Title: Polar bear dens on the Seal and Caribou Rivers, Manitoba

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Abstract

During aerial surveys we opportunistically located clusters of polar bear (*Ursus maritimus* Phipps, 1774) earth dens on and near the Seal and Caribou Rivers in Northern Manitoba in 2011, 2022, and 2023. Polar bear denning has not been documented in the published literature there before, but there is local knowledge of denning in this area. These dens are of two different types (shallow dens and pits), with similar characteristics to those in the Western Hudson Bay polar bear subpopulation's main denning area, 120 km farther south. It is not possible to determine whether these findings represent a northward extension of denning by this subpopulation but changes in den distribution, particularly in such previously-overlooked areas, need to be monitored and understood to effectively conserve polar bears in a warming climate.

Keywords

Caribou River, den, Hudson Bay, Manitoba, polar bear, Seal River, *Ursus maritimus*

Plain Language Summary

We found polar bear dens on and near the Seal and Caribou Rivers, in a part of Northern Manitoba where they have not been documented before; but they were known by local people. These earth dens are of two different types (shallow dens and pits) and the dens were similar to those in the known denning area over 120km farther south. We can't tell whether these dens were used for raising cubs or just conserving energy while on shore during summer. Understanding if and how polar bears are changing where they den will be important for conserving polar bears as the Arctic climate warms.

Introduction

Polar bears (*Ursus maritimus* Phipps) are unique among ursids because only parturient female bears spend prolonged winter periods in dens. Where polar bears seasonally lose access to sea ice, pregnant females excavate maternity dens on shore (Stirling et al. 1977). The west coast of Hudson Bay, and formerly the Quebec coast, are the only places where polar bears are known to construct earth dens (Jonkel et al. 1972, Stirling et al. 1977, Florko et al. 2020). Throughout the rest of their pan-Arctic range they dig dens primarily in snowdrifts (Harington 1968, Belikov 1980, Durner et al. 2003, Aars 2013). In the Hudson Bay Lowlands these earth dens are dug exclusively in peat underlain by continuous permafrost, typically on riverbanks or thermokarst lakeshores (Clark et al. 1997), though dens in sand ridges have been documented farther south in Hudson and James Bays where permafrost is discontinuous or even absent (Doutt 1967, Jonkel et al. 1972, Obbard & Walton 2004). Tree cover is common at these sites and their roots are thought to provide stability to den ceilings (Scott and Stirling 2002). At some point during winter, female bears in northern Manitoba apparently dig a snow den adjacent to their earth den and use that for parturition and subsequent development of neonates for the remainder of the winter (Ramsay & Stirling 1990); however, the relationship between earth dens and snow dens is not fully understood. Moreover multiple types of earth dens have been described: pits used for temporary resting, deep maternity dens, and shallow dens whose function is unclear but may include both summer thermoregulation and maternity denning under associated snowdrifts (Jonkel et al. 1972, Clark et al. 1997).

Most polar bears in the Western Hudson Bay subpopulation excavate maternity dens in a known concentrated denning area in Wapusk National Park and the adjoining Churchill Wildlife Management Area (Ramsay & Stirling 1990, Clark et al, 1997, Lunn et al. 2004, Richardson et al. 2007), which appears to have been used for centuries (Scott and Stirling 2002). Here, we describe the locations and characteristics of polar bear earth dens located on two river systems in northern Manitoba, in a part of the province where polar bear denning has not been previously documented in published literature (Florko et al. 2020).

Methods

The 2022 and 2023 den surveys were carried out under the authority of a University of Saskatchewan animal care committee exemption #009Exempt2022Clark (27 April, 2022), Manitoba Wildlife Scientific Permits #WB25958 and #WB26451, and Manitoba Park Permit #PP-CAR-23-001.

Polar bear dens were located opportunistically during an aerial survey for grizzly bear (*Ursus arctos* L.) dens in late June 2022 and 2023. We distinguished polar bear dens from suspected grizzly bear dens (which were few, and as yet unconfirmed) by substrate: polar bears uniformly den in peat in this region (Clark et al. 1997) whereas grizzlies in similar habitats strongly select drier and well-drained substrates (McLoughlin et al. 2002, Smereka et al. 2017). Dens were spotted from a Bell 206B helicopter with two to three observers aboard, flying approximately 500m above sea level along rivers with exposed alluvial deposits and eskers (hypothesized grizzly denning habitat, Smereka et al. 2017). Over rivers, observers scanned the banks for holes

approximately one meter in diameter and diggings of any size that might constitute den sites: all of which are typically visible from a helicopter in this landscape (Clark et al. 1997). Observed dens were visually checked for occupancy from the air and ground, then dimensions were measured and classified following the typology of Clark et al. (1997). Den and pit depth was measured perpendicular to the slope the excavations were on, and width was measured parallel to the slope. A cluster of approximately 20 dens and several pits was also observed during the 2011 Western Hudson Bay polar bear aerial survey; a systematic survey that sampled the subpopulation's full summer range (Stapleton et al. 2014). Those dens were not individually measured or characterized, but we report them here because of their consistency with our more recent observations (Figure 1). Summary statistics were calculated in Microsoft Excel (Mac).

