

# DEN USE AND SOCIAL INTERACTIONS OF POLAR BEARS DURING SPRING IN A DENSE DENNING AREA ON HERALD ISLAND, RUSSIA

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**Abstract:** Estimates of the number of polar bear (*Ursus maritimus*) maternity dens and observations of social interactions were made over 40 days in a dense denning area on Herald Island, Russia, following female emergence from dens. Twenty-six dens were found throughout the accessible areas of the island (density = 6.2 dens/km<sup>2</sup>); 11 were concentrated in the Main Valley (12.1 dens/km<sup>2</sup>). Females emerged from dens from 17 March (the first observation day) until 31 March 1993. Sixteen females with cubs-of-the-year were observed for 156 hours. Mean litter size was 2.0. Females averaged 15.5 days (range = 8–27) in the denning area from emergence until leaving for the ice. Younger females spent less time outside their dens than older females. Number of dens used other than their own averaged 2.4 dens for all females. Younger females were not observed to use any den other than their own, whereas older females averaged 3.2 dens/female. Females spent considerable time grazing on grasses. Interactions between females defending and competing for dens resulted in spatial separation of family groups and limited access to resources. Presence of other females close to dens sometimes caused a female with cubs to abandon her den. Avoidance of older females by younger females may demonstrate hierarchy in dense denning areas. My observations support the importance of protecting Herald Island and the surrounding marine area as key polar bear breeding and foraging habitats.

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**Key words:** Herald island, maternity den, polar bear, social behavior, *Ursus maritimus*.

Throughout their breeding area, female polar bears (*Ursus maritimus*) give birth to their young on land in maternal dens made in the snow. Denning and parturition on sea ice has been confirmed only for some polar bears from the Beaufort Sea population (Amstrup 1986). The majority of pregnant females from the Chukchi–Alaskan population come to Wrangel and Herald islands, north of the Chukotka Peninsula, to hibernate. In addition to the continent, these islands are the only land available to polar bears in this area of the Arctic Ocean. Both Wrangel and Herald islands are known as areas with high densities of polar bear maternal dens (Belikov 1977, 1982). On Wrangel, however, den densities vary significantly over the island (Stishov 1991).

Pregnant females come to Wrangel Island beginning in late August and continue arriving until November. Usually by the end of October the snow cover is thick enough for most females to have settled in dens for hibernation. They give birth in December and January and remain in their dens until March–April, although a few females emerge from maternal dens at the end of February. Peak emergence is late March and early April. Where polar bear denning has been studied, females not forced to leave for the ice by disturbance will often stay within the denning area up to several weeks following emergence (Harrington 1968, Lønø 1970, Belikov and Kupriyanov 1977, Belikov 1982).

Polar bear denning biology has been studied throughout the Arctic (Belikov 1976, Lentfer and Hensel 1980,

