provide for exchange of gases. A heavy ice layer in the denning chamber of some dens indicates that temperatures sometimes rise above freezing. Possibly another chamber is dug when ice on the floor and ceiling decreases insulating value of snow and affects gas exchange through the snow. Tunnels show varying degrees of use. A portion of the original 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 formed in the spring. Exit tunnels may be long, possibly to conserve heat in the denning chamber. It appears that in some cases bears claw at the ceiling as snow drifts over them to maintain a fairly constant snow depth above the den. The snow from the ceiling falls to the floor so the height of the denning chamber remains about the same.

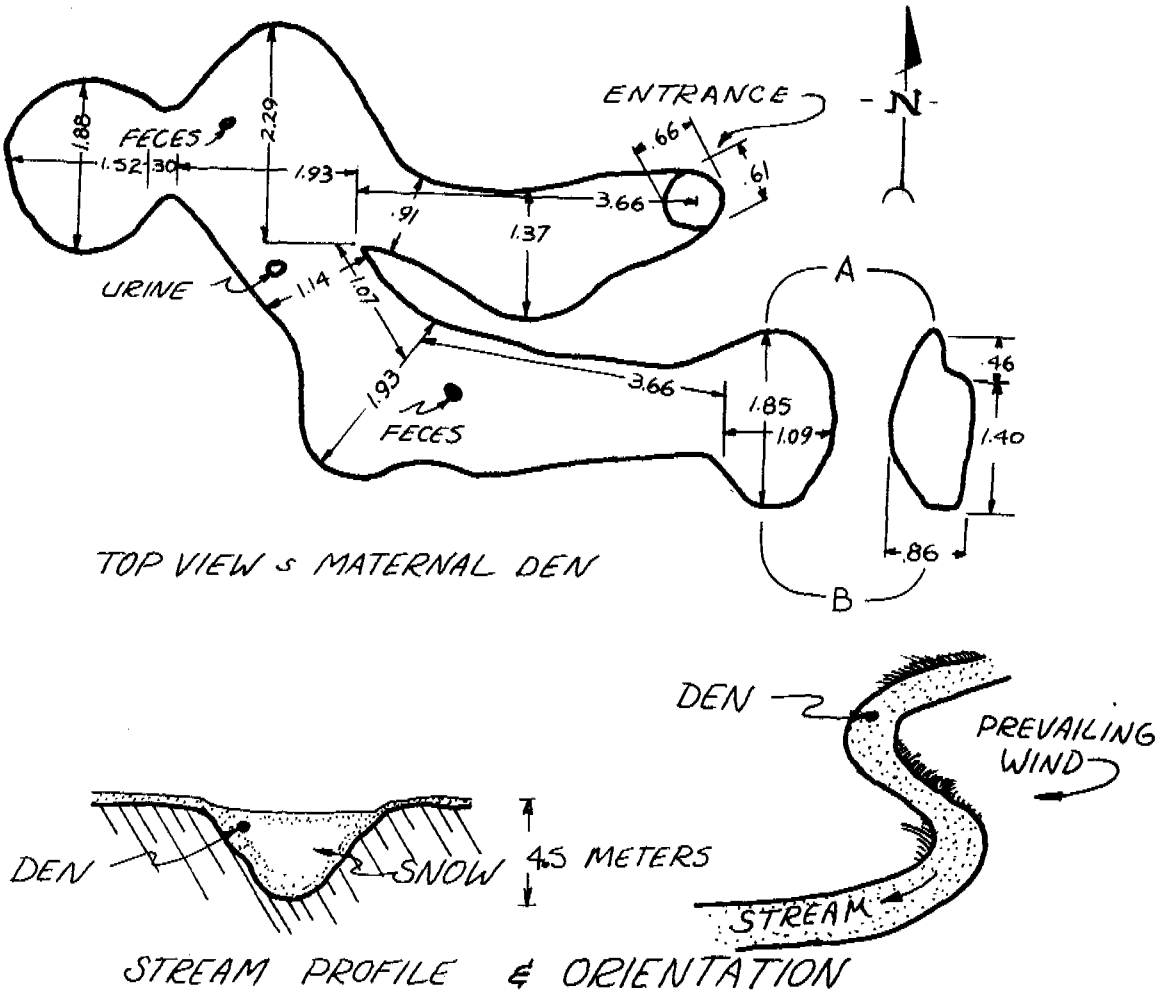

Fig. 1. Polar bear (female and two cubs) overwintering maternity den with two denning chambers, located 42 km south of Oliktok Point, 1973. Dimensions in meters.

Table 4. Measurements in centimeters of 11 Alaskan polar bear overwintering maternity dens.

