

Long-term changes in the movement and distribution of polar bears in the Southern Beaufort Sea

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Background

- Throughout their range, polar bears (*Ursus maritimus*) rely on the sea ice as habitat for hunting, mating, traveling, and in some cases, denning. In the Southern Beaufort Sea, polar bears retreat north to the multi-year pack ice when the ice over the continental shelf melts each summer (Stirling 2002).

- Recently, the distribution of sea ice in the Southern Beaufort Sea has changed dramatically, especially in summer. The three lowest minimum ice extents were September 2007, 2008, and 2009.

- The impact of these recent changes on polar bear movement is unknown. Amstrup et al. (2000) examined the movements and distribution of polar bears captured in the Beaufort Sea between 1985 and 1994. Since then, examinations of polar bear movement have been limited.

- A quantitative understanding of how polar bear behaviour is linked to sea ice is essential for developing models that predict population-level impacts of climate change. This study is an examination of recent polar bear movement data.

Objective

We aimed to test the hypothesis that recent declines in available sea ice have resulted in increased polar bear movement rate, distance traveled, and home range size as bears are forced to travel longer distances to reach the multi-year pack ice that serves as their summer refuge.

Study Area

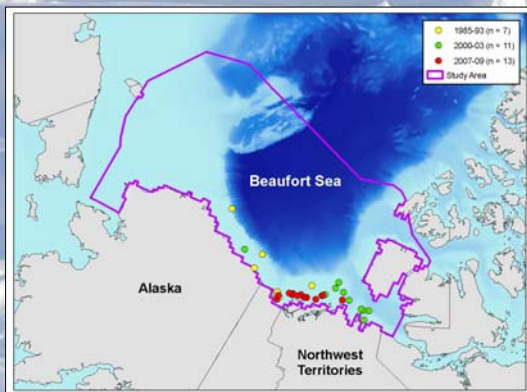


Figure 1. Locations of collars deployed on adult female polar bears (> 4 years) during 3 periods. Bears were located on the sea ice and immobilized via remote drug delivery from a helicopter during early spring (April-May) or fall (Oct-Nov). The "Study Area" polygon is the MCP around all observed polar bear locations and was used to examine trends in sea ice conditions (Fig. 2).

Acknowledgements

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Data Collection



- Polar bear locations were determined from Doppler-shift collars deployed during 1985-2003 (see Amstrup et al. 2000 for details) and satellite-linked global positioning system (GPS) collars deployed during 2007-09.

- To compare movements across all periods, GPS locations were sampled at 6.3 day intervals.

Changes in Sea Ice Concentration

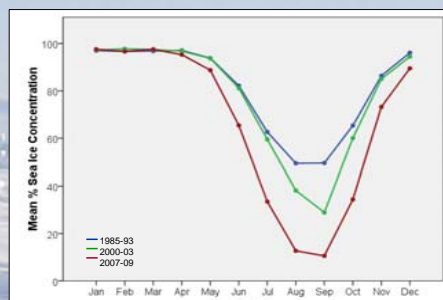
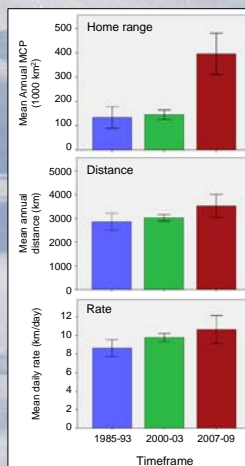


Figure 2. Monthly mean sea ice concentration in the area occupied by all collared bears across 3 timeframes. Concentration values for 25 x 25 km grid cells were obtained from the National Snow and Ice Data Centre (Boulder, CO; Cavalieri et al. 2009, Meier et al. 2009).

Annual Movements



- Annual home range size changed significantly over time ($P = 0.007$), increasing from 133,769 km² in 1985-93 to 395,500 km² in 2007-09.

- Annual movement rate ($P = 0.56$) and distance traveled ($P = 0.45$) did not vary over time.

Figure 3. Annual movement patterns (± 1 SEM) of adult female polar bears in 1985-93 ($n = 9$), 2000-03 ($n = 21$), and 2007-09 ($n = 7$). For movement analyses, we used linear mixed models to control for bear ID and tested for effects of Month, Year, and Reproductive status (solitary vs. with cubs) on polar bear movements.

Monthly Movements

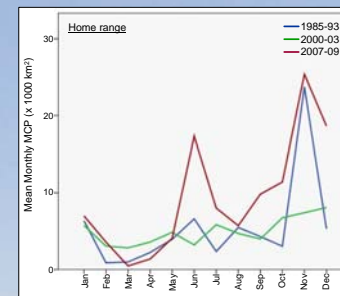


Figure 4. Monthly home range size of adult female polar bears in 1985-93 ($n = 68$), 2000-03 ($n = 195$), and 2007-09 ($n = 106$). Trends in movement rate, area, and distance were all similar.

- Area occupied, distance traveled, and mean movement rate all varied across months ($P < 0.001$) and between the 3 periods ($P < 0.010$).

- In recent years, movements peaked in the fall (Oct-Dec) and early summer (June).

- Across all timeframes, movements were lowest in late winter (Feb-Apr).

- Reproductive status had no effect on any monthly or annual movement characteristics.

- In 2000-03 and 2007-09, bears moved north in July and south in October. Bears generally moved west in the fall and returned east in the late winter and early spring (Fig. 5).

- In recent years, some bears have moved as far west as Wrangel Island and into the Bering Strait before returning to the Canadian coast.

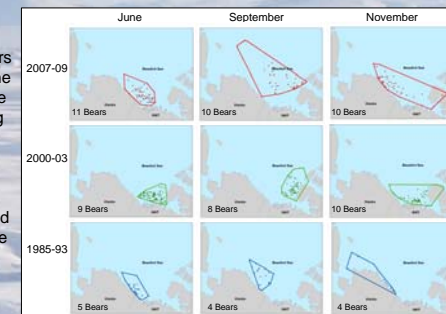


Figure 5. Distribution (minimum convex polygon) of all collared bears in June, September and November. Analyses of net monthly movements of individuals showed significant directional tendencies (Rayleigh's Z test, $P < 0.05$) during 2000-03 and 2007-09. In 1985-93, statistical analyses were limited by low sample sizes.

Conclusions

- Annual home ranges of Southern Beaufort Sea polar bears increased 196% over the period of study. This shift in space use is likely related to changes in available sea ice habitat and potentially linked to changes in prey distribution.

- An increase in spring and summer movements is correlated with a trend toward earlier sea ice breakup. All movement characteristics are consistent with bears having to move further offshore to reach the summer pack ice.

- Polar bears are limited in their ability to increase rates and distance of travel, but our data suggest they are now spreading their movements over a greater area. This change in space use could have profound impacts on energy budgets and the intra- and inter-specific interactions of polar bears in the Beaufort Sea.

Literature Cited

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