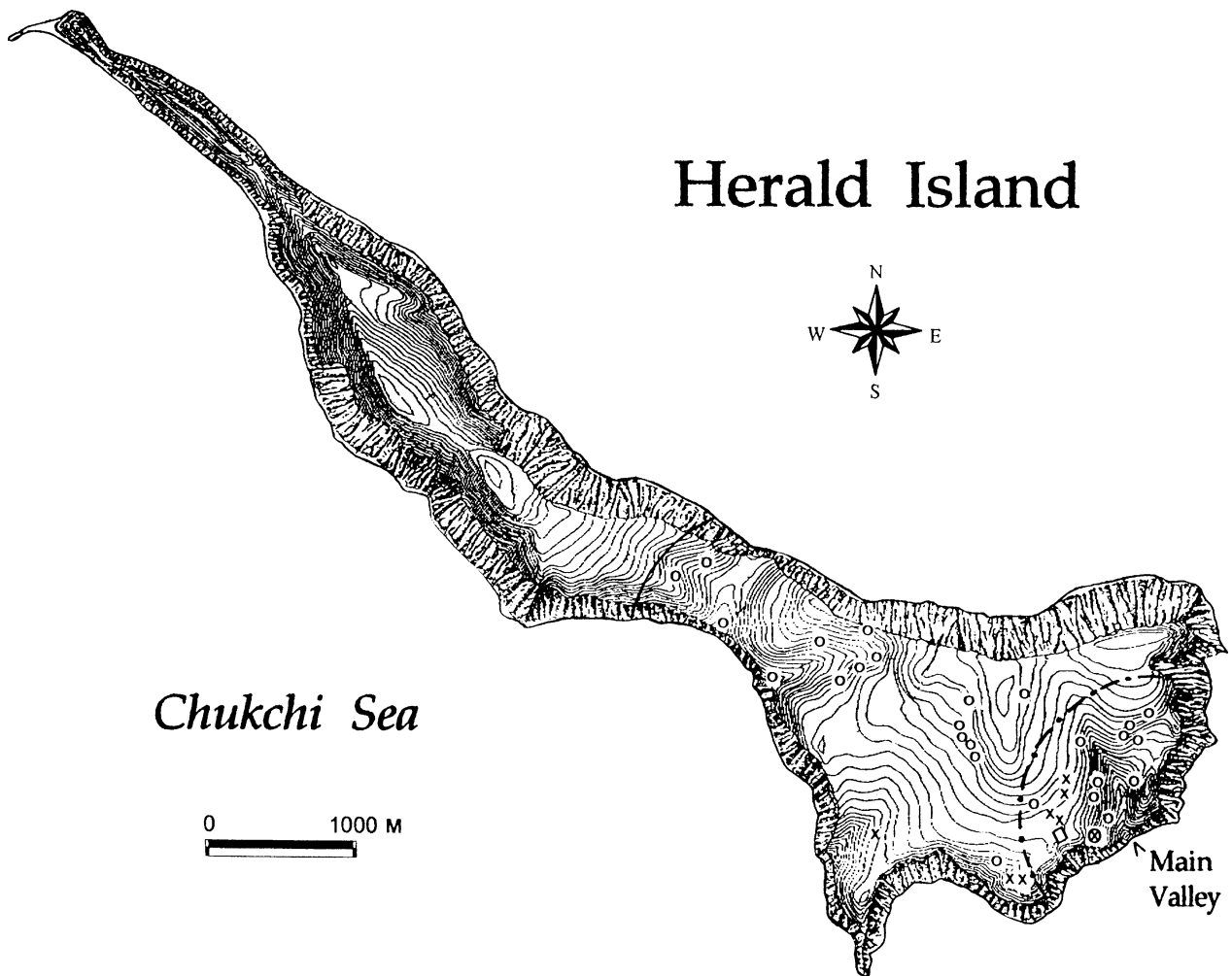
Belikov 1982, Amstrup 1986). However, data on the behavior of females with cubs during the spring are scarce. The only ethological observations of polar bears in a denning area were conducted on Kongsøya, Svalbard, by Hansson and Thomassen (1983). Very little is known about polar bear social interactions in denning areas with a high density of maternal dens. The objectives of this study were (1) to estimate the number and distribution of polar bear maternity dens and (2) to observe, record, and interpret polar bear activities with special attention to the social and territorial behavior of breeding females in a dense denning area on Herald Island.

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## STUDY AREA

Herald Island is situated in the Chukchi Sea 56 km northeast of Wrangel Island at 71°20'N, 175°45'W. The 8-km<sup>2</sup> island is a rocky ridge 9.5 km long and 0.1–2.1 km wide (Fig. 1). Its coast is formed by very steep to nearly vertical cliffs. Top slope inclinations range from 25° to 60°, alternating with numerous gently sloping terraces of

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**Fig 1.** Herald Island, Russia, 1993, showing Main Valley and locations of cabin (square), blinds (x), maternal dens (o), and main blind (circle with x). The solid line indicates the boundary of accessible area. The line with dashes and dots indicates the boundary of the observation area.

mostly southern, southeastern, and eastern exposures. Elevations of the upper slopes are 150–350 m. There are only 3 deep and narrow valleys in the wide southeastern part of the island, 2 open to the south and 1 to the east. These valleys provide the only corridor for polar bears between the terraces and the ice. The prevailing wind in autumn is northwest, and deep snow collects along all terraces and on valley slopes with the first snowfall. The valleys are well protected from the prevailing northern winds.