Results

In 2022 and 2023 we observed 14 apparent polar bear dens, all on islands within the rivers, and with steep peat banks (Figure 1). Based on their dimensions and characteristics, six of these were defined as pits (Figure 2), and eight were defined as shallow dens (Figure 3). Ages appeared to vary but two shallow dens had likely been used the previous autumn and/or winter: one on the Seal River had claw marks visible on the permafrost of the back den wall which would have melted out over summer (Figure 3), and another contained a quantity of polar bear hair on the floor. These dens were all dug into peat substrate within a lichen-dominated plant community and intermittent tree cover (*Picea glauca*), similar to den sites described by Clark et al. (1997). Dimensions of three pits and eight shallow dens measured are summarized in Table 1. The average aspect of pits and dens, calculated together was 331 degrees (northwest) with an r

(measure of concentration) of 0.409 (Rayleigh's Z-test, $Z=65.86$, $df=11$, $p<0.001$). The dens observed in 2011 were oriented mainly east and southeast.

Discussion

Here we describe polar bear earth dens in an area where they had not yet been documented within the Western Hudson Bay subpopulation's range. Since locating this species' dens was not the primary object of either survey, more polar bear dens may well be present along the Seal and Caribou rivers where suitable peat substrate exists. While our sample of dens is likely biased towards those most visible from the air, we did circle most islands during our 2022 and 2023 surveys and did note any additional dens in the vicinity of ones we landed at. The dens we observed were highly clustered: such aggregation is not atypical (Clark et al. 1997), nor unexpected since peat is uncommon along the portions of either river that we surveyed (Dredge & Nixon 1992).

The site characteristics of these dens were largely consistent with those described in the Wapusk/CWMA (Jonkel et al. 1972, Clark et al. 1997, Scott and Stirling 2002, Richardson et al. 2007). Similarly, the dimensions of the dens we examined are within the range of measurements for shallow dens (Clark et al. 1997). Pit dimensions we measured varied but were similar to previous measurements, and this range is likely due to agglomeration through repeated digging and apparent re-use (Clark et al. 1997). Notably, all pits were on a north-facing point of land; as were inland pits measured previously (Clark et al. 1997, Clark et al. unpublished field notes). Polar bears consistently select such features since they're likely to be exposed to cooling north

92 winds during the onshore season (Clark and Stirling 1998). Although aspects of the pits we
93 measured were uniformly northwest the shallow dens varied; oriented both northwest and
94 southeast. Our sample size was small but Clark et al. (1997) also observed high variation in den
95 orientation. A northwesterly aspect may not be ideal for snowdrift formation in this area – a
96 characteristic important for over-winter maternity denning (Liston et al. 2016) – but dens facing
97 southeast would be. Overall these attributes suggest that some of these particular dens may have
98 been temporary dens used for thermoregulating in summer but others could have been maternity
99 dens. Confirmation of either such use would be important, and would likely yield deeper insight
100 into how den sites are chosen where the preferred substrate is limited. Such awareness could
101 inform polar bear denning area protection efforts as continuous permafrost melts and denning
102 habitat for this subpopulation becomes scarcer (Richardson et al. 2007).
103
104 Polar bear dens have not previously been documented on these rivers, or indeed even from this
105 area of Manitoba in the published literature (Florko et al. 2020). However they were apparently
106 well known to local residents who travel that direction from Churchill and were unsurprised at
107 our findings, describing seeing tracks of family groups on the adjacent coast in spring as they
108 return to the sea ice (D. Clark, unpublished field notes). Notably, those observations specifically
109 indicate maternity denning. Traditional and local knowledge is a demonstrably effective way to
110 locate and document polar bear den locations, status, and phenology (Voorhees et al. 2014,
111 Kochnev 2018, LaForest et al. 2018) so we have no reason to doubt the accuracy of those
112 observations. Indeed, before our 2023 surveys, one local guide told us about seeing dens on the
113 Caribou River from the air, precisely where we subsequently found them.
114