	Minimum	Mean	Maximum
Entrance width	61	74	152
Entrance height	43	71	97
Tunnel length	91	282	549
Tunnel diameter	53	77	114
Chamber width	81	148	183
Chamber length	81	168	305
Chamber height	51	83	97

In March or April bears tunnel to the surface and come out of the den. They travel short distances from the den and return to it, probably to enable cubs to become acclimated to outside temperatures. Females may feed on vegetation at this time. One to 2 weeks after first emerging, bears leave the den permanently and travel toward sea ice and seal hunting areas. They may form temporary shelters in the snow at this time (Fig. 2).

Uspenski and Kistchinski (1972) reported that adult feces were not found in maternity dens or chambers and that cub feces were occasionally found. Harington (1968), from examination of eight dens, reported minute fragments of fecal material in two and relatively large amounts of excreta within 37 m of entrances of three. Larsen (pers. comm.) found fecal material covered by snow under the floor of dens. Possibly this is fairly common but not discovered by other investigators.

Other investigators have reported most dens on land fairly close to the coast. Of 113 dens recorded by Harington (1968) in Canada, 61 percent were within 8 km and 81 percent within 16 km of the coast; none was more than 48 km inland. Stirling et al. (1975) stated that most maternity denning in the western Canadian Arctic occurs along the coastal area of Banks Island and western Victoria Island. On Wrangel Island Uspenski and Chernyavski (1965) reported more than 50 percent of the dens within 8 km of the coast.

Dens may be quite concentrated in core areas. Uspenski and Kistchinski (1972) reported not less than 60 dens in 1968-69 in the Drem-Head Mountains, an area of 8 by 30 km on Wrangel Island. In one case six dens were within 300 m^2 and three of them within 135 and 200 cm of one another. Harington (1968) likewise reported areas where dens were concentrated in Canada.

Arctic Alaska has a relatively simple coastline without deep fjords, large offshore islands with varied relief, or hills and mountains adjacent to the coast, some or all of which are found in most other polar bear denning areas. As in other areas, bears in Alaska den along the coast and inland but they also den on fast ice and drifting ice (Table 5). Fast ice along some sections of the Alaska coast is quite broken and accumulates drifting snow in contrast to windswept, smooth fjords in some other sections of the Arctic.

Lentfer (1975) discussed denning on drifting sea ice. Alaskan polar bear researchers and hunting guides have seen females with cubs 3 to 4 months old and only recently out of the den, distributed fairly uniformly across drifting sea ice from the junction of shorefast and drifting ice to about 130 km offshore from Point Barrow. Cub sightings may be more frequent in the vicinity of Point Barrow because research activities and hunting have been more intensive there than elsewhere. The farthest that cubs have been reported offshore is 200 km. Because some cubs were so small, limited in mobility and separated from land by extensive broken ice and open water, it appeared they could not have