Suitable den sites are found all over the terraces and in snow along the cliff bases. Aerial den surveys on Herald Island conducted by the Wrangel Island Nature Reserve from 1985 to 1989 revealed from 19 to 37 dens for any single count (Stishov 1991). The actual number of ma-

ternity dens on Herald, however, may be significantly higher, as 100 dens were reported by Belikov (1982).

## METHODS

I observed polar bear activities on Herald Island from 17 March to 25 April 1993. Most observations of polar bear activities were made from 8 snow blinds; some observations were also made by an assistant, I. Menyushina, from near the cabin (Fig. 1). The main study method was direct visual observations combining focal animal (Altmann 1974) and active scanning (Ovsyanikov 1993) methods. Observations were made with 12 x 40 binoculars and with 30–60X telescopes. Polar bear behavior was recorded verbally in an opportunistic manner describ-

ing as many details as possible. I also used drawings and photographs to record spatial patterns and behavioral sequences during interactions. The usual observation distance was 70–1,000 m in the denning area and 200–5,000 m for bears on the ice.

In several cases ( $n = 11$ ) simultaneous observations (2 observers surveyed slopes simultaneously from different points) were necessary to record an entire sequence of bear activity. The majority of observations were concentrated in 1 large valley (Main Valley) on the southeastern part of the island and were made from the blind on the steep slope directly above the outfall of the valley (Fig. 1). This position provided a broad view of both Main Valley and the surrounding ice. In addition to observing from the blinds, I made 1 excursion to the northwestern end of the island and 6 trips to the southeastern part of the island west of the Main Valley.

Dens were located and monitored visually from the same distances and observation points from which bear activity was recorded. All dens found were marked on a 1:25,000 map of Herald Island. I examined dens and tracks for additional information. I examined dens closely only after the last female bear with cubs left for the ice. A total of 8 snow blinds were built around the cabin to provide a view of the surrounding area before bears emerged from maternal dens. All blinds were located <400 m from the cabin except 1 (Fig. 1). I avoided disturbing the bears by extremely careful behavior and by wearing only white camouflage clothing outside the cabin. I used no engines or other noise-producing mechanical items on the island during the observation period. I used helicopters twice—to get to the Island on 17 March, when only 1 den was opened in observation area, and to leave the island on 25 April, after the last female with cubs left for the ice.

Female bears were individually identified by their size, body constitution, thickness, fur color, dark spots on the fur (stains from blood, feces, urine, or dirt), and the number, size, color, and condition of accompanying cubs. To verify a bear's identification, the 2 observers determined the identity independently at least twice (up to 7 times for 1 female) for each of individually recognized females. Female age classes were determined by the animal's appearance (size, body constitution, foreleg hair length) as either young adult (class 1, probably <5–6 years) or middle age–old (class 2, >7 years). Females of smaller size, with lighter heads and shorter foreleg hair were assigned to class 1; large, tall females with massive heads and longer foreleg hair, to class 2.

Observations were carried out every day except during a 3-day blizzard with zero visibility. Snow storms and

limited visibility occurred on 15 of 37 days. Observations during snow storms were made as viewing conditions permitted. Observation time totalled 224 hours, with an average of 6 hours of observation/day. The maximum single-day observation was 10.5 hours.

## RESULTS

A total of 16 females with cubs were observed during the observation period. Mean litter size for the 16 females was 2.0 cubs; 3 litters consisted of 1 cub, 10 litters had 2 cubs, and three litters had 3 cubs. Nine of these females were residential with their maternity dens located in the Main Valley viewing area. Females whose maternity dens were outside this area are referred to as non-residential. Of the 7 non-residential females, 2 were seen only when they were leaving the island.

Six residential females and 2 non-residential females were identified individually and observed continuously when they were visible in the viewing area. The total time each residential female was seen was: F-P, 45 hours; F-SQ, 35 hours 50 minutes; F-WG, 13 hours; F-SF, 10 hours 15 minutes; F-NR, 14 hours; and F-YC, 4 hours 40 minutes. Total time for each non-residential female was F-MR, 13 hours and F-N, 16 hours. Other females were distinguished from identified bears by the absence of identifying features. When there was a probability that the same female was seen repeatedly, the observations were excluded from estimation of bear number and litter size. The total viewing time for all 16 females was 156 hours.