Although these dens are approximately 120 km north of the nearest edge of the main known denning area, it is not possible to conclude from our data whether or not they represent a northward extension of polar bear denning activity in northern Manitoba or simply indicate a lack of systematic observations there. Several of these dens and pits appeared years-old, exhibiting the collapse and revegetation typical of long-established dens (Scott and Stirling 2002), but precisely how old they are would help determine whether these dens represent a recent shift in denning activity or not. The geographic distribution of polar bear dens is known to change within observable timeframes: shifting between sea ice and land (Stirling and Andriashek 1992, Fischbach et al. 2007, Olson et al. 2017), among terrestrial regions due to changing sea ice and snow conditions (Derocher et al. 2011, Merkel and Aars 2022, Patil et al. 2022), or in altitude (Escajeda et al. 2018). Ramsay & Andriashek (1990) found some evidence for a northward shift of active dens within the CWMA (including what's now Wapusk National Park) between the 1970s and 1980s but this phenomenon has not been investigated since. Jonkel et al. (1972) observed evidence of denning activity outside what is contemporarily considered the main denning area though, and different studies have even found markedly different den structures and substrates in different portions of the Hudson and James Bay coast (Doutt 1967, Kolenosky and Prevett 1983). Since polar bear den site selection is evidently a dynamic behaviour, our observations point out the importance of not treating denning areas simply as fixed, bounded entities. Even these denning sites may not be stable over the long-term as the regional climate warms. On two of islands where we observed dens the peat had apparently been drying out (Figure 4). Peat desiccation in the Hudson Bay Lowlands has been shown to result from decreased snow cover (Bouchard et al. 2013) and such a process could result in permafrost melt, erosion, and ultimately loss of denning sites (Richardson et al. 2007).

These observations are significant because there is sustained concern about declining reproductive output in Western Hudson Bay polar bears (Lunn et al. 2016, Atkinson et al. 2022) and earth dens are considered critical for reproduction in that subpopulation (Clark et al. 1997). Consequently, any potential change in den distribution within its range needs to be monitored and the causes of such change more thoroughly understood (Yee et al. 2017). Although local knowledge indicates at least some maternity denning on the Seal and Caribou Rivers, the extent of that needs to be more precisely determined. Fuller understanding of polar bear denning in northern Manitoba will be important since ecotourism is expanding in the region, and protecting denning habitat will require sustained attention in the planning and management of such activities. Similarly, the Seal River Watershed is proposed as the site of a new Indigenous Protected Area (Puzyreva et al. 2022), and since three of the pits and five of the shallow dens we found are within that watershed, these findings demonstrate that initiative's significant conservation value. We recommend that future monitoring and investigation of polar bear denning in Western Hudson Bay (and other regions where polar bears den on shore) pay greater attention to variability in spatial distribution, especially in the context of habitat conservation in a warming climate.

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Competing Interests Statement

The authors declare no competing interests.

Author Contribution Statement

DC: lead in funding acquisition, conceptualization, methodology, 2022 & 2023 implementation, writing-original draft, project administration
JK: supporting in 2023 implementation, writing- review & editing
CCM: supporting in 2022 implementation, writing- review & editing
SA: lead in 2011 implementation, methodology, project administration; supporting in writing-review & editing

Community Involvement Statement

There is no community body to oversee research in Churchill, MB but individual community members from different cultural backgrounds, and having significant on-the-land experience, were invited by the First Author (who began working in Churchill in 1992 and lived there from 1997-2000) to participate in den surveys in 2022 and 2023. Polar bear den locations and attribute data from 2022 and 2023 were shared with the Seal River Watershed Alliance, an Indigenous Protected Area establishment initiative. Preliminary findings have been communicated back through public presentations in Churchill, on June 24, 2022, and April 03, 2024, as well as in a workshop at the Churchill Northern Studies Centre on March 27, 2024.

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Data Availability Statement

Data from 2022 and 2023 den surveys are being archived on the Polar Data Catalogue (polardata.ca, DOI pending). Precise den location data will not be made available to ensure the protection of den sites.

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Tables & Figures

Table 1. Average dimensions (cm) of measured pits (n=3) and shallow dens (n=8), with standard deviations in parentheses

Figure 1. Locations of polar bear shallow dens and pits in northern Manitoba north of the main denning area, observed in 2011, 2022, and 2023 (main map: azimuth equidistant projection, inset map: WGS_1984_EPSG_Canada_Polar_Stereographic). Size of circles is proportional to the number of dens at specific locations.