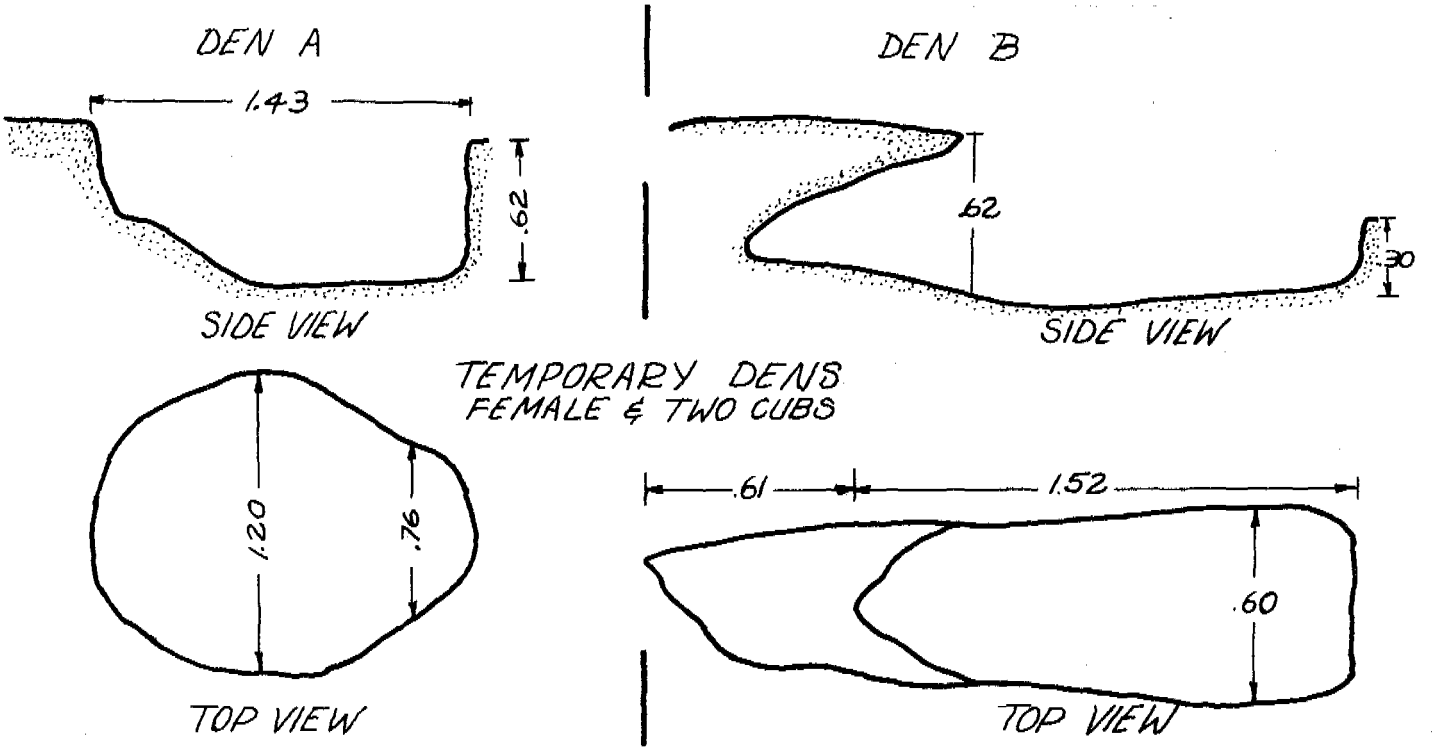

Fig. 2. Two temporary dens used by a female polar bear and two cubs while traveling from overwintering den on land to sea ice. Oliktok Point area, 1973. Dimensions in meters.

Table 5. Search effort, number, and distance* from Alaska coast of polar bear maternity dens and cub litters.

	Land	Offshore Island	Fast Ice	Drifting Ice
Pt. Hope-Lisburne area				
Search effort	Low	Low	Low	Moderate
No. dens	0	0	1	1
Distance from coast	-	-	1	90
No. cub litters	0	0	0	17
Distance from coast	-	-	-	230(25-415)
Barrow area				
Search effort	Moderate	Moderate	Moderate	High
No. dens	6	0	0	1
Distance from coast	10(0-26)	-	-	164
No. cub litters	0	0	3	54
Distance from coast	-	-	9(2-25)	77(6-205)
Oliktok area				
Search effort	High	High	High	Moderate
No. dens	4	1	6	1
Distance from coast	34(18-48)	2	7(0-19)	90
No. cub litters	0	0	5	9
Distance from coast	-	-	5(0-13)	74(19-150)
Barter Island area				
Search effort	High	High	High	Low
No. dens	5	1	5	0
Distance from coast	17(0-26)	5	11(2-30)	-
No. cub litters	0	0	1	3
Distance from coast	-	-	48	65(60-70)

* Distances are means and ranges in kilometers.

traveled from land and, therefore, must have been born on the ice. Locations on drifting ice at which three dens were documented were 90 km northwest of Cape Lisburne, 164 km north-northwest of Point Barrow and 140 km northwest of the Colville Delta. Dens were on heavy, multi-year ice adjacent to old pressure ridges. Ice movement makes it difficult to assess relative values of different areas of drifting ice for denning. A den 164 km north-northwest of Point Barrow sighted on 2 April 1974 was calculated to have drifted 650 km from a point just north of Barter Island where it was formed the preceding late October or November (calculations by Dr. Drew Rothrock, AIDJEX, Univ. of Washington). Ice drift in this region parallels the coast at a mean speed of 2-5 km per day until it separates from the coast as it passes Point Barrow.

All 11 inland dens included in Table 5 were along banks where snow had accumulated. Ten were on river banks and one on a lake bank. Similarly, the eight shoreline and island dens were in deep drifts along cutbanks. Fifteen dens on sea ice were along pressure ridges where snow had accumulated.

Polar bears west and north of Alaska form somewhat discrete subpopulations with only a limited amount of interchange (Manning 1971, Lentfer 1974, Wilson 1976). Discussion thus far has been mainly about the northern population. Wrangel Island and the Siberian coast may serve as a denning area for a portion of the western population. Ice drift patterns could tend to maintain the subpopulations but active movements by bears themselves to previously used denning and feeding areas could also aid in maintaining separate groups.