I also saw single pairs of courting polar bears on the ice on 4, 18, and 23 April for 5 hours 40 minutes, 40 minutes, and 1 hour 20 minutes, respectively. In addition, a courting pair was recorded from fresh tracks passing near the island on 14 April, which I followed for >3 km. The 3 observed pairs appeared to be different couples; however, I could not confirm this. A lone male was seen on the ice on 4, 14, 16, and 18 April for 15 minutes, 7 minutes, 1 hour 33 minutes, and 42 minutes, respectively. A lone male was observed at the cabin on 4 April for 10 minutes. A lone female was observed on 19, 20, and 21 April for 3 hours 50 minutes, 3 hours 45 minutes, and 15 minutes, respectively, and was judged to be the same individual based on her appearance. The first 2 times she was seen in the denning area and entered a den; the third time she was seen at the cabin. Females with cubs approached the cabin only a few times to distances of 50 m, 5 m, and <1 m.

## Den Density and Female Activity

I found a total of 26 maternity dens throughout the areas to which I had access (Fig. 1). Another 5 (not shown in Fig. 1) were seen in the snow at the base of cliffs, but I could not confirm their use as maternity dens and omitted them from den density estimates. Dens were classified as maternity by direct visual observations of female emergence and consequent use and by such identification features as den depth, distribution and character of snow at the entry, and tracks around the entry. A maternity den is always deep, has no excavated fresh snow at the entry, and always has a progressive accumulation of bear sign around the entry (footprints, claw scratches, urine spots, and feces). Temporal dens were also recorded within the observation area.

A total of 17 maternity dens were located <1.5 km from the cabin. Eleven were in the Main Valley, including 7 which were in sight from the main blind and were monitored daily. Another regularly monitored den was on a terrace in the Main Valley west of the cabin. Other dens were observed periodically or occasionally. The density of maternity dens within the accessible area (4.2 km<sup>2</sup>, Fig. 1.) was 6.2 dens/km<sup>2</sup>. In the permanent observation area, including the core portion of the Main Valley and adjacent area near the cabin terrace (0.8 km<sup>2</sup>, Fig. 1.), the den density was 12.1 dens/km<sup>2</sup>. The total density of polar bear dens over the island is unknown, because the snow banks at the base of the coastal cliffs were inaccessible.

On my first observation day, 17 March, I saw 1 female with cubs outside her den; 2 dens were found opened that day. Six of the 17 maternity dens were opened before 20 March; all other dens were opened on 20 March or later. The last den was opened on 31 March.

The length of a female's presence in the denning area from the time of first den emergence until leaving for the ice varied from 8 to 27 days; average duration was 15.5 days (SD = 6.3,  $n = 6$ ). The 2 youngest females (F-YC and F-SF) appeared nervous about the presence of other females near their dens. They were in the denning area for 8 and 14 days, respectively, but they were seen on the surface only 3 (F-YC) and 10 days (F-SF). F-YC was observed out of her den only twice during the 8 days following emergence (each time without cubs) until leaving for the ice with her cubs on her third appearance. During the 14 days (28 Mar–10 Apr) that F-SF spent in the area after emergence, she went far from the den only once. She was seen at the entrance to the den with cubs 5 times, but she never led her litter far away.

A third female identified as young (F-NR) spent 18 days in the denning area from the time she was first seen but was observed at the surface on only 3 days. The average

length of stay in the denning area for the 3 youngest females was 13.3 days (SD = 4.1), whereas the average number of days they appeared on the surface was 5.3 days (SD = 3.2). In contrast, 3 females that appeared older (F-P, F-SQ, and F-WG) remained within the denning area for 27, 17, and 9 days, respectively, for an average of 17.7 days (SD = 7.3). They were seen on the surface for 13 (F-P), 12 (F-SQ), and 7 (F-WG) days for an average of 10.7 days (SD = 2.6). Within the denning area, older females spent more time on the surface and entered dens only in bad weather.

Two non-resident females, F-MR and F-N, remained in the Main Valley for 4 and 12 days and were seen on the surface for 4 and 5 days, respectively. The last Main Valley resident female, F-NR, left on 16 April. The last non-resident female, F-N, left the Main Valley on 24 April. Outside of the Main Valley, the last female with cubs was seen on 18 April.