Figure 2. Polar bear resting pits, approximately 1.3m across, along the Seal River, 2022

Figure 3. A polar bear's shallow den on the Seal River, June 2022, with an entrance 97cm across, and claw marks still visible in the permafrost on the back wall of the den

Figure 4. Polar bear dens on an island on the Caribou River, 2023. Dens are visible on the near shore, towards the right-hand end of the island.

316 Table 1. Average dimensions (cm) of measured pits (n=3) and shallow dens (n=8), with standard
317 deviations in parentheses
318

Den type	Chamber depth	Chamber width	Chamber height
Pits	162 (118)	136 (44)	n/a
Shallow dens	166 (80)	121 (45)	72 (14)

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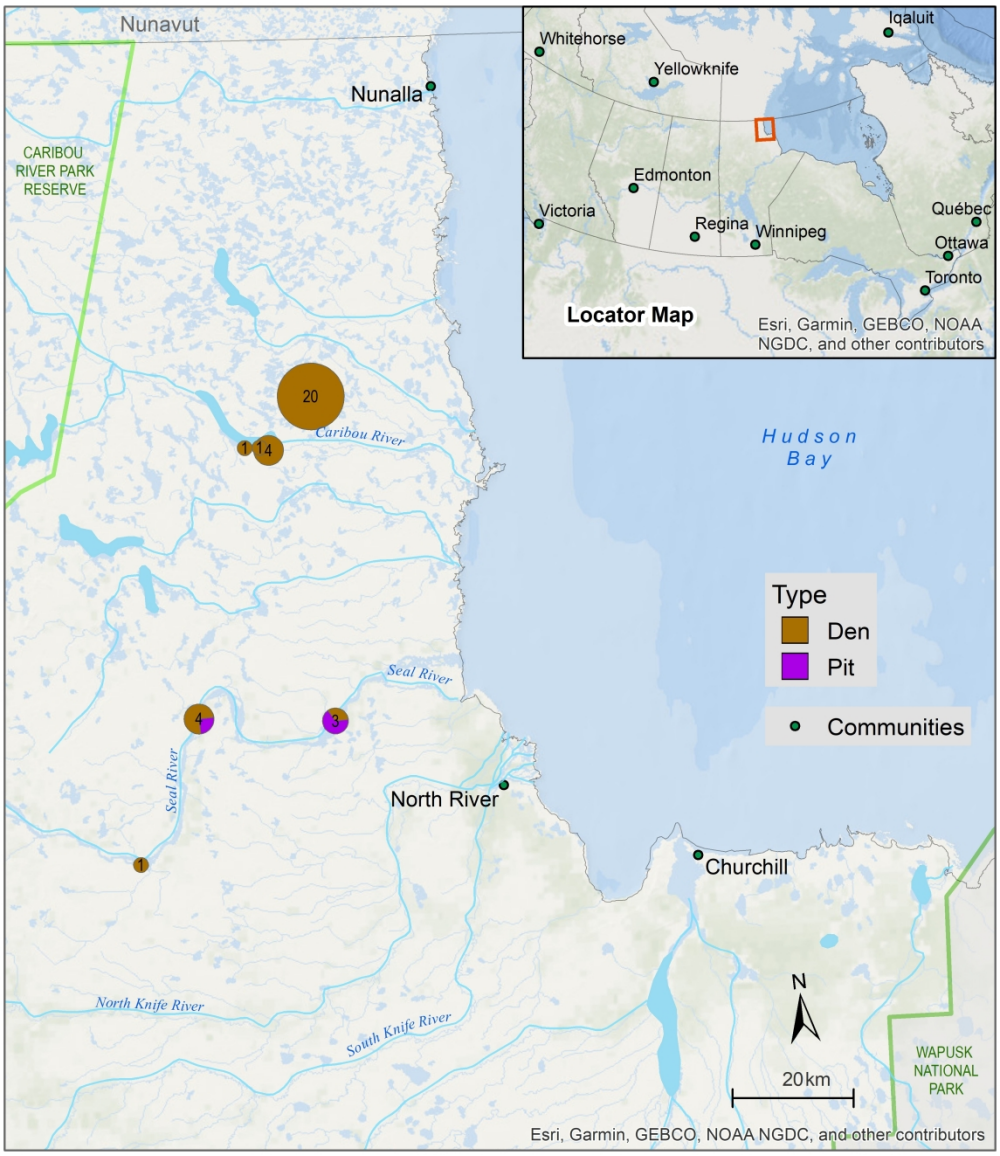

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165x190mm (600 x 600 DPI)

Figure 2. Polar bear resting pits, approximately 1.3m across, along the Seal River, 2022

1981x1320mm (72 x 72 DPI)

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