Management Considerations

Denning is especially critical in the life cycle of polar bears. Bears that den on shore and fast ice can be subjected to hunting and other human disturbance for a period of several months. Therefore, denning and related factors require special management consideration.

The native exemption to the Marine Mammals Protection Act of 1972 does not place any restrictions on the taking of female polar bears and their young by natives provided waste does not occur. Females accompanied by young and their young were protected even from subsistence hunters before the Marine Mammals Act. The State of Alaska has requested return of management. The proposed state program would completely protect females accompanied by young and their young and would also protect pregnant females coming ashore to den by a closed season from 1 June through 31 December.

Increasing human activity associated with oil and gas exploration and development could also affect denning. Human activity could cause females coming to shore to den in October and November to move back onto the drifting sea ice and den there. The drifting ice would provide a

less stable platform than land or shorefast ice and denning success might therefore be reduced. Human activity might also affect bears that had selected sites for denning. 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) 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 undoubtedly 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 disturbance for the normal denning period and for an additional several months after birth. It is possible that bears in the wild, when disturbed in the den, might neglect cubs or leave dens with cubs before they were developed enough to withstand the severe mid-winter environment. There is some evidence that this has happened. On 2 and 3 March 1974 a seismic crew observed a female with a new cub traveling northeast across Prudhoe Bay. The bears had left their den a month earlier than normal, possibly because of seismic or other human activity. The cub was extremely small, had difficulty in traveling and very possibly may not have survived. On the other hand, a den with two cubs was observed for several weeks on Niakok Island in Prudhoe Bay during winter 1973-74 by oil company personnel without the bears abandoning their den (C.R. Knowles pers. comm.). Belikov (1976) observed a den throughout the denning period from October to April at fairly close range without bears prematurely deserting the den.

Possible effects of disturbance to denning bears are more serious when one considers how much of the Alaskan coast could be affected by increasing development. The State of Alaska is considering oil and gas leasing on state lands between Naval Petroleum Reserve No. 4 (Pet 4) and the Arctic Wildlife Range, in addition to development already proceeding in Prudhoe Bay. The present federal selfsufficiency energy policy is causing accelerated exploration on Pet 4. A gas pipeline is proposed from Prudhoe Bay through the Arctic Wildlife Range. West of Pet 4 the Native Claims Settlement Act has classified much of the coastal area as a native deficiency withdrawl. Land so classified could come under native ownership with economic development a prime objective. The Beaufort Sea Outer Continental Shelf is of prime interest for oil and gas development. Thus, there is potential for development along the entire north Arctic coast and offshore from Point Hope to the Canadian Border.

There is a pressing need to classify areas which are especially important for denning and prevent or minimize disturbances in these areas. This is difficult because denning in Alaska is sparsely distributed over large areas rather than concentrated in core areas. Another difficulty in delineating critical denning areas is that efforts to locate dens have not been uniform in all areas. Effort has been concentrated from the Colville River to Canada where it appeared development would first occur. With these limitations in mind, two areas have been tentatively identified as important for denning. They extend from the Colville

Delta to the Canning River and from the Jago River to the Sadlerochit River (Fig. 3). It is not known if the significant number of cubs reported and tagged north of Barrow indicates an area of concentrated denning 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 and early April are probably born fairly close to where they are observed, but by late April cubs could have traveled considerable distances.

RECOMMENDATIONS

Marking and recapturing of polar bears in the Barrow area should be continued. Between 20 and 30 percent of the animals now being captured have been previously marked. This high rate of recapture is providing reproductive histories for a number of individual females and will give more precision to estimates of reproductive parameters.

The process of den site selection could be monitored by radio-tracking pregnant females. Likewise, activities after leaving winter dens could be monitored by radio-tracking. Tracking from a satellite has many advantages over tracking from an aircraft, and a satellite tracking program with emphasis on tracking pregnant females and females with cubs should be developed into a functioning program.

Effects of disturbance on individual bears, particularly denning females, should be quantified to the extent possible. This would require observing effects of disturbance, either artificial or actual, during the pre-denning, denning and post-denning periods. Techniques being developed in Canada to transmit physiological data from polar bears may have application here.

Specific areas important for denning should be delineated and protective measures proposed. This is especially important since there is potential for oil and gas development along most of Alaska's northern coast and on the Beaufort Sea Outer Continental Shelf. Delineation of denning areas would require extensive aerial and ground surveys. Protective measures could include the following:

1. Reduced activity along the coast during the late October-early November period when bears are coming ashore to den.

2. Nearshore seismic exploration using reduced charges from boats during summer rather than from fast ice during late winter.

3. "One time only" seismic exploration in coastal areas by treating seismic information from public lands as public property.