## Den Use, Competition, and Activity Outside the Den

Following den emergence, older females typically but temporarily used maternity dens other than their own. Female F-P, for example, used at least 3 different maternity dens after the original occupants left the area (Table 1). For the 6 residential and 2 non-residential females, the average number of maternity dens used after emergence was 2.4 dens/female. Younger females were not observed to use any maternity den other than their own. Older females' average number of maternity dens used, including their original maternity den, was 3.2 dens/female ( $n = 5$ ). The actual number of dens temporarily used after emergence may have been higher, as not all dens in the Main Valley could be seen from the main snow blind; also, some females moved to areas of the island that I did not monitor.

The number of different females that used the 8 dens I regularly observed averaged 2.25 females/den (range 1–5). The den used the most was occupied in turn by 4 females with cubs and 1 solitary female (Table 1). This den was used by its original occupant, F-SQ, an older female with 2 cubs, for 17 days (24 Mar through 9 Apr) following den emergence. When F-SQ left, the den was closed by snow. The next occupant was F-MR, an older, non-resident female with 3 cubs. She occupied the den from 14 to 15 April. On 15 April F-MR was supplanted by F-P, who entered the den when F-MR was out with her cubs. F-P occupied the den from 15 to 16 April. After F-P left the den, it was occupied by a solitary female on 18 April. The lone female spent several hours inside, then left. Finally, from 23 to 24 April, an older, non-

**Table 1. Maternal dens and litter size of females polar bears on Herald Island, Russia, Mar–Apr 1993.**

Female ID	Status <sup>a</sup>	Number of cubs	Original maternal den	Other dens used	Observation period after emergence	Total observation time (hr:min)	Number of days observed	Days stayed after emergence
F-P	R	1	D8	D2,D10,D14	21 Mar–16 Apr	45:00	13	27
F-9	R	2	D9	unknown	21 Mar–13 Apr	0:55	3	24
F-SQ	R	2	D10	D20	24 Mar–9 Apr	35:50	12	17
F-WG	R	2	D12	D1,D2	27 Mar–4 Apr	13:00	7	9
F-2	R	3	D2	unknown	28 Mar	0:45	1	unknown
F-SF	R	3	D14	none	28 Mar–10 Apr	10:15	10	14
F-3	N	2	D5	unknown	29 Mar	0:20	1	unknown
F-NR	R	2	D11	none	30 Mar–16 Apr	14:00	3	18
F-YC	R	2	D20	none	31 Mar–7 Apr	4:40	3	8
F-11	N	2	unknown	unknown	6 Apr	1:20	1	unknown
F-12	N	1	unknown	unknown	7 Apr	0:07	1	unknown
F-N	N	2	D6	D14,D10	13 Apr–24 Apr	16:00	5	>12
F-MR	N	3	unknown	D10,D14	13 Apr–16 Apr	13:00	4	unknown
F-15	N	2	D22	unknown	13 Apr	0:10	1	unknown
F-16	N	2	D21	unknown	18 Apr	0:15	1	unknown
F-17	N	1	unknown	unknown	27 Mar	0:10	1	unknown

<sup>a</sup> R = Main Valley resident; N = non-resident.

resident female with 2 cubs (F-N) occupied the den. At least 2 females from outside the Main Valley, F-MR and F-N, arrived in the Valley and remained for a few days on their way to the sea, using unoccupied dens of the Main Valley resident females.

Active den use duration—the time from emergence of the first den occupant until the last use by any female—for dens used by any female during the season is known for 8 dens and averaged 18.1 days (range = 9–32). Maternity dens used by only the original female were used less than dens used by different females (11.5 days, range = 9–14 vs. 20.3 days, range = 10–32, respectively).

All individually identified females were observed grazing on grasses. Female bears that spent appreciable time outside their dens ( $n = 5$ , or 62.5%) grazed every day they were observed. For example, female F-P was seen grazing each of the 11 days she was observed; another female, F-WG, was observed grazing during each of the 9 days she was seen. One day F-WG spent 95 minutes grazing and, following a half-hour break nursing her cubs, she spent >40 minutes grazing along the valley bottom. She was still grazing when she moved out of view. Cubs were also observed grazing. Both young residential females were observed grazing infrequently. F-SF grazed only once, on 3 April for 69 minutes; F-NR grazed only on 31 March and 4 April for 30 and 45 minutes, respectively.

During the time within the denning area spent outside of the den, all observed females (except the 2 young female bears which stayed near their dens) appeared to be

monitoring ice conditions. They approached the cliff edge, sniffed toward the sea, and reacted to sounds from the moving ice and winds from the sea by approaching the edge and surveying toward the sea.

### Intraspecific Interactions

From the beginning of mass den emergence by females (28 Mar), often more than 1 female (family group) was in sight. Up to 5 females were observed in the viewing area simultaneously for extended periods of time from 28 March until 16 April. Usually females maintained several dozen meters between each other. However, on a few occasions distances between interacting females were 10, 7, and <1 m. F-SQ and F-WG once nursed cubs simultaneously sitting 70 m apart and in plain sight of the other.

When in sight of each other, all females attentively watched each other. Younger females appeared more disturbed by other females than did older females. I observed 12 direct intraspecific interactions between females with cubs in the denning area. In 11 cases 1 female avoided the other; in 1 the avoidance was mutual. Asymmetrical avoidance, where 1 individual is aware of another's presence and retreats while the other remains ignorant, was typical for young females (F-SF—5 cases, F-YC—1 case, F-NR—2 cases, or 73% of all asymmetrical avoidances).

Two interactions involved females guarding or defending a den. On 3 April, F-SQ rushed back to her den from a day bed 150 m away and stood at the en-

trance upon seeing F-WG grazing slowly toward the den. Before F-WG started moving toward F-SQ's den, she grazed in view of F-SQ for about 15 minutes, with F-SQ appearing at ease. The distance between the 2 females then was greater than between either of them and the den. F-SQ appeared to become calm as it became obvious that F-WG was passing the den. On 15 April, female F-P with 1 cub occupied a den in use (although temporarily unoccupied) by a non-residential female (F-MR) with 3 cubs. When F-MR returned to the den during a strong wind she was threatened at the entrance by an open mouth display from F-P from inside the den. After short confrontation F-MR left the area.

Displacement from a day bed was observed on 16 April. F-P displaced F-NR from her overnight day bed by approaching her directly. F-NR arose and left her day bed urinating on the snow when F-P came within 40 m. F-P then occupied the abandoned day bed.

In 1 case, the departure of a young female bear (F-SF) with 3 cubs from her den may have resulted from repeated approaches by an older female, F-P. F-SF opened her den on 28 March. That same day F-P first appeared in the creek bottom beneath F-SF's den. F-P grazed in the valley near F-SF's den on subsequent days, weather permitting. Also, every day at least 2–4 females visited the Main Valley, walking and grazing in the creek bottom beneath F-SF's den. Every time another female bear was in sight, F-SF became alert or appeared wary, retreating to the den if she were out or watching the other females from the entrance and not allowing her cubs to come out.

On 30 March, F-P closely approached F-SF's den and made a day bed about 50 m from the entrance. F-SF reacted by hissing and alarm coughing and closed the entrance with her body. On 6 April, F-P approached F-SF's den even closer, making her day bed <40 m from the den; she then nursed her cub. This time F-SF watched F-P from the entrance. The next day F-SF called her cubs out to walk around the den entrance, but forced them back into the den just as F-P appeared in the valley walking along the creek bottom. On 8 April a severe snow storm began and continued until 11 April. On 10 April F-SF came out of her den and tried to lead her 3 cubs away. However, the cubs could hardly withstand the extremely strong wind, the female was nervous, and, after an 8-minute walk near the entrance, the family returned to the den. On 12 April as the snow storm died down, F-P appeared from F-SF's den. Apparently, F-SF had left her den and moved the cubs to another place during the blizzard and was not seen again.