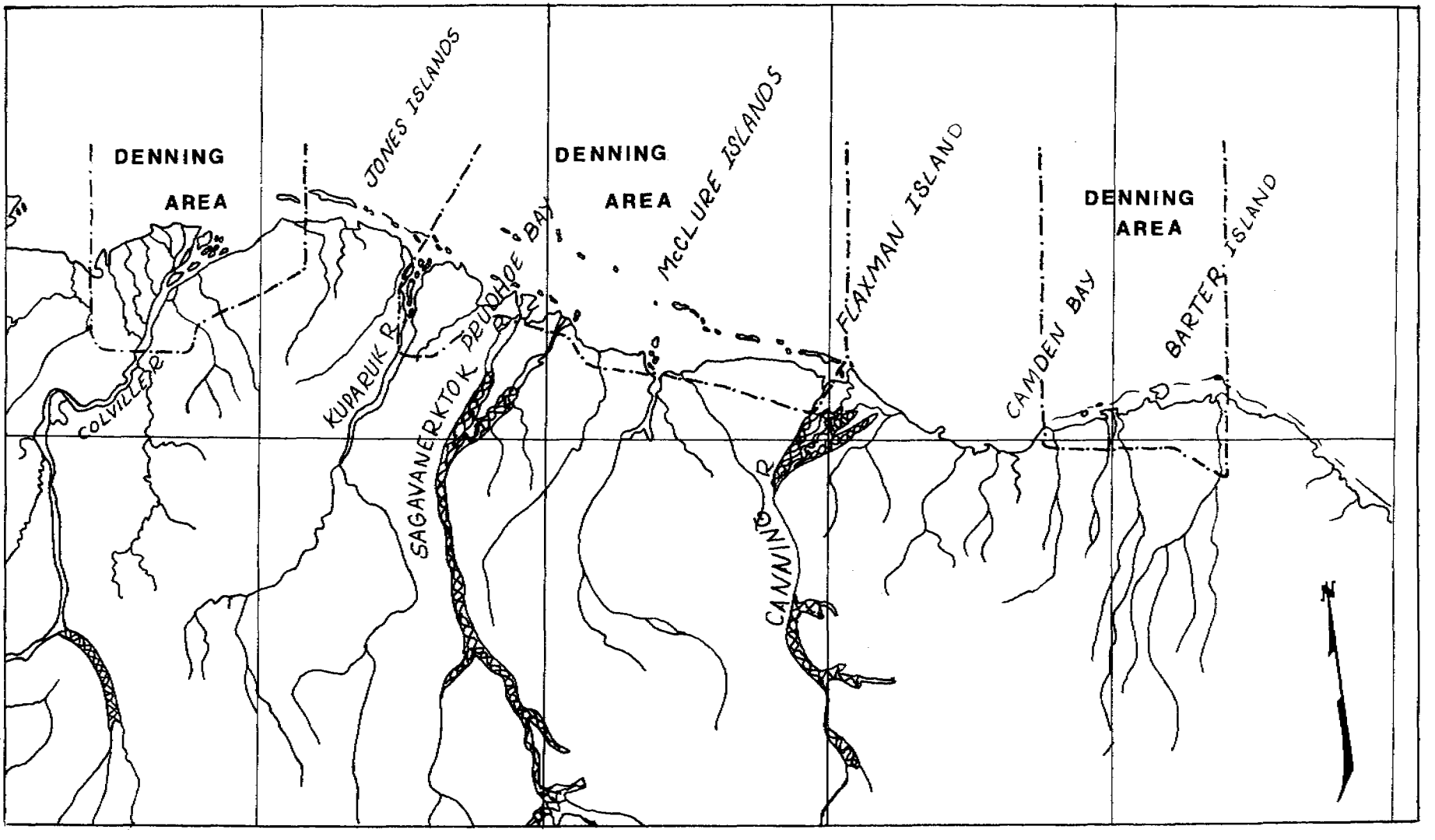

Fig. 3. Northeast Alaska polar bear denning areas.

4. Routing of pipelines and roads at right angles to rather than parallel and adjacent to the coast.

5. A development plan for northern Alaska agreed to by the various landowners and management agencies which would establish alternating zones of development and minimal disturbance along the north coast. Exploration and extraction could proceed in a development zone for a number of years until extraction was complete. Activity could then transfer to an undeveloped zone, and the zone where extraction had been completed would then become a zone of minimal disturbance.

6. Establishment of "no activity" zones around active polar bear dens. This must be in conjunction with other measures to assure that there are dens to protect.

Female reproductive tracts which have been preserved and stored should be examined and reported on.

A management program for polar bears which protects females with young and their young should be implemented.

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