Between den opening on 28 March and the last sighting on 10 April, F-SF appeared from her maternal den a total of 19 times. Nine times F-SF only looked from the entry and did not come out, 4 times she was out without cubs, but only once (of 4 times out) she went to the creek bottom to graze (during blizzard, without cubs, when no other females were near). I saw cubs looking out of the den 2 times; they were seen out on the surface only 5 times (31 Mar; 4, 7, 8, 10 Apr). These cubs were very small and had difficulty following their mother around the entry. On 8 April F-SF tried to lead cubs to the creek bottom, but when they remained at the entry the mother returned to the den. When the family was out at the entry, twice F-SF pulled the smallest cub by its skin as it could not follow her. These cubs were the smallest of all the litters. Cubs of this size could not climb ice blocks and swim across the leads while on the ice. The day after the family left, F-P appeared from F-SF's maternity den and came down to the outfall of the creek where she attentively watched the snow at the base of the cliff next to the outfall for 14 minutes. While watching the snow at the base, F-P several times looked toward F-SF's abandoned den. Previously, no female visiting the valley watched the snow at the base of the hollow, suggesting that F-SF might have moved her cubs there.

*Courtship.*—During the study period, I observed 3 pairs of polar bears engaged in courtship behavior pass near the island along the foot of the cliffs. Each couple was followed, but not chased, at a distance by a lone male polar bear. No competition between mature males was recorded during these observations. However, 1 paired male had a fresh, bloody wound on his neck. Courting couples did not remain for more than a few hours at 1 spot.

I observed 1 interaction on the ice between a female with cubs (F-WG) and a pair of courting and copulating bears. On 4 April at 0900 hours a pair of bears was seen courting beneath the cliffs and moving eastward then southeastward away from the island. At 1015 hours, F-WG passed along the creek bottom, leading her cubs toward the valley outfall. By 1100 hours the family was on the ice heading away from Herald Island eastward. At 1123 hours, F-WG encountered tracks left by the courting pair. She sniffed in the direction the tracks led, then hurriedly walked away in the opposite direction. At 1210 hours, however, she met the couple resting after copulation on the field of flat ice. The family approached the pair within 100 m, as the pair was behind blocks of ice. The male recognized the presence of other bears and rushed toward the intruders. Upon seeing the couple, female F-WG changed direction and ran at top speed to

escape, leading her cubs away. She quickly slowed her speed, however, so as not to leave the cubs behind. The male stopped his rush toward them after 70 m, intently sniffed the tracks of the family, growled toward them, then for approximately 3 minutes sniffed a piece of ice (possibly marked by urine and surrounded by many bear tracks) before turning back to his mate. His female watched the interaction from behind a small block of ice. F-WG continued southward, quickly walking away from the couple until she disappeared from the observer's view.

Single males near the island were observed mostly on the ice hunting ringed seals (*Phoca hispida*). Only 1 male was seen on the top of the island (he approached the cabin), and 2 times I found fresh tracks of an adult male visiting the Main Valley. No males approached a den. Perhaps males were attracted to the top by tracks and urine marks of females in estrous—a lone female was seen on the top of the island on 18–19 April. By following her tracks I found that she came from the ice. A urine mark looking like an estrous mark was found on a snow-covered rock on the terrace 400 m from the cabin. The mark was rather large, about 10 cm in diameter and of strong yellow-orange color, and had been left on the upper side of snow drifted around a stone about 0.7 m high. I could see it very well from a long distance (150–200 m). I have never observed a female bear with cubs in spring or a lone female in autumn urinating on any protruding object.

The first ringed seal was seen near Herald Island on 12 April. On 16 April as she first entered onto the ice, F-MR and her 3 cubs found a seal carcass that had been killed by another bear approximately 1 km from the cliffs. Earlier in the day a mature male was seen hunting in this area; he may have killed the seal. After she finished the remains, F-MR also exhibited hunting behavior by investigating leads and trying unsuccessfully to break through the ice. Simultaneously, an adult male was seen hunting seal about 300 m from the family.

## DISCUSSION AND CONCLUSIONS

The high density of polar bear maternity dens encountered on Herald Island is unique among other breeding areas of the species. The polar bear den density I report for Herald Island is a minimum estimate for this season. The density would be higher if I included dens along the foot of the cliffs. On Wrangel Island similarly high concentrations of polar bear maternal dens were found only in a few locations and only in certain years. Belikov (1977), for instance, reported that in the spring of 1972 he found 12 maternity dens in a strip of banked snow 2.5 km long on the Dream-Head Mountains. Six of these

dens were concentrated within a 400 m-long snow strip. Hansson and Thomassen (1983) reported 20 dens within 2 km<sup>2</sup> on Kongsøya, Svalbard, in 1979 in a rather small observation area surrounded by slopes unsuitable for dens. In 1978, however, there were only 5 dens in the same area. An average den density for Kongsøya for 4 years (1972, 1973, 1977, and 1980) was 0.4–0.9 dens/km<sup>2</sup> of suitable denning habitat (Hansson and Thomassen 1983). On Wrangel Island the average maternity den density recorded in the year with the highest number of denning females in the area of the highest den concentration (Dream-Head Mountain) was 0.5 dens/km<sup>2</sup> (Belikov 1977). An average den density on Wrangel Island for a number of years in the best denning habitats, Dream-Head and Warring, never exceeded 0.5 and 2.5 dens/km<sup>2</sup>, respectively (Unpubl. annual report, Letopis Prirodi, Wrangel Island Nature Reserve, Ushakovskoe, Russia, 1985–1992). However, Belikov (1982) reported an average density for all of Herald Island of 12.5 dens/km<sup>2</sup>.

Observed interactions between female bears guarding their dens against other females and competing for temporal use of dens in spring may indicate short-term territorial interactions. These interactions resulted in spatially separating family groups and, on some occasions, limiting access of one of the participants to resources (e.g., dens, grazing areas). Younger females avoiding older ones may also reduce locomotor activity for their cubs. Spatial separation of family groups and females' interest in one another's dens (which once even resulted in a confrontation at a den entrance) was observed on Kongsøya, Svalbard (Hansson and Thomassen 1983). However, the intensity of spatial conflicts observed on Kongsøya seemed lower than on Herald. On Wrangel Island spatial conflicts between females were not observed even in the dense denning habitats (Belikov and Kupriyanov 1977, unpubl. data).

Avoidance of older females by younger females may also indicate a hierarchy in dense denning areas because it reduced activities of certain females on the surface and reduced access to resources such as grazing areas and additional dens. Observations on Kongsøya, Svalbard (Hansson and Thomassen 1983), did not reveal any hierarchy among family groups of polar bears in denning areas in the spring. I suggest that female–female avoidance during post emergence and its influence on females' activity in denning areas may vary in different denning habitats and under different densities. A long stay in the denning area after den emergence may be important for preparing cubs for their move onto the ice. Earlier departure caused by disturbance may influence the survival of cubs forced to follow their mother to the ice while they

are still too young and too weak. My observations on Herald Island support previous studies that conclude that female bears are sensitive to disturbances during denning (Lønø 1970, Uspenski and Kistchinski 1972, Belikov 1976, Lentfer and Hensel 1980, Belikov 1982, Amstrup and DeMaster 1988).

Lactating females grazing on grasses were reported from Wrangel Island (Belikov et al. 1977) and Kongsøya, Svalbard (Hansson and Thomassen 1983). Belikov et al. (1977) showed a certain level of grass digestion by bears in an investigation of vegetative material in bear feces collected at den sites. The authors of both publications suggested, however, that grass may provide important minerals and vitamins rather than calories. Considerable time spent grazing by Herald Island females suggests that grass may have a caloric value for some bears. In any case, grazing may be important for lactating females; therefore, limiting a female's access to grazing grounds may unfavorably influence nutrition. More research is needed to clarify the effect of grasses in the polar bear diet.

My observations on Herald Island showed that female bears with young cubs avoided other bears. However, this seemed to be a normal precaution against threats. Taylor et al. (1985) suggested that mature male polar bear predation on cubs may influence cub survival. I did not observe any evidence of that. However, the presence of mature males around Herald Island may positively influence females with cubs because the females may scavenge on carcasses left by males. This could help support a family during the critical first weeks on the ice when hunting opportunities are limited.

Observed interaction between the courting pair and the female with cubs on the ice appeared to be a short-term territorial interaction (i.e., protection of a spatially distributed resource—a female in estrous) accompanied by threatening displays from the male and a rapid retreat by the family. The male, however, showed no intention to chase or to hunt the cubs.

These observations strengthen the importance of Herald Island and the surrounding marine area as essential key breeding and hunting habitats for the Chukchi-Alaskan polar bear population.

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